



Division 27 - COMMUNICATIONS
UNLV Campus Wiring Design Guide

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SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

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PART 1 - GENERAL

1.1.1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1.1.2 SUMMARY

- A. Section Includes:
 - 1. Grounding conductors.
 - 2. Grounding connectors.
 - 3. Grounding busbars.
 - 4. Grounding labeling.

1.1.1.3 REFERENCES

- A. Abbreviations and Acronyms
 - 1. AWG American Wire Gauge
 - 2. BBC Backbone Bonding Conductor
 - 3. IDF Intermediate Distribution Frame
 - 4. PBB Primary Bonding Busbar
 - 5. SBB Secondary Bonding Busbar
 - 6. SBC Secondary Bonding Conductor
 - 7. TBB Telecommunications Bonding Backbone
 - 8. TBC Telecommunications Bonding Conductor
 - 9. TE Telecommunications Enclosure
 - 10. TR Telecommunications Room
- B. Reference Standards, Specifications, and Codes
 - 1. ANSI/TIA-607-D Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
 - 2. ANSI/TIA-568.0-D Generic Telecommunications Cabling for Customer Premises American National Standards Institute (ANSI)
 - 3. National Electrical Code (NEC) 250

1.1.1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For communications equipment room signal reference grid. Include

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plans, elevations, sections, details, and attachments to other work.

1.1.1.5 INFORMATIONAL SUBMITTALS

- A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
 - 1. Ground rods.
 - 2. Ground and roof rings.
 - 3. BBC, PBB, SBB, SBCs, and routing of their bonding conductors.
 - 4. Conductors used for grounding and bonding.
 - 5. Grounding connectors.
- B. Qualification Data: For Installer, installation supervisor, and field inspector.
- C. Qualification Data: For testing agency and testing agency's field supervisor.
- D. Field quality-control reports.

1.1.1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Result of the ground-resistance test, measured at the point of BBC connection.
 - b. Result of the bonding-resistance test at each SBB and its nearest grounding electrode.

1.1.1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
- B. Contractor Qualifications.
 - 1. The Contractor shall follow licensing requirements to install cabling infrastructure in the state where the work will be executed. The license shall be submitted.
 - 2. The Contractor should have at least one BICSI Registered Communications Distribution Designer (RCDD) on staff for the duration of the project. The Contractor should offer proof of RCDD certification by submitting a copy of the certification.
 - 3. Contractor shall have at least one BICSI registered Technician on site for the duration of the project. He or she shall act in the capacity of the supervisor for the foreman and or foremen/workers onsite.
 - 4. All persons acting as foreman shall be at a minimum BICSI registered Installer

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Level II Copper / Fiber.

5. The Contractor is responsible to prove their personnel have the necessary training and certification(s) to satisfy testing requirements.

1.1.1.8 CONTRACTOR RESPONSIBILITIES

- A. The contractor shall provide all labor, materials, tools, and equipment required for the complete installation of a telecommunications system grounding and bonding system as described in this specification and within the construction drawings.

1.1.1.9 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.
- C. Comply with TIA-607-D.
- D. Comply with NEC 250

1.1.1.10 CONDUCTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Southwire
 2. Hubbell Electrical Systems.
 3. Panduit Corp.
 4. Or Approved Equal
- B. Comply with UL 486A-486B.
- C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
 1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
 2. Cable Tray Equipment Grounding Wire: No. 6 AWG.
- D. Cable Tray Grounding Jumper:
 1. Not smaller than No. 6 AWG and not longer than 12 inches (300 mm). If the jumper is a wire, it shall have a crimped grounding lug with two holes and a long barrel for two crimps. If the jumper is a flexible braid, it shall have a one-hole ferrule. Attach with a grounding screw or connector provided by the cable tray manufacturer.
 2. Not smaller than No. 10 AWG and not longer than 12 inches (300 mm). If the jumper is a wire, it shall have a crimped grounding lug with one hole and standard barrel for one crimp. If the jumper is a flexible braid, it shall have a one-

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or two-hole ferrule. Attach with a grounding screw or connector provided by the cable tray manufacturer.

- E. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmils (14.2 sq. mm), 14 strands of No. 17 AWG conductor, and 1/4 inch (6.3 mm) in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

1.1.1.11 CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Electrical Systems (Burndy)
 - 2. Chatsworth Products, Inc.
 - 3. Harger Lightning & Grounding.
 - 4. Panduit Corp.
 - 5. TE Connectivity Ltd.
 - 6. Or approved equal.
- B. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
- C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
 - 1. Electroplated tinned copper, C and H shaped.
- D. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.
- E. Busbar Connectors: Cast silicon bronze, solderless compression or exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch (15.8- or 25.4-mm) centers for a two-bolt connection to the busbar.
- F. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturers for materials being joined and installation conditions.

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1.1.1.12 GROUNDING BUSBARS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Harger
 2. B-line, an Eaton business.
 3. Chatsworth Products, Inc (CPI).
 4. Hubbell Incorporated.
 5. Erico
 6. Or approved equal.
- B. PBB: Pre-Drilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, length as indicated on Drawings but a minimum of 12 inches. The busbar shall be NRTL listed for use as PBB and shall comply with TIA-607-D.
1. Bonding Busbars shall have holes for use with correctly matched Bonding Conductor Lugs.
 2. Bonding Busbars shall be made of copper, or copper alloys having a minimum of 95% conductivity when annealed as specified by the International Annealed Copper Standard (IACS).
 3. Mounting Hardware: Stand-off brackets that provide a 4-inch (100-mm) clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
 4. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
 5. Lugs should be compression or exothermic type.
- C. SBB: Pre-Drilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches (6.3 by 50 mm) in cross section, length as indicated on Drawings but a minimum of 12 inches. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-D.
1. Bonding Busbars shall have holes for use with correctly matched Bonding Conductor Lugs.
 2. Bonding Busbars shall be made of copper, or copper alloys having a minimum of 95% conductivity when annealed as specified by the International Annealed Copper Standard (IACS).
 3. Mounting Hardware: Stand-off brackets that provide at least a 2-inch (50-mm) clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.

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4. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
 5. Lugs should be compression or exothermic type
- D. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-D. Predrilling shall be with holes for use with lugs specified in this Section.
1. Cabinet-Mounted Busbar: Terminal block, with copper-plated hardware for attachment to the cabinet.
 2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch (483- or 584-mm) equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
 3. Rack-Mounted Vertical Busbar: 72 or 36 inches (1827 or 914 mm) long, with stainless-steel or copper-plated hardware for attachment to the rack.

1.1.1.13 IDENTIFICATION

- A. Comply with requirements for identification products in Section 270553 "Identification for Communications Systems."

PART 2 - EXECUTION

2.1.1.1 EXAMINATION

- A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.
- B. Inspect the test results of the ac grounding system measured at the point of BCT connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

2.1.1.2 INSTALLATION

- A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.
- B. The facility shall be equipped with a telecommunications grounding and bonding system. This system shall be used to ground all telecommunications cable shields, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current-carrying conductor. The telecommunications grounding and bonding system shall be installed independent of the building's electrical and building ground and shall be designed in accordance with the recommendations found in ANSI/TIA-

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607-D.

- C. The main Telecommunications Entrance Facility in each building shall be equipped with a PBB and shall be connected to the building electrical entrance grounding facility. Each TE and/or TR shall be provided with a SBB. The intent is to provide a telecommunications grounding system that is equal in potential to the building electrical grounding system. This will minimize ground loop current potential between telecommunications equipment and the electrical system that supplies power to the equipment.
- D. The PBB should be connected with each SBB using TBC. Size the TBC per the tables in ANSI/TIA 607-D or the current version.
- E. When the SBB is not bonded directly to the TBB, the SBC shall bond the SBB to the TBB.
- F. All metal equipment racks, cabinets, backboards, cable shields, strength members, splice cases, cable trays, similar continuous cable support mechanisms, and the like entering or residing in TEs or TR shall be grounded to the local SBB or the PBB using a minimum 6 AWG stranded copper bonding conductor and compression connectors.
- G. All wires used for telecommunications grounding purposes shall be identified with green insulation or green tape. Non-insulated wires shall be identified at each termination point using green tape. All cables and busbars shall be identified and labeled in accordance with ANSI/TIA 606-C.
- H. The PBB and SBB shall be designed and/or approved by a qualified Professional Engineer (PE), licensed in the jurisdiction where the work is to be performed. The PBB and SBB shall adhere to the recommendations found in ANSI/TIA 607-D and shall be installed in accordance with industry best practices.
- I. When there are multiple TBBs, the BBC is employed to interconnect them through the associated busbars, either on the same floor in a multi-story building or in the same general area of a single-story building.
- J. The SBC is employed to connect the telecommunications equipment, racks, and cabinets to the SBB.
- K. A licensed electrical contractor shall perform the installation and termination of the PBB to the building service entrance ground using a TBC.

2.1.1.3 APPLICATION

- A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
 - 1. The bonding conductors between the SBB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
 - 2. The bonding conductors between the PBB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 6 AWG minimum.

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C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

D. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches (900 mm).

E. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch (900-mm) intervals.
4. Install grounding and bonding conductors in 3/4-inch (21-mm) PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.
 - a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a SBB.

2.1.1.4 GROUNDING ELECTRODE SYSTEM

- A. The BCT between the PBB and the ac service equipment ground shall not be smaller than No. 1/0 AWG.

2.1.1.5 GROUNDING BUSBARS

- A. Indicate locations of grounding bus bars on Drawings. Install busbars horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 12 inches (300 mm) above finished floor unless otherwise indicated.
- B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

2.1.1.6 CONNECTIONS

- A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

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- B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
- C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
 - 1. Use a crimping tool and the die specific to the connector.
 - 2. Pre-twist the conductor.
 - 3. Apply an antioxidant compound to all bolted and compression connections.
- D. Primary Protector: Bond to the PBB with insulated bonding conductor.
- E. Interconnections: Interconnect all SBBs with the PBB with the telecommunications backbone conductor. If more than one PBB is installed, interconnect PBBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot (1 sq. mm/linear meter) of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.
- F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted or vertically mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the SBB No. 2 AWG bonding conductors.
- G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each SBB and PBB to the vertical steel of the building frame.
- H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each SBB to the ground bar of the panelboard.
- I. Shielded Cable: Bond the shield of shielded cable to the SBB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding shielded balanced twisted-pair cables.
- J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.
- K. Access Floors and Raised Floors: Bond all metal parts of access floors to the SBB.
- L. Equipment Room Signal Reference Grid: Provide a low-impedance path between telecommunications cabinets, equipment racks, and the reference grid, using No. 6 AWG bonding conductors.
 - 1. Install the conductors in grid pattern on 4-foot (1200-mm) centers, allowing bonding of one pedestal from each access floor tile.

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2. Bond the SBB of the equipment room to the reference grid at two or more locations.
3. Bond all conduits and piping entering the equipment room to the SBB at the perimeter of the room.

2.1.1.7 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.
- B. Comply with IEEE C2 and NEC 250 grounding requirements.
- C. Grounding Manholes and Handholes: Install a driven ground rod through the manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) extends above the finished floor. If necessary, install a ground rod before the manhole is placed and provide a minimum No. 1/0 AWG bare, tinned-copper conductor from the ground rod into the manhole through a waterproof sleeve in the manhole wall. Protect ground rods passing through the concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, non-shrink grout.
- D. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect grounding conductors to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

2.1.1.8 IDENTIFICATION

- A. Labels shall be preprinted or computer-printed type.
 1. Label PBB(s) with "fs-PBB," where "fs" is the telecommunications space identifier for the space containing the PBB.
 2. Label SBB(s) with "fs-SBB," where "fs" is the telecommunications space identifier for the space containing the SBB.
 3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

2.1.1.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
- C. All workmanship shall be in full conformance with applicable building, electrical, and

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other codes, as determined by the authority having jurisdiction (AHJ).

- D. Products shall be installed in accordance with manufacturer's instructions.
- E. All materials shall be installed in a neat manner.
- F. Strictly adhere to all Building Industry Consulting Service International (BICSI) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.
- G. Contractor shall keep all foods and liquids (water, drinks, etc.) away from the installation area in designated break areas.
- H. Any damage to a building or site caused by a contractor shall be restored at contractor's expense to match the condition prior to damage. If necessary and requested by the general contractor, the contractor shall provide professional services to clean or repair damage at their own expense.
 - 1. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a PBB and an SBB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
 - a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.
 - 2. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
 - a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the PBB and in each SBB. Maximum acceptable A/C current level is 1 A.
- I. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify the Architect promptly and include recommendations to reduce ground resistance.
- J. Grounding system will be considered defective if it does not pass tests and inspections.
- K. Prepare test and inspection reports.

END OF SECTION 270526

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PART 1 - GENERAL

1.1.1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and

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Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1.1.2 SUMMARY

- A. Section Includes:
 - 1. Ladder cable tray.
 - 2. Wire-mesh cable tray.
 - 3. Trough cable tray.
 - 4. Cable tray supports.
 - 5. Cable tray splices and fasteners.
 - 6. Cable tray accessories.
 - 7. Cable tray installation tools.
 - 8. Cable tray grounding.
 - 9. Hooks.
 - 10. Metal conduits and fittings.
 - 11. Nonmetallic conduits and fittings.
 - 12. Optical-fiber-cable pathways and fittings.

1.1.1.3 DEFINITIONS

- A. ANSI: American National Standards Institute.
- B. AWG: American wire gauge.
- C. BICSI: Building Industry Consulting Service International.
- D. NECA: National Electrical Contractors Association.
- E. NFPA: National Fire Protection Agency.
- F. TIA: Telecommunications Industry Association.
- G. UL: Underwriters Laboratory.

1.1.1.4 ACTION SUBMITTALS

- A. Shop Drawings: For conduit routing, sizing, and pathway
 - 1. Submit cut-sheets for each of the pathway products bid for review.
 - 2. Show floor plan drawings with all pathway routing with distances and locations of all low voltage conduit in Low Voltage consultant scope in PDF format for review prior to installation.
 - 3. Provide one (1) full size and one (1) half size set hard copy and a soft CAD copy As-Built of all field routing of conduit, cabling and tray system drawings per

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Substantial Completion.

- B. Product Data: Provide component descriptions and describe electrical characteristics of components.
- C. Warranty: Ensure all warranties specify that the Owner is entitled to all rights guaranteed by the warranty for various components.
- D. Shop Drawings: For each type of cable tray.
 - 1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings before installation.
 - 2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
 - a. Vertical and horizontal offsets and transitions.
 - b. Clearances for access above and to sides of cable trays.
 - c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
 - d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.
- E. Delegated-Design Submittal: For seismic restraints.
 - 1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
 - 2. Design Calculations: Calculate requirements for selecting seismic restraints.
 - 3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.1.1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
 - 2. Vertical and horizontal offsets and transitions.
 - 3. Clearances for access above and to side of cable trays.
 - 4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

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- B. Seismic Qualification Data: Certificates, for cable trays, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

PART 2 - PRODUCTS

2.1.1.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.
- B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."

2.1.1.2 GENERAL REQUIREMENTS

- A. Subject to owner's final approval of bid responses submitted by contractor, the following manufacturer's products will be considered in bid responses; and as compliant to these technical specifications. In order to assure achievement of maximum system performance, individual components must be performance-certified to match interfacing and interactive components. Products must not be mixed and matched between different vendors. Vendor solutions must be implemented as single vendor end-to-end engineered systems to assure compatibility.
- B. The main routing and support systems for communication cables on the UNLV campus are:
 - 1. Cable tray system (hallways)
 - 2. J-hooks and adjustable cable support (bags) (accessible false ceiling areas)
 - 3. Conduit home runs (hard ceiling areas, inaccessible ceiling areas, in-floor boxes, masonry walls)The CR standard for a combined system is an overhead distribution method based on the use of a cable tray and J-hook system for routing and an EMT conduit stub-up to the WAO device boxes.
- C. All cable trays and J-hooks shall be dedicated for CR use only. No other building cabling system (800 MHz radio, access control, building automation, etc) is to be installed within the cable tray and J-hooks. Separate cable support shall be supplied.

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- D. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
 - 1. Source Limitations: Obtain cable trays and components from single manufacturer.
- E. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, sizes, and configurations.
- F. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
 - 1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
 - 2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
 - 3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.1.1.3 LADDER CABLE TRAY

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. B-line, an Eaton business.
 - 2. Belden Inc.
 - 3. Chatsworth Products, Inc (CPI).
 - 4. Legrand US.
 - 5. Or approved equal.
- B. Description:
 - 1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
 - 2. Width: [12 inches (300 mm)] [18 inches (450 mm)] [24 inches (600 mm) [36 inches (900 mm)] unless otherwise indicated on Drawings.
 - 3. Minimum Usable Load Depth: 4 inches (100 mm).
 - 4. Straight Section Lengths: 20 feet (6.0 m), except where shorter lengths are required to facilitate tray assembly.
 - 5. Rung Spacing: 9 inches (225 mm) on center.
 - 6. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
 - 7. Minimum Cable-Bearing Surface for Rungs: 7/8-inch (22-mm) width with radius edges.
 - 8. No portion of the rungs shall protrude below the bottom plane of side rails.

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9. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
10. Fitting Minimum Radius: 12 inches (300 mm).
11. Splicing Assemblies: Bolted type using serrated flange locknuts.
12. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:

1. Steel:

- a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
- b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
- c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
- d. Finish: Hot dip galvanized after fabrication, complying with ASTM A123/A123 M, Class B2.

- 1) Hardware: Galvanized, ASTM B 633.

2.1.1.4 WIRE-MESH CABLE TRAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line, an Eaton business.
2. Belden Inc.
3. Chatsworth Products, Inc (CPI).
4. Legrand US.
5. Unistrut; a part of Atkore International, Inc.
6. Or approved equal.

B. Description:

1. Configuration: Galvanized-steel wire mesh, complying with NEMA VE 1.
2. Width: [12 inches (300 mm)] [18 inches (450 mm)] [24 inches (600 mm)] unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: 4 inches (100 mm).
4. Straight Section Lengths: 12 feet (3.7 m), except where shorter lengths are required to facilitate tray assembly.

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5. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
6. Splicing Assemblies: Bolted type using serrated flange locknuts.
7. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:

1. Steel:
 - a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
 - b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
 - c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
 - d. Finish: Hot dip galvanized after fabrication, complying with ASTM A123/A123 M, Class B2.
 - 1) Hardware: Galvanized, ASTM B 633.
 - e. Finish: Hot-dipped galvanized after fabrication, complying with ASTM A 653/A 653M, G90 (Z275).
 - 2) Hardware: Galvanized, ASTM B 633.

2.1.1.5 TROUGH CABLE TRAY

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. B-line, an Eaton business.
 2. Belden Inc.
 3. Chatsworth Products, Inc (CPI).
 4. Legrand US.
 5. Unistrut; a part of Atkore International, Inc.
 6. Or approved equal.
- B. Description:
 1. Configuration:
 - a. A flat bearing surface with a solid bottom contained within two longitudinal side rails, with both edges welded to the side rails complying with NEMA VE 1.

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- b. Single, formed sheet with a solid bottom, complying with NEMA VE 1.
 2. Covers: Solid type made of same materials and with same finishes as cable tray.
 3. Width: [12 inches (300 mm)] [18 inches (450 mm)] [24 inches (600 mm)] [36 inches (900 mm)] unless otherwise indicated on Drawings.
 4. Minimum Usable Load Depth: 4 inches (100 mm).
 5. Straight Section Lengths: 20 feet (6.0 m), except where shorter lengths are required to facilitate tray assembly.
 6. Splicing Assemblies: Bolted type using serrated flange locknuts.
 7. Splicing Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
- C. Materials and Finishes:
1. Steel:
 - a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
 - b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
 - c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
 - d. Finish: Hot dip galvanized after fabrication complying with ASTM A123/A123 M, Class B2.
 - 1) Hardware: Galvanized, ASTM B 633.
 - e. Finish: Hot-dip mill galvanized before fabrication complying with ASTM A 653/A 653M, G90 (Z275).
 - 1) Hardware: Galvanized, ASTM B 633.

1.1.1.2 CABLE TRAY SUPPORTS

- A. Provide a method of attaching cable tray to the ceiling, wall or floor.
- B. Supports will be sized at minimum to match the width of the cable tray that is supported. The support may be wider than cable tray.
- C. Each support will be punched with a hole-pattern that accepts tray attachment hardware and/or will have tabs that can be bent over the tray wires to secure the tray to the support.
- D. Supports will be manufactured from steel.
- E. Provide installation hardware to attach cable tray supports to building structure.

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1.1.1.3 CABLE TRAY SPLICES AND FASTENERS

- A. Provide a method of splicing and electrically bonding cable tray sections together.
- B. Provide a method for securing cable tray to ceiling, wall and floor supports.
- C. Provide a method for attaching cable tray directly to the top of racks.
- D. Provide a method for attaching cable tray supports to raised floor pedestals.
- E. Provide a method for attaching an electrical bonding conductor to the cable tray.

1.1.1.4 CABLE TRAY ACCESSORIES

- A. Provide a divider to separate cable tray into multiple pathways. The divider should be the same height as the sidewalls of the cable tray.
- B. Provide a cover for cable tray. The cover should be sized to match the width of the cable tray.
- C. Provide a solid bottom for cable tray. The bottom should be sized to match the width of the cable tray.
- D. Provide a bend radius to connect the sidewalls of adjoining cable tray wherever a splice or an intersection in the cable tray pathway results in a 4 inch (100 mm) or wider gap between the sidewalls. The bend radius should be the same height as the sidewalls of the cable tray.
- E. Provide a radius drop to form cable over a smooth curve wherever cable exits or enters the side, bottom or end of cable tray.
- F. Provide a bracket for attaching duplex junction boxes to the side of the tray.
- G. Provide a clear, plastic label holder that can be used in plenum spaces that attaches to the side of the tray to identify each pathway and/or drop location.
- H. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- I. Barrier Strips: Same materials and finishes as for cable tray.
- J. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.
- K. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
- L. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
- M. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

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1.1.1.5 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."
- B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch (1800-mm) intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."
- D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.
- E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

1.1.1.6 COMMUNICATIONS J-HOOKS

- A. Description: Prefabricated sheet metal cable supports for telecommunications cable.
- B. J-hooks shall be installed to ensure horizontal pathways or cables do not rest directly on the ceiling panels, support channels, ceiling support wires, HVAC ducts or pipes.
- C. Provide a minimum of 6 inches (150 mm) between suspended ceiling and cabling pathway.
- D. J-hooks shall be spaced at a maximum of 48-inches in the main bundle, 48 to 60-inches apart in the secondary bundles and within 6-inches of an EMT conduit stub-up.
- E. Main cable bundle will be made up of 4-inch saddle bags and supported on a minimum of 3/8" threaded rod. Ceiling wires or pencil rod is acceptable for secondary cable bundles. Cable supports shall not exceed 40% fill ratio. Refer to manufacturer's recommendations.
- F. Location of J-hooks shall be indicated on the Electrical Design and/or Telecommunications drawings.
- G. Cables shall not be secured to the J-hook with cable ties or vinyl tape.

1.1.1.7 METAL CONDUITS AND FITTINGS

- A. General Requirements for Metal Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.

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3. Refer to 26 0533 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS for manufacturer.

B. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. IMC: Comply with ANSI C80.6 and UL 1242.

E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

F. EMT: Comply with ANSI C80.3 and UL 797.

G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Fittings for EMT:

- a. Material: Steel or die cast.
- b. Type: Setscrew or compression.

2. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions were installed, and including flexible external bonding jumper.

3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

1.1.1.8 NON-METALLIC CONDUITS AND FITTINGS

A. General Requirements for Non-metallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

C. Continuous HDPE: Comply with UL 651B.

D. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and

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material.

- E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1.1.1.9 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Description: Comply with UL 2024; flexible-type pathway, approved for plenum or riser installation unless otherwise indicated.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.

1.1.1.10 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 2 - EXECUTION

3.1 PATHWAY APPLICATION

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: GRC or RNC, Type EPC-80-PVC.
 - 2. Concealed Conduit, Aboveground: EMT.
 - 3. Underground Conduit: RNC, Type EPC-40-PVC.
 - 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT.
 - 2. Exposed and Subject to Physical Damage: GRC. Pathway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Gymnasiums.
 - 3. Concealed in Ceilings and Interior Walls and Partitions: EMT or innerduct.
 - 4. Damp or Wet Locations: GRC.
 - 5. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway and EMT.
 - 6. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts:

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Riser- type, optical-fiber-cable pathway, and EMT.

7. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: Riser-type, optical-fiber-cable pathway Riser-type, communications-cable pathway or EMT.
8. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
9. Be installed in the most direct and accessible route possible (parallel to building lines and located in and above accessible hallways).
10. Contain no more than two 90-degree bends in any dimensional plane or exceed 100-feet in length between pulling points or interior pull boxes. A pull box is not to be used in place of a conduit sweep. See table 2.
11. Stub up to an accessible ceiling area and within 6-inches of a J-hook or cable tray from a device box.
12. Be reamed at both ends and have a plastic bushing installed on each end to prevent damage during cable installation.
13. Have a pull string (also called a pull cord) installed in all conduits with a minimum test rating of 200 lb.
14. Be installed through areas in which flammable materials may be stored or over and adjacent to boilers, incinerators, hot water lines or steam lines.
15. All conduits shall be bonded and grounded in accordance with the CEC and ANSI-J- STD-607-A, where applicable.
16. All conduits shall adhere to the maximum allowable conduit fill for cables as shown in Table 3.

Table 2 Conduit Bend Radiuses

INTERNAL DIAMETER	MINIMUM BEND RADIUS
2 INCHES OR LESS	6 TIMES THE INTERNAL CONDUIT DIAMETER
2 1/4 INCHES OR MORE	10 TIMES THE INTERNAL CONDUIT DIAMETER

Wall-mounted riser conduits and/or sleeves entering a Telecommunications Space (ER/TR) shall have a plastic spillway installed onto the end of the conduit to prevent kinking of the installed cable bundle. BEJED, Inc. part number BJ-2049B-002, or equal.

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Table 3: Maximum Allowable Conduit Fill

Conduit Trade Size		Maximum Number of Cables Based Upon 40% Allowable Fill									
		Cable Outside Diameter mm (inches)									
		3.3 -0.13	4.6* -0.18	5.6 -0.22	6.1 -0.24	7.4 -0.29	7.9 -0.31	9.4 -0.37	13.5 -0.53	15.8 -0.62	17.8 -0.7
16	½	1	1	0	0	0	0	0	0	0	0
21	¾	6	5	4	3	2	2	1	0	0	0
27	1	8	8	7	6	3	3	2	1	0	0
35	1 ¼	16	14	12	10	6	4	3	1	1	1
41	1 ½	20	18	16	15	7	6	4	2	1	1
53	2	30	26	22	20	14	12	7	4	3	2
63	2 ½	45	40	36	30	17	14	12	6	3	3
78	3	70	60	50	40	20	20	17	7	6	6
91	3 ½							22	12	7	6
103	4							30	14	12	7

*** The Outside Diameter of Berk-Tek LANMARK 350TM CMP**

- C. Minimum Pathway Size: 1-inch trade size.
- D. Pathway Fittings: Compatible with pathways and suitable for use and location.
 - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 - 3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface pathways only where indicated on Drawings. Seek prior approval from Architect or PSU before installing surface pathways.

3.2 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
 - NECA 1.

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1. NECA/BICSI 568.
 2. TIA-569-D.
 3. NECA 101
 4. NECA 102.
 5. NECA 105.
 6. NECA 111.
- B. Provide all components of the tray system (tray, supports, splices, fasteners, and accessories) from a single manufacturer. Cable tray shall be secured to the structural ceiling, building truss system, wall or floor using manufacturer's recommended supports and appropriate hardware as defined by local code or the authority having jurisdiction (AHJ).
- C. When the pathway is overhead, cable tray shall be installed with a minimum clearance of 12 inches (300 mm) above the tray. Leave 12 inches (300 mm) in between the tray and ceiling/building truss structure. Multiple tiers of cable tray shall be installed with a minimum clearance of 12 inches (300 mm) in between the trays. When located above an acoustical drop ceiling, cable tray shall be installed a minimum of 3 inches (75 mm) above the drop ceiling tiles.
- D. When installed under a raised floor, cable tray shall be installed with a minimum 3/4 inches (19 mm) clearance between the top of the tray and the bottom of the floor tiles or floor system stringers, whichever are lower in elevation. Maintain a 3-inch (75 mm) clearance between trays wherever trays cross over.
- E. Cable tray shall be supported every 5 feet (1.5 m) of span or less in accordance with ANSI/EIA/TIA-569 and NEMA VE-2 (2006). Support cable tray within 2 feet (0.6 m) of every splice and intersection. Support intersections on all sides. Support cable tray on both sides of every change in elevation/direction. The weight of the load on the cable tray must not exceed the stated limits per span in the manufacturer's published load table. Use additional supports where needed.
- F. Secure cable tray to each support with a minimum of one fastener. Follow the manufacturers' recommended assembly, splice and intersection-forming practices.
- G. Use installation tools and practices recommended by the manufacturer to field fabricate cable tray intersections and changes in elevation. Use side-action bolt cutters with an offset head to cut cable tray.
- H. Cable tray shall be bonded to the Telecommunications Grounding Busbar (TGB) using an approved ground lug on the tray and a minimum #6 grounding wire or as recommended by the AHJ. Follow UL Classified splicing methods recommended by the manufacturer or ground the tray per NEC requirements and verify bonds at splices and intersections between individual cable tray sections. Cable pathway should be electrically continuous through bonding and attached to the TGB.
- I. The quantity of cables within the tray will not exceed a whole number value equal to 50% of the interior area of the tray divided by the cross-sectional area of the cable. Cable fill will not exceed the depth of the cable tray's side rail [2 inches (50 mm)] [4

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inches (100 mm)] [6 inches (150 mm)].

- J. The combined weight of cables within the tray will not exceed stated load capacity in manufacturer's specifications.
- K. Separate different media type within the tray. Treat each type of media separately when determining cable fill limits.
- L. When pathways for other utilities or building services are within 2 feet (0.6 m) of the cable tray, cover the tray after cables are installed.
- M. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- N. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- O. Complete pathway installation before starting conductor installation.
- P. All communications pathways are to be independently supported. Suspending pathways from piping, HVAC ductwork, ceiling grids, etc. is not acceptable.
- Q. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- R. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- S. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- T. Support conduit within 12 inches of enclosures to which they are attached.
- U. Pathways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange pathways to keep a minimum of 2 inches of concrete cover in all

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directions.

4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
- V. Stub-ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for pathways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- W. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- X. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- Y. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- Z. Do not rely on locknuts to penetrate non-conductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- AA. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- BB. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12-inches of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.
- CC. Surface Pathways:
1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings or where prior approval has been obtained from Architect or PSU.
 2. Install surface pathway with a minimum 2-inch radius control at bend points.
 3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48-inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- DD. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
1. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
 2. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where

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necessary to comply with these requirements.

- EE. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.
 - FF. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service pathway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
 - GG. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
 - HH. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes at 18-inches above finished floor, measured to center of box, unless indicated otherwise. Where installed in an existing building, match the height of existing electrical outlets.
 - II. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
 - JJ. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
 - KK. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
 - LL. Fasten Junction and pull boxes to or support from building structure. Do not support boxes by conduits
 - MM. Set metal floor boxes level and flush with finished floor surface.
 - NN. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- 3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS
- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.
 - B. Sleeve and sleeve seals shall comply with the wall rating of the wall requiring penetration.
- 3.4 GROUNDING
- A. Cable trays and ladder racks shall be grounded as prescribed in Article 250 of the

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NEC, in accordance with all local code requirements and in accordance with the latest edition of ANSI/TIA - 607 "Grounding and Bonding Requirements for Commercial Building Telecommunications Systems". Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

- B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch (1800-mm) intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."
- D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.
- E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."
- F. Provide braided or stranded ground straps between each adjoining section of steel ladder rack. Provide braided aluminum ground straps between adjoining sections of aluminum cable trays. Mechanically bond ground straps to each section of ladder rack or cable tray.
- G. Where ladder racks or cable trays are painted, remove paint down to bare metal before attaching ground straps or grounding conductors.
- H. Provide a continuous, stranded, insulated No. 6 AWG ground conductor between each cable tray and ladder rack and the telecommunications ground bar in the equipment rooms. Attach grounding conductor to cable tray, ladder rack and ground bar with two (2) hole compression lugs. See drawings for location of ground bar.

3.5 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.6 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.
 - 3. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall

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remain in place until the risk of damage is over.

4. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
5. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 270528

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SECTION 270543 - UNDERGROUND PATHWAYS AND STRUCTURES FOR COMMUNICATION SYSTEMS

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PART 1 -

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GENERAL

1.1.A.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1.A.2 SUMMARY

- A. Section Includes:
 1. Metal conduit and fittings, including GRC and PVC-coated GRC.
 2. Rigid nonmetallic duct.
 3. Duct accessories, including rigid innerduct and fabric innerduct.
 4. Precast concrete handholes.
 5. Polymer concrete handholes and boxes with polymer concrete cover.
 6. Fiberglass handholes and boxes with polymer concrete cover.
 7. Fiberglass handholes and boxes.
 8. High density plastic boxes.
 9. Precast maintenance holes.
 10. Cast-in-place maintenance holes.
 11. Utility structure accessories.
 12. Micro-Duct

1.1.A.3 DEFINITIONS

- A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials, such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as a component of a duct bank.
- C. Duct Bank:
 1. Two or more ducts installed in parallel, with or without additional casing materials.
 2. Multiple duct banks.
- D. GRC: Galvanized rigid conduit.
- E. IMC: Intermediate metal conduit.
- F. RNC: Rigid nonmetallic conduit.
- G. Traffic ways: Locations where vehicular or pedestrian traffic is a normal course of

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events.

1.1.A.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include duct-bank materials, including spacers and miscellaneous components.
2. Include duct and conduits and their accessories, including elbows, end bells, bends, fittings, duct spacers, and solvent cement.
3. Include accessories for maintenance holes, handholes, and boxes.
4. Include underground-line warning tape.

B. Shop Drawings:

1. Precast or Factory-Fabricated Underground Utility Structures:

- a. Include plans, elevations, sections, details, attachments to other work, and accessories.
- b. Include duct entry provisions, including location and duct size.
- c. Include reinforcement details.
- d. Include frame and cover design and maintenance hole chimneys.
- e. Include **ladder** entry and **step** details.
- f. Include grounding details.
- g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
- h. Include joint details.

2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

- a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
- b. Include duct entry provisions, including location and duct size.
- c. Include cover design.
- d. Include grounding details.
- e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.1.A.5 INFORMATIONAL SUBMITTALS

A. Duct and Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

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2. Drawings shall be signed and sealed by a qualified professional engineer.

- B. Product Certificates: For concrete and steel used in precast concrete maintenance holes and handholes, as required by ASTM C 858.
- C. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.
- D. Source quality-control reports.
- E. Field quality-control reports.

1.1.A.6 MAINTENANCE MATERIALS SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Furnish cable-support stanchions, arms, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

1.1.A.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.1.A.8 FIELD CONDITIONS

- A. Interruption of Existing Communications Service: Do not interrupt communications service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary communications service according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of the proposed interruption of communications service.
 - 2. Do not proceed with interruption of communications service without the Owner's written permission.
- B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.
- C. Ground Water: Assume ground-water level is 36 inches (900 mm) below ground surface unless a higher water table is noted on Drawings.
- D. Obtain a copy of the most recent campus layout map.
- E. Determine where the conduit entrance point is for each building.
- F. Determine location, availability, and size of the closest existing underground conduit system access point (MH/PB).
- G. Conduit routes shall not cross open land areas where future building may occur.
- H. All branch conduits exiting a MH/PB shall be designed as Subsidiary conduits only (exit from the end wall of the MH/PB, not from the side wall). Lateral conduits entering/exiting MH/PB's are not allowed.

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PART 2 - PRODUCTS

2.1.1.1 METAL CONDUITS AND FITTINGS

- A. GRC: Comply with ANSI C80.1 and UL 6.
- B. PVC-Coated Steel Conduit: PVC-coated [**GRC**].
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems; a part of Atkore International.
 - 2. Allied Tube & Conduit; a part of Atkore International.
 - 3. Anamet Electrical, Inc.
 - 4. Calconduit.
 - 5. Electri-Flex Company.
 - 6. FSR Inc.
 - 7. Korkap.
 - 8. NEC, Inc.
 - 9. Opti-Com Manufacturing Network, Inc (OMNI).
 - 10. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - 11. Perma-Cote.
 - 12. Picoma Industries, Inc.
 - 13. Plasti-Bond.
 - 14. Republic Conduit.
 - 15. Or approved equal.
- D. General Requirements for Metal Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 - 2. Comply with TIA-569-C and TIA-758-C.

2.1.1.2 RIGID NONMETALLIC DUCTS

- A. Underground Plastic Utilities Duct: **Type EPC-80-PVC and/or Type EPC-40-PVC** RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of

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the following:

1. ARNCO Corp.
2. Beck Manufacturing.
3. CANTEX INC.
4. CertainTeed Corporation.
5. Condux International, Inc.
6. Crown Line Plastics.
7. ElecSys, Inc.
8. Electri-Flex Company.
9. Endot Industries Inc.
10. IPEX USA LLC.
11. Lamson & Sessions.
12. Manhattan/CDT.
13. National Pipe & Plastics.
14. Opti-Com Manufacturing Network, Inc (OMNI).
15. Or approved equal.

C. General Requirements for Nonmetallic Ducts and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569-C and TIA-758-C.

D. Solvents and Adhesives: As recommended by duct manufacturers.

2.1.1.3 FLEXIBLE NONMETALLIC DUCTS

A. HDPE Duct: **Type EPEC 40-HDPE** or **Type EPEC 80-HDPE** complying with NEMA TC 7 and UL 651A.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ARNCO Corp.
 - b. Carlon; a brand of Thomas & Betts Corporation.
 - c. National Pipe & Plastics.
 - d. Opti-Com Manufacturing Network, Inc (OMNI).
 - e. Premier Conduit.

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- f. Or approved equal.
- 2. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
- 3. Comply with TIA-569-C and TIA-758-C.

2.1.1.4 DUCT ACCESSORIES

- A. Rigid Innerduct: **Smooth** or **Corrugated** HDPE duct, orange in color, designed for installation within a duct or pathway.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Blue Diamond Industries.
 - b. Carlon; a brand of Thomas & Betts Corporation.
 - c. Dura-Line.
 - d. Eastern Wire.
 - e. Endot Industries Inc.
 - f. Opti-Com Manufacturing Network, Inc (OMNI).
 - g. Premier Conduit.
 - h. Thomas & Betts Corporation; A Member of the ABB Group.
 - i. Or approved equal.
- B. Fabric Innerduct: Continuous, polyester, single or multi-pocket fabric innerduct, with internal pull tape and tracer wire.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Maxcell.
 - b. Or approved equal.
- C. Duct Spacers: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit; a part of Atkore International.
 - b. CANTEX INC.
 - c. Carlon; a brand of Thomas & Betts Corporation.
 - d. IPEX USA LLC.

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- e. PenCell Plastics.
 - f. Underground Devices, Inc.
 - g. Or approved equal.
- D. Underground-Line Warning Tape: Underground-line warning tape specified in Section 270553 "Identification for Communications Systems."

2.1.1.5 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Description: Monolithically poured, factory-fabricated, reinforced-concrete walls, and bottom unless open-bottom enclosures are indicated. Frame and cover shall form the top of the enclosure and shall have a load rating consistent with that of handhole or box.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1. Christy Concrete Products.
 - 2. Elmhurst-Chicago Stone Co.
 - 3. Oldcastle Precast, Inc.
 - 4. Rinker Group, Ltd.
 - 5. Riverton Concrete Products.
 - 6. Utility Concrete Products, LLC.
 - 7. Utility Vault Co.
 - 8. Wausau Tile Inc.
 - 9. Or approved equal.
- C. Comply with ASTM C 858 for design and manufacturing processes.
- D. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
- E. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
- F. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
- 1. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - 2. Cover Handle: Recessed.
- G. Frame and Cover: Weatherproof aluminum frame, with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
- 1. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - 2. Cover Handle: Recessed.

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- H. Cover Finish: Non-Skid finish shall have a minimum coefficient of friction of 0.50.
 - I. Cover Legend: Molded lettering, "COMMUNICATIONS."
 - J. Configuration: Units shall be designed for flush burial and have open, closed, or integral closed bottom unless otherwise indicated.
 - K. Extensions and Slabs: Designed to mate with the bottom of the enclosure and made of the same material as the enclosure.
 - 1. Extension shall provide increased depth of 12 inches (300 mm).
 - 2. Slab: Same dimensions as bottom of enclosure and arranged to provide closure.
 - L. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
 - M. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct and duct banks, plus an additional **6 inches (150 mm)** to **12 inches (300 mm)** vertically and horizontally to accommodate alignment variations.
 - 1. Knockout panels shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - 2. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
 - 3. Knockout panel openings shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
 - 4. Knockout panels shall be 1-1/2 to 2 inches (38 to 50 mm) thick.
 - N. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - 1. Type and size shall match fittings to duct or conduit to be terminated.
 - 2. Fittings shall align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.
 - O. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
- 2.1.1.6 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER
- A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
 - B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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1. Armorcast Products Company.
 2. NewBasis.
 3. Oldcastle Enclosure Solutions.
 4. Quazite: Hubbell Power Systems, Inc.
 5. Or approved equal.
- C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- D. Color: [**Gray**] [**Green**].
- E. Configuration: Units shall be designed for flush burial and have open, closed, or integral closed bottom unless otherwise indicated.
- F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- G. Cover Finish: Non Skid finish shall have a minimum coefficient of friction of 0.50.
- H. Cover Legend: Molded lettering, "COMMUNICATIONS."
- I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure walls.
- J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- K. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.
- 2.1.1.7 FIBERGLASS HANDHOLES AND BOXES WITH POLYMER CONCRETE FRAME AND COVER
- A. Description: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Armorcast Products Company.
 2. Christy Concrete Products.
 3. NewBasis.
 4. Oldcastle Enclosure Solutions.
 5. Quazite: Hubbell Power Systems, Inc.
 6. Or approved equal.
- C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground

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Enclosure Application" Article.

- D. Color: **Gray** or **Green**.
- E. Configuration: Units shall be designed for flush burial and have open, closed, or integral closed bottom unless otherwise indicated.
- F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- G. Cover Finish: Non-Skid finish shall have a minimum coefficient of friction of 0.50.
- H. Cover Legend: Molded lettering, "COMMUNICATIONS."
- I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure walls.
- J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- K. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.1.1.8 FIBERGLASS HANDHOLES AND BOXES

- A. Description: Molded of fiberglass-reinforced polyester resin, with covers made of polymer concrete, reinforced concrete, cast iron, hot-dip galvanized-steel diamond plate, fiberglass.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Christy Concrete Products.
 - 2. Nordic Fiberglass, Inc.
 - 3. Oldcastle Enclosure Solutions.
 - 4. Quazite: Hubbell Power Systems, Inc.
 - 5. Or approved equal.
- C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- D. Color: Gray or Green.
- E. Configuration: Units shall be designed for flush burial and have open, closed, or integral closed bottom unless otherwise indicated.
- F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- G. Cover Finish: Non-Skid finish shall have a minimum coefficient of friction of 0.50.
- H. Cover Legend: Molded lettering, "COMMUNICATIONS."

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- I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure walls.
- J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- K. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.1.1.9 HIGH-DENSITY PLASTIC BOXES

- A. Description: Injection molded of high-density polyethylene or copolymer-polypropylene. Cover shall be made of polymer concrete, hot-dip galvanized-steel diamond plate, plastic.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Nordic Fiberglass, Inc.
 - 2. Oldcastle Enclosure Solutions.
 - 3. PenCell Plastics.
 - 4. Quazite: Hubbell Power Systems, Inc.
 - 5. Or approved equal.
- C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- D. Color: Gray or Green.
- E. Configuration: Units shall be designed for flush burial and have open, closed, or integral closed bottom unless otherwise indicated.
- F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- G. Cover Finish: Non-Skid finish shall have a minimum coefficient of friction of 0.50.
- H. Cover Legend: Molded lettering, "COMMUNICATIONS"
- I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure walls.
- J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- K. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.1.1.10 PRECAST MAINTENANCE HOLES

- A. Description: One-piece units and units with interlocking mating sections, complete with

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accessories, hardware, and features.

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carder Concrete Products.
 2. Christy Concrete Products.
 3. Elmhurst-Chicago Stone Co.
 4. Oldcastle Precast, Inc.
 5. Rinker Group, Ltd.
 6. Riverton Concrete Products.
 7. Utility Concrete Products, LLC.
 8. Utility Vault Co.
 9. Wausau Tile Inc.
 10. Or approved equal.
- C. Standard: Comply with ASTM C 858.
- D. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.
- E. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct and duct banks, plus an additional **6 inches (150 mm)** or **12 inches (300 mm)** vertically and horizontally to accommodate alignment variations.
1. **Splayed** or **Center window** location.
 2. Knockout panels shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or roofs of maintenance holes, but close enough to corners to facilitate racking of cables on walls.
 3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 4. Knockout panel openings shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
 5. Knockout panels shall be 1-1/2 to 2 inches (38 to 50 mm) thick.
- F. Duct Entrances in Maintenance hole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
1. Type and size shall match fittings to duct or conduit to be terminated.
 2. Fittings shall align with elevations of approaching duct and be located near interior corners of maintenance holes to facilitate racking of cable.

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- G. Ground Rod Sleeve: Provide a 3-inch (75-mm) PVC sleeve in maintenance hole floors 2 inches (50 mm) from the wall adjacent to, but not underneath, the duct routed from the facility.
- H. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.1.1.11 CAST-IN-PLACE MAINTENANCE HOLES

- A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for duct entrance and sleeve for ground rod.
- B. Materials: Comply with ASTM C 858 and with Section 033000 "Cast-in-Place Concrete."
- C. Structural Design Loading: As specified in "Underground Enclosure Application" Article.

2.1.1.12 UTILITY STRUCTURE ACCESSORIES

- A. Accessories for Utility Structures: Utility equipment and accessory items used for utility structure access and utility support, listed and labeled for intended use and application.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Bilco Company (The).
 - 2. Campbell Foundry Company.
 - 3. Carder Concrete Products.
 - 4. Christy Concrete Products.
 - 5. E.J.
 - 6. Elmhurst-Chicago Stone Co.
 - 7. McKinley Iron Works, Inc.
 - 8. Neenah Foundry Company.
 - 9. NewBasis.
 - 10. Oldcastle Precast, Inc.
 - 11. Osburn Associates, Inc.
 - 12. Pennsylvania Insert Corporation.
 - 13. Quazite: Hubbell Power Systems, Inc.
 - 14. Rinker Group, Ltd.
 - 15. Or approved equal.
- C. Maintenance hole Frames, Covers, and Chimney Components: Comply with structural

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design loading specified for maintenance hole.

