

PROJECT MANUAL

FDVA **Clifford Sims - Nurse Call Replacement** Panama City, Florida

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Project Number 35/35960985-35853

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SECTION 260010 - SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes requirements generally applicable to all electrical Work on the Project, including but not limited to Work specified in Divisions 26, 27, and 28.
- B. Related Requirements:

1.2 REFERENCES

- A. Abbreviations and Acronyms for Electrical Terms and Units of Measure:

- 1. 8P8C: An 8-position 8-contact modular jack.
- 2. A: Ampere, unit of electrical current.
- 3. AC or ac: Alternating current.
- 4. AFCI: Arc-fault circuit interrupter.
- 5. AGC: Automatic gain control.
- 6. AIC: Ampere interrupting capacity.
- 7. AL, Al, or ALUM: Aluminum.
- 8. ASD: Adjustable-speed drive.
- 9. ATP: Acceptance test procedure.
- 10. ATS: Automatic transfer switch.
- 11. A/V: Audio/visual.
- 12. AWG: American wire gauge; see ASTM B258.
- 13. BAS: Building automation system.
- 14. BDA: Bi-directional amplifier.
- 15. BIL: Basic impulse insulation level.
- 16. BIM: Building information modeling.
- 17. BMS: Building management system.
- 18. BNC: Bayonet Neill-Concelman - type of connector.
- 19. B/W: Black and white.
- 20. CAD: Computer-aided design or drafting.
- 21. CATV: Community antenna television.
- 22. CB: Circuit breaker.
- 23. CCD: Charge-coupled device.
- 24. CCTV: Closed-circuit television.
- 25. cd: Candela, the SI fundamental unit of luminous intensity.
- 26. CO/ALR: Copper-aluminum, revised.
- 27. COPS: Critical operations power system.
- 28. CU or Cu: Copper.
- 29. CU-AL or AL-CU: Copper-aluminum.
- 30. DACR: Digital alarm communicator receiver.
- 31. DACT: Digital alarm communicator transmitter.

- 32. DAS: Distributed antenna system.
- 33. dB: Decibel, a unitless logarithmic ratio of two electrical, acoustical, or optical power values.
- 34. dB(A-weighted) or dB(A): Decibel acoustical sound pressure level with A-weighting applied in accordance with IEC 61672-1.
- 35. dB(adjusted) or dBa: Decibel weighted absolute noise power with respect to 3.16 pW (minus 85 dBm).
- 36. dBm: Decibel absolute power with respect to 1 mW.
- 37. dBmV: Decibel absolute voltage with respect to 1 mV across identical impedance.
- 38. DC or dc: Direct current.
- 39. DCOA: Designated critical operations area.
- 40. DDC: Direct digital control (HVAC).
- 41. DGP: Data gathering panel.
- 42. DHCP: Dynamic host configuration protocol.
- 43. EGC: Equipment grounding conductor.
- 44. ELV: Extra-low voltage.
- 45. EMF: Electromotive force.
- 46. EMI: Electromagnetic interference.
- 47. EMP: Electrical maintenance program (operation and maintenance); electromagnetic pulse (transient analysis).
- 48. EPS: Emergency power supply.
- 49. EPSS: Emergency power supply system.
- 50. ERCES: Emergency responder communications enhancement system.
- 51. ESS: Energy storage system.
- 52. EV: Electric vehicle.
- 53. EVPE: Electric vehicle power export equipment.
- 54. EVSE: Electric vehicle supply equipment.
- 55. FACU: Fire-alarm control unit.
- 56. FAS: Fire-alarm system.
- 57. fc: Footcandle, an internationally recognized unit of illuminance equal to one lumen per square foot or 10.76 lx. The simplified conversion 1 fc = 10 lx in the Specifications is common practice and considered adequate precision for building construction activities. When there are conflicts, lux is the primary unit; footcandle is specified for convenience.
- 58. FCC: Federal Communications Commission; fire command center.
- 59. FLC: Full-load current.
- 60. ft: Foot.
- 61. ft-cd: Foot-candle, the antiquated U.S. standard unit of illuminance, equal to one international candle measured at a distance of one foot, that was superseded in 1948 by the unit "footcandle" when the SI unit candela (cd) replaced the international candle; see "fc."
- 62. FTP: File transfer protocol.
- 63. FXO: Foreign exchange office.
- 64. GEC: Grounding electrode conductor.
- 65. GFCI: Ground-fault circuit interrupter.
- 66. GFPE: Ground-fault protection of equipment.
- 67. GND: Ground.
- 68. GROL: General Radiotelephone Operator License (FCC).

- 69. H.323: Audio and video protocol.
- 70. HACR: Heating, air conditioning, and refrigeration.
- 71. HDPE: High-density polyethylene.
- 72. HID: High-intensity discharge.
- 73. HP or hp: Horsepower.
- 74. HVAC: Heating, ventilating, and air conditioning.
- 75. Hz: Hertz.
- 76. I&TFAS: Inspection and testing of fire-alarm system.
- 77. IB-PSC: In-building public safety communications.
- 78. IBT: Intersystem bonding termination.
- 79. ICT: Information and communications technology.
- 80. IDC: Initiating device circuit.
- 81. inch: Inch. To avoid confusion, the abbreviation "in." is not used.
- 82. I/O: Input/output.
- 83. IP: Ingress protection rating (enclosures); Internet protocol (communications).
- 84. IR: Infrared.
- 85. IS: Intrinsically safe.
- 86. IT&R: Inspecting, testing, and repair.
- 87. ITE: Information technology equipment.
- 88. kAIC: Kiloampere interrupting capacity.
- 89. kcmil or MCM: One thousand circular mils.
- 90. kV: Kilovolt.
- 91. kVA: Kilovolt-ampere.
- 92. kvar: Kilovolt-ampere reactive.
- 93. kW: Kilowatt.
- 94. kWh: Kilowatt-hour.
- 95. LAN: Local area network.
- 96. lb: Pound (weight).
- 97. lbf: Pound (force).
- 98. LCD: Liquid-crystal display.
- 99. LCDI: Leakage-current detector-interrupter.
- 100. LED: Light-emitting diode.
- 101. Li-ion: Lithium-ion.
- 102. lm: Lumen, the SI-derived unit of luminous flux.
- 103. LNG: Liquefied natural gas.
- 104. LP-Gas: Liquefied petroleum gas.
- 105. LRC: Locked-rotor current.
- 106. LTE: Long-term evolution (mobile device technology standard).
- 107. LV: Low voltage.
- 108. lx: Lux, the SI-derived unit of illuminance equal to one lumen per square meter.
- 109. m: Meter.
- 110. MATV: Master antenna television.
- 111. MCC: Motor-control center.
- 112. MDC: Modular data center.
- 113. MG set: Motor-generator set.
- 114. MIDI: Musical instrument digital interface.
- 115. MLO: Main lugs only.
- 116. MPEG: Moving Picture Experts Group.
- 117. MPEG-2: Abbreviation for the ISO/IEC Moving Picture Experts Group's standard

- for generic coding of moving pictures and associated audio information (ISO/IEC 13818) released in 1995 and used for most over-the-air and satellite broadcast digital television.
- 118. MPEG-4: Abbreviation for the ISO/IEC Moving Picture Experts Group's standard framework for coding of audio-visual objects (ISO/IEC 14496) released in 1999, with digital rights management and more advanced compression algorithms than MPEG-2.
 - 119. MOV: Metal-oxide varistor.
 - 120. MV: Medium voltage.
 - 121. MVA: Megavolt-ampere.
 - 122. mW: Milliwatt.
 - 123. MW: Megawatt.
 - 124. MWh: Megawatt-hour.
 - 125. NAC: Notification appliance circuit.
 - 126. N.C.: Normally closed.
 - 127. NFC: Near field communications.
 - 128. Ni-Cd: Nickel-cadmium.
 - 129. NICET: National Institute for Certification in Engineering Technologies, a division of the National Society of Professional Engineers.
 - 130. Ni-MH: Nickel-metal hydride.
 - 131. NIU: Network interface unit.
 - 132. N.O.: Normally open.
 - 133. NPT: National (American) standard pipe taper.
 - 134. NTSC: National Television System Committee.
 - 135. OCPD: Overcurrent protective device.
 - 136. ONT: Optical network terminal.
 - 137. PC: Personal computer.
 - 138. PCS: Power conversion system.
 - 139. PCU: Power-conditioning unit.
 - 140. Percent obs/ft (percent obs/m): Percent obscuration per unit distance; unit of measure for sensitivity of smoke detectors.
 - 141. PF or pf: Power factor.
 - 142. PHEV: Plug-in hybrid electric vehicle.
 - 143. PIR: Passive infrared.
 - 144. PLC: Programmable logic controller.
 - 145. PLFA: Power-limited fire alarm.
 - 146. PoE: Power over Ethernet.
 - 147. POTS: Plain old telephone service. See "public switched telephone network" definition.
 - 148. PSTN: Public switched telephone network.
 - 149. PTZ: Pan-tilt-zoom.
 - 150. PV: Photovoltaic.
 - 151. PVC: Polyvinyl chloride.
 - 152. pW: Picowatt.
 - 153. RAID: Redundant array of inexpensive disks; redundant array of independent disks.
 - 154. RAM: Random-access memory.
 - 155. RAT: Radio alarm transmitter.
 - 156. REX: Request-to-exit.

