SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

Revise this Section by deleting and inserting text to meet Project-specific requirements.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

See "Sustainable Design Considerations" Article in the Evaluations for a discussion of sustainable design requirements that may impact the editing of this Section.

1. GENERAL
   * + 1. SUMMARY
          1. Section Includes:

Backboards.

Category 5e balanced twisted pair cable.

Category 6 balanced twisted pair cable.

Category 6a balanced twisted pair cable.

Balanced twisted pair cabling hardware.

RS-485 cabling.

Low-voltage control cabling.

Control-circuit conductors.

Identification products.

* + - 1. DEFINITIONS

Retain terms that remain after this Section has been edited for a project.

* + - * 1. EMI: Electromagnetic interference.
        2. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
        3. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.
        4. RCDD: Registered Communications Distribution Designer.
      1. SUBMITTALS
         1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
         2. Manufacturer’s installation instructions shall be provided along with product data.
         3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
         4. Product Data: For each type of product.
         5. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
         6. Qualification Data: For testing agency, RCDD, layout technician, installation supervisor, and field inspector.
         7. Source quality-control reports.

Retain "Field quality-control reports" paragraph below if Contractor is responsible for field quality-control testing and inspecting.

* + - * 1. Field quality-control reports.
      1. QUALITY ASSURANCE

Retain "Testing Agency Qualifications" paragraph below if Contractor or manufacturer selects testing agency or if Contractor is required to provide services of a qualified testing agency in "Field Quality Control" Article.

* + - * 1. Testing Agency Qualifications: Accredited by NETA.

Retain subparagraph below for balanced twisted pair cabling.

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

1. PRODUCTS

Manufacturers and products listed in SpecAgent and Masterworks Paragraph Builder are neither recommended nor endorsed by the AIA or Deltek. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications.

Coordinate products in this Section with other Sections; for instance, if Division 27 cabling Sections are being included, delete duplicate cabling articles in this Section.

* + - 1. PERFORMANCE REQUIREMENTS
         1. 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.

See the Evaluations for discussion of flame travel and smoke density.

* + - * 1. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

Flame Travel Distance: 60 inches or less.

Peak Optical Smoke Density: 0.5 or less.

Average Optical Smoke Density: 0.15 or less.

* + - * 1. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
        2. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.
        3. RoHS compliant.
      1. BACKBOARDS
         1. Description: Plywood, [**fire-retardant treated,**]3/4 by 48 by 96 inches
         2. Painting: Paint plywood on all sides and edges with [**flat**] [**eggshell**] [**black**] <**Insert color**> [**latex**] [**alkyd**] paint.
      2. CATEGORY 5e BALANCED TWISTED PAIR CABLE

See the Evaluations for a discussion of cable types. Specify shielding or screening in "Shielding/Screening" paragraph below.

* + - * 1. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz.
        2. 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:

Belden Inc.

CommScope, Inc.

General Cable; Prysmian Group North America.

Or equal.

* + - * 1. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 5e cables.
        2. Conductors: 100-ohm, 24 AWG solid copper.
        3. Shielding/Screening: [**Unshielded twisted pairs (UTP)**] [**Shielded twisted pairs (FTP)**] [**Screened twisted pairs (F/UTP)**] [**Screened and shielded twisted pairs (F/FTP)**].
        4. Cable Rating: [**Riser**] [**Plenum**].
        5. Jacket: [**White**] [**Gray**] <**Insert color**> thermoplastic.
      1. CATEGORY 6 BALANCED TWISTED PAIR CABLE

See the Evaluations for a discussion of cable types. Specify shielding or screening in "Shielding/Screening" paragraph below.

* + - * 1. Description: Four-pair, balanced-twisted pair cable, [**with internal spline,**] certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.
        2. 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:

Belden CDT Networking Division/NORDX.

CommScope, Inc.

General Cable; Prysmian Group North America.

Or equal.

* + - * 1. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.
        2. Conductors: 100-ohm, 23 AWG solid copper.
        3. Shielding/Screening: [**Unshielded twisted pairs (UTP)**] [**Shielded twisted pairs (FTP)**] [**Screened twisted pairs (F/UTP)**] [**Screened and shielded twisted pairs (F/FTP)**].
        4. Cable Rating: [**Riser**] [**Plenum**].
        5. Jacket: [**White**] [**Gray**] [**Blue**] [**Yellow**] <**Insert color**> thermoplastic.
      1. CATEGORY 6a BALANCED TWISTED PAIR CABLE

See the Evaluations for a discussion of cable types. Specify shielding or screening in "Shielding/Screening" paragraph below.

* + - * 1. Description: Four-pair, balanced-twisted pair cable,[**with internal spline,**] certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.
        2. 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:

Belden CDT Networking Division/NORDX.

CommScope, Inc.

General Cable; Prysmian Group North America.

Or equal.

* + - * 1. Standard: Comply with TIA-568-C.2 for Category 6a cables.
        2. Conductors: 100-ohm, 23 AWG solid copper.
        3. Shielding/Screening: [**Unshielded twisted pairs (UTP)**] [**Shielded twisted pairs (FTP)**] [**Screened twisted pairs (F/UTP)**] [**Screened and shielded twisted pairs (F/FTP)**].
        4. Cable Rating: [**Riser**] [**Plenum**].
        5. Jacket: [**White**] [**Gray**] [**Blue**] [**Yellow**] <**Insert color**> thermoplastic.
      1. BALANCED TWISTED PAIR CABLE HARDWARE
         1. Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.
         2. 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:

Belden CDT Networking Division/NORDX.

General Cable; Prysmian Group North America.

Leviton Manufacturing Co., Inc.

Or equal.

Retain "General Requirements for Cable Connecting Hardware" paragraph below to specify performance requirements for all balanced twisted pair hardware specified in this article.

* + - * 1. General Requirements for Balanced Twisted Pair Cable Hardware:

Comply with the performance requirements of [**Category 5e**] [**Category 6**] [**Category 6a**] [**Category 7**].

Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.

Cables shall be terminated with connecting hardware of same category or higher.

Retain first option in first paragraph below to allow balanced twisted pair cable and hardware from different manufacturers. Retain second option to require that balanced twisted pair cable and hardware from the same manufacturer.

* + - * 1. Source Limitations: [**Obtain balanced twisted pair cable hardware from single source from single manufacturer**] [**Obtain balanced twisted pair cable hardware from same manufacturer as balanced twisted pair cable, from single source**].

See discussion in the Evaluations about 110-style IDC connectors and connector blocks.

* + - * 1. Connecting Blocks: [**110-style IDC for Category 5e**] [**110-style IDC for Category 6**] [**66-style IDC for Category 5e**]. Provide blocks for the number of cables terminated on the block, plus [**25**] <**Insert number**> percent spare, integral with connector bodies, including plugs and jacks where indicated.

Delete "Cross-Connect" paragraph below if cross-connection is accomplished exclusively on patch panels.

* + - * 1. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

Coordinate "Number of Terminals per Field" subparagraph below with Drawings for quantity of fields.

Number of Terminals per Field: [**One**] <**Insert number**> for each conductor in assigned cables.

* + - * 1. 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.

Features:

Universal T568A and T568B wiring labels.

Labeling areas adjacent to conductors.

Feature in first subparagraph below allows for swapping out a connector.

Replaceable connectors.

24 or 48 ports.

Construction: 16-gauge steel and mountable on 19-inch equipment racks.

Coordinate "Number of Jacks per Field" subparagraph below with Drawings for quantity of fields.

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

Cords are generally available in lengths of up to 20 feet and longer in 24-inch increments.

* + - * 1. Patch Cords: Factory-made, four-pair cables in [**36-inch**] [**48-inch**] <**Insert length**>lengths; terminated with an eight-position modular plug at each end.

Retain one of two subparagraphs below. Retain first for Category 6 or Category 6a; retain second for Category 5e patch cords.

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.

Patch cords shall have color-coded boots for circuit identification.

* + - * 1. Plugs and Plug Assemblies:

Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded balanced twisted pair cable.

Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.

**Requirement** below is optional in TIA-568-C.1.

Marked to indicate transmission performance.

* + - * 1. Jacks and Jack Assemblies:

Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded balanced twisted pair cable.

Designed to snap-in to a patch panel or faceplate.

Standards:

Category 5e, unshielded balanced twisted pair cable shall comply with IEC 60603-7-2.

Category 5e, shielded balanced twisted pair cable shall comply with IEC 60603-7-3.

Category 6, unshielded balanced twisted pair cable shall comply with IEC 60603-7-4.

Category 6, shielded balanced twisted pair cable shall comply with IEC 60603-7.5.

Category 6a, unshielded balanced twisted pair cable shall comply with IEC 60603-7-41.

Category 6a, shielded balanced twisted pair cable shall comply with IEC 60603-7.51.

Requirement below is optional in TIA-568-C.1.

Marked to indicate transmission performance.

Coordinate "Faceplate" paragraph below with other items specified to be mounted in workstation faceplates. Revise paragraph if faceplate elevations are on Drawings.

* + - * 1. Faceplate:

[**Two**][**Four**] [**Six**] port, vertical single-gang faceplates designed to mount to single-gang wall boxes.

[**Eight**] [**Ten**] [**Twelve**] port, vertical double-gang faceplates designed to mount to double-gang wall boxes.

Retain "Plastic Faceplate" or "Metal Faceplate" subparagraph below, or retain both as required to match Section 262726 "Wiring Devices."

Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."

Metal Faceplate: [**Stainless steel**] [**Brass**] <**Insert description**>, complying with requirements in Section 262726 "Wiring Devices."

For use with snap-in jacks accommodating any combination of balanced twisted pair, optical fiber, and coaxial work area cords.

Flush mounting jacks, positioning the cord at a 45-degree angle.

* + - * 1. Legend:

Machine printed, in the field, using adhesive-tape label.

Snap-in, clear-label covers and machine-printed paper inserts.

* + - 1. TWIN-AXIAL DATA HIGHWAY CABLE
         1. Standard Cable: NFPA 70, Type CM.

Retain one wire size with the corresponding stranding configuration option in first subparagraph below.

Paired, <**Insert number**> pairs, [**No. 20**] [**No. 22**] [**No. 24**] AWG, stranded [**(7x28)**] [**(7x30)**] [**(7x32)**] tinned-copper conductors.

Polypropylene insulation.

Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.

PVC jacket.

Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.

Flame Resistance: Comply with UL 1685.

* + - * 1. Plenum-Rated Cable: NFPA 70, Type CMP.

Retain one wire size with the corresponding stranding configuration option in first subparagraph below.

Paired, <**Insert number**> pairs, [**No. 20**] [**No. 22**] [**No. 24**] AWG, stranded [**(7x28)**] [**(7x30)**] [**(7x32)**] tinned-copper conductors.

Plastic insulation.

Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.

Plastic jacket.

Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.

NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.

Flame Resistance: Comply with NFPA 262.

* + - 1. RS-232 CABLE
         1. 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:

Belden Inc.

General Cable; Prysmian Group North America.

Southwire Company.

Or equal.

RS-232 communications require three to nine conductors with an overall shield. Circuit is limited to a distance of not more than 50 feet. Add other conductor count cables as needed for Project.

* + - * 1. PVC-Jacketed, TIA 232-F:

[**Three**] [**Nine**], No. 22 AWG, stranded (7x30) tinned copper conductors.

Polypropylene insulation.

Aluminum foil-polyester tape shield with 100 percent shield coverage.

PVC jacket.

Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

NFPA 70 Type: Type CM.

Flame Resistance: Comply with UL 1581.

* + - * 1. Plenum-Type, TIA 232-F:

[**Three**] [**Nine**], No. 22 AWG, stranded (7x30) tinned copper conductors.

PE insulation.

Aluminum foil-polyester tape shield with 100 percent shield coverage.

Fluorinated ethylene propylene jacket.

Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

Flame Resistance: Comply with NFPA 262.

* + - 1. RS-485 CABLE

RS-485 communications require a single twisted pair for half-duplex communications. Some manufacturers use two twisted pairs to provide full duplex. See manufacturer's data to determine the wiring requirements. Circuit is limited to a distance of not more than 4000 feet.

* + - * 1. Standard Cable: NFPA 70, Type CMG.

Paired, [**one pair**] [**two pairs**], twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.

PVC insulation.

Unshielded.

PVC jacket.

Flame Resistance: Comply with UL 1685.

* + - * 1. Plenum-Rated Cable: NFPA 70, Type CMP.

Paired, [**one pair**] [**two pairs**], No. 22 AWG, stranded (7x30) tinned-copper conductors.

Fluorinated ethylene propylene insulation.

Unshielded.

Fluorinated ethylene propylene jacket.

NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.

Flame Resistance: NFPA 262.

* + - 1. LOW-VOLTAGE CONTROL CABLE

Retain "Paired Cable" or "Plenum-Rated, Paired Cable" paragraph below, or both. Other conductor sizes, configurations, and insulation types are available.

* + - * 1. Paired Cable: NFPA 70, Type CMG.

[**One**][**Multi-**]pair, twisted, [**No. 16 AWG, stranded (19x29)**] [**No. 18 AWG, stranded (19x30)**] tinned-copper conductors.

PVC insulation.

Unshielded.

PVC jacket.

Flame Resistance: Comply with UL 1685.

* + - * 1. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

[**One**][**Multi-**]pair, twisted, [**No. 16 AWG, stranded (19x29)**] [**No. 18 AWG, stranded (19x30)**] tinned-copper conductors.

PVC insulation.

Unshielded.

PVC jacket.

NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.

Flame Resistance: Comply with NFPA 262.

* + - 1. CONTROL-CIRCUIT CONDUCTORS
         1. 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:

General Cable; Prysmian Group North America.

Service Wire Co.

Southwire Company.

Or equal.

* + - * 1. Class 1 Control Circuits: Stranded copper, [**Type THHN/THWN-2, complying with UL 83 in raceway**] [**Type THW, complying with UL 83 in raceway**] [**Type XHHW-2, complying with UL 44 in raceway**] [**Type TC, complying with UL 1277 in raceway**] [**Type MC, complying with UL 1569**].
        2. Class 2 Control Circuits: Stranded copper, [**Type THHN/THWN-2, complying with UL 83 in raceway**] [**Type XHHW-2, complying with UL 44 in raceway**] [**power-limited cable, concealed in building finishes**] [**power-limited tray cable, in cable tray**].
        3. Class 3 Remote-Control and Signal Circuits: Stranded copper, [**Type THHN/THWN-2, complying with UL 83 in raceway**] [**Type XHHW-2, complying with UL 44 in raceway**] [**power-limited cable, concealed in building finishes**] [**power-limited tray cable, in cable tray**] [**Type TW or Type TF, complying with UL 83, in raceway**].
        4. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.

Smoke control signaling and control circuits.

<**Insert list of critical circuits that require CI cable**>.

* + - 1. FIRE-ALARM WIRE AND CABLE
         1. 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:

Allied Wire & Cable Inc.

CommScope, Inc.

West Penn Wire.

Or equal.

* + - * 1. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

NFPA 70 permits wire sizes down to No. 16 AWG.

* + - * 1. Signaling Line Circuits: Twisted, shielded pair, [**not less than**] [**No. 18 AWG**] [<**Insert wire size**> **AWG**] [**size as recommended by system manufacturer**].

Retain "Circuit Integrity Cable" subparagraph below if use of cable is an option.

Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

* + - * 1. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

NFPA 70 permits wire sizes down to No. 18 AWG.

Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.

Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.

Retain "Multiconductor Armored Cable" subparagraph below if use of cable is an option.

Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor[**with outer jacket**] with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

* + - 1. SOURCE QUALITY CONTROL

Retain "Testing Agency" paragraph below if required. Independent certification may be acceptable to authorities having jurisdiction without further monitoring of plant's quality-control and testing program by Owner.

* + - * 1. Testing Agency: [**Director’s Representative will engage**] [**Engage**] a qualified testing agency to evaluate cables.
        2. Factory test twisted pair cables according to TIA-568-C.2.
        3. Cable will be considered defective if it does not pass tests and inspections.
        4. Prepare test and inspection reports.

1. EXECUTION
   * + 1. EXAMINATION

According to BICSI ITSIMM, telecommunications cables should be tested on receipt. Low-voltage wires and cables do not normally require testing before installation.

* + - * 1. Test cables on receipt at Project site.

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

* + - 1. INSTALLATION OF RACEWAYS AND BOXES

Retain one of first two subparagraphs below.

Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

Outlet boxes for cables shall be no smaller than 4 inches square by [**1-1/2 inches**] [**2-1/8 inches**] deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.

Flexible metal conduit shall not be used.

* + - * 1. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
        2. Install manufactured conduit sweeps and long-radius elbows if possible.
        3. Raceway Installation in Equipment Rooms:

Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.

Install cable trays to route cables if conduits cannot be located in these positions.

Secure conduits to backboard if entering the room from overhead.

Extend conduits [**3 inches**] <**Insert dimension**> above finished floor.

Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

* + - * 1. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.
      1. INSTALLATION OF CONDUCTORS AND CABLES
         1. Comply with NECA 1.
         2. General Requirements for Cabling:

Comply with TIA-568-C Series of standards.

Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."

Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.

Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.

Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.

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.

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." Install lacing bars and distribution spools.

Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.

Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.

Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.

Support: Do not allow cables to lie on removable ceiling tiles.

Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

Provide strain relief.

Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.

Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

* + - * 1. Balanced Twisted Pair Cable Installation:

Comply with TIA-568-C.2.

Do not untwist balanced twisted pair cables more than 1/2 inch at the point of termination to maintain cable geometry.

* + - * 1. Installation of Control-Circuit Conductors:

Install wiring in raceways.

Use insulated spade lugs for wire and cable connection to screw terminals.

* + - * 1. Open-Cable Installation:

Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than [**30 inches**] <**Insert dimension**> apart.

Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

* + - * 1. Installation of Cable Routed Exposed under Raised Floors:

Install plenum-rated cable only.

Install cabling after the flooring system has been installed in raised floor areas.

Below each feed point, neatly coil a minimum of [**72 inches**] <**Insert dimension**> of cable in a coil not less than [**12 inches**] <**Insert dimension**> in diameter.

See "Standards and Best Practices" Article in the Evaluations for discussion of EMI.

* + - * 1. Separation from EMI Sources:

Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.

Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches.

Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches.

Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches.

Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.

Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches.

Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches.

Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.

Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches.

Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches.

Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.

Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

* + - 1. REMOVAL OF CONDUCTORS AND CABLES
         1. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.
      2. CONTROL-CIRCUIT CONDUCTORS
         1. Minimum Conductor Sizes:

Class 1 remote-control and signal circuits; [**No 14**] <**Insert wire size**> AWG.

Class 2 low-energy, remote-control, and signal circuits; [**No. 16**] <**Insert wire size**> AWG.

Class 3 low-energy, remote-control, alarm, and signal circuits; [**No 12**] <**Insert wire size**> AWG.

* + - 1. FIRESTOPPING
         1. Comply with TIA-569-D, Annex A, "Firestopping."
         2. Comply with BICSI TDMM, "Firestopping" Chapter.
      2. GROUNDING

Retain one or both paragraphs below.

* + - * 1. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
      1. IDENTIFICATION
         1. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.
         2. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.
      2. FIELD QUALITY CONTROL

Retain one of first four paragraphs below. Retain first "Testing Agency" paragraph below if Owner will hire an independent testing agency.

* + - * 1. Testing Agency: Director’s Representative will engage a qualified testing agency to perform tests and inspections.

Retain "Testing Agency" paragraph below to require Contractor to hire an independent testing agency.

* + - * 1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

Retain "Manufacturer's Field Service" paragraph below to require a factory-authorized service representative to perform tests and inspections.

* + - * 1. Manufacturer's Field Service: Engage a Company Service Advisor to test and inspect components, assemblies, and equipment installations, including connections.

Retain "Perform tests and inspections" paragraph below to require Contractor to perform tests and inspection and retain option to require Contractor to arrange for assistance of a factory-authorized service agent.

* + - * 1. Perform tests and inspections [**with the assistance of a** Company Service Advisor].

Retain "Tests and Inspections" paragraph below to describe tests and inspections to be performed.

* + - * 1. Tests and Inspections:

Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.

Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

Retain first subparagraph below if verification of quality is to be performed before completion of the cabling.

Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.

Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

* + - * 1. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
        2. End-to-end cabling will be considered defective if it does not pass tests and inspections.
        3. Prepare test and inspection reports.

END OF SECTION 260523