1. Frame and Cover: Weatherproof, **gray cast iron complying with ASTM A 48/A 48M, Class 30B** or **cast aluminum**, with milled cover-to-frame bearing surfaces; **26-inch (660-mm)** Or **29-inch (725-mm)** diameter.
 - a. Cover Finish: Non-Skid finish shall have a minimum coefficient of friction of 0.50.
 - b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
2. Cover Legend: Cast in. Selected to suit the system.
3. Maintenance hole Chimney Components: Precast concrete rings, with dimensions matched to those of roof opening.
 - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities of less than 2.0 cu. ft. (60 L), where packaged mix complying with ASTM C 387, Type M, may be used.
 - b. Seal joints are watertight using preformed plastic or rubber conforming to ASTM C 990. Install sealing material according to the sealant manufacturers' printed instructions.
- D. Maintenance hole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.
- E. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.
 1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbs (58-kN) minimum tension.
- F. Pulling Eyes in Non-Concrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- (31-mm-) diameter eye, rated 2500-lbs (11-kN) minimum tension.
- G. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
 1. Ultimate Yield Strength: 40,000-lbs (180-kN) shear and 60,000-lbs (270-kN) tension.
- H. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch (13-mm) ID by 2-3/4 inches (69 mm) deep, flared to a minimum of 1-1/4 inches (31 mm) at base.
 1. Tested Ultimate Pullout Strength: 12,000 lbs (53 kN) minimum.
- I. Ground Rod Sleeve: 3-inch (75-mm), PVC duct sleeve in maintenance hole floors 2 inches (50 mm) from the wall adjacent to, but not underneath, the duct entering the structure.

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- J. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip, with 1/2-inch (13-mm) bolt, 5300-lbs (24-kN) rated pullout strength, and minimum 6800-lbs (30-kN) rated shear strength.
- K. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymers.
 - 1. Stanchions: Nominal 36 inches (900 mm) high by 4 inches (100 mm) wide, with minimum of nine holes for arm attachment.
 - 2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 20 inches (500 mm) with 250-lb (114-kg) minimum capacity. Top of arm shall be nominally 4 inches (100 mm) wide, and arm shall have slots along full length for cable ties.
- L. Duct-Sealing Compound: Non-Hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic duct, metallic duct, duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- M. Fixed Maintenance Hole Ladders: Arranged for attachment to **roof or wall and floor** of maintenance hole. Ladder, mounting brackets, and braces shall be fabricated from **nonconductive, structural-grade, fiberglass-reinforced resin or hot-dip galvanized steel**.
- N. Portable Maintenance Hole Ladders: UL-listed, heavy-duty **wood** or **fiberglass** specifically designed for portable use for access to electrical maintenance holes. Minimum length equal to distance from deepest maintenance hole floor to grade plus 36 inches (900 mm). One required.
- O. Cover Hooks: **Heavy duty, designed for lifts 60 lbs (270 N) and greater** or **Light duty, designed for lifts less than 60 lbs (270 N)**. As required per the customer's request. Two required.

2.1.1.13 MICRO-DUCT

- A. Indoor micro-duct – All micro-duct shall be composed of dielectric materials. The micro-duct shall be suitable for installation in cable tray, metallic conduit, and conventional inner duct. During installation, micro-duct cable ends are to be completely sealed to prevent ingress of contaminants, including water. Upon completion of micro-duct installation, all internal micro-ducts shall pass the standard pressure test and proof test per the manufacturer's recommended procedures. All unoccupied micro-ducts shall be plugged or capped on both ends. Indoor micro-duct specifications are as follows:
 - 1. Manufacturer: Dura-Line
 - 2. Micro-duct Type: 1, 2, 3, 4, 7, 12, 19 and 24 way, 8.5mm OD/6mm ID
 - 3. Micro-duct rating: UL rated Riser, Plenum, or LSHF
 - 4. Handling Temperature: 0 degrees C to +40 degrees C

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5. Maximum Pulling Tension: Per Manufacturer's Recommendations
 6. Bending Radius: 20x OD during installation, 10x OD after installation
 7. All micro-ducts shall be tested to and in compliance with Telcordia GR-3155-CORE. Micro-ducts must be compliant as a stand-alone element of the air-blown cabling system.
- B. Outdoor micro-duct – All micro-duct shall be composed of all dielectric materials (except for armored versions or locate wire where applicable). The micro-duct shall be suitable for underground conduit, direct buried or aerial applications as appropriate. During installation, micro-duct cable ends and individual micro-ducts are to be completely sealed to prevent ingress of contaminants, including water. Upon completion of micro-duct installation, all micro-ducts shall pass the standard pressure test and proof test per the manufacturer's recommended procedures. All unoccupied micro-ducts shall be capped on both ends with airtight/water tight end caps. Outdoor micro-duct specifications are as follows:
1. Manufacturer: Dura-Line
 2. Micro-duct Type: 1, 2, 3, 4, 7, 12, 19, and 24 way, 8.5mm OD/6mm ID
 3. Micro-duct Rating: HDPE/OSP
 4. Handling Temperature: -20 degrees C to +40 degrees C
 5. Maximum Pulling Tension: Per Manufacturer's Recommendations
 6. Bending Radius: 20x OD during installation, 10x OD after installation

2.1.1.14 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
- B. Non-Concrete Handhole and Pull-Box Prototype Test: Test prototypes of maintenance holes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 1. Tests of materials shall be performed by an independent testing agency.
 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1.1.1 GENERAL

- A. Conduit shall be Polyvinyl-Chloride (PVC) Schedule 40 or 80 (dependent upon concrete encasement requirements), corrosion-resistant plastic with a 4-inch inside diameter for underground installations, and Galvanized Rigid Steel (GRS) or PVC Externally Coated GRS for riser applications.

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- B. Spacers shall be used in the trench to support the conduits.
- C. A solid core #10 AWG copper wire shall be installed externally along any conduit run for the purpose of locating and tracing the conduit route.
- D. Fabric multi-cell type of innerduct shall be considered for conduits planned for fiber optic cable installations.
- E. All installed conduits shall be cleaned and verified with a flexible mandrel and a stiff brush. Mandrels shall be 12-inches in length and sized to within 1/4-inch of the inside diameter of the conduit.
- F. All conduits shall be provided with mule tape with a minimum of 200 pound pulling tension.
- G. All unused entrance conduits shall be capped/plugged with expandable type duct plugs (i.e. Jackmoon) inside the building to prevent rodents, water or gases from entering the building.
- H. Conduit stubs entering the building shall extend beyond the foundation and landscaping to prevent shearing of the conduit and allow for access. Conduit entering from a below grade point shall extend 4-inches above the finished floor in the ER/TR. Conduit entering from ceiling height shall terminate 4 inches below the finished ceiling.
- I. All future conduit stubs shall be flagged for easy identification and a 3M® programmable electronic ball marker shall be placed according to manufacturer instructions and at locations identified by UNLV staff and at locations identified by UNLV staff. Facility information to be programmed into the marker balls shall be provided at time of installation.
- J. All metallic conduit and sleeves shall be reamed, bushed and capped when placed.
- K. The minimum depth of a trench shall allow for 24-inches of cover from the top of the conduit/cable to final grade. Warning tape containing metallic tracings shall be placed a minimum of 18-inches above the underground conduit/duct structure and direct-buried cable to minimize any chance of an accidental dig-up. Both ends of the metallic warning tape shall be accessible after installation.
- L. There shall not be more than the equivalent of two (2) 90-degree bends (180-degrees total) between pull points, including offsets and kicks. Back-to-back 90-degree bends shall be avoided. All bends shall be manufactured long sweeping bends with a radius not less than 6 times the internal diameter of conduits 2-inches or smaller or 10 times the internal diameter of conduits larger than 2-inches. Bends made manually shall not reduce the internal diameter of the conduit.
- M. A university representative will observe and inspect utilities trenching, excavation, backfilling, and compaction as appropriate. Contractor shall appropriately schedule all inspections prior to commencing trenching and backfilling operations. All installations are subject to satisfactory inspection by the University's representative.
- N. Contractor shall submit a USA ticket to locate and mark all subsurface utilities, such as power, communications, gas, water, outdoor lighting, etc. 48 hours (or in accordance with statutes regulating utilities) prior to any excavation on campus. An Underground

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Service Alert (USA) call number receipt (ticket) shall be present and on-site and all utilities located and marked before any construction work involving excavation begins.

- O. Conduits shall be secured with rebar, or equal when covering conduits with concrete.
- P. Conduit shall be encased in concrete or cement slurry when the following conditions exist:
 1. Minimum conduit depth cannot be attained. Conduits pass under sidewalks, roadways, driveways, railroad tracks, and at bend Points.
 2. All conduit bends and sweeps shall be concrete encased to prevent movement and "burn-through" by the pull rope during cable installations.
 3. An orange colored additive shall be raked or trowel-worked into the wet concrete or cement slurry to identify the duct structure as communications.
 4. Reinforcing bars within the concrete shall be used at any location subject to extreme stress.
 5. Customer Representative shall inspect and approve all conduits prior to encasement.

3.1.1.2 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, maintenance holes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify the Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into maintenance holes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to maintenance holes and handholes, and as approved by the Architect.
- C. Clear and grub vegetation to be removed and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

3.1.1.3 UNDERGROUND DUCT APPLICATION

- A. Duct for Communications: **Type EPC-80-PVC, Type EPC-40-PVC, or Type EB-20-PVC** RNC, in concrete-encased duct bank unless otherwise indicated.
- B. Duct for Communications: **Type EPC-80-PVC, Type EPC-40-PVC, Type DB-60-PVC, or Type DB-120-PVC** RNC, in direct-buried duct bank unless otherwise indicated.
- C. Duct for Communications: **Type EPEC-40-HDPE or Type EPEC-80-HDPE** duct in direct-buried duct bank unless otherwise indicated.
- D. Underground Duct Crossing **Paved Paths, Walks, Driveways, Roadways and Railroads**: **Type EPC-40-PVC** RNC, encased in reinforced concrete.

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E. Stub-Ups for Communications: Concrete-encased **RNC**, **GRC**, or **PVC-coated GRC**.

3.1.1.4 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for Communications:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, **[H-10] [H-20]** structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: [**Precast concrete, AASHTO HB 17, H-20**] [**Polymer concrete, SCTE 77, Tier 15**] [**Fiberglass enclosures with polymer concrete frame and cover, SCTE 77, Tier 15**] [**Fiberglass-reinforced polyester resin, SCTE 77, Tier 15**] [**High-density plastic, SCTE 77, Tier 15**] structural load rating.
3. Units in Sidewalk and Similar Applications with a Safety Factor for Non Deliberate Loading by Vehicles: [**Precast concrete, AASHTO HB 17, H-5**] [**Precast concrete, AASHTO HB 17, H-10**] [**Polymer concrete units, SCTE 77, Tier 8**] [**Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8**] [**High-density plastic, SCTE 77, Tier 8**] structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: [**Fiberglass-reinforced polyester resin**] [**High-density plastic**], structurally tested according to SCTE 77 with 3000-lbs (13 345-N) vertical loading.
5. Cover design load shall not exceed the design load of the handhole or box.

B. Maintenance holes: [**Precast**] [**or**] [**cast-in-place**] concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.1.1.5 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Replace area [**immediately after backfilling is completed**] [**or**] [**after construction in immediate area is complete**].
- C. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- E. Cut and patch existing pavement in the path of underground duct, duct bank, and utility structures according to the "Cutting and Patching" Article in Section 017300 "Execution."

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3.1.1.6 DUCT AND DUCT-BANK INSTALLATION

- A. Where indicated on Drawings, install duct, spacers, and accessories into the duct configuration shown. Duct installation requirements in this Section also apply to duct banks.
- B. Install duct and duct bank according to NEMA TCB 2 and TIA-758-C.
- C. Slope: Pitch duct and duct bank a minimum slope of 1:100 down toward maintenance holes and handholes and away from buildings and equipment. Slope duct and duct bank from a high point in runs between two maintenance holes, to drain in both directions.
- D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches (1200 mm), both horizontally and vertically, at other locations unless otherwise indicated.
 - 1. Duct and duct banks shall have a maximum of two 90-degree bends, or the total of all bends shall be no more than 180 degrees between pull points.
- E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings, so those of adjacent ducts do not lie in the same plane.
- F. Installation Adjacent to High-Temperature Steam Lines: Where duct or duct banks are installed parallel to underground steam lines, perform calculations showing the duct or duct bank will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct or duct bank crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.
- G. End-Bell Entrances to Maintenance holes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 6 inches (150 mm) o.c. for 4-inch (100-mm) duct, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct slope and without forming a trap in the line.
 - 2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to the maintenance hole or handhole. Install an expansion fitting near the center of all straight-line direct-buried duct and duct banks, with calculated expansion of more than 3/4 inch (19 mm).
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- H. Terminator Entrances to Maintenance holes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches (150 mm) on center. for 4-inch (100-mm) duct and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to terminator spacing 10 feet (3 m) from the terminator without reducing duct slope and without forming a trap in the line.

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2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to the maintenance hole or handhole. Install an expansion fitting near the center of all straight-line duct or duct bank, with calculated expansion of more than 3/4 inch (19 mm).
- I. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet (3 m) outside the building wall, without reducing duct slope away from the building or forming a trap in the duct. Use fittings manufactured for RNC duct-to-GRC conduit transition. Install GRC penetrations of building walls as specified in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."
- J. Sealing: Provide temporary closure at terminations of duct that has cables pulled. Seal spare ducts at terminations. Use sealing compounds and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
- K. Innerduct: Install immediately after mandreling duct. Size and type as indicated on Drawings.
- L. Pulling Cord: Install 200-lbs- (1000-N-m) test nylon cord in empty duct and innerduct.
- M. Concrete-Encased Duct and Duct Bank:
 1. Excavate trench bottom to provide firm and uniform support for duct or duct bank. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches (150 mm) in nominal diameter.
 2. Width: Excavate trench 12 inches (300 mm) wider than duct or duct bank on each side.
 3. Width: Excavate trench 3 inches (75 mm) wider than duct or duct bank on each side.
 4. Depth: Install top of duct and duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
 5. Support duct and duct bank on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 6. Minimum Space Between Duct: 3 inches (75 mm) between the edge of duct and exterior envelope wall, 2 inches (50 mm) between ducts for services, and 4 inches (100 mm) between power and communications ducts.
 7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet (6 m) of duct. Place spacers within 24 inches (600 mm) of duct ends. Stagger spacers approximately 6 inches (150 mm) between tiers. Secure spacers to earth and duct to prevent floating during concreting. Tie the entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around the duct or duct bank.
 8. Elbows: Use manufactured duct elbows for stub-ups, at building entrances, and

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at changes of direction in duct run unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.

9. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.
 - a. Couple GRC to duct with adapters designed for this purpose and encase coupling with 3 inches (75 mm) of concrete.
 - b. Stub-Ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum 4 inches (100 mm) above finished floor and minimum 3 inches (75 mm) from conduit side to edge of slab.
 - c. Stub-Ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches (1500 mm) from edge of wall. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum 4 inches (100 mm) above finished floor and no less than 3 inches (75 mm) from conduit side to edge of wall.
10. Reinforcement: Reinforce concrete-encased duct and duct bank where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
11. Forms: Use trench walls to form side walls of duct and duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
12. Concrete Cover: Install a minimum of 3 inches (75 mm) of concrete cover between edge of duct to exterior envelope wall, 2 inches (50 mm) between ducts, and 4 inches (100 mm) between power and communications duct.
13. Concreting Sequence: Pour each run of envelope between maintenance holes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing-rod dowels extending a minimum of 18 inches (450 mm) into concrete on both sides of the joint near the corners of the envelope.
14. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between ducts and at the exterior surface of the envelope. Do not allow a heavy mass of concrete to fall directly onto the duct. Allow concrete to flow to the center of the bank and rise up in the middle,

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uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

- N. Underground-Line Warning Tape: Bury conducting underground-line warning tape specified in Section 270553 "Identification for Communication Systems" no less than 12 inches (300 mm) above all concrete-encased duct and duct bank and approximately 12 inches (300 mm) below grade. Align tape parallel to and within 3 inches (75 mm) of the centerline of the duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

3.1.1.7 INSTALLATION OF CONCRETE MAINTENANCE HOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Maintenance Hole Installation:

1. Finish interior surfaces with a smooth-troweled finish.
2. Knockouts for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches (38 to 50 mm) thick, arranged as indicated.
3. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.

B. Precast Concrete Handhole and Maintenance Hole Installation:

1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units' level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to the same density as adjacent undisturbed earth.

C. Elevations:

1. Maintenance hole Roof: Install with rooftop at least 15 inches (380 mm) below finished grade.
2. Maintenance hole Frame: In paved areas and traffic ways, set frames flush with finished grade. Set other maintenance hole frames 1 inch (25 mm) above finished grade.
3. Install handholes with bottom below frost line.
4. Handhole Covers: In paved areas and traffic ways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

- D. Drainage: Install drains in bottom of maintenance holes where indicated. Coordinate with drainage provisions indicated.

- E. Maintenance hole Access: Circular opening in maintenance hole roof; sized to match

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cover size.

1. Maintenance holes with Fixed Ladders: Offset access opening from maintenance hole centerlines to align with ladder.
 2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with maintenance hole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.
- F. Waterproofing: Apply waterproofing to exterior surfaces of maintenance holes and handholes after concrete has cured for at least three days. Waterproofing materials and installation are specified in the waterproofing section. After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of maintenance hole chimneys after mortar has cured at least three days.
- G. Damp-proofing: Apply damp-proofing to exterior surfaces of maintenance holes and handholes after concrete has cured at least three days. Damp-proofing materials and installation are specified in Section 071113 "Bituminous Damp-proofing." After duct has been connected and grouted, and before backfilling, damp proof joints and connections, and touch up abrasions and scars. Damp Proof exterior of maintenance hole chimneys after mortar has cured at least three days.
- H. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, as required for installation and support of cables and conductors and as indicated.
- I. Fixed Maintenance hole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in maintenance holes.
- J. Field-Installed Bolting Anchors in Maintenance holes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (97 mm) for maintenance holes and 2 inches (50 mm) for handholes, for field-installed anchor bolts installed. Use a minimum of two anchors for each cable stanchion.
- 3.1.1.8 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE
- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct and duct bank, and seal joints between box and extension as recommended by the manufacturer.
 - B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to the same density as adjacent undisturbed earth.
 - C. Elevation: In paved areas and traffic ways, set cover flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
 - D. Install handholes and boxes with bottom below frost line.
 - E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as

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indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

- F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- G. For enclosures installed in asphalt paving and subject to occasional, non-deliberate, heavy-vehicle loading, form and pour a concrete ring, encircling, and in contact with, enclosure, and with top surface screened to the top of the box cover frame. Bottom of the ring shall rest on compacted earth.
 - 1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with a troweled finish.
 - 2. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).

3.1.1.9 MICRO-DUCT INSTALLATION

- A. Beginning installation means the contractor accepts existing conditions.
- B. Contractor shall furnish all required tools to facilitate Micro-duct installation without damage to the micro-duct. Such equipment is to include, but not limited to, sheaves, winches, cable reels, cable reel jackets, duct entrance funnels, pulling tension gauges, and similar devices. All equipment shall be of substantial construction to allow steady progress once pulling has begun. Makeshift devices that may move or wear in a manner to pose a hazard to the micro-duct shall not be used. Pulling a Micro-duct with a motorized vehicle is not acceptable.
- C. Micro-duct pulling shall be done in accordance with the manufacturer's recommendations. Manufacturer's recommendations shall be part of the Micro-duct submittal. Recommended pulling tensions and minimum bending radii shall not be exceeded. Any micro-duct bent or kinked to a radius less than recommended shall not be installed.
- D. During pulling operation an adequate number of workers shall be present to allow observation at all points of duct entry and exit as well as to feed Micro-duct and operate pulling equipment.
- E. Pulling lubricant shall be used to ease pulling tensions. Lubricant shall be of a type that is non-injurious to the Micro-duct sheath material used. Lubricant shall not harden or become adhesive with age.
- F. Avoid abrasion and other damage to Micro-duct during installation.
- G. Prior to pulling Micro-duct, thoroughly mandrel conduits to remove foreign materials. Verify cable trays are free of foreign debris, sharp edges, and protruding uncapped bolts.
- H. Verify tubes are sealed prior to pulling Micro-duct.
- I. Pull Micro-duct with Kellm grips and break away swivels using the manufacturer's recommended pulling tension for break point.

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- J. A minimum of 24 hours shall be maintained between the installation of the Micro-duct and the installation of fiber units per manufacturer's specifications.
- K. The following three test sequences shall be followed per manufacturer's specifications after installation of micro-duct:
 - 1. Air Flow Testing
 - 2. Pressure Testing
 - 3. Continuity Testing
- L. Contractor shall verify that any water in Micro-ducts is removed prior to jetting any fiber unit.
- M. Contractor shall cap all Micro-duct tubes with appropriately sized Micro End Caps

3.1.1.10 GROUNDING

- A. Ground underground duct, duct bank, and utility structures according to Section 270526 "Grounding and Bonding for Communications Systems."

3.1.1.11 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
 - 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch-(300-mm-) long mandrel equal to duct size minus 1/4 inch (6 mm). If obstructions are indicated, remove obstructions and retest.
 - 3. Test maintenance hole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 270526 "Grounding and Bonding for Communications Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.1.1.12 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris.
- B. Clean internal surfaces of maintenance holes, including sump.
 - 1. Sweep floor, removing dirt and debris.
 - 2. Remove foreign material.

END OF SECTION 270543

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SECTION 270544 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

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PART 1 -

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GENERAL

1.1.1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1.1.2 SUMMARY

- A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

- B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
2. A firestop system consists of an item or items penetrating a fire rated structure, the opening in the structure, the sealing materials, and assembly of the materials used to seal the penetrated structure. Firestop systems comprise an effective block for fire, heat, vapor and pressurized water stream. All penetrations through fire rated building structures (walls and floors) shall be sealed with an appropriate firestop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating items i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall be properly fire stopped using state approved fire-resistant materials installed in accordance with the manufacturer's tested methods. All penetrations through fire rated surfaces shall comply with the following:
 - a. ASTM E 84: Standard Test Methods for Surface Burning Characteristics of Building Materials
 - b. ASTM E 119: Methods of Fire Tests of Building Construction Materials
 - c. ASTM E 814: Standard Method of Fire Tests of Through-Penetration Firestops
 - d. ASTM C 719: Adhesion and Cohesion of Elastomeric Joint Sealants under Cyclic Movement
 - e. ASTM C 920: Standard Specification of Elastomeric Joint Sealants
 - f. UL 263: Fire Tests of Building Construction Materials

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- g. UL 723: Surface Burning Characteristics of Building Materials
- h. UL 1479: Fire Tests of Through Penetration Firestops
- i. UL 2079: Standard for Fire Tests of Joint Systems

1.1.1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1.1.1 SLEEVES

- A. Wall Sleeves:
 - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized-steel sheet.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter, less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.1.1.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. STI

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- b. Hilti.
 - c. HOLDRITE.
 - d. Metraflex Company (The).
 - e. Spec Seal
 - f. Or approved equal.
- 2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Carbon steel.
 - 4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.1.1.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Hilti.
 - c. HOLDRITE.
 - d. Metraflex Company (The).
 - e. Spec Seal
 - f. STI
 - g. Or approved equal.