- 157. RF: Radio frequency.
- 158. RFI: (electrical) Radio-frequency interference; (contract) Request for interpretation.
- 159. RMS or rms: Root-mean-square.
- 160. RPM or rpm: Revolutions per minute.
- 161. SCADA: Supervisory control and data acquisition.
- 162. SCCR: Short-circuit current rating.
- 163. SCR: Silicon-controlled rectifier.
- 164. SIP: Session initiation protocol.
- 165. SLC: Signaling-line circuit.
- 166. SPD: Surge protective device.
- 167. SPDT: Single pole, double throw.
- 168. sq.: Square.
- 169. SWD: Switching duty.
- 170. TCP/IP: Transmission Control Protocol/Internet Protocol.
- 171. TEFC: Totally enclosed fan-cooled.
- 172. TR: Tamper resistant.
- 173. TVSS: Transient voltage surge suppressor.
- 174. UHF: Ultra-high frequency.
- 175. UL: (standards) UL Standards & Engagement Inc.; (product categories) UL, LLC.
- 176. UL CCN: UL Category Control Number.
- 177. UPS: Uninterruptible power supply.
- 178. USB: Universal serial bus.
- 179. UTC: Coordinated universal time.
- 180. UV: Ultraviolet.
- 181. V: Volt, unit of electromotive force.
- 182. V(ac): Volt, alternating current.
- 183. V(dc): Volt, direct current.
- 184. VA: Volt-ampere, unit of complex electrical power.
- 185. VAR: Volt-ampere reactive, unit of reactive electrical power.
- 186. VFC: Variable-frequency controller.
- 187. VOM: Volt-ohm-multimeter.
- 188. VoIP: Voice over Internet Protocol.
- 189. VPN: Virtual private network.
- 190. VRLA: Valve regulated lead acid; also called "sealed lead acid (SLA)" or "valve regulated sealed lead acid."
- 191. VU: Volume unit.
- 192. W: Watt, unit of real electrical power.
- 193. WAN: Wide area network.
- 194. Wh: Watt-hour, unit of electrical energy usage.
- 195. WPT: Wireless power transfer.
- 196. WPTE: Wireless power transfer equipment.
- 197. WR: Weather resistant.

B. Abbreviations and Acronyms for Electrical Raceway Types:

- 1. EMT: Electrical metallic tubing.
- 2. EMT-A: Aluminum electrical metallic tubing.
- 3. EMT-S: Steel electrical metallic tubing.

4. EMT-SS: Stainless steel electrical metallic tubing.
5. ENT: Electrical nonmetallic tubing.
6. EPEC: Electrical HDPE underground conduit (thin wall).
7. EPEC-A: Type A electrical HDPE underground conduit.
8. EPEC-B: Type B electrical HDPE underground conduit.
9. ERM: Electrical rigid metal conduit.
10. ERM-A: Aluminum electrical rigid metal conduit.
11. ERM-S: Steel electrical rigid metal conduit.
12. ERM-S-G: Galvanized-steel electrical rigid metal conduit.
13. ERM-S-PVC: PVC-coated-steel electrical rigid metal conduit.
14. ERM-SS: Stainless steel electrical rigid metal conduit.
15. FMC: Flexible metal conduit.
16. FMC-A: Aluminum flexible metal conduit.
17. FMC-S: Steel flexible metal conduit.
18. FMT: Steel flexible metallic tubing.
19. FNMC: Flexible nonmetallic conduit. See "LFNC."
20. HDPE: HDPE underground conduit (thick wall).
21. HDPE-40: Schedule 40 HDPE underground conduit.
22. HDPE-80: Schedule 80 HDPE underground conduit.
23. IMC: Steel electrical intermediate metal conduit.
24. LFMC: Liquidtight flexible metal conduit.
25. LFMC-A: Aluminum liquidtight flexible metal conduit.
26. LFMC-S: Steel liquidtight flexible metal conduit.
27. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
28. LFNC: Liquidtight flexible nonmetallic conduit.
29. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
30. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
31. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.
32. PVC: Rigid PVC conduit.
33. PVC-40: Schedule 40 rigid PVC conduit.
34. PVC-80: Schedule 80 rigid PVC Conduit.
35. PVC-A: Type A rigid PVC concrete-encased conduit.
36. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.
37. RGS: See ERM-S-G.
38. RMC: See ERM.
39. RTRC: Reinforced thermosetting resin conduit.
40. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.
41. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
42. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.
43. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
44. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

C. Abbreviations and Acronyms for Electrical Single-Conductor and Multiple-Conductor Cable Types:

1. AC: Armored cable.

2. CATV: Coaxial general-purpose cable.
3. CATVP: Coaxial plenum cable.
4. CATVR: Coaxial riser cable.
5. CI: Circuit integrity cable.
6. CL2: Class 2 cable.
7. CL2P: Class 2 plenum cable.
8. CL2R: Class 2 riser cable.
9. CL2X: Class 2 cable, limited use.
10. CL3: Class 3 cable.
11. CL3P: Class 3 plenum cable.
12. CL3R: Class 3 riser cable.
13. CL3X: Class 3 cable, limited use.
14. CM: Communications general-purpose cable.
15. CMG: Communications general-purpose cable.
16. CMP: Communications plenum cable.
17. CMR: Communications riser cable.
18. CMUC: Under-carpet communications wire and cable.
19. CMX: Communications cable, limited use.
20. DG: Distributed generation cable.
21. FC: Flat cable.
22. FCC: Flat conductor cable.
23. FPL: Power-limited fire-alarm cable.
24. FPLP: Power-limited fire-alarm plenum cable.
25. FPLR: Power-limited fire-alarm riser cable.
26. IGS: Integrated gas spacer cable.
27. ITC: Instrumentation tray cable.
28. ITC-ER: Instrumentation tray cable, exposed run.
29. MC: Metal-clad cable.
30. MC-FPL/FPLR/FPLP: Metal-clad cable containing FPL, FPLR, or FPLP.
31. MC-HL: Metal-clad cable, hazardous location.
32. MI: Mineral-insulated, metal-sheathed cable.
33. MTW: (machine tool wiring) Moisture-, heat-, and oil-resistant thermoplastic cable.
34. MV: Medium-voltage cable.
35. NM: Nonmetallic sheathed cable.
36. NMC: Nonmetallic sheathed cable with corrosion-resistant nonmetallic jacket.
37. NMS: Nonmetallic sheathed cable with signaling, data, and communications conductors, plus power or control conductors.
38. NPLF: Non-power-limited fire-alarm circuit cable.
39. NPLFP: Non-power-limited fire-alarm circuit cable for environmental air spaces.
40. NPLFR: Non-power-limited fire-alarm circuit riser cable.
41. NUCC: Nonmetallic underground HDPE conduit with conductors.
42. OFC: Conductive optical fiber general-purpose cable.
43. OFCG: Conductive optical fiber general-purpose cable.
44. OFCP: Conductive optical fiber plenum cable.
45. OFCR: Conductive optical fiber riser cable.
46. OFN: Nonconductive optical fiber general-purpose cable.
47. OFNG: Nonconductive optical fiber general-purpose cable.
48. OFNP: Nonconductive optical fiber plenum cable.

49. OFNR: Nonconductive optical fiber riser cable.
50. P: Marine shipboard cable.
51. PLTC: Power-limited tray cable.
52. PLTC-ER: Power-limited tray cable, exposed run.
53. PV: Photovoltaic cable.
54. RHH: (high heat) Thermoset rubber, heat-resistant cable.
55. RHW: Thermoset rubber, moisture-resistant cable.
56. SA: Silicone rubber cable.
57. SE: Service-entrance cable.
58. SER: Service-entrance cable, round.
59. SEU: Service-entrance cable, flat.
60. SIS: Thermoset cable for switchboard and switchgear wiring.
61. TBS: Thermoplastic cable with outer braid.
62. TC: Tray cable.
63. TC-ER: Tray cable, exposed run.
64. TC-ER-HL: Tray cable, exposed run, hazardous location.
65. THW: Thermoplastic, heat- and moisture-resistant cable.
66. THHN: Thermoplastic, heat-resistant cable with nylon jacket outer sheath.
67. THHW: Thermoplastic, heat- and moisture-resistant cable.
68. THWN: Thermoplastic, moisture- and heat-resistant cable with nylon jacket outer sheath.
69. TW: Thermoplastic, moisture-resistant cable.
70. UF: Underground feeder and branch-circuit cable.
71. USE: Underground service-entrance cable.
72. XHH: Cross-linked polyethylene, heat-resistant cable.
73. XHHW: Cross-linked polyethylene, heat- and moisture-resistant cable.

D. Abbreviations and Acronyms for Electrical Flexible Cord Types:

1. SEO: 600 V extra-hard-usage, hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp locations.
2. SEOW: 600 V extra-hard-usage, hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp or wet locations.
3. SEOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp locations.
4. SEOWW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp or wet locations.
5. SJEO: 300 V hard-usage, junior hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp locations.
6. SJEOW: 300 V hard-usage, junior hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp or wet locations.
7. SJEOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer

- cover for damp locations.
8. SJEOOW: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp or wet locations.
 9. SJO: 300 V hard-usage, junior hard-service cord with thermoset insulation and oil-resistant thermoset outer cover for damp locations.
 10. SJOW: 300 V hard-usage, junior hard-service cord with thermoset insulation and oil-resistant thermoset outer cover for damp or wet locations.
 11. SJOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer cover for damp locations.
 12. SJOOW: 300 V hard-usage, junior hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer cover for damp or wet locations.
 13. SJTO: 300 V hard-usage, junior hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer cover for damp locations.
 14. SJTOW: 300 V hard-usage, junior hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer cover for damp or wet locations.
 15. SJTOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer cover for damp locations.
 16. SJTOOW: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer cover for damp or wet locations.
 17. SO: 600 V extra-hard-usage, hard-service cord with thermoset insulation and oil-resistant thermoset outer covering for damp locations.
 18. SOW: 600 V extra-hard-usage, hard-service cord with thermoset insulation and oil-resistant thermoset outer covering for damp or wet locations.
 19. SOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer covering for damp locations.
 20. SOOW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer covering for damp or wet locations.
 21. STO: 600 V extra-hard-usage, hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer covering for damp locations.
 22. STOW: 600 V extra-hard-usage, hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer covering for damp or wet locations.
 23. STOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer covering for damp locations.
 24. STOOW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer covering for damp or wet locations.

E. Abbreviations for Communications Spaces:

1. EF: Entrance facility; generally serves campus or building. EF may include an ER.
2. ER: Equipment room; generally serves campus or building.
3. TE: Telecommunications enclosure; generally serves a single tenant or floor.
4. TR: Telecommunications room; generally serves a single tenant or floor.

F. Abbreviations for Communications Facilities:

1. HC: Horizontal cross-connect; also called "floor distributor" (FD).
2. IC: Intermediate cross-connect; also called "building distributor" (BD).
3. MC: Main cross-connect; also called "campus distributor" (CD).

G. Abbreviations for Grounding and Bonding:

1. BBC: Backbone bonding conductor, for connecting multiple TBBs serving the same floor.
2. PBB: Primary bonding busbar; located in main distribution frame room, ideally near electrical service entrance.
3. RBB: Rack bonding busbar; located in equipment cabinets and racks.
4. SBB: Secondary bonding busbar; located in intermediate distribution frame rooms.
5. TBB: Telecommunications bonding backbone, for connecting SBBs to PBB.
6. TBC: Telecommunications bonding conductor, for connecting PBB to intersystem bonding termination device or busbar at electrical service entrance.
7. TEBC: Telecommunications equipment bonding conductor, for connecting RBBs to SBBs or PBB.
8. UBC: Unit bonding conductor, for connecting individual communications equipment to RBBs or SBBs.

H. Definitions:

1. 8-Position 8-Contact (8P8C) Modular Jack: An unkeyed jack with up to eight contacts commonly used to terminate twisted pair and multiconductor Ethernet cable. Also called a "TIA-1096 miniature 8-position series jack" (8PSJ), or an "IEC 8877 8-pole jack."
 - a. Be careful when suppliers use "RJ45" generically. Obsolete RJ45 jacks used for analog telephone cables have rejection keys. 8P8C jacks used for digital telephone cables and Ethernet cables do not have rejection keys.
2. Agile Receiver: A broadband receiver that can be tuned to any desired channel.
3. Backbone: Primary segment of ERCES between donor antenna and distribution cabling.
4. Basic Impulse Insulation Level (BIL): Reference insulation level expressed in impulse crest voltage with a standard wave not longer than 1.5 times 50 microseconds and 1.5 times 40 microseconds.
5. Broadband: For the purposes of this Section, wide bandwidth equipment or systems that can carry signals occupying in the frequency range of 54 to 1002 MHz. A broadband communication system can simultaneously accommodate television, voice, data, and many other services.
6. Broadcast Media: Loudspeakers, radios, cellular phones, and other media that will carry the selected message to the selected audience.
7. Cable: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "cable" is (1) a conductor with insulation, or a stranded conductor with or without insulation (single-conductor cable); or (2) a combination of conductors insulated from one another (multiple-conductor cable).

8. Carrier: A pure-frequency signal that is modulated to carry information. In the process of modulation, the signal is spread out over a wider band. The carrier frequency is the center frequency on any television channel.
9. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.
10. Communications Jack: A fixed connecting device designed for insertion of a communications cable plug.
11. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.
12. Conductive Cable: Cable containing non-current-carrying electrically conductive members such as metallic strength members and metallic vapor barriers.
13. Conductor: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "conductor" is (1) a wire or combination of wires not insulated from one another, suitable for carrying an electric current; (2) (National Electrical Safety Code) a material, usually in the form of wire, cable, or bar, suitable for carrying an electric current; or (3) (general) a substance or body that allows a current of electricity to pass continuously along it.
14. Conduit: A structure containing one or more duct raceways.
15. Control Unit: A system component that monitors inputs and controls outputs through various types of circuits.
 - a. Autonomous Control Unit (ACU): The primary control unit for an in-building mass notification system (MNS).
 - b. Emergency Communications Control Unit (ECCU): A system capable of sending mass notification messages to individual buildings, zones of buildings, individual outdoor loudspeaker arrays, or zones of outdoor loudspeaker arrays; or a building, multiple buildings, outside areas, or a combination of these.
 - c. Fire-alarm control unit (FACU).
 - d. Wireless Control Unit: A component that transmits/receives and processes wireless signals.
16. Designated Seismic System: An architectural, electrical, or mechanical system and its components for which the component importance factor is greater than 1.0 when determined in accordance with Section 018123 "Facility Seismic and Wind Criteria."
17. Direct Buried: Installed underground without encasement in concrete or other protective material.
18. Downlink: The signal from a base station to portable radios.
19. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.
20. Duct Raceway: A single enclosed raceway for conductors or cable.
21. Electrical Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
22. Emergency Communications System (ECS): A system for the protection of life by indicating the existence of an emergency situation and communicating information necessary to facilitate an appropriate response and action.

- a. Distributed Recipient Mass Notification System (DRMNS): A system meant to communicate directly to targeted individuals and groups that might not be in a contiguous area.
 - b. Emergency Voice/Alarm Communications System (EVACS): Dedicated manual or automatic facilities for originating and distributing voice instructions, as well as evacuation signals pertaining to an emergency, to the occupants of a building.
 - c. Mass Notification System (MNS): A system used to provide information and instructions to people in buildings or other spaces using intelligible voice communications and including visual signals, text, graphics, tactile, or other communication methods (in-building MNS); and could have the capability to provide real-time information to outdoor areas and to communicate with other notification systems provided for a campus, region, or global geographic setting (wide-area MNS).
23. Emergency Systems: Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction that is designed to ensure continuity of lighting, electrical power, or both, to designated areas and equipment in the event of failure of the normal supply for safety of human life.
24. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:
- a. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
 - b. Concrete Box: A box intended for use in poured concrete.
 - c. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
 - d. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.
 - e. Cover Plate: A cover designed for protecting wiring devices installed in flush-mounted device boxes while permitting their safe operation; also called a faceplate or wallplate.
 - f. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.
 - g. Device Box: A box with provisions for mounting a wiring device directly to the box.
 - h. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.
 - i. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.
 - j. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub

- water at the floor level.
- k. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the entrance of scrub water at the floor level.
 - l. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
 - m. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.
 - n. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.
 - o. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.
 - p. Raised-Floor Box: A floor box intended for use in raised floors.
 - q. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.
 - r. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.
 - s. Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.
 - t. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.
 - u. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.
25. Essential Electrical Systems: (healthcare facilities) Those systems designed to ensure continuity of electrical power to designated areas and functions of a healthcare facility during disruption of normal power sources, and also to minimize disruption within the internal wiring system.
26. Fault Limited: Providing or being served by a source of electrical power that is limited to not more than 100 W when tested in accordance with UL 62368-1.
- a. The term "fault limited" is intended to encompass most Class 1, 2, and 3 power-limited sources complying with Article 725 of NFPA 70; Class ES1 and ES2 electrical energy sources that are Class PS1 electrical power sources (e.g., USB); and Class ES3 electrical energy sources that are Class PS1 and PS2 electrical power sources (e.g., PoE). See UL 62368-1 for discussion of classes of electrical energy sources and classes of

electrical power sources.

27. Headend: The control center of the MATV system, where incoming signals are amplified, converted, processed, and combined into a common cable along with any locally originated television signals, for transmission to user-interface points. It is also called the "central retransmission facility."
28. High-Performance Building: A building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.
29. High Power Loudspeaker Array (HPLA): A product providing capability for voice and tone communication to large outdoor areas.
30. Jack: Also commonly called an "outlet," it is the fixed, female connector.
31. Jacket: A continuous nonmetallic outer covering for conductors or cables.
32. Local Operator Console (LOC): Equipment used by authorized personnel and emergency responders to activate and operate a mass notification system (MNS).
33. Luminaire: A complete lighting unit consisting of a light source such as a lamp, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light.
34. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.
35. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the Energy Independence and Security Act (EISA) of 2007.
36. Monitoring: Acquisition, processing, communication, and display of system and equipment status data and event and alarm signals.
37. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.
38. Multi-Outlet Assembly: A type of surface, flush, or freestanding raceway designed to hold conductors, receptacles, and switches, assembled in the field or at the factory.
39. Nonsecure: Unlocked or open. (For doors and gates.)
40. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein. Also called "single-line diagram."
41. Plenum: A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
42. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
43. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.
44. Protective Device: A device that senses when an abnormal current flow, abnormal voltage potential, or other abnormal electrical waveform exists and then disconnects the affected portion of the circuit from the system. Common

- protective devices include fuses, circuit breakers, relays, ground-fault circuit interrupters, and arc-fault circuit interrupters.
45. Public Switched Telephone Network (PSTN): Analog telephone technology that uses twisted pair cables from a telephone-provider central office for the transmission medium. "PSTN" refers to the telephone network; "POTS" refers to the individual subscriber line.
 46. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.
 47. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.
 48. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
 49. Secure: Closed and locked and with no unlock or open commands pending. (For doors and gates.)
 50. Sheath: A continuous metallic covering for conductors or cables.
 51. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
 52. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.
 53. UL Category Control Number (CCN): An alphabetic or alphanumeric code used to identify product categories covered by UL's Listing, Classification, and Recognition Services.
 54. Uplink: The signal from a portable radio to the base station.
 55. Voice over Internet Protocol (VoIP): Digital telephone packet technology that uses the internet for its transmission medium.
 56. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:
 - a. Control Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is supplied from a battery or other Class 2 or Class 3 power-limited source.
 - b. Line Voltage: (1) (controls) Designed to operate using the supplied low-voltage power without transformation. (2) (transmission lines, transformers, SPDs) The line-to-line voltage of the supplying power system.
 - c. Extra-Low Voltage (ELV): Not having electromotive force between any two conductors, or between a single conductor and ground, exceeding 30 V(ac rms), 42 V(ac peak), or 60 V(dc).
 - d. Low Voltage (LV): Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 30 V but not exceeding 1000 V.
 - e. Medium Voltage (MV): Having electromotive force between any two conductors, or between a single conductor and ground, that is rated about 1 kV but not exceeding 69 kV.
 - f. High Voltage: (1) (circuits) Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 69 kV but not exceeding 230 kV. (2) (safety) Having sufficient electromotive force to inflict bodily harm or injury.

- 57. Wire: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "wire" is a slender rod or filament of drawn metal. A group of small wires used as a single wire is properly called a "stranded wire." A wire or stranded wire covered with insulation is properly called an "insulated wire" or a "single-conductor cable." Nevertheless, when the context indicates that the wire is insulated, the term "wire" will be understood to include the insulation.
- 58. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.3 COORDINATION

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions:
 - 1. Notify Owner no fewer than days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.
 - 3. Coordinate interruption with systems impacted by outage including, but not limited to, the following:
 - a. Exercising generators.
 - b. Emergency lighting.
 - c. Elevators.
 - d. Fire-alarm systems.
 - 4. Arrange to provide temporary emergency and standby electrical power so facility may remain occupied during the outage in accordance with requirements specified in Section 015000 "Temporary Facilities and Controls." Coordinate power requirements with Owner.
- B. Interruption of Existing Telephone Service: Do not interrupt telephone service to facilities occupied by Owner or others unless permitted under the following conditions:
 - 1. Notify Owner no fewer than 14 days in advance of proposed interruption of telephone service.
 - 2. Do not proceed with interruption of telephone service without Owner's written permission.
- C. Interruption of Existing Internet Service: Do not interrupt internet service to facilities occupied by Owner or others unless permitted under the following conditions:
 - 1. Notify Owner no fewer than 14 days in advance of proposed interruption of internet service.
 - 2. Do not proceed with interruption of internet service without Owner's written

permission.

- D. Interruption of Existing Fire-Alarm System: Do not interrupt fire-alarm system to facilities occupied by Owner or others unless permitted under the following conditions:
 - 1. Notify Owner no fewer than 14 days in advance of proposed interruption of fire-alarm system.
 - 2. Do not proceed with interruption of fire-alarm system without Owner's written permission.
- E. Interruption of Existing Nurse Call System: Existing nurse call system shall not be interrupted. Components of the existing nurse call system are not to be removed until new system components are installed and functional in place of the existing component to be removed.

1.4 PREINSTALLATION MEETINGS

- A. Electrical Preconstruction Conference: Schedule conference with Architect and Owner, not later than 10 days after Notice to Proceed. Agenda topics include, but are not limited to, the following:
 - 1. Phasing and Cutover Plan.
 - a. Contractor is responsible for creating a detailed phasing and cutover plan to ensure continuous nurse call coverage during system installation and transition.
 - b. Coordinate phasing and any required temporary nurse call solutions facility and staff.
 - c. See section 1.5 for more information on Phasing and Cutover Plan requirements.
 - 2. Installation and Procurement Schedule.
 - 3. Status and schedule for required submittals.
 - 4. Facility ICRA Plan Requirements
 - 5. Commissioning activities.

1.5 PHASING AND CUTOVER PLAN

- A. General Requirements
 - 1. The Contractor shall prepare and submit a Phasing and Cutover Plan for the installation of the new nurse call system. The plan must ensure continuous nurse call coverage throughout all phases of the work and must be coordinated with facility operations to minimize disruption to patient care.
 - 2. The plan shall be submitted for review and approval by the Owner and Engineer prior to the start of any demolition or installation activities related to the nurse call system.

B. Contractor Submittal Requirements

1. The Phasing and Cutover Plan shall include, at a minimum, the following information:
 - a. Phasing Strategy
 - 1) Identify proposed work areas and sequence
 - 2) Provide a narrative description of how each area will be brought on line.
 - 3) Include a phasing map or floor plan clearly delineating boundary of each phase.
 - 4) Indicate the anticipated duration of work per phase.
 - b. Continuity of Service
 - 1) Describe the method(s) by which uninterrupted nurse call coverage will be maintained during each phase.
 - 2) Indicate whether existing devices will remain in service until new devices are online.
 - 3) Detail any temporary systems, backup devices, or communication procedures that will be used during cutover periods.
 - c. Cutover Procedure
 - 1) Provide a step by step description of the process for transitioning each area from the existing system to the new system.
 - 2) Define when and how old components of the new system will be disabled and removed.
 - 3) Identify test procedures to confirm operational status of the new system prior to decommissioning of existing devices.
 - 4) Include criteria for owner acceptance and sign-off prior to final cutover in each phase.
 - d. Stakeholder Communication Plan
 - 1) Identify points of contact for the Contractor, facility, clinical staff, and nurse call vendor.
 - 2) Describe the process for providing advance notice to affected departments minimum of 72 hours prior to impact.
 - 3) Define schedule and format for on going coordination meetings or daily huddles during active phases.
 - e. Contingency Planning
 - 1) Identify fallback procedures in the event that a cutover cannot be completed as planned.
 - 2) Describe how system functionality will be restored or maintained in case of installation or programming failure.
 - 3) Provide an emergency communication protocol for issues occurring

during a cutover.

C. Additional Requirements

1. All phasing must be coordinated to limit active work to one patient room or area at a time, unless otherwise approved by the facility.
2. The contractor shall be responsible for protecting patient privacy and maintaining infection control standards in all occupied areas.
3. The contractor shall not initiate work in any area until written approval of the corresponding phase has been provided by the owner.

D. Deliverables

1. Phasing Narrative: Written description of sequence, duration, and approach.
2. Phasing Map: Plan drawing(s) showing phased work areas.
3. Cutover Procedure: Step-by-step plan for disconnecting old and activating new system.
4. Contingency Plan: Description of fallback protocols and emergency coverage procedures.
5. Communication Plan: Roles, contact, notification timelines, and coordination methods.

1.6 INFORMATIONAL SUBMITTALS

A. Electrical Installation Schedule: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for electrical installation Work to Owner and Architect including, but not limited to, milestone dates for the following activities:

1. Submission of power system studies.
2. Submission of specified coordination drawings.
3. Submission of action submittals specified in Division 26.
4. Orders placed for major electrical equipment.
5. Arrival of major electrical equipment on-site.
6. Preinstallation meetings specified in Division 26.
7. Utility service outages.
8. Utility service inspection and activation.
9. Mockup reviews.
10. Closing of walls and ceilings containing electrical Work.
11. System startup, testing, and commissioning activities for major electrical equipment.
12. System startup, testing, and commissioning activities for emergency lighting.
13. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
14. Pouring of concrete housekeeping pads for electrical equipment and testing of concrete samples.
15. Requests for special inspections.
16. Requests for inspections by authorities having jurisdiction.

- B. Installation Schedule for Communications Systems: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for installation of the communications Work to Owner and Architect including, but not limited to, milestone dates for the following activities:

1. Submission of specified coordination drawings.
2. Submission of action submittals specified in Division 27.
3. Orders placed for major equipment.
4. Arrival of major equipment on-site.
5. Preinstallation meetings specified in Division 27.
6. Telephone and internet service outages.
7. Telephone and internet service inspection and activation.
8. Mockup reviews.
9. Closing of walls and ceilings containing the communications Work.
10. System startup, testing, and commissioning activities for communications equipment.
11. System startup, testing, and commissioning activities for the Work specified in other divisions that depends on the Work specified in Division 27.
12. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
13. Requests for special inspections.
14. Requests for inspections by authorities having jurisdiction.

- C. Welding certificates.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:

1. Provide emergency operation, normal operation, and preventive maintenance manuals for each system, equipment, and device listed below:
 - a. Nurse Call System.
2. Include the following information:
 - a. Manufacturer's operating specifications.
 - b. User's guides for software and hardware.
 - c. Schedule of maintenance material items recommended to be stored at the Project site.
 - d. Detailed instructions covering operation under both normal and abnormal conditions.
 - e. Time-current curves for overcurrent protective devices and manufacturer's written instructions for testing and adjusting their settings.
 - f. List of load-current and overload-relay heaters with related motor nameplate data.
 - g. List of lamp types and photoelectric relays used on the Project, with ANSI and manufacturers' codes.

- h. Manufacturer's instructions for setting field-adjustable components.
 - i. Manufacturer's instructions for testing, adjusting, and reprogramming microprocessor controls.
 - j. EPSS: Manufacturer's system checklists, maintenance schedule, and maintenance log sheets in accordance with NFPA 110.
 - k. Exterior pole inspection and repair procedures.
- B. Software and Firmware Operational Documentation: Provide software and firmware operational documentation, including the following:
 - 1. Software operating and upgrade manuals.
 - 2. Names, versions, and website addresses for locations of installed software.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.
 - 5. Testing and adjusting of panic and emergency power features.
 - 6. For lighting controls, include the following:
 - a. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
 - b. Operation of adjustable zone controls.
- C. Software:
 - 1. Program Software Backup: Provide username and password for approved online or cloud solution.
 - 2. Provide to Owner upgrades and unrestricted licenses for Government use for installed and backup software, including operating systems and programming tools required for operation and maintenance.

PART 2 - PRODUCTS

2.1 SUBSTITUTION LIMITATIONS FOR COMMUNICATIONS EQUIPMENT

- A. Substitution requests for communications equipment will be entertained under the following conditions:
 - 1. Substitution requests may be submitted for consideration prior to the Communications Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with the Project performance requirements while significantly increasing value for Owner throughout life of facility.
 - 2. Contractor is responsible for sequencing and scheduling equipment procurement. After the Communications Preconstruction Conference, insufficient lead time for equipment delivery will not be considered a valid reason for substitution.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL WORK

- A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' written instructions, comply with NFPA 70 and NECA NEIS 1 for installation of electrical Work on the Project. Consult Architect for resolution of conflicting requirements.

END OF SECTION 260010

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermoplastic-insulated wire.
2. Thermoset-insulated wire.
3. Metallic sheathed cable.
4. Nonmetallic jacketed cable.
5. Connectors and splices.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
2. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
3. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
4. Section 260533.13 "Conduits for Electrical Systems" specifies installation of raceways referenced by this Section.
5. Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling" specifies installation of sleeves and sleeve seals referenced by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.

1.2 DEFINITIONS

- A. NICET: National Institute for Certification in Engineering Technologies; a division of the National Society of Professional Engineers (NSPE).

1.3 ACTION SUBMITTALS

- A. Product Schedule: Indicate type, use, location, and termination locations.
- B. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer's published instructions.

B. Field Reports:

1. Field reports for infrared scanning

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 THERMOPLASTIC-INSULATED WIRE

- A. Description: Thermoplastic-insulated wire for use in accordance with Article 310 of NFPA 70.

B. UL ZLGR - Type THHN Insulated Wire:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.
2. Standard Features:
 - a. Referenced Standard: Article 310 of NFPA 70.
 - b. Insulation Voltage Rating: 600 V.
 - c. Insulation Temperature Rating: 90 deg C.
 - d. Conductor Material: Copper.
 - e. Conductor Size: As indicated on the Drawings.

- 1) Minimum Conductor Size: 12 AWG.

C. UL ZLGR - Type THWN-2 Insulated Wire:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.
2. Standard Features:
 - a. Referenced Standard: Article 310 of NFPA 70.
 - b. Insulation Voltage Rating: 600 V.

- c. Insulation Temperature Rating: 90 deg C.
- d. Conductor Material: Copper.
- e. Conductor Size: As indicated on the Drawings.

- 1) Minimum Conductor Size: 12 AWG.

2.3 THERMOSET-INSULATED WIRE

- A. Description: Thermoset-insulated wire for use in accordance with Article 310 of NFPA 70.

- B. UL ZKST - Type XHHW-2 Insulated Wire:

- 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

- a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.

- 2. Standard Features:

- a. Referenced Standard: Article 310 of NFPA 70.
 - b. Insulation Voltage Rating: 600 V.
 - c. Insulation Temperature Rating: 90 deg C.
 - d. Conductor Material: Copper.
 - e. Conductor Size: As indicated on the Drawings.

- 1) Minimum Conductor Size: 12 AWG.

- 3. Other Available Features Required by the Project:

- a. Marked "Sunlight Resistant" or "SR," indicating compliance with artificial weathering test.

2.4 METALLIC SHEATHED CABLE

- A. UL AWEZ - Armored Cable, Type AC:

- 1. Description: A factory assembly of insulated current-carrying conductors with an equipment grounding conductor in an overall metallic sheath that is listed for use as an equipment grounding conductor.
- 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

- a. Armored Cable: UL CCN AWEZ, including UL 4.

- 3. Standard Features:

- a. Referenced Standard: Article 320 of NFPA 70.
 - b. Circuits: Single circuit.
 - c. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
 - d. Ground Conductor: Insulated.
 - e. Armor: Aluminum, interlocked.
4. Other Available Features Required by the Project:
- a. Marked "LS" or "For Use in Cable Trays," indicating compliance with UL 1685 flame and limited smoke test.

2.5 NONMETALLIC JACKETED CABLE

A. UL QPOR - Power and Control Tray Cable, Type TC:

- 1. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in a nonmetallic jacket.
- 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Power and Control Tray Cable: UL CCN QPOR, including UL 1277.
- 3. Standard Features:
 - a. Comply with NEMA WC 57/ICEA S-73-532 for Type TC cables used for control, thermocouple extension, and instrumentation.
 - b. Comply with NEMA WC 70/ICEA S-95-658 for Type TC cables used for power distribution.
 - c. Conductors: Copper.
 - d. Ground Conductor: Insulated.
 - e. Conductor Insulation: Type XHHW-2. Comply with UL 44.
- 4. Other Available Features Required by the Project:
 - a. Marked "TC-ER," indicating that cable is designed for use with ASDs, with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.
 - 1) Marked "TC-ER-JP," indicating that cable is also suitable for pulling through structural members in accordance with Article 336.10(9) of NFPA 70.
 - 2) Marked "TC-ER-HL," indicating that cable is also suitable for use in hazardous (classified) environments.

2.6 CONNECTORS AND SPLICES

A. UL PJOX - Armored and Metal-Clad Cable Fittings:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Type AC and Type MC Cable Connectors: UL CCN PJOX, including UL 514B.
2. Standard Features: For steel and aluminum sheathed cables, designed to connect conductors specified in this Section.

B. UL ZMVV - Wire Connectors and Soldering Lugs:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Wire Connectors and Soldering Lugs: UL CCN ZMVV, including UL 486A-486B or UL 486C.
2. Standard Features:
 - a. One piece, seamless, designed to terminate conductors specified in this Section.
 - b. Material: Copper.
 - c. Type: One hole with standard barrels.
 - d. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders:

1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits:

1. Material: Copper.
 - a. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger. Stranded cable is acceptable for conductors #14AWG and larger.

C. ASD Output Circuits Cable: Extra-flexible stranded for all sizes.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW-2, single conductors in raceway.
- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.
- D. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.
- E. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.
- F. ASD Output Circuits: Type XHHW-2 in metal conduit.
- G. Feeders and Branch Circuits exposed to sunlight above roof: Type XHHW-2, single conductors in raceway.
- H. Branch Circuits for Light Fixture Whips: Type AC-HCF

3.3 INSTALLATION OF LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

- A. Comply with manufacturer's published instructions.
- B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:
 - 1. Electrical Construction: ICC IBC, ICC IFB, NFPA 1, NFPA 70, and NECA NEIS 1.
 - 2. Electrical Maintenance: NFPA 70B.
 - 3. Electrical Safety: NFPA 70E.
 - 4. Temporary Electric Power Work: NECA NEIS 200.
 - 5. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
 - 6. Work in Confined Spaces: NFPA 350.
 - 7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
 - 8. Installation of Type AC and Type MC Cables: NECA NEIS 120.
 - 9. Consult Architect for resolution of conflicting requirements.
- C. Special Installation Techniques:
 - 1. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
 - 2. Complete raceway installation between conductor and cable termination points prior to pulling conductors and cables.

3. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
4. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
5. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
6. Provide support for cables.
7. Complete cable tray systems installation prior to installing conductors and cables.
8. Connections:
 - a. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
 - b. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
9. Wiring at Outlets: Install conductor at each outlet, with at least 6 inch of slack.

D. Interfaces with Other Work:

1. Identification:
 - a. Identify and color-code conductors and cables.
 - b. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.
2. Sleeves and Sleeve Seals: Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.
3. Firestopping: Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.4 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.

B. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
3. Perform each of the following visual and electrical tests:

- a. Inspect exposed sections of conductor and cable for physical damage and correct connection in accordance with the single-line diagram.
- b. Test bolted connections for high resistance using one or more of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey.
- c. Inspect compression-applied connectors for correct cable match and indentation.
- d. Inspect for correct identification.
- e. Inspect cable jacket and condition.
- f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
- g. Continuity test on each conductor and cable.
- h. Uniform resistance of parallel conductors.

C. Nonconforming Work:

1. Wire or cable assembly will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.5 MAINTENANCE

- A. Infrared Scanning of Splices: Within 60 days of Substantial Completion, perform infrared scan of splices, joints, and connections in conductors 3 AWG and larger. Remove covers so splices, joints, and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison. Correct deficiencies determined during the scan.
1. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
 2. Field Reports for Infrared Scanning: Prepare certified report that identifies cables splices checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grounding and bonding conductors.
2. Grounding and bonding clamps.
3. Grounding and bonding bushings.
4. Grounding and bonding hubs.
5. Grounding and bonding connectors.
6. Intersystem bonding bridge grounding connectors.
7. Grounding and bonding busbars.
8. Grounding (earthing) electrodes.
9. Grounding electrode enclosures.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.
 - a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
 - b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
 - c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

B. Shop Drawings: Prepare and submit the following:

1. Plans showing dimensioned locations of grounding features described in "Field Quality Control for Grounding and Bonding" Article, including the following:
 - a. Grounding electrode access enclosures.
 - b. Grounding electrodes.
 - c. Grounding arrangements and connections for separately derived systems.

C. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturer's published instructions.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:

1. In addition to items specified in Section 260010 "Supplemental Requirements for Electrical," include the following:
 - a. Plans showing locations of grounding features described in "Field Quality Control for Grounding and Bonding" Article, including the following:
 - 1) Grounding electrode access enclosures.
 - 2) Grounding electrodes.
 - 3) Grounding arrangements and connections for separately derived systems.
 - b. Instructions for periodic testing and inspection of grounding features at test wells based on NETA MTS.
 - 1) Tests must determine if ground-resistance or impedance values remain within specified maximums, and instructions must recommend corrective action if values do not.
 - 2) Include recommended testing intervals.

1.5 QUALIFICATIONS

- A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.
- B. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1.6 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

- A. Soil Resistivity: Grounding (earthing) Work on the Project must account for soil resistivity conditions specified in Section 018116 "Facility Environmental Requirements."
- B. Electrical and ICT Equipment Grounding (Earthing): Do not exceed 10 Ω resistance to ground (earth).

1. Contact Engineer for resolution if 10 Ω specified resistance to ground (earth) is not attained after second attempt to increase effectiveness of grounding (earthing) electrode.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 GROUNDING AND BONDING CONDUCTORS

A. Equipment Grounding Conductor:

1. Standard Features: 600 V, , copper wire or cable, green color, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. ASTM - Bare Copper Grounding and Bonding Conductor:

1. Standard Features: Complying with one or more of the following:
 - a. Soft or Annealed Copper Wire: ASTM B3.
 - b. Concentric-Lay Stranded Copper Conductor: ASTM B8.
 - c. Tin-Coated Soft or Annealed Copper Wire: ASTM B33.
 - d. 19-Wire Combination Unilay-Stranded Copper Conductor: ASTM B787/B787M.
 - e. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 in diameter.
 - f. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - g. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - h. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. UL KDER - Armored Grounding Wire:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
2. Standard Features: Single corrosion-resistant copper, aluminum, or copper-clad aluminum conductor within helically formed steel armor.

2.3 GROUNDING AND BONDING CLAMPS

- A. Description: Clamps suitable for attachment of grounding and bonding conductors to grounding electrodes, pipes, tubing, and rebar. Grounding and bonding clamps specified in this article are also suitable for use with communications applications.
- B. UL KDER and KDSH - Hex-Fitting-Type Pipe and Rod Grounding and Bonding Clamp:
 - 1. Source Limitations: Obtain products from single manufacturer.
 - 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
 - 3. Standard Features:
 - a. Two pieces with stainless steel bolts.
 - b. Clamp Material: Silicon bronze.
 - c. Listed for outdoor use.
- C. UL KDER and KDSH - U-Bolt-Type Pipe and Rod Grounding and Bonding Clamp:
 - 1. Source Limitations: Obtain products from single manufacturer.
 - 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
 - 3. Standard Features:
 - a. Clamp Material: Brass.
 - b. Listed for outdoor use.
- D. UL KDER and KDSH - Strap-Type Pipe and Rod Grounding and Bonding Clamp:
 - 1. Source Limitations: Obtain products from single manufacturer.
 - 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

3. Standard Features:
 - a. Clamp Material: Copper.
 - b. Listed for outdoor use.

E. UL KDER - Beam Grounding and Bonding Clamp:

1. Source Limitations: Obtain products from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
3. Standard Features: Mechanical-type, terminal, ground wire access from four directions; with dual, tin-plated or silicon bronze bolts.

F. UL KDER - Exothermically Welded Connection:

1. Source Limitations: Obtain products from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
3. Standard Features: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING AND BONDING BUSHINGS

- A. Description: Bonding bushings connect conduit fittings, tubing fittings, threaded metal conduit, and unthreaded metal conduit to metal boxes and equipment enclosures, and have one or more bonding screws intended to provide electrical continuity between bushing and enclosure. Grounding bushings have provision for connection of bonding or grounding conductor and may or may not also have bonding screws.
- B. UL KDER - Bonding Bushing:
 1. Source Limitations: Obtain products from single manufacturer.
 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

3. Standard Features: Threaded bushing with insulated throat.

C. UL KDER - Grounding Bushing:

1. Source Limitations: Obtain products from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
3. Standard Features: Threaded bushing with insulated throat and mechanical-type wire terminal.

2.5 GROUNDING AND BONDING HUBS

A. UL KDER - Grounding and Bonding Hub:

1. Source Limitations: Obtain products from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
3. Standard Features: Insulated, gasketed, watertight hub with mechanical-type wire terminal.

2.6 GROUNDING AND BONDING CONNECTORS

A. UL KDER - Pressure-Type Grounding and Bonding Busbar Cable Connector:

1. Source Limitations: Obtain products from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
3. Standard Features: Copper or copper alloy, for compression bonding of one or more conductor directly to copper busbar. Listed for direct burial.
4. Sustainable Design Features:

B. UL KDER - Lay-In Lug Mechanical-Type Grounding and Bonding Busbar Terminal:

1. Source Limitations: Obtain products from single manufacturer.

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
 3. Standard Features: Mechanical-type, copper rated for direct burial terminal with set screw.
- C. UL KDER - Split-Bolt Service-Post Pressure-Type Grounding and Bonding Busbar Terminal:
1. Source Limitations: Obtain products from single manufacturer.
 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
 3. Standard Features: Bolts that surround cable and bond to cable under compression when nut is tightened after assembly is screwed into busbar opening.
- D. UL KDER - Crimped Pressure-Type Grounding and Bonding Cable Connector:
1. Source Limitations: Obtain products from single manufacturer.
 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
 3. Standard Features: Crimp-and-compress connectors that bond to conductor when connector is compressed around conductor.
 - a. Copper, C and H shaped.
- E. UL KDER - Signal Reference Grid Grounding and Bonding Connector:
1. Source Limitations: Obtain products from single manufacturer.
 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

- a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
3. Standard Features: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

2.7 INTERSYSTEM BONDING BRIDGE GROUNDING CONNECTORS

- A. Description: Devices that provide means for connecting communications systems grounding and bonding conductors at service equipment or at disconnecting means for buildings or structures.
- B. UL KDSH - Two-Piece Intersystem Bonding Bridge Grounding Connector:
 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
 2. Standard Features: Copper body and polycarbonate cover; four terminating points.

2.8 GROUNDING AND BONDING BUSBARS

- A. Description: Miscellaneous grounding and bonding devices that serve as common connection for multiple grounding and bonding conductors.
- B. UL KDER - Equipment Room Grounding and Bonding Busbar:
 1. Source Limitations: Obtain products from single manufacturer.
 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 3. Standard Features:
 - a. Bus: Rectangular bar of annealed copper.
 - b. Mounting Stand-Off Insulators: Lexan or PVC.
 - 1) Comply with UL 891 for use in 600 V switchboards, impulse tested at 5000 V.

4. Other Available Features Required by the Project:

- a. Dimensions: 1/4 by 4 inch in cross section; length as required for installing specified grounding and bonding connections.
- b. Predrilled Hole Pattern: Suitable for installing specified grounding and bonding connectors.
- c. Mounting Hardware: Stand-off brackets that provide 2 inch clearance to access rear of bus. Brackets and bolts must be stainless steel.

2.9 SIGNAL REFERENCE GRIDS

- A. Description: Means for providing low-impedance path to ground over a large area, approximating an equipotential plan, while simultaneously mitigating large current spikes from faults or lightning.

2.10 GROUNDING (EARTHING) ELECTRODES

A. UL KDER - Rod Electrode:

1. Source Limitations: Obtain products from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
3. Standard Features: Copper-clad steel; 3/4 inch by 10 ft.

2.11 GROUNDING ELECTRODE ENCLOSURES

- A. Description: Enclosures designed to protect grounding electrodes from damage while providing access for inspection and testing of the grounding system.

B. Grounding Electrode Access Well Enclosure:

1. Source Limitations: Obtain products from single manufacturer.
2. Standard Features:
 - a. Well Material: Concrete.
 - b. Cover Material: Cast iron.
 - c. Cover Strength: Driveway use.
3. Other Available Features Required by the Project:
 - a. Round:
 - 1) Nominal Diameter: 10 inch.

- 2) Nominal Height: 36 inch.
- 3) Slotted sides for installation after grounding connections made.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine facility's 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 electrical system.
- B. Inspect test results of grounding system measured at point of electrical service equipment connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of electrical service equipment only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF GROUNDING AND BONDING PRODUCTS

- A. Grounding and Bonding Conductors:
 1. Provide solid conductor for 8 AWG and smaller, and stranded conductors for 6 AWG and larger unless otherwise indicated.
 2. Custom-Length Insulated Equipment Bonding Jumpers: 6 AWG, 19-strand, Type THHN.
 3. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.
 4. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.
 5. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.
 6. Underground Grounding Conductors: Install bare copper conductor, 2/0 AWG minimum.
- B. Grounding and Bonding Connectors:
 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.
- C. Grounding and Bonding Busbars: Provide in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated on the Drawings.

3.3 INSTALLATION OF GROUNDING AND BONDING

- A. Comply with manufacturer's published instructions.
- B. Reference Standards:
 - 1. Electrical Construction: ICC IBC, ICC IFB, NFPA 1, NFPA 70, and NECA NEIS 1.
 - 2. Electrical Maintenance: NFPA 70B.
 - 3. Electrical Safety: NFPA 70E.
 - 4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
 - 5. Communications Work: BICSI N1.
 - 6. Work in ITE Rooms: NFPA 75.
 - 7. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
 - 8. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
 - 9. Work in Confined Spaces: NFPA 350.
 - 10. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
 - 11. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
 - 12. Consult Architect for resolution of conflicting requirements.
- C. Special Techniques:
 - 1. Grounding and Bonding Conductors:
 - a. Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
 - b. Underground Grounding Conductors:
 - 1) Bury at least 30 inch below grade.
 - 2) Duct-Bank Grounding Conductor: Bury 12 inch above duct bank when indicated as part of duct-bank installation.
 - 2. Grounding and Bonding Connectors: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
 - a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 - b. Make connections with clean, bare metal at points of contact.
 - c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.

- d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 - e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
 - f. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1) Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate adjacent parts.
 - 2) Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3) Use exothermic-welded connectors for outdoor locations; if disconnect-type connection is required, use bolted clamp.
 - g. Grounding and Bonding for Piping:
 - 1) Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use bolted clamp connector or bolt lug-type connector to pipe flange by using one of lug bolts of flange. Where dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2) Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with bolted connector.
 - 3) Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
 - h. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
 - i. Grounding for Steel Building Structure: Install driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 ft apart.
3. Grounding and Bonding Busbars:
- a. Install busbar horizontally, on insulated spacers 2 inch minimum from wall, 6 inch above finished floor unless otherwise indicated.
 - b. Where busbars are indicated on both sides of doorways, route bonding conductor up to top of door frame, across top of doorway, and down; connect to continuation of horizontal busbar.
4. Electrodes:

- a. Ground Rods: Drive rods until tops are 2 inch below finished floor or final grade unless otherwise indicated.
 - 1) Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2) Use exothermic welds for below-grade connections.
 - b. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least same distance from other grounding electrodes, and connect to service grounding electrode conductor.
 - c. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and must be at least 12 inch deep, with cover.
 - 1) Install at least one test well for each service unless otherwise indicated. Install at ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
 - d. Ring Electrode: Install grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around perimeter of building.
 - 1) Install tinned-copper conductor not less than 2/0 AWG for ring electrode and for taps to building steel.
 - 2) Bury ring electrode not less than 24 inch from building's foundation.
 - e. Concrete-Encased Electrode (Ufer Ground):
 - 1) Fabricate in accordance with NFPA 70; use minimum of 20 ft of bare copper conductor not smaller than 4 AWG.
 - a) If concrete foundation is less than 20 ft long, coil excess conductor within base of foundation.
 - b) Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.
5. Grounding at Service:
- a. Equipment grounding conductors and grounding electrode conductors must be connected to ground busbar. Install main bonding jumper between neutral and ground buses.
6. Grounding Underground Distribution System Components:
- a. Duct-Bank Grounding Conductor: Bury 12 inch above duct bank when

indicated as part of duct-bank installation.

- b. Comply with IEEE C2 grounding requirements.
- c. Grounding Manholes and Handholes: Install driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inch will extend above finished floor. If necessary, install ground rod before manhole is placed and provide 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inch above to 6 inch below concrete. Seal floor opening with waterproof, nonshrink 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 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields in accordance with manufacturer's published instructions with splicing and termination kits.
- e. Pad-Mounted Transformers and Switches: Install two ground rods and ring electrode around pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than 2 AWG for ring electrode and for taps to equipment grounding terminals. Bury ring electrode not less than 6 inch from foundation.

7. Equipment Grounding and Bonding:

- a. Install insulated equipment grounding conductors with feeders and branch circuits.
- b. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1) Feeders and branch circuits.
 - 2) Lighting circuits.
 - 3) Receptacle circuits.
 - 4) Single-phase motor and appliance branch circuits.
 - 5) Three-phase motor and appliance branch circuits.
 - 6) Flexible raceway runs.
 - 7) Armored and metal-clad cable runs.
 - 8) Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - 9) X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.
- c. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more,

including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

- d. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- e. Isolated Grounding Receptacle Circuits: Install insulated equipment grounding conductor connected to receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.
- f. Isolated Equipment Enclosure Circuits: For designated equipment supplied by branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.
- g. Poles Supporting Outdoor Lighting Fixtures: Bond insulated equipment grounding conductor to equipment grounding terminal inside pole base.
- h. Metallic Fences: Comply with requirements of IEEE C2.

- 1) Grounding Conductor: Bare, tinned copper, not less than 8 AWG.
- 2) Gates: Must be bonded to grounding conductor with flexible bonding jumper.
- 3) Barbed Wire: Strands must be bonded to grounding conductor.

8. Fence Grounding:

- a. Grounding Method: At each grounding location, drive grounding rod vertically until top is 6 inch below finished grade. Connect rod to fence with 6 AWG conductor. Connect conductor to each fence component at grounding location.
- b. Fences greater than 100 ft of Buildings, Structures, Walkways, and Roadways: Ground fence at maximum intervals of 1500 ft.
- c. Fences within 100 ft of Buildings, Structures, Walkways, and Roadways: Ground fence at maximum intervals of 750 ft.
 - 1) Gates and Other Fence Openings: Ground fence on each side of opening.
 - a) Bond metal gates to gate posts by connecting bonding jumper between gate post and gate frame.
 - b) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use 2 AWG wire and bury it at least 18 inch below finished grade.
- d. Protection at Crossings of Overhead Electrical Power Lines: Ground fence

at location of power line crossing and at maximum distance of 150 ft on each side of crossing.

- e. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground fence and bond fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.4 FIELD QUALITY CONTROL FOR GROUNDING AND BONDING

A. Administrant for Electrical Power Tests and Inspections:

- 1. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.

B. Field tests and inspections must be witnessed by Engineer .

C. Tests and Inspections:

- 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
- 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.
- 3. Test completed grounding system at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells , and at individual ground rods. Make tests at ground rods before conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method in accordance with IEEE Std 81.
 - c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

D. Nonconforming Work:

- 1. Grounding system will be considered defective if it does not pass tests and inspections.
- 2. Remove and replace defective components and retest.

E. Collect, assemble, and submit test and inspection reports.

- 1. Report measured ground resistances that exceed the following values:
 - a. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 Ω .

- b. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 Ω .
- c. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 Ω .
- d. Manhole Grounds: 10 Ω .

3.5 PROTECTION

- A. After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Support systems.
2. Mounting, anchoring, and attachment components.
3. Installation of fabricated metal supports.
4. Installation of concrete bases.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

1.2 DELEGATED DESIGN SERVICES

- A. Delegated Design Professionals: Engage qualified structural professional engineer to design hangers and supports for electrical systems.

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 the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
2. Include rated capacities and furnished specialties and accessories.

- B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

1. Hangers. Include product data for components.
2. Slotted support systems.
3. Equipment supports.
4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittals: For hangers and supports for electrical systems.

1. Include design calculations and details of hangers.
2. Include design calculations for seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 REGULATORY AGENCY APPROVALS

1.6 QUALIFICATIONS

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Prepare design calculations in accordance with criteria specified in Section 260010 "Supplemental Requirements for Electrical".

2.2 SUPPORT SYSTEMS

- A. Steel Slotted Support Systems:

1. Standard Features: Preformed steel channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center in at least one surface.
 - a. Referenced Standard: MFMA-4 factory-fabricated components for field assembly.
 - b. Material for Channel, Fittings, and Accessories: Galvanized steel.
 - c. Channel Width: Selected for applicable load criteria.
 - d. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

- B. Conduit and Cable Support Devices:

1. Standard Features: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit:

1. Standard Features: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.

D. Structural Steel for Fabricated Supports and Restraints:

1. Standard Features: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

2.3 MOUNTING, ANCHORING, AND ATTACHMENT COMPONENTS

A. Powder-Actuated Fasteners:

1. Standard Features: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors:

1. Standard Features: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

C. Concrete Inserts:

1. Standard Features: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.

D. Clamps for Attachment to Steel Structural Elements:

1. Standard Features: MSS SP-58 units are suitable for attached structural element.

E. Through Bolts:

1. Standard Features: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.

F. Toggle Bolts:

1. Standard Features: All steel springhead type.

G. Hanger Rods:

1. Standard Features: Threaded steel.

PART 3 - EXECUTION

3.1 SELECTION OF HANGERS AND SUPPORTS

- A. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as required by NFPA 70. Minimum rod size must be 1/4 inch in diameter.
- B. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- C. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with manufacturer's published instructions.
- B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:
 - 1. Electrical Construction: ICC IBC, ICC IFB, NFPA 1, NFPA 70, and NECA NEIS 1.
 - 2. Hot Work: NFPA 51B.
 - 3. Work in Confined Spaces: NFPA 350.
 - 4. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
 - 5. Installation of Steel Conduit: NECA NEIS 101.
 - 6. Installation of Aluminum Conduit: NECA NEIS 102.
 - 7. Installation of Metal Cable Tray Systems: NECA NEIS 105.
 - 8. Installation of Nonmetallic Cable Tray Systems: NECA NEIS 111.
 - 9. Consult Architect for resolution of conflicting requirements.
- C. Special Installation Techniques:
 - 1. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination must be weight of supported components plus 200 lb.
 - 2. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - a. To Wood: Fasten with lag screws or through bolts.

- b. To New Concrete: Bolt to concrete inserts.
 - c. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - d. To Existing Concrete: Expansion anchor fasteners.
 - e. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inch thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inch thick.
 - f. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 - g. To Light Steel: Sheet metal screws.
 - h. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
3. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

D. Interfaces with Other Work:

- 1. Provide vibration controls with hangers and supports.
- 2. Touchup Finishes:
 - a. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1) Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
 - b. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
 - c. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.
- 3. Installation of Fabricated Metal Supports:
 - a. Provide site-fabricated metal supports.
 - b. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
 - c. Field Welding: Comply with AWS D1.1/D1.1M. Submit welding certificates.

END OF SECTION 260529

SECTION 260533.13 - CONDUITS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type EMT duct raceways and elbows.
2. Type ERMC duct raceways, elbows, couplings, and nipples.
3. Type FMC duct raceways.
4. Type IMC duct raceways.
5. Type LFMC duct raceways.
6. Type PVC duct raceways and fittings.
7. Fittings for conduit, tubing, and cable.
8. Joint compounds.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
2. Section 078413 "Penetration Firestopping" specifies firestopping referenced by this Section.
3. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" specifies nonmetallic underground conduit with conductors (Type NUCC).
4. Section 260529 "Hangers and Supports for Electrical Systems" specifies conduit hangers and supports referenced by this Section.
5. Section 260543 "Underground Ducts and Raceways for Electrical Systems" specifies exterior duct banks, manholes, and underground utility construction.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels.

1.2 REFERENCES

A. Abbreviations and Acronyms for Electrical Raceway Types:

1. EMT: Electrical metallic tubing.
2. EMT-A: Aluminum electrical metallic tubing.
3. EMT-S: Steel electrical metallic tubing.
4. EMT-SS: Stainless steel electrical metallic tubing.
5. ENT: Electrical nonmetallic tubing.
6. EPEC: Electrical HDPE underground conduit (thin wall).
7. EPEC-A: Type A electrical HDPE underground conduit.
8. EPEC-B: Type B electrical HDPE underground conduit.

9. ERM: Electrical rigid metal conduit.
10. ERM-A: Aluminum electrical rigid metal conduit.
11. ERM-S: Steel electrical rigid metal conduit.
12. ERM-S-G: Galvanized-steel electrical rigid metal conduit.
13. ERM-S-PVC: PVC-coated-steel electrical rigid metal conduit.
14. ERM-SS: Stainless steel electrical rigid metal conduit.
15. FMC: Flexible metal conduit.
16. FMC-A: Aluminum flexible metal conduit.
17. FMC-S: Steel flexible metal conduit.
18. FMT: Steel flexible metallic tubing.
19. FNMC: Flexible nonmetallic conduit. See "LFNC."
20. HDPE: HDPE underground conduit (thick wall).
21. HDPE-40: Schedule 40 HDPE underground conduit.
22. HDPE-80: Schedule 80 HDPE underground conduit.
23. IMC: Steel electrical intermediate metal conduit.
24. LFMC: Liquidtight flexible metal conduit.
25. LFMC-A: Aluminum liquidtight flexible metal conduit.
26. LFMC-S: Steel liquidtight flexible metal conduit.
27. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
28. LFNC: Liquidtight flexible nonmetallic conduit.
29. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
30. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
31. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.
32. PVC: Rigid PVC conduit.
33. PVC-40: Schedule 40 rigid PVC conduit.
34. PVC-80: Schedule 80 rigid PVC Conduit.
35. PVC-A: Type A rigid PVC concrete-encased conduit.
36. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.
37. RGS: See ERM-S-G.
38. RMC: See ERM.
39. RTRC: Reinforced thermosetting resin conduit.
40. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.
41. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
42. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.
43. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
44. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

B. Definitions:

1. Conduit: A structure containing one or more duct raceways.
2. Direct Buried: Installed underground without encasement in concrete or other protective material.
3. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.
4. Duct Raceway: A single enclosed raceway for conductors or cable.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product data for sustainable design features for each type of product.
- C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer's published instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 TYPE EMT DUCT RACEWAYS AND ELBOWS

- A. UL FJMX - Stainless Steel Electrical Metal Tubing (EMT-SS) and Elbows:
 - 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN FJMX; including UL 797A.
 - 2. Standard Features:
 - a. