SECTION 27 13 00
COMMUNICATIONS CABLING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Pathways.
2. UTP cabling.
3. Cable connecting hardware, patch panels and cross connects
4. Cable connecting hardware, and cross-connects.
5. Telecommunications outlet/connectors.
6. Cabling identification products.
7. Cable management system.

1.02

1.03 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. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

G. RCDD: Registered Communications Distribution Designer.

H. UTP: Unshielded twisted pair.

1.04 BACKBONE CABLING DESCRIPTION

A. Provide a backbone cabling system establishing 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. Do not use bridged taps and splitters as part of backbone cabling.

1.05 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the nearest communications equipment room or enclosure. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
   1. Provide no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
   2. Do not install bridged taps and splices in the horizontal cabling system.
   3. Do not install splitters as part of the optical fiber cabling system

1.06 PERFORMANCE REQUIREMENTS

A. General Performance: Comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard for the backbone and horizontal cabling system.

1.07 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. For coaxial cable, provide the following installation data for each type used:
      a. Nominal OD.
      b. Minimum bending radius.
      c. Maximum pulling tension.

B. Shop Drawings:
   1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
   2. Cabling administration drawings and printouts.
   3. Wiring diagrams to show typical wiring schematics including the cross-connects.
   4. Cross-connects. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
   5. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.
   6. Cable tray layout showing cable tray route to scale with relationship between the tray and adjacent structural, electrical and mechanical elements.

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

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

1.08 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, and field testing program development by an RCDD.

2. Installation Supervision: Install under the direct supervision of Registered Technician, 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.

B. Testing Agency Qualifications: An NRTL.
1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. 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.

D. 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.

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

F. Grounding: Comply with ANSI-J-STD-607-A.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site. Test each pair of UTP cable for open and short circuits.
1. Test optical fiber cables to determine the continuity of the strand end to end. Use optical
2. Test each pair of UTP cable for open and short circuits.
3. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.
4. Test each pair of UTP cable for open and short circuits.

1.10 PROJECT CONDITIONS

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

1.11 COORDINATION

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

1.12 EXTRA MATERIALS

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: One of each type.
2. UTP 4-pair Station Cable: 1,000 feet.
3. UTP Backbone Cable: 100 feet.
4. Patch-Panel Units: One of each type.

5. Device Plates: 10 of each type.

PART 2 - PRODUCTS

2.01 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. It is the intent of the Specification that one manufacturer, not a combination, be selected for each particular class of material.

C. Cable Support:
1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

D. Cable Tray: Refer to 27 11 00, Paragraph 2.02.

E. Conduit and Boxes: Comply with requirements in Section 26 05 33 "Raceway and Boxes for Electrical Systems. Do not use flexible metal conduit.
1. Provide outlet boxes no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.02 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements in Section 06 10 00 "Rough Carpentry" for plywood backing panels.

2.03 UTP CABLE (BACKBONE AND HORIZONTAL)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Belden CDT Inc.; Electronics Division.
2. Berk-Tek; a Nexans company.
3. Mohawk; a division of Belden CDT.
4. Superior Essex Inc.

B. Description: Multi-pair Backbone Cable: Category 5e, 100-ohm, 25-pair UTP binder groups covered with a gray thermoplastic jacket. Horizontal: Category 5e, 100-ohm, 4-pair UTP, covered with a blue thermoplastic jacket.
1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 5e.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

C. Multi-pair backbone cables: Provide copper backbone cable that meets or exceeds the following specifications:

1. Electrical Specifications:

Maximum DC Resistance	28.6 Ω/1,000 ft (9.4 Ω/100m)
Maximum DC Resistance Unbalanced	5%
Maximum Capacitance Unbalanced (pair to ground)	1,000 pF/1000 ft. (328 pF/m)
Mutual Capacitance @ 1kHz	18 nF/1000 ft (5.9 nF/100 m), max.

2. Attenuation (dB/100 m [328 ft.]):

Frequency	Attenuation (Max.)
1.00 MHz	2.3 dB
4.00 MHz	4.9 dB
10.00 MHz	8.5 dB
16.00 MHz	12 dB

3. Worst Pair Near-End Crosstalk (NEXT) dB/100 m [328 ft]:

Frequency	Pair-To-Pair NEXT (Max.)
1.0 MHz	13.8 dB
4.0 MHz	11.2 dB
10.0 MHz	10.2 dB
16.0 MHz	9.2 dB

D. Description: Horizontal Cable: Category 6 Voice and Data Channel Performance Specifications: Provide plenum rated, component compliant cable with guaranteed channel performance capabilities listed below. The data channel is comprised of the passive components including cabling, connectors, patch panel port, and patch cords, providing up to a total of 4 connections between the Owner's network electronics. The Owner's network electronics are not part of this contract.

E. Extend Voice and Data horizontal cables between the voice and/or data station location and its associated MDF or IDF. Provide 4 pair, 24AWG, UTP. Terminate on the 8 pin modular jacks provided at each Outlet.

F. Provide voice and data station cables in conformance with ANSI/TIA/EIA 568B series Commercial Building Telecommunications Cabling Standard, and be part of the UL® LAN Certification and Follow-up Program. Applications standards supported include, but are not limited to, IEEE 802.3, 10BASE-T, IEEE 802.5, 16Mbps (328 ft [100m], 104 Workstations) and TP-PMD. Provide cables that are capable of supporting evolving high-end applications, including but not limited to: 1000Base-T; 100 Base-T; 100Mbps TP-PMD; 155 Mb/s ATM; and 622Mbps ATM using parallel transmission schemes.

G. Electrical and Mechanical Specifications listed below:
   a. DC resistance 27.1 Ω/1,000 ft (8.9 Ω/100 m), maximum.
   b. DC resistance Unbalance: 3%, maximum.
   c. Mutual Capacitance @ 1 kHz: 14pF/1000 ft (4.6 nF/100m), maximum.

d. Capacitance Unbalance (pair to ground): 200pF/1,000 ft (66 pF/100m).
e. Characteristic Impedance: 100 Ω ± 15 Ω from 1-300 MHz.
f. Outside diameter: .23 in.
g. Weight: 31.0 lb./1000 ft.
h. Data cable shall be color blue. Voice cable shall be yellow.

4. Provide Category 6 cables that meet or exceed the latest TIA/EIA standard at the time of the bid, and have guaranteed performance to 250 MHz over Swept Frequency:

Freq (MHz)	Insertion Loss dB/100m	NEXT (dB)	PS NEXT (dB)	ELFEXT (dB)	PS ELFEXT	Return Loss
0.772	1.8	76.0	74.0	70.0	67.0	‡
1	2.0	74.3	72.3	67.8	64.8	20
4	3.8	65.3	63.3	55.8	52.8	23
8	5.3	60.8	58.8	49.7	46.7	24.5
10	6.0	59.3	57.3	47.8	44.8	25
16	7.6	56.2	54.3	43.7	40.7	25
20	8.5	54.8	52.8	41.8	38.8	25
25	9.5	53.3	51.3	39.8	36.8	24.3
31.25	10.7	51.9	49.9	37.9	34.9	23.6
62.5	15.4	47.4	45.4	31.9	28.9	21.5
100	19.8	44.3	42.3	27.8	24.8	20.1
200	29.0	39.8	37.8	21.8	18.8	18.0
250	32.8	38.3	36.3	19.8	16.8	17.3

‡ Indicates Not Specified

H. Voice and Data Patch Cords:
1. Provide Patch Cords in conformance with the requirements of ANSI/TIA/EIA 568B series Commercial Building Telecommunications Cabling Standard, and are part of the UL® LAN Certification and Follow-up Program.
2. Provide Patch Cords that are UL® Verified for ANSI/TIA/EIA 568B series Electrical Performance; UL® and c (UL®) Listed for Fire Safety; produced by and ISO 9001 Certified Manufacturer; and FCC Compliant.
3. Provide Patch Cords that are equipped with an 8-pin modular connector on each end and shall conform to the length(s) specified. In addition, patch cords shall be constructed with strain relief and snag prevention.
4. Provide Category 6 Patch Cords consisting of 24 AWG copper, stranded conductors, tightly twisted into individual pairs and that meet or exceed the following electrical specifications:

a. General:

DC Resistance per lead	9.4Ω/100m (328ft), maximum
DC resistance unbalance	5%, Maximum
Mutual Capacitance	6.6 nF/100m (328 ft). maximum
Characteristic Impedance	100Ω ± 15% from 1 to 100 MHz

b. Worst Pair Near-End Crosstalk and Return Loss, dB/100 m [328 ft.]:

Frequency (MHz)	Pair-To-Pair NEXT (Max.) dB (2 Meter)	Return Loss (dB)
1.00	65.0	19.8
4.00	65.0	21.6
8.00	65.0	22.5
10.00	65.0	22.8
16.00	62.0	23.4
20.00	60.1	23.7
25.0	58.1	24.0
31.25	56.2	23.0
62.5	50.4	20.0
100.0	46.4	18.0
200.0	40.6	15.0
250	38.8	14.0

c. Patch Cords shall incorporate the "cross-over lead" concept. The patch cord shall have built-in exclusive features to prevent accidental polarity reversals and split pairs.
d. Patch Cords shall be from the same manufacturer as the data jacks and patch panels, and shall contribute to the channel performance as specified herein.
e. Provide two (2) modular patch cords for each wired port on the patch panels, according to the following percentages and lengths:
   1) 50% as 7' cables
   2) 25% as 5' cables
   3) 25% as 3' cables
f. Provide an additional 100-10’ Patch Cords
g. Hand deliver Patch Cords to the Owner and obtain written receipt confirming delivery. It is the Communication Systems Installer’s responsibility to obtain signature receipt for these patch cords.

2.04 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hubbell Premise Wiring.
   2. Leviton Voice & Data Division.
   3. Molex Premise Networks; a division of Molex, Inc.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Terminate cables with connecting hardware of same category or higher.

C. Connecting Blocks:
   1. 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.

2. By the same manufacturer as the telephone jacks.
3. Fire retardant, molded plastic consisting of horizontal index strips for terminating 25 pairs of conductors each.
4. Provide index strips marked with five colors on the high teeth, separating tip and ring.
5. Provide fanning strips located on each side of the block for dressing cable pairs. terminated on the adjacent index strips.
6. Provide blocks that accommodate 22 through 26 AWG conductors.
7. Provide blocks with mounting legs.
8. Create separate termination fields for vertical backbone and horizontal station cable terminations

D. 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.
2. Number of Jacks per Field: One for each four-pair UTP cable indicated conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

E. Patch Panels: Category 6 Data Patch Panel:
1. Category 6 RJ45/110 Type modular jack panels shall be 48 ports as shown on the Technology Drawings. One wire management-retaining trough shall be installed above every patch panel as shown on the Technology Drawings. Modular Jack Panels shall accommodate both T568A/T568B configurations.
2. The patch panel shall support the appropriate Category 6 applications and contribute to the overall Channel Performance specification. The patch panel shall facilitate cross connection and inter connection using modular patch cords.
3. Provide rear cable management strain relief brackets, one for each row of patch panel terminations.
4. Electrical Requirements:

Frequency (MHz)	NEXT Pair-to Pair (dB)	FEXT (dB)	Return Loss (dB)	Insertion Loss (dB)
1.0	75.0	75.0	30.0	0.10
4.0	75.0	75.1	30.0	0.10
8.0	75.0	65.0	30.0	0.10
10.0	74.0	63.1	30.0	0.10
16.0	69.9	59.0	30.0	0.10
20.0	68.0	57.1	30.0	0.10
25.0	66.0	55.1	30.0	0.10
31.25	64.1	53.2	30.0	0.11
62.50	58.1	47.2	28.1	0.16
100.0	54.0	43.1	24.0	0.20
200.0	48.0	37.1	18.0	0.28
250.0	46.0	35.1	16.0	0.32

F. Jacks and Jack Assemblies: Provide Category 6 jacks that meet or exceed Category 6 transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA 568B series

Commercial Building Telecommunications Cabling Standard, and be part of the UL LAN Certification and Follow-up Program. Category 6 jacks shall contribute to the overall Channel Performance Specifications. Jacks shall be snap-in, 110 style, 8-pin insulation displacement contact (IDC), modular (RJ-45) jacks as specified herein and indicated on the Technology Outlet Plans. Communication outlet devices shall be gray. Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

G. Faceplates:
1. Provide single- or double gang utility outlet faceplates for voice, data, video and audio outlets as specified, equipped with front loading snap-in modules. Provide stainless steel wall mounted faceplates. Provide wall phone outlets in stainless steel 630A style, with 8-wire RJ-45 jacks, that support wall phone mounting without any additional hardware. Provide white faceplates for ceiling mounted outlet installations. It is the Communication Systems Installer's responsibility to coordinate with Division 26 00 00 for faceplate colors.
2. All faceplates shall have clear plastic windows at both the top and bottom of the faceplate to accommodate labels. Faceplates which do not have both top and bottom clear plastic label windows are not acceptable, and shall be replaced by the Communication Systems Installer at no expense to the Owner.
3. Unused ports at each faceplate shall be provided with blank module inserts. Blank inserts shall be the same color as the communication outlet devices.
4. Stainless steel faceplates used for wall mount telephone locations shall be labeled with permanent machine generated labels.

2.05 GROUNDING

A. Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.06 IDENTIFICATION PRODUCTS

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

2.07 Unspecified Equipment and Material:

A. Provide any item of equipment or material not specifically addressed on the Drawings or in this Document and required to provide a complete and functional installation in a level of quality consistent with other specified items.

2.08 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 ENTRANCE FACILITIES

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

3.02 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 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.
   2. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceway and Boxes for Electrical 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.

3.03 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A.

B. Comply with requirements for demarcation point and pathways specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Section 26 05 23 "Raceways and Boxes for Electrical Systems" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:
   1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
   2. Install cable trays to route cables if conduits cannot be located in these positions.

3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 1 - 3 inches above finished floor unless otherwise indicated.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.04 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:
1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
8. 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.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. In the communications equipment room, install a 10-foot long service loop on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
12. Observe the bending radius and pulling strength requirements of all the voice system station, and riser cable during handling and installation.
13. Each run of cable between the voice termination block and patch to the Technology Outlet shall be continuous without any splices.
14. Wiring color codes shall be strictly observed and terminations shall be uniform throughout the system. Identification markings and systems shall be uniform.
15. Provide one voice station cable to each pay phone location as shown on applicable drawings. Terminate on punch down blocks, label and crosswire all pay phone cables and connect cable to the line provided by Local Exchange Carrier. Payphones are by others.

C. UTP Cable Installation:
1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
   3. Do not run cable through structural members or in contact with pipes, ducts, or other potentially damaging items.

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

F. Separation from EMI Sources:
   1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
   2. Separate open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
   3. Separate communications cables in grounded metallic raceways and unshielded power lines or electrical equipment as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
   4. Separate communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures 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.
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
   5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
   6. Separation between Communications Cables and Fluorescent Fixtures: Minimum 5 inches.

3.05 FIRESTOPPING

A. Specified in Section 07 84 13 "Penetration Firestopping."

3.06 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Install bonding and grounding in accordance with the ANSI/TIA/EIA 607, NEC® and NFPA. Horizontal cables shall be grounded in compliance with ANSI/NFPA 70 and local requirements and practices. Horizontal equipment includes cross connect frames, patch panels and racks, active telecommunications equipment and test apparatus and equipment.

E. Provide a Telecommunications Bonding Backbone utilizing a #6-AWG or larger bonding conductor that provides direct bonding between IDFs. This is part of the grounding and bonding infrastructure (part of the telecommunications pathways and spaces in the building structure), and is independent of equipment or cable.

F. Provide any necessary screws, anchors, clamps, tie wraps, distribution rings, and miscellaneous grounding support hardware to complete the installation of the grounding system.

G. Affix grounding conductors with permanent labels in a visible location at each end of the conductor, and as close as practicable to the bonding point at each end of the conductor. Clearly identify both the source and destination of the bonding conductors.

3.07 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
   1. Confirm labeling scheme with the Owner prior to final labeling.
   2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.

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, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

E. Cable and Wire Identification:
   1. Label each cable within 4 inches 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 device if color of wire 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. 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 being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
   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. Provide preprinted or computer-printed type labels with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:
   1. Cable Labels: Use flexible vinyl or polyester that flexes as cables are bent.

3.08 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:
   1. Visually inspect UTP 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/EIA-568-B.1.
   2. Visually confirm Category 6 marking of outlets, cover plates, outlet/connectors, and patch panels.
   3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   4. Test UTP copper 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. Provide test instruments that meet or exceed applicable requirements in TIA/EIA-568-B.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.
   5. Multi-pair Voice Riser Tests:
      a. Test each pair of multi-pair voice riser cables for proper polarity; no reversals; no transpositions; continuity; no shorts; no AC voltages; no DC voltages; no opens; and proper numbering at each termination.
      b. Bring cables and/or pairs not meeting the requirements of the standard into full compliance, at no additional cost to the Owner.
      c. Document cable testing in accordance with Submittals Article. Provide a table of test results in a 3-ring binder submitted with the as-built Drawings.
   6. Category 6 Data, and Voice UTP Cable Testing:

a. Test voice and data jack in each Outlet for Category 6 ANSI/TIA/EIA 568B series compliance, using a Certified Level III testing instrument. Tests shall verify both the integrity of all conductors and correctness of the termination sequence. Tests shall also include length, mutual capacitance, characteristic impedance, attenuation and near-end and far-end crosstalk. Testing shall be performed between modular jacks at the Outlets and the modular jacks at the patch panel field.
b. The Communication Systems Installer shall bring cables and/or pairs not meeting the requirements of the standard into full compliance, at no additional cost to the Owner.
c. Document cable testing in accordance with Submittals Article. Provide a table of test results in a 3-ring binder submitted with the as-built Drawings.

D. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.
a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.

E. Document data for each measurement. Print data for submittals 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.

F. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

G. End-to-end cabling will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports.

END OF SECTION 27 13 00