2.1.1.4 GROUT

- A. Description: Non-Shrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.1.1.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

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1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

PART 3 - EXECUTION

3.1.1.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed.
 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved openings.
 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using **[steel]** pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size

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sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

3.1.1.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.1.1.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 270544

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PART 1 -

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GENERAL

1.1.1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1.1.2 SUMMARY

- A. Section Includes:
 1. Color and legend requirements for labels and signs.
 2. Labels.
 3. Bands and tubes.
 4. Tapes.
 5. Signs.
 6. Cable ties.
 7. Fasteners for labels and signs.

1.1.1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for communications identification products.
- B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule:
 1. Outlets: Scaled drawings indicating location and proposed designation.
 2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation.
 3. Racks: Scaled drawings indicating location and proposed designation.
 4. Patch Panels: Enlarged scaled drawings showing rack row, number, and proposed designations.

PART 2 - PRODUCTS

2.1.1.1 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 70 and TIA 606-B.
- B. Comply with ANSI Z535.4 for safety signs and labels.
- C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

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D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.1.1.2 COLOR AND LEGEND REQUIREMENTS

A. Equipment Identification Labels:

1. Black letters on a white field.
2. Identification labels are required on, but not limited to, racks, cabinets, patch panels, cable, grounding busbars.

2.1.1.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Seton Identification Products
 - b. Brother.
 - c. Or approved equal.

B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Seton Identification Products
 - b. Brother.
 - c. Or approved equal.

C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- (0.08-mm-) thick, vinyl flexible labels with acrylic pressure-sensitive adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Seton Identification Products
 - b. Brother.
 - c. Or approved equal.
2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield

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overlaps the entire printed legend.

3. Marker for Labels: Permanent, waterproof black ink marker recommended by tag manufacturer.
 4. Marker for Labels: Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- (0.08-mm-) thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Seton Identification Products
 - b. Brother.
 - c. Or approved equal.
 2. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches (37 by 150 mm) for raceway and conductors.
 - b. 3-1/2 by 5 inches (76 by 127 mm) for equipment.
 - c. As required by authorities having jurisdiction.

2.1.1.4 BANDS AND TUBES

- A. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches (50 mm) long, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Or approved equal.

2.1.1.5 UNDERGROUND-LINE WARNING TAPE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
 2. Or approved equal.
- B. Tape:
1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground communications utility lines.
 2. Printing on tape shall be permanent and shall not be damaged by burial

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operations.

3. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

C. Color and Printing:

1. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, and ANSI Z535.4.
2. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL-FIBER CABLE".

D. Tag: Type I:

1. Pigmented polyolefin, bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Width: 3 inches (75 mm).
3. Thickness: 4 mils (0.1 mm).
4. Weight: 18.5 lb./1000 sq. ft. (9.0 kg/100 sq. m).
5. Tensile according to ASTM D 882: 30 lbs (133.4 N) and 2500 psi (17.2 MPa).

E. Tag: Type II:

1. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Width: 3 inches (75 mm).
3. Thickness: 12 mils (0.3 mm).
4. Weight: 36.1 lb./1000 sq. ft. (17.6 kg/100 sq. m).
5. Tensile according to ASTM D 882: 400 lbs (1780 N) and 11,500 psi (79.2 MPa).

F. Tag: Type ID:

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Width: 3 inches (75 mm).
3. Overall Thickness: 5 mils (0.125 mm).
4. Foil Core Thickness: 0.35 mil (0.00889 mm).
5. Weight: 28 lb./1000 sq. ft. (13.7 kg/100 sq. m).
6. Tensile according to ASTM D 882: 70 lbs (311.3 N) and 4600 psi (31.7 MPa).

G. Tag: Type IID:

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1. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Width: 3 inches (75 mm).
3. Overall Thickness: 8 mils (0.2 mm).
4. Foil Core Thickness: 0.35 mil (0.00889 mm).
5. Weight: 34 lb./1000 sq. ft. (16.6 kg/100 sq. m).
6. Tensile according to ASTM D 882: 300 lbs (1334 N) and 12,500 psi (86.1 MPa).

2.1.1.6 SIGNS

A. Baked-Enamel Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlton Industries, LP.
 - b. Or approved equal.
2. Preprinted aluminum signs punched or drilled for fasteners, with colors, legend, and size required for application.
3. 1/4-inch (6.4-mm) grommets in corners for mounting.
4. Nominal Size: 7 by 10 inches (180 by 250 mm).

B. Metal-Backed Butyrate Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Or approved equal.
2. Weather-resistant, non-fading preprinted, cellulose-acetate butyrate signs, with 0.0396-inch (1-mm) galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
3. 1/4-inch (6.4-mm) grommets in corners for mounting.
4. Nominal Size: 10 by 14 inches (250 by 360 mm).

C. Laminated-Acrylic or Melamine-Plastic Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.

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- b. Or approved equal.
2. Engraved legend.
3. Thickness:
 - a. For signs up to 20 sq. in. (129 sq. cm), minimum 1/16 inch (1.6 mm) thick.
 - b. For signs larger than 20 sq. in. (129 sq. cm), 1/8 inch (3.2 mm) thick.
 - c. Engraved legend with white letters on a dark gray background.
 - d. Punched or drilled for mechanical fasteners with 1/4-inch (6.4-mm) grommets in corners for mounting.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.1.1.7 VELCRO CABLE TIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. HellermannTyton.
 2. Or approved equal.
- B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 deg F (23 deg C) according to ASTM D 638: 12,000 psi (82.7 MPa).
 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 4. Color: Black, except where used for color-coding.
- C. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 deg F (23 deg C) according to ASTM D 638: 12,000 psi (82.7 MPa).
 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 4. Color: Black.
- D. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
 1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 deg F (23 deg C) according to ASTM D 638: 7000 psi (48.2 MPa).

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3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: Black.

2.1.1.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1.1.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond, using materials and methods recommended by the manufacturer of identification products.

3.1.1.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout the Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.
- G. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- H. Vinyl Wraparound Labels:
 1. Secure tight to the surface of the raceway or cable at a location with high visibility and accessibility.
 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
 3. Provide label 6 inches (150 mm) from cable end.
- I. Snap-Around Labels:

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1. Secure tight to surface at a location with high visibility and accessibility.
2. Provide label 6 inches (150 mm) from cable end.

J. Self-Adhesive Wraparound Labels:

1. Secure tight to surface at a location with high visibility and accessibility.
2. Provide label 6 inches (150 mm) from cable end.

K. Self-Adhesive Labels:

1. On each item, install a unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.

L. Snap-Around, Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

M. Underground-Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where the width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.
2. Limit use of underground-line warning tape to direct-buried cables.
3. Install underground-line warning tape for direct-buried cables and cables in raceways.

N. Cable Ties: General purpose, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.1.1.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. The labeling system shall clearly identify all components of the system: racks, cables, panels and outlets. The labeling system shall designate the cable's origin and destination. Station identifiers shall match the corresponding patch panel port number for each drop. The drops will be in consecutive order whenever possible. They shall increment from left to right then top to bottom on each individual faceplate. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. All label printing will be machine generated using indelible ink. Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end.

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- C. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.
- D. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with self-adhesive labels containing wiring system legend.
 - 1. System legends shall be as follows:
 - a. Telecommunications.
- E. Faceplate labels will be the manufacturer's labels provided with the outlet assembly unless otherwise specified. The labeling schema shall be as follows:
 - 1. All labels will be in the format of "310-306-1- 24" Where "310" is the Station room number, "306" is the IDF or MDF room number, "1" is the Patch Panel identifier, and "24" is the port that the drop terminates to in the patch panel.

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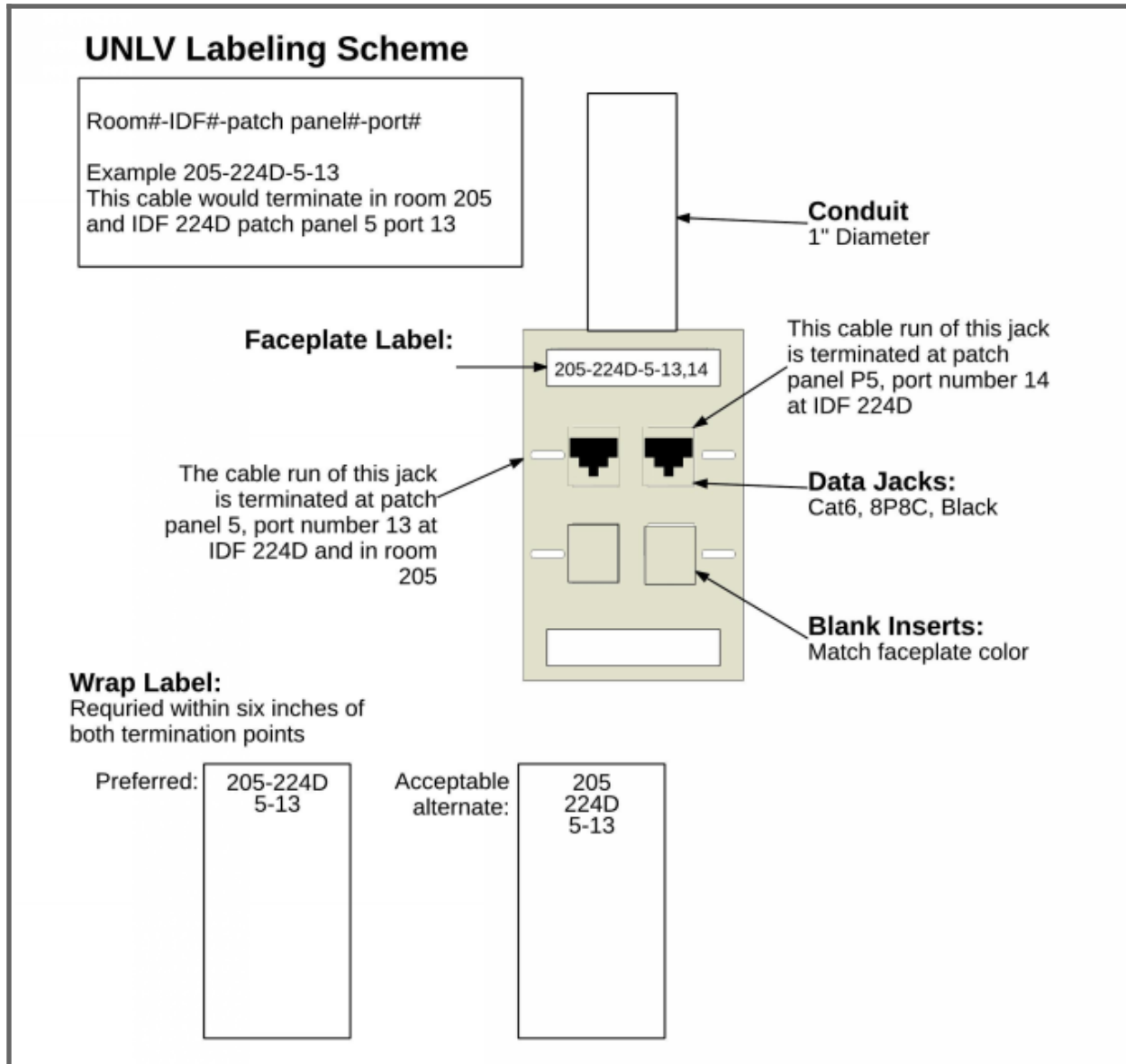


Diagram: UNLV Labeling Scheme

- F. Cable Wrap labels: Wrap labels are required within 6 inches of the cable's termination point at both ends. Wrap labels will follow the format listed in this section, i.e. "310-306-1- 24" Splitting this into two lines is acceptable in which case "310-306" would go on the first line and "1-24" would go on the second line. The font size will be the largest size that fits the required information but no smaller than 8-point font.
- G. Station labels: The Station label will follow the format listed in this section. However, the top label includes both top ports i.e. "310-306-1-24,25". The first patch panel port number will always be the left face plate port and the second patch panel port number will always be the right face plate port. The bottom label will follow the same guidelines when used. When unused the label will be left blank. The font size will be the largest

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size that fits the required information but no smaller than 10-point font.

- H. Data Room Patch Panel: The patch panel identifier will be labeled by the installer on the left side of the patch panel in a place that is easily visible. Counting from the top of the rack down, the first installed patch panel will be identified with the number 1, the second with the number 2 and so on.
- I. The patch panel port label will be in the format listed above "310-306-1- 24". Space limitations will require the label to be in two rows. The font size will be the largest size that fits the required information but no smaller than 8-point font. These labels should be center justified and located directly above the port they are labeling or in other manufacturer provided locations for port labels.

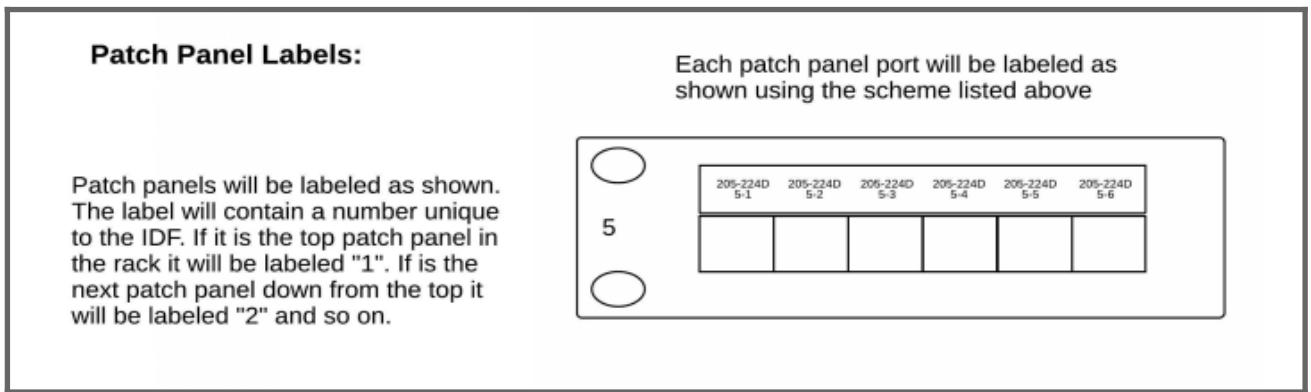


Diagram: Patch Panel Labels

- J. Tube Cell Conduit: The marker plate for tube cell conduit shall be 1"x 3" in size and must be made of a material able to withstand environmental conditions (e.g., extreme heat, underwater, and dirt/dust). The marker plate shall be placed approximately one foot from the conduit entry and exit. The marker plate label will be in the format of V-41-D to V-44-D, where V stands for vault and 41 is the previous vault number and 44 is the next vault number. The letter D shows which section of campus the vault is located in.

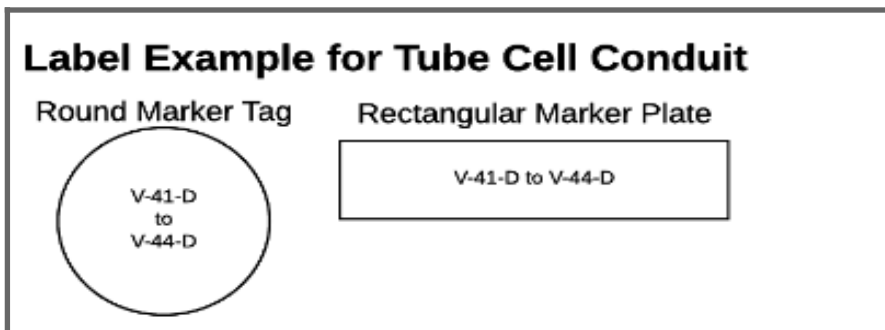


Diagram: Label Example for Tube Cell Conduit

- K. Individual Fiber Microducts: The individual microduct identifier will be labeled by the

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installer within 6 inches of the microduct leaving the cartridge. The label shall be three lines with the first line showing the number of strands and type of fiber. The second line shall show the distant termination points for this microduct. The third line shall show the local termination point for the microduct. The enclosure information (lines 2 and 3) is in the following format: SCS 114 F1 A-C, where SCS is the building name, 114 is the room the enclosure is located, F1 is the enclosure number, A-C are the enclosure slots the strands are located in. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. All label printing will be machine generated using indelible ink. Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end.

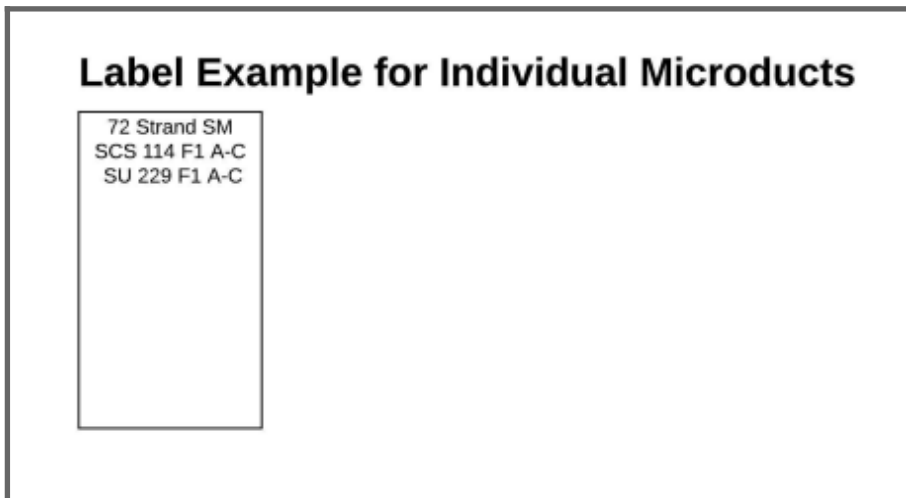


Diagram Label Example for Individual Microducts

L. Equipment Room Labeling:

1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.
2. Patch Panels: Label individual rows in each rack, starting at top and working down, with self-adhesive labels.

M. Fiber Optic Cable Termination Cabinet/Housing Labeling

1. Label each cable with a self-adhesive wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.
2. Fiber optic termination housings shall be labeled using the metal panel provided by the termination-housing manufacturer. The panel shall be overlaid with one-piece, self-adhesive, full-size, laser printer generated label sheet adhered to the slide out metal panel or inside door of the enclosure, where applicable using an 8.5-inch by 11-inch laser printable adhesive backed sheet, part number Avery 5165 or equal. Reference Figure 13.
3. Fiber strand numbering shall be consistent with the Consecutive Fiber

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strand number and the strand type.

P. Fiber Optic Cable Sheath Labeling

1. Fiber optic cables located inside buildings shall have their sheaths labeled within 12 inches of the fiber termination housing, the point at which the cable enters and/or exits the room and at one mid-point location when the cable is installed in a cable tray or ladder rack, as a minimum.
2. Fiber optic cables located in maintenance holes (MH) shall have their sheaths labeled in at least one location that is visible from grade level. MH's and PB's containing splice closures shall be labeled on each side of the splice closure and shall be visible from grade level.
3. The fiber optic cable label shall consist of a plastic yellow and black type tag with a self-laminating cover for use with pre-printed labels and attached with a plastic tie wrap. Panduit type PST-FO, self-laminating GMV4 Rigid Vinyl is the preferred manufacturer, or equal.
4. The individual non-air-blown fiber identifier will be labeled by the installer within 6 inches of the fiber leaving the cartridge. The label shall be four lines with the first line showing the number of strands and type of fiber. The second line shall show the distant termination points for this fiber strand. The fourth line shall show the local termination point for the fiber strand. The third line may be included with lines 2 or 4, if space allows. The fiber information (lines 2 and 4) is in the following format: SCS 114, where SCS is the building name, and 114 is the room the enclosure is located. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. All label printing will be machine generated using indelible ink. Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end.
5. Individual Fiber Microduct the individual microduct identifier will be labeled by the installer within 6 inches of the microduct leaving the cartridge. The label shall be three lines with the first line showing the number of strands and type of fiber. The second line shall show the distant termination points for this microduct. The third line shall show the local termination point for the microduct. The enclosure information (lines 2 and 3) is in the following format: SCS 114 F1 A-C, where SCS is the building name, 114 is the room the enclosure is located, F1 is the enclosure number, A-C are the enclosure slots the strands are located in. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. All label printing will be machine generated using indelible ink. Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end.

Q. Copper Cable Termination Housing Labeling

1. Building entrance terminals shall be labeled with the name of the building, the building zone number, the building CAAN number, the cable pair numbers entering the terminal and the cable pair numbers exiting the terminal (if

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applicable).

2. Labels shall be pre-printed using an electronic label maker such as the Brother P-Touch® or a laser printer. When using an electronic label maker, the label shall be 18 point, "font 1" black block letters on a white background. When printing labels on a desktop printer, the size and type shall be black, Helvetica, 10 Font, block letters on a white background.

R. Copper Cable Sheath Labeling

1. Copper cables located inside buildings shall have their sheaths labeled within 12 inches of the termination housing, the point at which the cable enters and/or exits the room and at one mid- point location when the cable is installed in cable tray or ladder rack, as a minimum.
2. Copper cables located in maintenance holes (MH) and pull boxes (PB) shall have their sheaths labeled in at least one location that is visible from grade level. Existing MH's and PB's containing splice closures shall be labeled on each side of the splice closure and shall be visible from grade level.
3. The copper cable label shall consist of a gray plastic type tag with a write-on surface attached with a plastic tie wrap. Panduit type CM4S-L8 is the preferred and recommended manufacturer, or equal.
4. Horizontal Cables: Label each cable with a self-adhesive wraparound label indicating the following, in the order listed:
 5. Room number.
 6. Colon.
 7. Faceplate number.

S. Locations of Underground Lines: Underground-line warning tape for copper, coaxial, hybrid copper/fiber, and optical-fiber cable.

T. Instructional Signs: Self-adhesive labels.

U. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Self-adhesive labels.

1. Apply to the exterior of the door, cover, or other access.

V. Equipment Identification Labels:

1. Indoor Equipment: Self-adhesive label.
2. Outdoor Equipment: Laminated-acrylic or melamine-plastic sign.
3. Equipment to Be Labeled:
 - a. Communications cabinets.
 - b. Uninterruptible power supplies.
 - c. Computer room air conditioners.
 - d. Fire-alarm and suppression equipment.

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- e. Egress points.
- f. Power distribution components.
- g. Patch panels.
- h. Communications grounding conductors and busbars.

END OF SECTION 270553

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SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

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PART 1 -

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GENERAL

1.1.1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1.1.2 SUMMARY

- A. Section Includes:
 - 1. Backboards.
 - 2. Boxes, enclosures, and cabinets.
 - 3. Power strips.
- B. Related Requirements:
 - 1. Section 271313 "Communications Copper Backbone Cabling" for copper data cabling associated with system panels and devices.
 - 2. Section 271323 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
 - 3. Section 271513 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.
 - 4. Section 271523 "Communications Optical Fiber Horizontal Cabling" for coaxial data cabling associated with system panels and devices.

1.1.1.3 DEFINITIONS

- A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.
- B. BICSI: Building Industry Consulting Service International.
- C. RCDD: Registered communications distribution designer.
- D. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.
- E. SBB: Telecommunications grounding bus bar.
- F. PBB: Telecommunications main grounding bus bar.

1.1.1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

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- B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work before purchase and installation.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
 - 3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.1.1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
- B. Seismic Qualification Data: Certificates, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.1.1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
 - 2. Installation Supervision: Installation shall be under direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

PART 2 - PRODUCTS

2.1.1.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified."

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2.1.1.2 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 A/C Grade 48 by 96 inches (19 by 1220 by 2440 mm).
- B. Backboard Paint: Pre-painted with fire rating stamp visible

2.1.1.3 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Panduit
 - 2. Or approved equal.
- B. All racks are to be four post, open frame, square hole, black, Panduit part number R4PCN. Substitutions must be authorized in writing by UNLV Network Development and Engineering
- C. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets shall be listed and labeled for intended location and use.
- D. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- E. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, Type FD, ferrous alloy, with gasketed cover.
- F. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized cast iron with gasketed cover.
- I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- J. Device Box Dimensions: 5 inches square by 2-7/8 inches deep (125 mm square by 78 mm deep).
- K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 4 with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Non-Metallic Enclosures: Plastic.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- L. Cabinets:
 - 1. NEMA 250, Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with the manufacturer's standard enamel.

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2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.1.1.4 POWER STRIPS

- A. Comply with requirements in Section 271116 "Communications Racks, Frames, and Enclosures."
- B. Power Strips: Comply with UL 1363.
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Vertical or Horizontal Rack mounting, with detachable flanges.
 3. Height: 1 RU.
 4. Housing: Metal.
 5. Six, 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles or (10) 30-A, 240-V ac, NEMA WD 6, Configuration L6-30P receptacles
 6. Front or Rear-facing receptacles.
 7. LED indicator lights for power and protection status.
 8. LED indicator lights for reverse polarity and open outlet ground.
 9. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
 10. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
 11. Cord connected with 15-foot (4.5-m) line cord.
 12. Rocker-type on-off switch illuminated when in on position.
 13. Surge Protection: UL 1449, Type 3.
 - a. Maximum Surge Current, Line to Neutral: 27 kA.
 - b. Protection modes shall be line to neutral, line to ground, and neutral to ground.
 - c. UL 1449 Voltage Protection Rating for line to neutral and line to ground shall be 600 V for neutral to ground.

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PART 3 - EXECUTION

3.1.1.1 ENTRANCE FACILITIES

- A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.
- B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for materials and installation requirements for underground, buried and/or aerial pathways.

3.1.1.2 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.
- C. Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.
- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Cabinet and Racks should be securely attached to the concrete floor using a minimum 3/8" hardware or as required by local codes.
- F. Cabinets and Racks should be placed with a minimum of 36-inch clearance from the walls on all sides of the rack. When mounted in a row, maintain a minimum of 36 inches from the wall behind and in front of the row of racks and from the wall at each end of the row.
- G. All racks and equipment shall be grounded to the telecommunications ground bus bar in accordance with section 27 05 26, Grounding and Bonding for Communications Systems of this document.
- H. Screws not used for installing rack mount patch panels and other hardware should be bagged and left with the rack upon completion of the installation.
- I. Rack mount termination equipment fields should be installed as per the requirements specified by the manufacturer's installation guides.
- J. Coordinate layout and installation of communications equipment in tracks and in room. Coordinate service entrance configuration with service provider.
 - 1. Meet jointly with systems providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations

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and space requirements of communications equipment.

4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

K. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

L. Backboards:

1. Install from 6 inches (150 mm) to 8 feet, 6 inches (2588 mm) above the finished floor. Ensure that fire-rating stamp is visible after installation.
2. Install plywood backboard with A grade exposed and C grade facing the wall.
3. Paint all sides of the backboard with two coats of paint, leaving fire rating stamp visible unless instructed otherwise by the owner in written instructions.
4. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" (current version) and TIA-569-D.

3.1.1.3 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.1.1.4 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices" Ch.

3.1.1.5 CABLE MANAGEMENT

- A. Comply with Section 271116 "Communications Cabinets, Racks, Frames and Enclosures."
- B. Cables may be loosely bundled using Velcro cable wraps; Plastic cable ties are prohibited.
- C. All cables, whether on the backing boards or in an equipment rack shall have cable management devices installed to support the cabling.
- D. Cable management devices supplied with termination devices or equipment racks shall be used as required for a neat and workmanlike installation

3.1.1.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606 standard.

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Comply with requirements in Division 27 Section "Identification for Communications Systems."

- B. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over the manufacturer's label.
- C. Paint and label colors for equipment identification shall comply with TIA/EIA-606 standard for Class 3 level of administration.

END OF SECTION 271100

SECTION 271116 - COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

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PART 1 -

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GENERAL

1.1.1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1.1.2 SUMMARY

- A. Section Includes:
 - 1. 19-inch equipment racks.
 - 2. Power strips.
 - 3. Grounding.
 - 4. Labeling.
- B. Related Requirements:
 - 1. Section 271110 "Communications Equipment Room Fittings" for backboards and accessories.
 - 2. Section 270526 "Grounding and Bonding for Telecommunications Equipment" for TMGBs and TGBs.
 - 3. Section 271313 "Communications Copper Backbone Cabling" for copper data cabling associated with system panels and devices.
 - 4. Section 271323 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
 - 5. Section 271513 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.

1.1.1.3 DEFINITIONS

- A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.
- B. BICSI: Building Industry Consulting Service International.
- C. LAN: Local area network.
- D. RCDD: Registered communications distribution designer.
- E. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.
- F. TGB (PBB): Telecommunications grounding bus bar.
- G. TMGB (SBB): Telecommunications main grounding bus bar.

1.1.1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

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1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
 2. Include rated capacities, operating characteristics, electrical characteristics, certifications, standards compliance, and furnished specialties and accessories.
- B. Shop Drawings: For communications racks, frames, and enclosures. Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
 3. Grounding: Indicate location of TGB (PBB) and its mounting detail showing standoff insulators and wall-mounting brackets.

1.1.1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
- B. Seismic Qualification Data: Certificates, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.1.1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD
 2. Installation Supervision: Installation shall be under direct supervision of RCDD who shall be present at all times when Work of this Section is performed at Project site.
 3. Field Inspector: Currently registered by BICSI as RCDD to perform on-site inspection.

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PART 2 - PRODUCTS

2.1.1.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined according to Telcordia GR-63-CORE requirements for Zone 4 Seismic Earthquake Environments.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- B. UL listed.
- C. RoHS compliant.
- D. Compliant with requirements of the Payment Card Industry Data Security Standard.

2.1.1.2 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels specified in Section 061000 "Rough Carpentry." 3/4" AC Grade fire rated

2.1.1.3 19-INCH EQUIPMENT RACKS

- A. Description: **four** post racks with cage nut rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch (482.6-mm) equipment mounting with an opening of 17.72-inches (450-mm) between rails.
- B. Description: **two** post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-D, 19-inch (482.6-mm) equipment mounting with an opening of 17.72-inches (450-mm) between rails.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Table: Approved Manufacturer Parts List

APPROVED MANUFACTURER'S PARTS LIST		
EQUIPMENT RACKS AND CABINETS		
ITEM DESCRIPTION	MANUFACTURER	MODEL NUMBER
4-POST RACK, STEEL, 45 RU, 30-INCH DEPTH, CAGE NUT MOUNTING HOLES, BLACK	PANDUIT	R4PCN

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2-POST RACK, ALUMINUM, 45 RU, 12-24 THREAD MOUNTING HOLES	PANDUIT	R2P
GROUND MOUNTED CABINET, NEMA 4/4X, 26 RU, 48"H X 24"W X 31"D	PANDUIT	ZDF48-6EA
WALL MOUNT CABINET, NEMA 12K, 19RU, 36"H X 24"W X 30"D, 28" USABLE DEPTH	GREAT LAKES	GL360N12DA
CABLE MANAGERS AND SHELVES		
PATCHLINK HORIZONTAL CABLE MANAGER, 1 RU, SINGLE SIDED, BLACK	PANDUIT	WMPFSE
PATCHLINK HORIZONTAL CABLE MANAGER, 2 RU, SINGLE SIDED, BLACK	PANDUIT	WMPF1E
PATCHRUNNER VERTICAL CABLE MANAGER, 45 RU, DUAL-SIDED, BLACK, W/ 2 FULL LENGTH, METAL, DUAL-HINGE, PUSH-TO-CLOSE DOORS	PANDUIT	PR2VD08
RACKMOUNT SHELF, VENTED, 2 RU, 16-INCH DEPTH	STARTECH	CABSHELFV
MICRODUCT DISTRIBUTION BOXES		
JUNCTION BOX; WALL-MOUNT; STEEL; GRAY; NEMA13; HINGED; 1/4 TURN LATCH, 16X12X8IN	HOFFMAN	CSD16128
JUNCTION BOX; WALL-MOUNT; STEEL; GRAY; NEMA13; HINGED; 1/4 TURN LATCH, 20X20X8IN	HOFFMAN	CSD20208
JUNCTION BOX; WALL-MOUNT; STEEL; GRAY; NEMA13; HINGED; 1/4 TURN LATCH, 24X24X10IN	HOFFMAN	CSD242410
JUNCTION BOX; WALL-MOUNT; STEEL; GRAY; NEMA4X; HINGED; 1/4 TURN LATCH, 16X12X8IN	HOFFMAN	CSD16128SS
JUNCTION BOX; WALL-MOUNT; STEEL; GRAY; NEMA4X; HINGED; 1/4 TURN LATCH, 20X20X8IN	HOFFMAN	CSD20208SS
JUNCTION BOX; WALL-MOUNT; STEEL; GRAY; NEMA4X; HINGED; 1/4 TURN LATCH, 24X24X10IN	HOFFMAN	CSD242410S S

D. General Requirements:

1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Material: Extruded steel
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Color: Black.

E. Floor-Mounted Racks:

1. Overall Height: 84 inches (2133.6 mm)

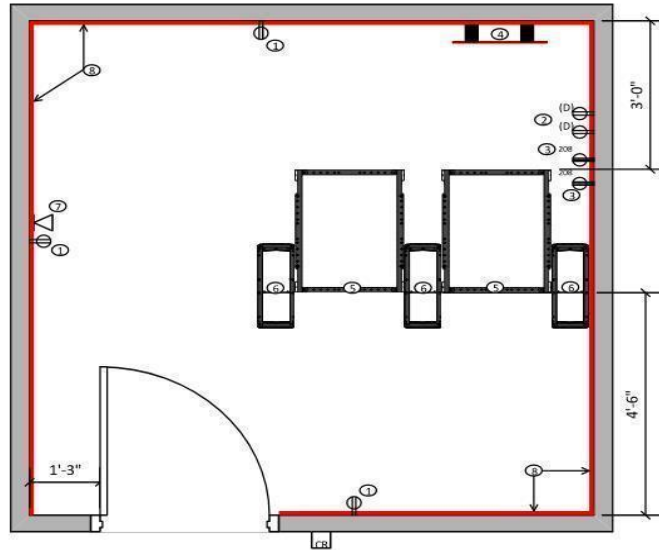
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2. Overall Depth: 30 inches (762 mm)
3. Overall Width; 23.25 (591 mm)
4. Four-Post Load Rating: [2000 lb. (907 kg).
5. Number of Rack Units per Rack: 45
 - a. Numbering: Every rack unit, on the interior of the rack.
6. Threads: [12-24]
7. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
8. Base shall have a minimum of four mounting holes for permanent attachment to floor.
9. Top shall have provisions for attaching to cable tray or ceiling.
10. Self-leveling.

F. Cable Management:

1. Panduit #PR2VD08 Dual-Sided Vertical Cable Manager, 8" Wide, 7-foot
2. Metal, with integral wire retaining fingers.
3. Baked-polyester powder coat finish.
4. Vertical cable management panels shall have front and rear channels, with covers.
5. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

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This is for initial design only.

OIT shall provide room layout and rack elevations to Planning and Construction for use in design.

Room size may vary depending on the number of data cables run to the MDF.

Reference current UNLV OIT Wiring Specifications for full room requirements.

KEYNOTES	
Number	Description
①	Non-Dedicated 20 Amp Receptacle
②	Dedicated 20 Amp NEMA 5-20 Receptacle
③	Dedicated 30 Amp NEMA L6-30 Receptacle
④	Secondary Grounding Busbar
⑤	4-post Network Rack
⑥	8-inch Vertical Manager
⑦	2-port Data outlet (location to be verified by NDE)
⑧	Fire-treated backer board, 3/4", 4' x 8', bottom at 8" AFF

Space Type: Support: IDF Room

Square Footage: 100 minimum

Audio/Visual: N/A

Ceiling: N/A

Adjacency: Central to served area

Fixed Equipment: Network Rack - anchored to floor

Casework: N/A

Natural Lighting: No

Heating and Cooling: Dedicated HVAC. Provide discrete support cooling system

Walls: Semi-gloss paint

Artificial Lighting: Service w/glare Reduction

Access: Proximity with backup keyed access

Other Requirements: Access to cable trays.

Acoustical Issues: N/A
Communications: As shown

Sleeve 4" conduits into room – exact location and number to be coordinated with IT.

Flooring: Sealed concrete or low dissipative VCT

Ladder rack to be installed at 90" AFF and shall be 18" wide. Layout to be determined by OIT

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Diagram: IDF Room Layout for Initial Design

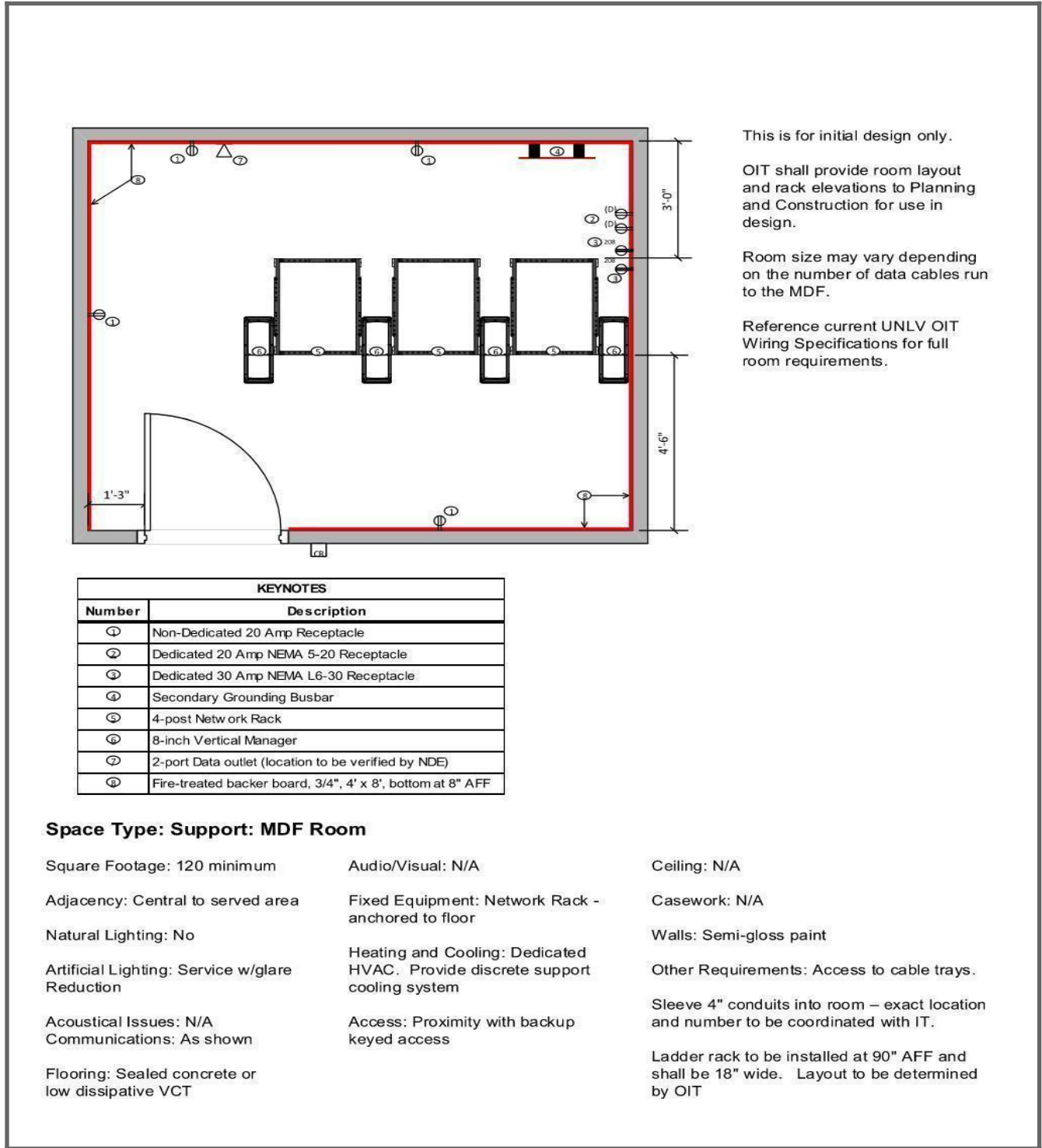


Diagram: MDF Room Layout for Initial Design

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2.1.1.4 CABINET/RACK POWER

- A. Each MDF Cabinet/Rack will have two quad 20 amp, 110 V.A.C. outlets, terminated with NEMA 5-20Rs, two 30 amp 208 V.A.C. outlets, terminated with NEMA L6-30Rs. All outlets will require dedicated electrical circuits. When available, all outlets will be serviced by the emergency power system and colored orange or otherwise marked as such. All outlets will be positioned within 4 feet of the rear of the provided racks at standard outlet height.
- B. Each IDF Cabinet/Rack will have two quad 20 amp, 110 V.A.C. outlets, terminated with NEMA 5-20Rs and two 30 amp 208 V.A.C. outlets, terminated with NEMA L6-30Rs. All outlets will require dedicated electrical circuits. When available, all outlets will be serviced by the emergency power system and colored orange or otherwise marked as such. All outlets will be positioned within 4 feet of the rear of the provided racks, at standard outlet height.
- C. Each IDF will include (2) non-dedicated, duplex, 110 VAC, 15 Amp convenience outlets as per TIA/EIA standard

2.1.1.5 POWER STRIPS

- A. Power Strips: Comply with UL 1363.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Rack mounting.
 - 3. Six **[15-A, 120-V ac, NEMA WD 6, Configuration 5-15R]** **[20-A, 120-V ac, NEMA WD 6, Configuration 5-20R]** receptacles or 30-A, 240-V ac, NEMA WD 6, Configuration L6-30P receptacles
 - 4. LED indicator lights for power and protection status.
 - 5. LED indicator lights for reverse polarity and open outlet ground.
 - 6. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
 - 7. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
 - 8. **[Close-coupled, direct plug-in]** **[Cord connected with 15-foot (4.5-m)]** line cord.
 - 9. Rocker-type on-off switch illuminated when in on position.
 - 10. Peak Single-Impulse Surge Current Rating: **[33]** kA per phase.
 - 11. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all three modes shall be not more than 330 V.
 - 12. Manufacturer to be called out by owner

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2.1.1.6 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Chatsworth Products, Inc.
 - 2. Harger Lightning & Grounding.
 - 3. Panduit Corp.
 - 4. Or approved equal.
- C. Rack and Cabinet TGBs (PBB): Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-606-B. Predrilling shall be with holes for use with lugs specified in this Section.
- D. The MDF will require the installation of a rack bonding busbar (RBB) connected with a rack bonding conductor through a telecommunications equipment bonding conductor (TEBC) using an irreversible compression connector sized to match the conductor gauges. The TEBC is then bonded directly to the SBB that is continuous copper conductor not less than #6 AWG.

The RBB shall:

- 1. Be provided with holes for use with correctly matched listed lugs and hardware.
 - 2. Be made of copper, or copper alloys having a minimum of 95% conductivity when annealed as specified by the International Annealed Copper Standard (IACS).
 - 3. Have minimum dimensions of 3/16 in. (4.76mm) thick by 3/4 in. (50mm) wide and shall be 19 in. (482.6mm) long.
 - 4. Shall mount to the back rack rails at the top of each rack.
 - 5. Be listed.
- E. The IDF will require the installation of a rack bonding busbar (RBB) connected with a rack bonding conductor through a telecommunications equipment bonding conductor (TEBC) using an irreversible compression connector sized to match the conductor gauges. The TEBC is then bonded directly to the SBB that is continuous copper conductor not less than #6 AWG.

The RBB shall:

- 1. Be provided with holes for use with correctly matched listed lugs and hardware.
- 2. Be made of copper, or copper alloys having a minimum of 95% conductivity when annealed as specified by the International Annealed Copper Standard (IACS).

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3. Have minimum dimensions of 3/16 in. (4.76mm) thick by 3/4 in. (50mm) wide and shall be 19 in. (482.6mm) long.
4. Shall mount to the back rack rails at the top of each rack.
5. Be listed.

2.1.1.7 LABELING

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1.1.1 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI TDMM for layout of communications equipment spaces.
- C. Comply with BICSI ITSIMM for installation of communications equipment spaces.
- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.
 1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
 2. Record agreements reached in meetings and distribute them to other participants.
 3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
 4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
- F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.1.1.2 GROUNDING

- A. Comply with NECA/BICSI 607.
- B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Ch.
- C. Locate TGB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches (50 mm) of clearance behind TGB (PBB). Connect TGB (PBB) with a

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minimum No. 4 AWG grounding electrode conductor from TGB (PBB) to suitable electrical building ground. Connect rack TGB (PBB) to near TGB (PBB) or the TMGB (SBB).

1. Bond the shield of shielded cable to patch panel, and bond patch panel to TGB (PBB) or TMGB (SBB).

3.1.1.3 IDENTIFICATION

- A. Coordinate system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Section 270553 "Identification for Electrical Systems."
- B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over the manufacturer's label.
- C. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 3 level of administration, including optional identification requirements of this standard.
- D. Labels shall be machine printed. Type shall be [**1/8 inch (3 mm)**] [**3/16 inch (5 mm)**] [**1/4 inch (6 mm)**] in height.

END OF SECTION 271116

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SECTION 271313 - COMMUNICATIONS COPPER BACKBONE CABLING

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PART 1 -

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GENERAL

1.1.1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.1.1.2 SUMMARY

- A. Section Includes:
 - 1. Twisted pair cable hardware, including plugs, jacks, patch panels, and cross-connects.
 - 2. High-count Category 5e twisted pair cable (legacy installations only).
 - 3. Grounding provisions for twisted pair cable.
 - 4. Cabling identification.
 - 5. Source quality control requirements for twisted pair cable.
- B. Related Requirements:
 - 1. Section 270513 "Conductors and Cables for Communications Systems" for data cabling associated with system panels and devices.

1.1.1.3 DEFINITIONS

- A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- B. EMI: Electromagnetic interference.
- C. F/FTP: Overall foil screened cable with foil screened twisted pair.
- D. FTP: Shielded twisted pair.
- E. F/UTP: Overall foil screened cable with unscreened twisted pair.
- F. IDC: Insulation displacement connector.
- G. Jack: Also commonly called an "outlet," it is the fixed, female connector.
- H. LAN: Local area network.
- I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
- J. RCDD: Registered Communications Distribution Designer.
- K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- L. S/FTP: Overall braid screened cable with foil screened twisted pair.
- M. Shield: A metallic layer, either a foil or braid, placed around a pair or group of

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conductors.

- N. S/UTP: Overall braid screened cable with unscreened twisted pairs.
- O. UTP: Unscreened (unshielded) twisted pair.

1.1.1.4 COPPER BACKBONE CABLING DESCRIPTION

- A. Copper backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
- B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.1.1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by RCDD.
 - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by the Owner.
 - 2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
 - 3. Cabling administration Drawings and printouts.
 - 4. Wiring diagrams to show typical wiring schematics, including the following:
 - a. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system
 - e. Cross-connects.
 - f. Patch panels.
 - g. Patch cords.
 - 5. Cross-Connects and Patch Panels: Detail mounting assemblies, and show elevations and physical relationship between the installed components.
- C. Twisted pair cable testing plan.

1.1.1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For RCDD, installation supervisor, and field inspector.
- B. Source quality-control reports.

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- C. Product Certificates: For each type of product.
- D. Field quality-control reports.

1.1.1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For splices and connectors to include in maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On USB media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.
- C. All installed cabling, infrastructure and end devices (as requested) will be documented on an as-built diagram and a record drawing in CAD format. As-builts will be provided to UNLV Planning and Construction (P&C) in PDF format at substantial completion and record drawings in CAD format within 30 days of substantial completion or at end of the project (whichever comes first). All CAD drawings will be provided in AutoCAD 2014 or AutoCAD 2020 format but saved down to AutoCAD 2014. Network Development and Engineering (NDE) will provide quality control and verify that the data and infrastructure requested/required to be documented is contained within the drawings. As-builts and record drawings will be created from the latest digital architectural drawings provided by P&C. Hand drawings are not acceptable. In the record drawing, several layers will be created or updated which will be used to document the below. It will include but is not limited to:
 - 1. Conduit (existing and newly installed)
 - 2. Cable Tray (existing and newly installed)
 - 3. J-hook (existing and newly installed)
 - 4. Cable Path
 - 5. Outlet Locations
 - 6. Fiber Path
 - 7. Fiber Enclosures (existing and newly installed)
 - 8. Microducts (existing and newly installed)
 - 9. End devices (Wireless Access Points, Security Cameras, etc)
 - 10. Any additional layers or information requested by NDE
- D. Contractor must allocate ample time for verification of as-builts, record drawings and subsequent corrected versions of those documents. If any record drawing/architectural drawing provided by P&C is not using the most recent drawing requirements (which will

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be provided at substantial completion), contractor shall update the drawing to ensure it complies. Network equipment (Including Voice, Data and A/V services) will not be provisioned until receipt of accepted test results and preliminary as-built drawings.

1.1.1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. A minimum of the items below. More may be required based upon the project size.
 - 1. Connecting Blocks: One of each type.
 - 2. Patch-Panel Units: One of each type.
 - 3. Plugs: Ten of each type.
 - 4. Jacks: Ten of each type.

1.1.1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field-testing program development by a Technician.
 - 2. Installation Supervision: Installation shall be under the direct supervision of RCDD, who shall be present at all times when work of this Section is performed at Project site.
 - 3. Testing Supervisor: Currently certified by BICSI as a Technician to supervise on-site testing.
- B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.1.1.10 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test each pair of twisted pair cable for open and short circuits.

1.1.1.11 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and a temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.1.1.12 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

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PART 2 - PRODUCTS

2.1.1.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agencies.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 450 or less.
- C. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- D. Grounding: Comply with TIA-607-B.

2.1.1.2 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. Communications, Plenum Rated: Type CMP complying with UL 1685
 - 2. Communications Riser Rated: Type CMR to complying with UL 1666.
- B. RoHS compliant.

2.1.1.3 HIGH-COUNT CATEGORY 5e TWISTED PAIR CABLE

- A. Description: 25 and 50-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Commscope/Uniprise
 - 2. Leviton/Berktek
 - 3. Siemon
 - 4. Panduit
 - 5. TE Connectivity
- C. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 5e cables.
- D. Conductors: 100-ohm, 24 AWG solid copper.
- E. Shielding/Screening: Unshielded balanced twisted pairs (UTP).
- F. Cable Rating: Riser.

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G. Jacket: Gray thermoplastic.

2.1.1.4 TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

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

1. Commscope/Uniprise
2. Leviton/Berktek
3. Siemon
4. Panduit
5. TE Connectivity
6. Approved equal

C. General Requirements for Cable Connecting Hardware:

1. Twisted pair cable hardware shall meet the performance requirements of Category 5e.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.
4. Source Limitations: Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.

D. Connecting Blocks: 110-style IDC for Category 5e. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

F. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Features:
 - a. Universal T568A and T568B wiring labels.
 - b. Labeling areas adjacent to conductors.
 - c. Replaceable connectors.
 - d. 24 or 48 ports.

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2. Construction: 16-gauge steel and mountable on 19-inch (483 mm) equipment racks.
3. Number of Jacks per Field: One for each four-pair twisted pair cable indicated.

G. Plugs and Plug Assemblies:

1. Male; eight position (8P8C); color-coded modular telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded twisted pair cable.
2. Standard: Comply with TIA-568-C.2.
3. Marked to indicate transmission performance.

H. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standard: Comply with TIA-568-C.2.
4. Marked to indicate transmission performance.

I. Patch Cords: Factory-made, four-pair cables in 36-inch (900-mm) lengths; terminated with an eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

J. Legend:

1. Factory labeled by silk-screening or engraving for stainless steel faceplates.
2. Machine printed, in the field, using adhesive-tape label.
3. Snap-in, clear-label covers and machine-printed paper inserts.

K. Splices

1. Copper cable splices (Aerial, Underground, and Direct-buried) shall be sealed using a bolt together, washer-less, stainless-steel type of closure with field adaptable/drillable/reusable 1, 2 and 3 section end plates to match the existing cable plant. Closure shall be Preformed Line Products® (PLP) or equal. No known equal.
2. The closure shall be sized to allow sufficient interior space for the fold-back method of splicing and to allow for the addition of future bridge spliced cables.
3. The closure shall be air pressure tested (flash-tested) upon installation and shall not be filled with encapsulant.

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4. All splice closures shall be properly supported, racked and lashed to the MH racks. Closures shall be supported by their own individual cable steps, in addition to the steps used to support the cable itself.
5. All splice closures shall be properly grounded to the MH grounding and bonding system.
6. All splices shall be inspected by a Communication Resources designated representative prior to the completion and sealing of the splice.

2.1.1.5 CABLING IDENTIFICATION

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

TERMINATION TYPE	COLOR	COMMENTS
First level backbone	Blue	Terminations of building backbone cable connecting MC to IC's
Horizontal	White	Terminations of horizontal cable in TS
Campus backbone	Green	Termination of backbone cable between buildings

2.1.1.6 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-B.
- C. Comply with NEC 250

2.1.1.7 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test cables on reels according to TIA-568-C.1.
- C. Factory test cables according to TIA-568-C.2.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1.1.1 ENTRANCE FACILITIES

- A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.
- B. Every High-pair copper cable shall be bonded and grounded for lightning protection per NEC 800-30A at both terminations using solid-state 5-pin protectors, 50 to 100-volt range.
- C. All copper cables shall be thoroughly cleaned and scuffed in a manner to insure a good mechanical bond when splicing. 3M Scotchcast 4435 non-conductive aluminum oxide

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abrasive strip, or UNLV approved equal shall be used. All cable shall be thoroughly cleaned with a non-toxic solvent, 3M Scotch cast 4414 or 4415 or UNLV approved equal.

3.1.1.2 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters. Conceal raceway and cables, except in unfinished spaces.
 - 1. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install cables parallel with or at right angles to sides and back of enclosure.

3.1.1.3 INSTALLATION OF PATHWAYS

- A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."
- B. Comply with Section 270528 "Pathways for Communications Systems."
- C. Drawings indicate general arrangement of pathways and fittings.
- D. End caps must be tapered and flexible and be capable of separate cable entries.
- E. Rigid bonding and strain relief bars must be an integral part of the finished closure.
- F. Re-enterable, polyurethane compound shall be used.

3.1.1.4 INSTALLATION OF COPPER BACKBONE CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. General Requirements for Cabling:
 - 1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
 - 2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM)," Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.
 - 4. Do not untwist twisted pair cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
 - 5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch

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panels.

6. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section Use lacing bars and distribution spools.
9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
10. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
11. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
12. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
13. No splice cases will be permitted in cable trays.
14. All splice closures for use on underground non-pressurized systems shall be manufactured of clear, self-extinguishing, tongue and groove fitting PVC.
15. All cable splices must be tagged or marked showing the cable number and pair count spliced. Markings may be placed on the splice closure or on both the in and out cables.
16. Supports: All cable splices shall be supported by a minimum of two cable hooks. Horizontal racking for support may utilize 3M Brand RC-100 rack adapters, manhole racks, or University approved equivalent.
17. Closures: 3M splice closures or University approved closures will be used for splicing throughout the system.
18. Protection: All cable splices must be protected from damage at sheath openings by mechanically protecting all conductors utilizing 3M Scotchcast Pair Saver 4458 or approved equivalent

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches

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(1524 mm) apart.

3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- D. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
 2. Install cabling after the flooring system has been installed in raised floor areas.
 3. Coil cable 6 feet (1800 mm) long not less than 12 inches (300 mm) in diameter below each feed point.
- E. Group connecting hardware for cables into separate logical fields.
- F. Separation from EMI Sources:
1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
 4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).

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- c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
- 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
- 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.1.1.5 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

3.1.1.6 GROUNDING

- A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- B. Comply with TIA-607-B, NECA/BICSI-607 and NEC 250.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.1.1.7 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 - 1. Administration Class: 3
 - 2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 4 level of administration, including optional identification requirements of this standard.
- C. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling" for cable and asset management software.
- D. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with a rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

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- E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, 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.
- F. Cable and Wire Identification:
 - 1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
 - 4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
 - b. Label each unit and field within distribution racks and frames.
 - 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- G. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
 - 1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.1.1.8 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
 - 1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling

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terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA-568-C.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 3. Test cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- F. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.
- G. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- H. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- I. Prepare test and inspection reports.
- J. All Data cables shall be tested in accordance with TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standard or better and best industry practices. If any of these are in conflict, the Contractor shall be responsible to bring any discrepancies to the attention of UNLV Network Development and Engineering. All results shall be PASS. Any *PASS test results will require troubleshooting and repair of the cable in question to achieve a PASS test result.
- K. Each cable shall be tested for wire map, length and performance. The data cables shall be bi-directional tested using a TIA 1152 level III or better cable analyzer. The cable analyzer shall be within the calibration period recommended by the manufacturer.

END OF SECTION 271313

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SECTION 271323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

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PART 1 -

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GENERAL

1.1.1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Equipment and material shall be Underwriter's Laboratories listed and labeled. The latest editions of the following standards are minimum requirements. If a conflict exists between applicable documents, then the order in the list below shall dictate the order of precedence in resolving conflicts. This order of precedence shall be maintained unless a lesser order document has been adopted as code by a local, state, or federal entity, and is therefore enforceable as law by a local, state, or federal inspection agency.
 - 1. BICSI TDMM Current Version
 - 2. BICSI ITSIMM Current Version
 - 3. ANSI/TIA-569-D Telecommunications Pathways and Spaces
 - 4. ANSI/TIA 568.0-D Generic Telecommunications Cabling for Customer Premises
 - 5. ANSI/TIA-568.1-D Commercial Building Telecommunications Cabling Standard
 - 6. ANSI/TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standard
 - 7. ANSI/TIA-568.3-D Optical Fiber Cabling Components Standard
 - 8. ANSI/TIA-606-C Administration Standard for Telecommunications Infrastructure
 - 9. ANSI/TIA-607-D Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
 - 10. ANSI/TIA-1152 Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling National Electrical Manufacturers Association (NEMA)
 - 11. National Electrical Code, latest revision (NEC)
 - 12. National Fire Protection Agency (NFPA) – 70
 - 13. Local, State and Federal Codes including Nevada Revised Statute (NRS) 278.583
 - 14. UL 497 Protectors
 - 15. UL 1459 Standard for Safety for Telephone Equipment
 - 16. UL 1863 Standard for Safety for Communications Circuit Accessories
 - 17. UL 2024 Standard for Safety for Optical Fiber Cable Raceway
 - 18. UL 723 Standard for Safety for Surface Burning Characteristics of Building Materials

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- 19. UL 1581 Standard for Safety for Reference Standard for Wires, Cables and Flexible Cords
- 20. National Electrical Safety Code (NESC)

1.1.1.2 SUMMARY

A. Section Includes:

- 1. 9/125 micrometer single-mode, indoor-outdoor optical fiber cable (OS2).
- 2. 9/125 micrometer single-mode, inside plant optical fiber cable (OS2).
- 3. 9/125 micrometer single-mode, Air-Blown outside plant optical fiber cable (OS2).
- 4. Optical fiber cable connecting hardware, patch panels, and cross-connects.
- 5. Cabling identification products.

1.1.1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- C. RCDD: Registered Communications Distribution Designer.

1.1.1.4 OPTICAL FIBER BACKBONE CABLING DESCRIPTION

- A. Optical fiber backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. The cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
- B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.
- C. Data communication service to each building shall consist of a minimum of 48 strands of 8.50/125-micron single-mode fiber and terminated at two separate major distribution locations on campus as determined by UNLV Network Development and Engineering. Fiber optic cable is to be contained in its own air-blown fiber tube-cell conduit. Single-mode fiber is to be terminated with LC style cassette connectors, UPC. Single-mode fiber will be terminated in a separate rack-mounted fiber optic enclosure. Contractor will install an air-blown fiber distribution unit in all MDF and IDF locations. Each fiber optic enclosure must be labeled with building, IDF room number, and fiber enclosure identifier of the opposing end. Patch panels to be mounted in such a manner as to allow the maximum usage of each rack. Appropriate wire management, determined by consultation with Network Development and Engineering and with regards to building design, shall be installed. Service loops of 10 feet of fiber-optic cable will be coiled, to meet manufacturer specifications, at both termination points within the fiber enclosure. Complete IDF room design, including rack layout, power requirements, cable management will be provided by UNLV Network Development and Engineering.

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D. Building to Building

1. All fiber installations for building to building interconnects will use air-blown fiber solutions. Contractors shall install components from a manufacturer on the approved air-blown fiber manufacturer list.

E. New Building

1. All fiber installations for new buildings on campus, including building to building interconnects and MDF to IDF connections will use air-blown fiber solutions. Contractors shall install components from a manufacturer on the approved air-blown fiber manufacturer list.

F. Existing Building

1. All fiber installations for buildings with existing air-blown fiber infrastructure will be installed using air-blown fiber solutions. Contractors shall install components from a manufacturer on the approved air-blown fiber manufacturer list.
2. All fiber installations for buildings without existing air-blown fiber infrastructure will be installed using traditional fiber cabling. Contractors shall install components from a manufacturer on the approved fiber manufacturer list.

G. Innerduct

1. Installation of non-air-blown (traditional) fiber cabling into a conduit shall require the installation of tube type innerduct. Innerduct sizing shall be large enough to ensure no more than a 60% fill ratio. Innerduct flammability requirements (e.g., plenum, non-plenum) shall be verified prior to installation and shall have a pull string inside the innerduct.
2. Fabric mesh type innerduct (MaxCell) may also be used

1.1.1.5 CONTRACTORS QUALIFICATIONS

- A. Contractor must possess a valid State of Nevada Contractor's License and have successfully performed at least three projects of low voltage cable installation with similar size and work scope, within two years of the date of the job they are bidding on. Proof of performance shall be in the form of reference sheets which shall include a brief description of the project, the start and end dates, and contact information.
- B. All contractor personnel who will be performing work on this project shall have been trained on the work they will be performing. They shall have been trained on the Contractor's company policies with respect to personnel safety, telecommunications industry cabling quality and neatness standards, and use of Construction Standard Institute (CSI)-standard specifications and drawings.
- C. Contractor, at all times during performance and until work is completed and accepted, shall have on the premises a competent supervisor, satisfactory to the Customer, and with authority to act for the Contractor. The supervisor must be a BICSI certified Installer and BICSI member in good standing.
- D. As a requirement to bidding and performing awarded work, the Contractor must have a current BICSI certified Registered Communications Distribution Designer (RCDD) on

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staff, either as a full-time employee or as a hired consultant. At UNLV's discretion, on a project-by-project basis, an RCDD consultant may be hired by the university to inspect work during and after completion. In these cases, the RCDD requirement will be met by the university and the Contractor will not be required to have an RCDD on staff. Based upon the inspection by UNLV's hired RCDD consultant or Network Development & Engineering (NDE) staff the Contractor will be responsible for correcting any work that does not meet the requirements detailed in this document.

- E. For jobs that require more than 24 data connections, weekly inspections, and approval of all work performed shall be conducted by the contractor's RCDD certified employee. The contractor will submit a weekly status report to the Customer detailing what work has been completed and inspected. The report will also include any issues encountered as part of the install.

1.1.1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by RCDD.
 - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by the Owner.
 - 2. Floor plan drawings and riser diagrams with all fiber routing indicating cabling distances, fiber manufacturer, and fiber type in CAD, Revit, or PDF format for review prior to purchase.
 - 3. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
 - 4. Cabling administration drawings and printouts.
 - 5. Wiring diagrams to show typical wiring schematics including the following:
 - a. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system.
 - e. Cross-connects.
 - f. Patch panels/Fiber enclosures.
 - g. Patch cords.
 - 6. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.
- C. Optical fiber cable testing plan.

1.1.1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For RCDD, installation supervisor, and field inspector.

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- B. Source quality-control reports.
- C. Product Certificates: For each type of product.
- D. Field quality-control reports.

1.1.1.8 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For splices and connectors to include in maintenance manuals.
- B. Test documents/results to be supplied to UNLV in .PDF and native format (FLW. or equal). The completed installation is to be approved by UNLV Network Development and Engineering.
- C. Installed manufacturer system warranty a minimum of 20 years. Contractor will submit proper documentation for warranty in the Owner's name
- D. All installed cabling, infrastructure, and end devices (as requested) will be documented on an as-built diagram and a record drawing in CAD format. As-builts will be provided to UNLV Planning and Construction (P&C) in PDF format at substantial completion and record drawings in CAD format within 30 days of substantial completion or at end of the project (whichever comes first). All CAD drawings will be provided in AutoCAD 2020 format. Network Development and Engineering (NDE) will provide quality control and verify that the data and infrastructure requested/required to be documented is contained within the drawings. Hand drawings are not acceptable. In the record drawing, several layers and/or group filters will be created or updated which will be used to document the below. It will include but is not limited to:
 - 1. Conduit (existing and newly installed)
 - 2. Cable Path
 - 3. Vaults and Pull Boxes (existing and newly installed)
 - 4. Microduct Distribution Boxes (existing and newly installed)
 - 5. Microducts (existing and newly installed)
 - 6. IDF/MDF Locations (existing and newly constructed)
 - 7. End devices (Wireless Access Points, Security Cameras, etc)
 - 8. Any additional layers or information requested by NDE
 - 9. Fiber Path
 - 10. Fiber Enclosures (existing and newly installed)
- E. Contractor must allocate ample time for verification of as-builts, record drawings, and subsequent corrected versions of those documents. If the record drawing/architectural drawing provided by NDE is not using the most recent campus plan (which will be provided at substantial completion), the contractor shall update the campus plan. Network equipment (Including Voice, Data, and A/V services) will not be provisioned until receipt of accepted test results and preliminary as-built drawings.

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1.1.1.9 MAINTENANCE MATERIAL SUBMITTALS

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

1.1.1.10 WARRANTY

- A. Communications Contractor shall provide a 1-year parts and labor warranty against defective workmanship and cable system component failure.
- B. All fiber cabling installations must be covered by an end-to-end manufacturer warranty of no less than 20 years. The warranty is required to cover cabling, components, and performance. Parts and labor for replacements must also be included in the warranty

1.1.1.11 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of shop drawings, cabling administration drawings, and field-testing program development by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of RCDD, who shall be present at all times when the work of this Section is performed at the Project site.
 - 3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
 - 4. Installers shall have an onsite supervisor and one technician, who are certified by the Manufacturer to install the Manufacturer's telecommunications products.
 - 5. Communications Contractor shall have obtained training from the Manufacturer within 1 year prior to performing the Work.
- B. Testing Agency Qualifications: Testing agencies must have personnel certified by BICSI on staff.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.1.1.12 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test each pair of twisted pair cable for open and short circuits.

1.1.1.13 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and a temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.1.1.14 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with

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Owner's telecommunications and LAN equipment and service suppliers.

1.1.1.15 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and a temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.1.1.16 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1.1.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- C. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- D. Grounding: Comply with TIA-607-C.

2.1.1.2 9/125 MICROMETER, SINGLE-MODE, INDOOR-OUTDOOR OPTICAL FIBER CABLE (OS2)

- A. Description: Single-mode, 9/125-micrometer, [12] [24] fibers, single loose tube, [unarmored] optical fiber cable.
- B. Description: Single-mode, 9/125-micrometer, [24] [36] [48] [72] [96] [144] fibers, stranded loose tube, optical fiber cable.
- C. Standards:
 - 1. Comply with TIA-492CAAB for detailed specifications.
 - 2. Comply with TIA-568-C.3 for performance specifications.
 - 3. Comply with ICEA S-104-696 for mechanical properties.
- D. Maximum Attenuation: 0.5 dB/km at 1310 nm; 0.5 dB/km at 1550 nm.
- E. Jacket:
 - 1. Jacket Color: Yellow.
 - 2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
 - 3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

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- F. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
 - 1. Plenum Rated, Nonconductive: Type of OFNP, complying with NFPA 262.
 - 2. Riser Rated, Nonconductive: [Type OFNR] [or] [Type OFNP], complying with UL 1666.
 - 3. Plenum Rated, Conductive: Type OFCP [or Type OFNP], complying with NFPA 262.
 - 4. Riser Rated, Conductive: Type OFCR [or Type OFCP]; complying with UL 1666
- 2.1.1.3 9/125 MICROMETER SINGLE-MODE, INSIDE PLANT OPTICAL FIBER CABLE (OS2)
- A. Description: Single-mode, 9/125-micrometer, [12] [24] fibers, single loose tube, optical fiber cable.
 - B. Description: Single mode, 9/125-micrometer, [24] [36] [48] [72] [96] [144] fibers, stranded loose tube, optical fiber cable.
 - C. Standards:
 - 1. Comply with TIA-492CAAB for detailed specifications.
 - 2. Comply with TIA-568-C.3 for performance specifications.
 - 3. Comply with ICEA S-83-596 for mechanical properties.
 - D. Maximum Attenuation: 0.5 dB/km at 1310 nm; 0.5 dB/km at 1550 nm.
 - E. Jacket:
 - 1. Jacket Color: Yellow.
 - 2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
 - 3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).
 - F. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
 - 1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
 - 2. Plenum Rated, Nonconductive: Type OFNP in listed plenum communications raceway.
 - 3. Plenum Rated, Nonconductive: Type OFNP, or Type OFNR in metallic conduit.
 - 4. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFNP, or Type OFNR in metallic conduit.
 - 5. Riser Rated, Nonconductive: [Type OFNR] [or] [Type OFNP], complying with UL 1666.

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6. Riser Rated, Nonconductive: Type OFNP or Type OFNR in listed riser or plenum communications raceway.
7. Riser Rated, Nonconductive: Type OFNP, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.1.1.4 MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY ONE OF THE FOLLOWING:

Table: Traditional (Coventional) Single-Mode Fiber Products

TRADITIONAL (CONVENTIONAL) SINGLE-MODE FIBER PRODUCTS		
ITEM DESCRIPTION	MANUFACTURER	MODEL NUMBER
12-STRAND SINGLE-MODE, OS2 - PLENUM RATED	BERK-TEK	PDP012AB0707
24-STRAND SINGLE-MODE, OS2 - PLENUM RATED	BERK-TEK	PDP024AB0707
1 RU ENCLOSURE SLIDING	LEVITON	5R1UM-S03
1 RU ENCLOSURE FIXED	LEVITON	5R1UM-F03
2 RU ENCLOSURE SLIDING	LEVITON	5R2UM-S06
2RU ENCLOSURE FIXED	LEVITON	5R2UM-F06
4 RU ENCLOSURE SLIDING	LEVITON	5R4UM-F12
4 RU ENCLOSURE FIXED	LEVITON	5R4UM-F15
12-F SM LC CASSETTE W/PIGTAILS	LEVITON	SPLCS-12L
24-F SM LC CASSETTE W/PIGTAILS	LEVITON	SPLCS-24L
12-STRAND SINGLE-MODE, OS2 - PLENUM RATED	COMMSCOPE	760004358
24-STRAND SINGLE-MODE, OS2 - PLENUM RATED	COMMSCOPE	760018630
1 RU ENCLOSURE	COMMSCOPE	760210732 HD-1U-FX
2 RU ENCLOSURE	COMMSCOPE	760210740 HD-2U-FX
4 RU ENCLOSURE	COMMSCOPE	760210757 HD-4U-FX
12-F SM LC CASSETTE W/PIGTAILS	COMMSCOPE	760248323
24-F SM LC CASSETTE W/PIGTAILS	COMMSCOPE	760248324
12-STRAND SINGLE-MODE, OS2 - PLENUM RATED	AFL	CP0124552901
24-STRAND SINGLE-MODE, OS2 - PLENUM RATED	AFL	CP0249841901
12-STRAND SINGLE-MODE, OS2 - PLENUM RATED, INDOOR/OUTDOOR	AFL	KR0129651801
24-STRAND SINGLE-MODE, OS2 - PLENUM RATED, INDOOR/OUTDOOR	AFL	KR0249611881

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12-STRAND SINGLE-MODE, OS2 - RISER RATED, INDOOR/OUTDOOR	AFL	KQ0129611801
24-STRAND SINGLE-MODE, OS2 - RISER RATED, INDOOR/OUTDOOR	AFL	KQ0249791801
XPRESS FIBER MANAGEMENT 4U PATCH PANEL, BLACK, EMPTY	AFL	XFM-4U-B-0
XPRESS FIBER MANAGEMENT 2U PATCH PANEL, BLACK, EMPTY	AFL	XFM-2U-B-0
XPRESS FIBER MANAGEMENT 1U PATCH PANEL, BLACK, EMPTY	AFL	XFM-1U-B-0
POLI-MOD PATCH AND SPLICE MODULES LOADED WITH 12-STRAND SINGLE-MODE FIBER WITH LC CONNECTORS	AFL	PM-L-12-ULC-0-S-01
POLI-MOD PATCH AND SPLICE MODULES LOADED WITH 24-STRAND SINGLE-MODE FIBER WITH LC CONNECTORS	AFL	PM-L-24-ULC-0-S-01
12-STRAND SINGLE-MODE, LOOSE TUBE, OS2 - PLENUM RATED, INDOOR/OUTDOOR	CORNING	012ESP-T4101D20
24-STRAND SINGLE-MODE, LOOSE TUBE, OS2 - PLENUM RATED, INDOOR/OUTDOOR	CORNING	024EWP-T4101D20
12-STRAND SINGLE-MODE, TIGHT BUFFER, OS2 - PLENUM RATED, INDOOR	CORNING	012E88-33131-29
24-STRAND SINGLE-MODE, TIGHT BUFFER, OS2 - PLENUM RATED, INDOOR	CORNING	024E88-33131-29
CLOSET CONNECTOR HOUSING 1 RU	CORNING	CCH-01U
CLOSET CONNECTOR HOUSING 2 RU	CORNING	CCH-02U
CLOSET CONNECTOR HOUSING 4 RU	CORNING	CCH-04U
CCH SPLICE CASSETTE, 12 F, SHUTTERED LC UPC DUPLEX, SINGLE-MODE (OS2)	CORNING	CCH-CS12-AE-P00RE
CCH SPLICE CASSETTE, 24 F, SHUTTERED LC UPC DUPLEX, SINGLE-MODE (OS2)	CORNING	CCH-CS24-AE-P00RE

2.1.1.5 9/125 MICROMETER SINGLE-MODE, AIR-BLOWN OUTSIDE PLANT OPTICAL FIBER CABLE (OS2)

- A. Description: Single mode, 9/125-micrometer, [24] [36] [48] [72] [96] [144] fibers, optical fiber cable.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Table: Approved Fiber Manufacturer's Parts List

APPROVED FIBER MANUFACTURER'S PARTS LIST		
AIR-BLOWN SINGLE-MODE FIBER PRODUCTS		
ITEM DESCRIPTION	MANUFACTURER	MODEL NUMBER
12-STRAND SINGLE MODE MICROCABLE - RISER RATED (ENT-A SM-12)	AFL	20002866*
24-STRAND SINGLE MODE MICROCABLE - RISER RATED	AFL	20000729*

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(ENT-A SM-24)		
48-STRAND SINGLE MODE MICROCABLE - RISER RATED (ENT-A SM-48)	AFL	20000730*
72-STRAND SINGLE MODE MICROCABLE - RISER RATED (ENT-A SM-72)	AFL	20003201*
ENTERPRISE FUTUREPATH MICRODUCT SYSTEM - 8.5 MM X 6 MM 4-WAY HDPE	DURALINE	10004655**
ENTERPRISE FUTUREPATH MICRODUCT SYSTEM - 8.5 MM X 6 MM 7-WAY HDPE	DURALINE	10004659**
ENTERPRISE FUTUREPATH MICRODUCT SYSTEM - 8.5 MM X 6 MM 12-WAY HDPE	DURALINE	10004662**
ENTERPRISE FUTUREPATH MICRODUCT SYSTEM - 8.5 MM X 6 MM 19-WAY HDPE	DURALINE	10004665**
ENTERPRISE FUTUREPATH MICRODUCT SYSTEM - 8.5 MM X 6 MM 24-WAY HDPE	DURALINE	10004668**
ENTERPRISE FUTUREPATH MICRODUCT SYSTEM - 8.5 MM X 6 MM 2-WAY RISER	DURALINE	10004866**
ENTERPRISE FUTUREPATH MICRODUCT SYSTEM - 8.5 MM X 6 MM 4-WAY RISER	DURALINE	10004591**
ENTERPRISE FUTUREPATH MICRODUCT SYSTEM - 8.5 MM X 6 MM 7-WAY RISER	DURALINE	10004592**
ENTERPRISE FUTUREPATH MICRODUCT STRAIGHT COUPLER - 8.5 MM X 8.5 MM	DURALINE	20001834
ENTERPRISE FUTUREPATH MICRODUCT REDUCER COUPLER - 8.5 MM X 8 MM	DURALINE	20001884
ENTERPRISE FUTUREPATH ENCLOSURE CONNECTOR - 8.5MM X 2	DURALINE	20001915
ENTERPRISE FUTUREPATH ENCLOSURE CONNECTOR - 8.5MM X 4	DURALINE	20001916
ENTERPRISE FUTUREPATH ENCLOSURE CONNECTOR - 8.5MM X 7	DURALINE	20001917
ENTERPRISE FUTUREPATH ENCLOSURE CONNECTOR - 8.5MM X 12	DURALINE	20001918
ENTERPRISE FUTUREPATH ENCLOSURE CONNECTOR - 8.5MM X 19	DURALINE	20001919
XPRESS FIBER MANAGEMENT 4U PATCH PANEL, BLACK, EMPTY	AFL	XFM-4U-B-0
XPRESS FIBER MANAGEMENT 2U PATCH PANEL, BLACK, EMPTY	AFL	XFM-2U-B-0
XPRESS FIBER MANAGEMENT 1U PATCH PANEL, BLACK, EMPTY	AFL	XFM-1U-B-0
POLI-MOD PATCH AND SPLICE MODULES LOADED WITH 12-STRAND SINGLE-MODE FIBER WITH LC CONNECTORS	AFL	PM-L-12-ULC-0-S- 01
POLI-MOD PATCH AND SPLICE MODULES LOADED WITH 24-STRAND SINGLE-MODE FIBER WITH LC CONNECTORS	AFL	PM-L-24-ULC-0-S- 01
* - Part number is for 1500ft lengths of fiber. Other lengths with different part numbers may be available		
** - Part number is for 1000ft length of FuturePath Microduct . Other lengths with different part numbers may be available		

C. Standards:

1. Comply with TIA-492CAAB for detailed specifications.

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2. Comply with TIA-568-C.3 for performance specifications.
 3. Comply with ICEA S-87-640 for mechanical properties.
- D. Maximum Attenuation: 0.5 dB/km at 1310 nm; 0.5 dB/km at 1550 nm.
 - E. Air-blown fiber tube cell conduit will be installed in all new buildings and in new building-to-building fiber installations unless otherwise directed.
 - F. Air-blown fiber will be used in existing buildings that contain existing air-blown fiber components unless otherwise directed.
 - G. Non-air-blown fiber will be used in existing buildings that do not have existing air-blown fiber components unless otherwise directed.
 - H. Installation of innerduct shall be required when installing non-air-blown fiber in conduits.
 - I. Terminations will be completed using no epoxy/no polish connectors or factory-terminated pigtailed with fusion splicing
 - J. All fiber will be terminated with LC / UPC cassette type connectors and be mounted in 12- or 24- fiber adapter plates.
 - K. Fiber enclosures will be from an NDE-approved manufacturer. Fiber cassette plates will be of standard size and will fit these enclosures.

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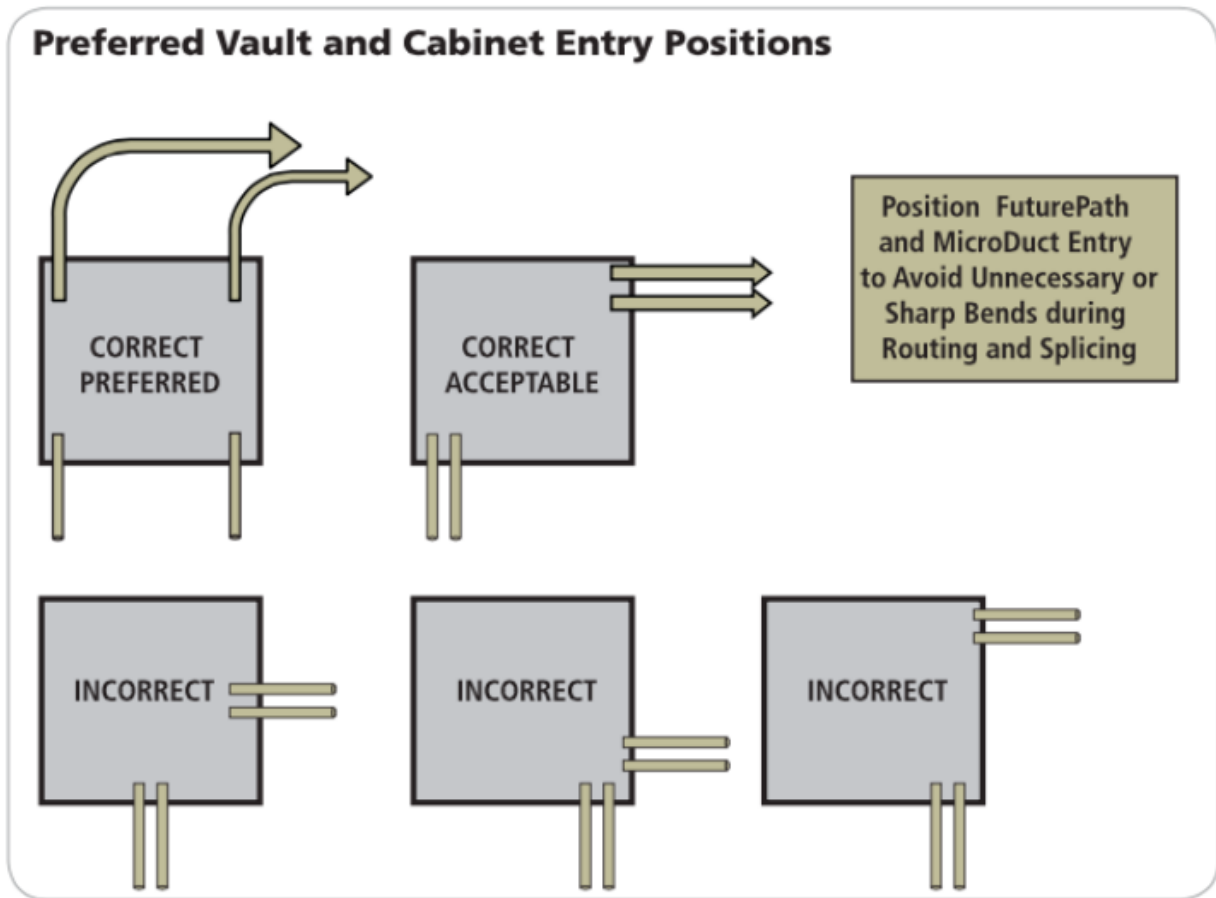


Diagram: Preferred Vault and Cabinet Entry Positions
2.1.1.6 OPTICAL FIBER CABLE HARDWARE

- A. Standards:
 - 1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
 - 2. Comply with TIA-568-C.3.
- B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
 - 1. Number of Connectors per Field: One for each fiber of cable or cables assigned to the field, plus spares and blank positions adequate to suit specified expansion criteria.
- C. Patch Cords: Factory-made, dual-fiber cables in 36-inch (900-mm) lengths.
- D. Connector Type: [**Type LC complying with TIA-604-10-B,**] connectors.
- E. Plugs and Plug Assemblies:

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1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than [0.25] [0.75] dB.
3. Marked to indicate transmission performance.

F. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex, and duplex; fixed telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than [0.25] [0.75] dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to a patch panel or faceplate.

2.1.1.7 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-C.

2.1.1.8 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.1.1.9 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test multimode optical fiber cables according to TIA-526-14-B and TIA-568-C.3.
- C. Factory test pre-terminated optical fiber cable assemblies according to TIA-526-14-B and TIA-568-C.3.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1.1.1 ENTRANCE FACILITIES

- A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service providers.

3.1.1.2 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters [and except in accessible ceiling spaces, in attics, and in gypsum board partitions where an unenclosed wiring method may be used]. Conceal raceway and cables except in unfinished spaces.

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1. Install plenum cable in environmental air spaces, including plenum ceilings. These spaces include but are not limited to drop type (open air) and hard lid type ceilings
 2. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
- 3.1.1.3 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES
- A. Comply with NECA 1, NECA 301, and NECA/BICSI 568.
- B. General Requirements for Optical Fiber Cabling Installation:
1. Comply with TIA-568-C.1 and TIA-568-C.3.
 2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
 3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by the manufacturer.
 6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
 7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with a new cable.
 8. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
 9. In the communications equipment room, provide a 10-foot- (3-m-) long service loop on each end of the cable.
 10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
 11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

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12. Air-blown fiber tube cell conduit will be installed in all new buildings and in new building-to-building
13. Air-blown fiber will be used in existing buildings that contain existing air-blown fiber components.
14. Non-air-blown fiber will be used in existing buildings that do not have existing air-blown fiber components.
15. Installation of innerduct shall be required when installing non-air-blown fiber in conduits.
16. Terminations will be completed using no epoxy/no polish connectors or factory-terminated pigtails with fusion splicing
17. All fiber will be terminated with LC / UPC connectors and be mounted in 12- or 24- fiber adapter plates.
18. Fiber enclosures will be from an NDE-approved manufacturer. Adapter plates will be of standard size and will fit these enclosures.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet (1800 mm) long not less than 12 inches (300 mm) in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

3.1.1.4 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.1.1.5 GROUNDING

- A. Install grounding according to the BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.
- B. Comply with TIA-607-C and NECA/BICSI-607.
- C. Locate the grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect

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grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.1.1.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-C. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 - 1. Administration Class: Latest Standard
 - 2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 3 level of administration including optional identification requirements of this standard.
- C. Comply with requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling" for cable and asset management software.
- D. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with a rigid frame and clear plastic cover. Furnish an electronic copy of the final comprehensive schedules for Project.
- E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, 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.
- F. Cable and Wire Identification:
 - 1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Label each unit and field within distribution racks and frames.
 - 3. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-C, for the following:
 - 1. Flexible vinyl or polyester that flexes as cables are bent.

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3.1.1.7 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
 - 1. Visually inspect optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA-568-D.3.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Optical Fiber Cable Tests:
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-D.3. Use only test cords and adapters that are qualified by the test equipment manufacturer for channel or link test configuration.
 - b. Link End-to-End Attenuation Tests:
 - 1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm for multimode and 13120 and 1550 nm for single-mode in one direction according to TIA-526-14-B, Method B, One Reference Jumper.
 - 2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than those calculated according to the equation in TIA-568-C.3.
 - c. Test results shall be automatically evaluated by the equipment, using the most up-to-date criteria from the TIA 568.3-D Standard, and the result shown as pass/fail. The test results shall include all tests performed and the actual test result achieved. All test results to be provided to the UNLV Network Development and Engineering in .PDF format prior to acceptance of completed project. All test results must be labeled with the specific data cable that was tested by its identifier on the patch panel.
 - d. Test evaluation for the panel to panel (backbone) shall be based on the

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values set forth in the TIA-568.3-D, Optical Fiber Cabling Components.

- e. Attenuation testing shall be performed with a stable launch condition using two-meter jumpers to attach the test equipment to the cable plant. The light source shall be left in place after calibration and the power meter moved to the far end to take measurements.
 - f. The expected results for each cable (or group of cables of the same nominal length) shall be calculated before the start of testing and recorded in a space provided on the Contractor's test matrix. Each strand of fiber in the respective cable shall be evaluated against this target number. Any fibers that exceed this number by more than -0.5dB shall be repaired or replaced at the installers' cost.
 - g. Where concatenated links are installed to complete a circuit between devices, the Contractor shall test each link from end to end to ensure the performance of the system. After the link performance test has been successfully completed, each link shall be concatenated and tested. The test method shall be the same used for the test described above. The evaluation criteria shall be established between UNLV Network Development and Engineering and the Contractor prior to the start of the test.
 - h. Single-mode Single mode optical fiber attenuation shall be measured at 1310 nm and 1550 nm using a laser light source and power meter. Tests shall be performed at both wavelengths in one direction on each strand of fiber. The set-up and test shall be performed in accordance with TIA-526-7-A Standard, Method 1A. Two-meter patch cords shall be used as test references and for the actual test. This test method utilizes a one-jumper reference, two-jumper test to estimate the actual link loss of the install cable plus two patch cords. Single-mode fiber optic cable must meet or exceed the following limits: 29 • Attenuation 0.4dB/km at 1310nm, 0.3dB/km at 1550nm. • Connectors Max loss for a mated pair of connectors shall be less than 0.5dB
- F. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- G. Remove and replace cabling where test results indicate that it does not comply with specified requirements.
- H. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- I. Prepare test and inspection reports.

END OF SECTION 271323

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SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

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PART 1 -

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GENERAL

1.1.1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Equipment and material shall be Underwriter's Laboratories listed and labeled. The latest editions of the following standards are minimum requirements. If a conflict exists between applicable documents, then the order in the list below shall dictate the order of precedence in resolving conflicts. This order of precedence shall be maintained unless a lesser order document has been adopted as code by a local, state or federal entity, and is therefore enforceable as law by a local, state, or federal inspection agency.
 - 1. BICSI TDMM Current version.
 - 2. BICSI ITSIMM Current version
 - 3. ANSI/TIA-569-D Telecommunications Pathways and Spaces
 - 4. ANSI/TIA 568.0-D Generic Telecommunications Cabling for Customer Premises
 - 5. ANSI/TIA-568.1-D Commercial Building Telecommunications Cabling Standard
 - 6. ANSI/TIA-568-C4 Balanced Twisted-Pair Telecommunications Cabling and Components Standard
 - 7. ANSI/TIA-568.3-D Optical Fiber Cabling Components Standard
 - 8. ANSI/TIA-606-C Administration Standard for Telecommunications Infrastructure
 - 9. ANSI/TIA-607-D Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
 - 10. ANSI/TIA-1152 Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling National Electrical Manufacturers Association (NEMA)
 - 11. National Electrical Code, latest revision (NEC)
 - 12. National Fire Protection Agency (NFPA) – 70
 - 13. Local, State and Federal Codes including Nevada Revised Statute (NRS) 278.583
 - 14. UL 497 Protectors
 - 15. UL 1459 Standard for Safety for Telephone Equipment
 - 16. UL 1863 Standard for Safety for Communications Circuit Accessories
 - 17. UL 2024 Standard for Safety for Optical Fiber Cable Raceway
 - 18. UL 723 Standard for Safety for Surface Burning Characteristics of Building Materials

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19. UL 1581 Standard for Safety for Reference Standard for Wires, Cables and Flexible Cords
20. National Electrical Safety Code (NESC)

1.1.1.2 SUMMARY

A. Section Includes:

1. Category 6 twisted pair cable.
2. Category 6a twisted pair cable.
3. Twisted pair cable hardware, including plugs and jacks.
4. Multi User telecommunications outlet assembly.
5. Cabling identification products.
6. Grounding provisions for twisted pair cable.
7. Source quality control requirements for twisted pair cable.

B. Related Requirements:

1. Section 270513 "Conductors and Cables for Communications Systems" for data cabling associated with system panels and devices.

1.1.1.3 DEFINITIONS

- A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- B. EMI: Electromagnetic interference.
- C. FTP: Shielded twisted pair.
- D. F/FTP: Overall foil screened cable with foil screened twisted pair.
- E. F/UTP: Overall foil screened cable with unscreened twisted pair.
- F. IDC: Insulation displacement connector.
- G. LAN: Local area network.
- H. Jack: Also commonly called an "outlet," it is the fixed, female connector.
- I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
- J. RCDD: Registered Communications Distribution Designer.
- K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

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- M. S/FTP: Overall braid screened cable with foil screened twisted pair.
- N. S/UTP: Overall braid screened cable with unscreened twisted pairs.
- O. UTP: Unscreened (unshielded) twisted pair.

1.1.1.4 COPPER HORIZONTAL CABLING DESCRIPTION

- A. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
 - 1. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
 - 2. Bridged taps and splices shall not be installed in the horizontal cabling.
- B. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment or in the horizontal cross-connect. Contractor shall use means and methods to achieve cabling runs under 295 feet (90 m).
- C. Copper Data Cabling and Components
- D. New buildings will be installed with Category 6A cable and components from one of the approved manufacturer's parts in Appendix A6.
- E. Existing building will be installed with Category 6A cable and components from one of the approved manufacturer's parts in Appendix A6. Category 6 is acceptable if approved by OIT
- F. All data cabling will have a service loop of data cabling that will be placed on the MDF/IDF ladder rack. The length of this loop will be in accordance with the current standards or per UNLV recommendations.
- G. All data patch panels for existing buildings are to be Leviton QuickPort patch panel (Model number 49255-H48) or Siemon MAX Copper Patch Panel (Model number MX-PNL-48).
- H. Equivalent patch panels must accept keystone Category 6 or 6A jacks, in 2U, 48 port configuration, and must meet or exceed EIA/TIA and ISO/IEC Category 6/Class E or Category 6A/Class EA requirements. They must also be capable of housing keystone data jacks from other manufacturers, be viewed, tested and approved by Network Development and Engineering staff.
- I. All data jacks shall be modular, unshielded, 4-pair, 8P8C, Category 6 or 6A, black unless otherwise specified, and must meet or exceed EIA/TIA and ISO/IEC Category 6/Class E or Category 6A/Class EA requirements.

1.1.1.5 CONTRACTORS QUALIFICATIONS

- A. Contractor must possess a valid State of Nevada Contractor's License and have successfully performed at least three projects of low voltage cable installation with similar size and work scope, within two years of the date of the job they are bidding on.

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Proof of performance shall be in the form of reference sheets which shall include a brief description of the project, the start and end dates, and contact information.

- B. All contractor personnel who will be performing work on this project shall have been trained on the work they will be performing. They shall have been trained on the Contractor's company policies with respect to personnel safety, telecommunications industry cabling quality and neatness standards, and use of Construction Standard Institute (CSI)-standard specifications and drawings.
- C. Contractor, at all times during performance and until work is completed and accepted, shall have on the premises a competent supervisor, satisfactory to the Customer and with authority to act for the Contractor. The supervisor must be a BICSI certified Technician and BICSI member in good standing.
- D. As a requirement to bidding and performing awarded work, the Contractor must have a current BICSI certified Registered Communications Distribution Designer (RCDD) on staff, either as a full-time employee or as a hired consultant. At UNLV's discretion, on a project-by-project basis, a RCDD consultant may be hired by the university to inspect work during and after completion. In these cases, the RCDD requirement will be met by the university and the Contractor will not be required to have a RCDD on staff. Based upon the inspection by UNLV's hired RCDD consultant or Network Development & Engineering (NDE) staff the Contractor will be responsible for correcting any work that does not meet requirements detailed in this document.
- E. For jobs that require more than 24 data connections, weekly inspections and approval of all work performed shall be conducted by the contractor's RCDD certified employee. The contractor will submit a weekly status report to the Customer detailing what work has been completed and inspected. The report will also include any issues encountered as part of the install.

1.1.1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by RCDD prior to installation.
 - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by the Owner.
 - 2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
 - 3. Cabling administration Drawings and printouts.
 - 4. Wiring diagrams and installation details of telecommunications equipment in PDF format, to show location and layout of telecommunications equipment, including the following:
 - a. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways, footages and routing, outlet locations, and faceplate types.
 - c. Telecommunications system access points.

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- d. Telecommunications grounding system.
 - e. Telecommunications conductors drop locations.
 - f. Typical telecommunications details.
 - g. Mechanical, electrical, and plumbing systems.
- C. Twisted pair cable testing plan.
- D. Samples: For telecommunications jacks and plugs, in specified finish, one for each type and configuration and faceplates for evaluation of technical features.

1.1.1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For RCDD, installation supervisor, and field inspector.
- B. Product Certificates: For each type of product.
- C. Source quality-control reports.
- D. Field quality-control reports.
- E. For jobs that require submittals, the Contractor shall furnish the following in a single consolidated submittal with an Approval copy to the Customer at the time of submission:
- 1. Contractor's license number and proof of qualifications.
 - 2. Reference sheets which provide three references. Each reference shall include a brief description of the project, the start and end dates, and contact information.
 - 3. The make and model of the materials to be used.
- F. The Contractor shall furnish the following in a single consolidated submittal with an Approval copy to the Customer at the time of award:
- 1. A copy of the RCDD certificate and BICSI member number as described in the above Contractor Qualifications section.
 - 2. A copy of the BICSI certificate and the BICSI member number of the lead technician as described in the above Contractor Qualifications section.
 - 3. A copy of the BICSI certificate and the BICSI member number of the supervisor as described in the above Contractor Qualifications section.
 - 4. A copy of a valid manufacturer certified installer certification.
- G. The Contractor shall furnish the following in a single consolidated submittal with an Approval copy to the Customer upon request:
- H. For all Category 6A and 6 installation technicians, provide the training certificates with a brief description of the training courses associated with each certificate.

1.1.1.8 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For splices and connectors to include in maintenance manuals.

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- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On USB media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.
- C. Test documents/results to be supplied to UNLV in .PDF and native format (FLW. or equal). Completed installation is to be approved by UNLV Network Development and Engineering.
- D. Installed manufacturer system warranty a minimum of 20 years. Contractor will submit proper documentation for warranty in the Owner's name
- E. All installed cabling, infrastructure and end devices (as requested) will be documented on an as-built diagram and a record drawing in CAD format. As-builts will be provided to UNLV Planning and Construction (P&C) in PDF format at substantial completion and record drawings in CAD format within 30 days of substantial completion or at end of the project (whichever comes first). All CAD drawings will be provided in AutoCAD 2014 or AutoCAD 2020 format but saved down to AutoCAD 2014. Network Development and Engineering (NDE) will provide quality control and verify that the data and infrastructure requested/required to be documented is contained within the drawings. As-builts and record drawings will be created from the latest digital architectural drawings provided by P&C. Hand drawings are not acceptable. In the record drawing, several layers will be created or updated which will be used to document the below. It will include but is not limited to:
 - 1. Conduit (existing and newly installed)
 - 2. Cable Tray (existing and newly installed)
 - 3. J-hook (existing and newly installed)
 - 4. Cable Path
 - 5. Outlet Locations
 - 6. Fiber Path
 - 7. Fiber Enclosures (existing and newly installed)
 - 8. Microducts (existing and newly installed)
 - 9. End devices (Wireless Access Points, Security Cameras, etc.)
 - 10. Any additional layers or information requested by NDE

Contractor must allocate ample time for verification of as-builts, record drawings and subsequent corrected versions of those documents. If any record drawing/architectural drawing provided by P&C is not using the most recent drawing requirements (which will be provided at substantial completion), contractor shall update the drawing to ensure it

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complies. Network equipment (Including Voice, Data and A/V services) will not be provisioned until receipt of accepted test results and preliminary as-built drawings.

1.1.1.9 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Connecting Blocks: Six of each type.
 - 2. Faceplates: Ten of each type.
 - 3. Jacks: One Hundred of each type.
 - 4. Multiuser Telecommunications Outlet Assemblies: Two of each type, if used in project.
 - 5. Patch-Panel Units: Ten of each type.
 - 6. Plugs: One Hundred of each type.
 - 7. Patch Cords: 75% of patch cords of all active parts.

1.1.1.10 WARRANTY

- A. Communications Contractor shall provide a 1-year parts and labor warranty against defective workmanship and cable system component failure.
- B. Communications Contractor shall execute a Lifetime warranty against materials defect and an Applications Assurance Warranty for 1GBase-T applications for parts and labor from the cable system Manufacturer
- C. All copper and fiber cabling installations must be covered by an end-to-end manufacturer warranty of no less than 20 years. The warranty is required to cover cabling, components, and performance. Parts and labor for replacements must also be included in the warranty

1.1.1.11 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of shop drawings, cabling administration drawings, and field-testing program development by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of RCDD, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
 - 4. Installers shall have an onsite supervisor and one technician who are certified by the Manufacturer to install the Manufacturer's telecommunications products.
 - 5. Communications Contractor shall have obtained training from the Manufacturer

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within 1 year prior to performing the Work.

- B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

- 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.1.1.12 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.

- 1. Test each pair of twisted pair cable for open and short circuits.

1.1.1.13 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and a temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.1.1.14 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1.1.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- C. Grounding: Comply with TIA-607-C.

2.1.1.2 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. Communications, Plenum Rated: Type CMP complying with UL 1685
 - 2. Communications, Non-plenum: Type CMR complying with UL 1666
- B. RoHS compliant.
- C. Criteria to include per the current testing standards but not limited to:
 - 1. Return Loss
 - 2. Insertion Loss
 - 3. NEXT (Near-End Crosstalk)
 - 4. PSNEXT (Power Sum Near-End Crosstalk)
 - 5. FEXT (Far End Crosstalk) Loss

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6. 6. ACRF (Attenuation to Crosstalk Ratio Far-End)
7. 7. PSACRF (Power Sum Attenuation to Crosstalk Ratio Far-End)
8. 8. Coupling Attenuation
9. 9. Propagation Delay
10. 10. Propagation Delay Skew
11. 11. PSANEXT (Power Sum Alien Crosstalk) Loss
12. 12. Average PSANEXT Loss
13. 13. PSAFEXT (Power Sum Alien Far-End Crosstalk) Loss (connecting hardware
14. only)
15. 14. PSAACRF (Power Sum Alien Attenuation to Crosstalk Ratio Far-End)
16. 15. Average PSAACRF
17. 16. ACRN (Attenuation to Crosstalk Ratio Near-End) – recorded for information only
18. 17. PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End) – recorded for
19. information only
20. 18. DC Loop Resistance
21. 19. DC Resistance Unbalance (Channel Test)

D. Tests

1. Test results for all Category 6 or 6A copper cables shall be provided in a Level III or Level IV tester's native format and PDF.
2. All Permanent Link tests shall have a "PASS" result for all required parameters from the frequency of 1 to 250 MHZ for Category 6 and frequency of 1 to 500 MHZ for Category 6A.
3. Any *PASS test results will require troubleshooting and repair of the cable in question to achieve a PASS test result.
4. All test results shall show electrical performance of the cabling system from 1 to 250 MHZ for Category 6 and frequency of 1 to 500 MHZ for Category 6A when testing for Insertion Loss, Near End Crosstalk, Power Sum Near-End Crosstalk, Attenuation to Crosstalk Ratio Far End, Power Sum Attenuation to Crosstalk Ratio Far End and Return Loss.
5. One hard copy and one soft copy in the tester's native format of all test results shall be provided to the Owner upon substantial completion.
6. Test results showing an asterisk (*) will not be accepted as it is below the acceptable margin of the tester's accuracy limits.

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2.1.1.3 CATEGORY 6 TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Berk-Tek Leviton; a Nexans/Leviton alliance.
 - 2. CommScope, Inc.
 - 3. Siemon Co. (The).
 - 4. Panduit
 - 5. Or approved equal.
- C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.
- D. Conductors: 100-ohm, 22-24 AWG solid copper.
- E. Shielding/Screening: Unshielded twisted pairs (UTP).
- F. Cable Rating: Riser, Plenum or OSP.
- G. Jacket: Coordinate with Owner for colors.
- H. Cable Outside Diameter: Maximum outside diameter 0.24.

Table: Approved Copper Manufacturer's Parts List

APPROVED COPPER MANUFACTURER'S PARTS LIST		
CATEGORY-6 (CAT-6) PRODUCTS		
ITEM DESCRIPTION	MANUFACTURER	MODEL NUMBER
CABLING - 1000 FT BULK, PLENUM	COMMSCOPE	UN874049914/10
CABLING - 1000 FT BULK, RISER	COMMSCOPE	UN884017214/10
PATCH PANEL - MODULAR/DISCREET	COMMSCOPE	760237047
JACKS - MODULAR, BLACK	COMMSCOPE	760237777
JACKS - UNIVERSAL (KEYSTONE), BLACK	COMMSCOPE	2291216-2
CABLING - 1000 FT BULK, PLENUM	UNIPRISE	CS34P BLU C6

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CABLING - 1000 FT BULK, RISER	UNIPRISE	CS34R BLU C6
PATCH PANEL - MODULAR/DISCREET	UNIPRISE	CPP-UDDM-SL-2U-48
JACKS - MODULAR, BLACK	UNIPRISE	UNJ600-BK
JACKS - UNIVERSAL (KEYSTONE), BLACK	UNIPRISE	KJ610 JACK-BLK
CABLING - 1000 FT BULK, PLENUM	BERKTEK	10032094
CABLING - 1000 FT BULK, RISER	BERKTEK	10032455
PATCH PANEL - MODULAR/DISCREET	LEVITON	49255-H48
JACKS - MODULAR, BLACK	LEVITON	61110-RE6
JACKS - UNIVERSAL (KEYSTONE), BLACK	LEVITON	61110-RE6
CABLING - 1000 FT BULK, PLENUM	SIEMON	9C6P4-E3-06-RXA
CABLING - 1000 FT BULK, RISER	SIEMON	9C6R4-E3-06-RXA
PATCH PANEL - MODULAR/DISCREET	SIEMON	MX-PNL-48K
JACKS - MODULAR, BLACK	SIEMON	MX6-F01
JACKS - UNIVERSAL (KEYSTONE), BLACK	SIEMON	MX6-K01
CABLING - 1000 FT BULK, PLENUM	PAN-GEN	7131970
CABLING - 1000 FT BULK, RISER	PAN-GEN	7133970
PATCH PANEL - MODULAR/DISCREET	PANDUIT	NKPP48FMY
JACKS - MODULAR, BLACK	PANDUIT	NK688MBL
JACKS - UNIVERSAL (KEYSTONE), BLACK	PANDUIT	NK688MBL
FACEPLATES W/ WINDOWS, ALMOND/BEIGE	COMMSCOPE	760138453
FACEPLATES W/ WINDOWS, ALMOND/BEIGE	UNIPRISE	M14L-148
FACEPLATES W/ WINDOWS, ALMOND/BEIGE	LEVITON	42080-4TS
FACEPLATES W/ WINDOWS, ALMOND/BEIGE	SIEMON	MX-FP-S-04-20
FACEPLATES W/ WINDOWS, ALMOND/BEIGE	PANDUIT	NK4FIWY

2.1.1.4 CATEGORY 6a TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Berk-Tek Leviton; a Nexans/Leviton alliance.
 2. CommScope, Inc..
 3. Siemon Co. (The).
 4. Panduit

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- 5. Or approved equal.
- C. Standard: Comply with TIA-568-C.3 for Category 6a cables.
- D. Conductors: 100-ohm, 22-24 AWG solid copper.
- E. Shielding/Screening: Unshielded twisted pairs (UTP).
- F. Cable Rating: Riser, Plenum or OSP.
- G. Jacket: Coordinate with Owner for color.
- H. Cable Outside Diameter: Maximum outside diameter 0.29.

Table: Approved Copper Manufacturer's Parts List

APPROVED COPPER MANUFACTURER'S PARTS LIST		
CATEGORY-6 AUGMENTED (CAT-6A) PRODUCTS		
ITEM DESCRIPTION	MANUFACTURER	MODEL NUMBER
CABLING - 1000 FT BULK, PLENUM	COMMSCOPE	760234859
PATCH PANEL - MODULAR/DISCREET	COMMSCOPE	760237047
JACKS - MODULAR, BLACK	COMMSCOPE	760241173
JACKS - UNIVERSAL (KEYSTONE), BLACK	COMMSCOPE	760241138
CABLING - 1000 FT BULK, PLENUM	SYSTIMAX	2091SD BLU C6A 4/23 U/UTP R1000
PATCH PANEL - MODULAR/DISCREET	UNIPRISE	CPP-SDDM-SL-2U-48
JACKS - MODULAR, BLACK	UNIPRISE	UNJ10G-BK
JACKS - UNIVERSAL (KEYSTONE), BLACK	UNIPRISE	USL10G-BLK
CABLING - 1000 FT BULK, PLENUM	BERKTEK	11082057
CABLING - 1000 FT BULK, RISER	BERKTEK	11082062
PATCH PANEL - MODULAR/DISCREET	LEVITON	49255-H48
JACKS - MODULAR, BLACK	LEVITON	6110G-RE6
JACKS - UNIVERSAL (KEYSTONE), BLACK	LEVITON	6110G-RE6
CABLING - 1000 FT BULK, PLENUM	SIEMON	9U6P4-A5-06-R1A
CABLING - 1000 FT BULK, RISER	SIEMON	9U6R4-A5-06-R1A
PATCH PANEL - MODULAR/DISCREET	SIEMON	Z6A-PNL-U24E
JACKS - MODULAR, BLACK	SIEMON	Z6A-01
JACKS - UNIVERSAL (KEYSTONE), BLACK	SIEMON	Z6A-K01
CABLING - 1000 FT BULK, PLENUM	PAN-GEN	7141819
CABLING - 1000 FT BULK, RISER	PAN-GEN	7143819
PATCH PANEL - MODULAR/DISCREET	PANDUIT	NKPP48FMY
JACKS - MODULAR, BLACK	PANDUIT	NK6X88MBL

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JACKS - UNIVERSAL (KEYSTONE), BLACK	PANDUIT	NK6X88MBL
FACEPLATES W/ WINDOWS, ALMOND/BEIGE	COMMSCOPE	760138453
FACEPLATES W/ WINDOWS, ALMOND/BEIGE	UNIPRISE	M14L-148
FACEPLATES W/ WINDOWS, ALMOND/BEIGE	LEVITON	42080-4TS
FACEPLATES W/ WINDOWS, ALMOND/BEIGE	SIEMON	10GMX-FPS04-20
FACEPLATES W/ WINDOWS, ALMOND/BEIGE	PANDUIT	NK4FIWY

2.1.1.5 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Berk-Tek Leviton; a Nexans/Leviton alliance.
 - 2. CommScope, Inc..
 - 3. Siemon Co. (The).
 - 4. Panduit
 - 5. Or approved equal.
- C. General Requirements for Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 6 or Category 6a.
 - 2. Comply with TIA-568-C.3, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of the same category or higher.
- D. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer. Obtain twisted pair cable hardware from the same manufacturer as twisted pair cable, from a single source.
- E. Connecting Blocks:
 - 1. 110-style IDC for Category 6.
 - 2. 110-style IDC for Category 6a.
 - 3. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.
- F. Cross-Connect: Modular array of connecting blocks arranged to terminate building

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cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.
- G. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
1. Features:
 - a. Universal T568A and T568B wiring labels.
 - b. Labeling areas adjacent to conductors.
 - c. Replaceable connectors.
 - d. 48 ports.
 2. Construction: 16-gauge steel and mountable on 19-inch (483 mm) equipment racks.
 3. Number of Jacks per Field: One for each four-pair cable indicated
- H. Patch Cords: Factory-made, four-pair cables in 12-inch, 24- inch 36-inch and 48-inch lengths; terminated with an eight-position modular plug at each end. Contractor to coordinate with the owner on specific lengths.
1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
 2. Patch cords shall have color-coded boots for circuit identification. Color shall be grey.
 3. Contractor to provide 75% of all patch cords of the same manufacturer of the horizontal cabling.
 4. Patch cords shall be of the same category as the cabling.
- I. Plugs and Plug Assemblies:
1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
 2. Standard: Comply with TIA-568-C.3.
 3. Marked to indicate transmission performance.
- J. Jacks and Jack Assemblies:
1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
 2. Designed to snap-in to a patch panel or faceplate.
 3. Standard: Comply with TIA-568-C.3.

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4. Marked to indicate transmission performance.

K. Faceplate:

1. [One][Two][Four] [Six] port, vertical single gang faceplates designed to mount to single gang wall boxes. Unless otherwise specified, all faceplates shall be four (4) PORT.
2. [Eight] [Ten] [Twelve] port, vertical double gang faceplates designed to mount to double gang wall boxes.
3. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices." And with the architects and interior designers.
4. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices." Any kitchen, outdoor or wet area will receive a stainless steel faceplate.
5. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45 or 90-degree angle.

L. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.1.1.6 MULTIUSER TELECOMMUNICATIONS OUTLET ASSEMBLY (MUTOA)

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Berk-Tek Leviton; a Nexans/Leviton alliance.
 2. CommScope, Inc..
 3. Siemon Co. (The).
 4. Panduit
 5. Or approved equal.
- B. Description: MUTOAs shall meet the requirements of "Twisted Pair Cable Hardware" Article.
1. Number of Terminals per Field: One for each conductor in assigned cables.
 2. Number of Connectors per Field:
 - a. One for each four-pair unshielded or shielded twisted-pair cable indicated.
 - b. One for each four-pair unshielded or shielded twisted-pair group of indicated cables, plus 25 percent spare positions.

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3. Mounting: [**Recessed in ceiling**] [**Wall**] [**Desk**] [**Furniture**].
4. NRTL listed as complying with UL 50 and UL 1863.
5. Label shall include maximum length of work area cords, based on TIA-568-C.3.
6. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

2.1.1.7 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.1.1.8 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-B.

2.1.1.9 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test cables on reels according to TIA-568-C.3.
- C. Factory test twisted pair cables according to TIA-568-C.3.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1.1.1 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters [and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used]. Conceal raceway and cables, except in unfinished spaces.
 1. Install plenum cable in environmental air spaces, including plenum ceilings. These spaces include but are not limited to open air and hard lid type ceilings.
 2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

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3.1.1.2 INSTALLATION OF PATHWAYS

- A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."
- B. Comply with Section 270528 "Pathways for Communications Systems."
- C. Drawings indicate general arrangement of pathways and fittings.

3.1.1.3 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. General Requirements for Cabling:
 - 1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
 - 2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.
 - 4. Do not untwist twisted pair cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
 - 5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 6. MUTOA shall not be used as a cross-connect point.
 - 7. Consolidation points may be used only for making a direct connection to equipment outlets:
 - a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
 - b. Locate consolidation points for twisted-pair cables at least 49 feet (15 m) from communications equipment room.
 - 8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by the manufacturer.
 - 10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
 - 11. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice

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cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

12. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
13. All data outlets will have a minimum of 12 inches of cable stored at each drop after the cable has been terminated. Cable shall not be stored in loops.
14. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of the cable.
15. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
16. Install all components in a neat and workmanlike manner.
17. Install all horizontal cables and termination frames in accordance with manufacturer's recommendations.
18. Ensure terminations are at 180 degrees to the jack with no more than ¼" un-twisting and no more than ½" un-jacketing.
19. Ensure terminations have no un-twisting and that tower separators are utilized to separate pairs.
20. Ensure pulling tensions of cables are not exceeded.
21. Maintain proper cable bend radius of 4 times the cable's outer diameter during placement.
22. No splices are permitted in UTP cabling.
23. No link shall exceed 295 feet (90 m). Contractor is responsible for verifying proper footages.
24. Contractor shall provide in a quick and timely fashion any additional materials or labor that may be damaged during the work at no charge to the owner.
25. Pull one additional "Mule Tape" or ¼" Nylon rope when pulling cables through any conduit utilizing existing pull string.
26. Place horizontal cables in pathways and spaces dedicated for communications cables.
27. Machine label all horizontal cables with cable number at both ends in accordance with UL-969 Standards.
28. Machine label all termination panels with cable numbers in accordance with UL-969 Standards.
29. Firestop all sleeves and conduit openings after cable installation.
30. Terminate all pairs and conductors at all ends according to manufacturer's instructions following color code sequence.

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31. Utilize Velcro cable wraps in all telecom rooms, IDFs data centers, MDFs, J-Hook systems, ladder rack and cable tray systems. Tie-wraps shall not be used bundle cable
32. Where installation of conduit is not required, plenum cable will be used. Cables are not permitted to lie atop a lay-in ceiling or simply drape over pipe and ductwork; appropriate J-hook/supports or dressing will be used.
33. Label and document the horizontal cable installation to include labeling and pathways on the As-Built drawings before installation.
34. Cabling installed in a wet environment shall be [water blocking type cable] [outdoor rated] [or] [OSP].

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet (1800 mm) long not less than 12 inches (300 mm) in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches

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(600 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.1.1.4 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

3.1.1.5 GROUNDING

- A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- B. Comply with TIA-607-C and NECA/BICSI-607.
- C. Locate the grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

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3.1.1.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-C. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 - 1. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Paint and label colors for equipment identification shall comply with TIA-606-C for level of administration.
- C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- E. Cable and Wire Identification:
 - 1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
 - 4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
 - b. Label each unit and field within distribution racks and frames.
 - 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
 - 1. Cables use flexible vinyl or polyester that flexes as cables are bent.

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3.1.1.7 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
- E. Tests and Inspections:
 - 1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA-568-C.3.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.3. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by the test equipment manufacturer for channel or link test configuration.
- F. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.
- G. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- H. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- I. Prepare test and inspection reports.

END OF SECTION 271513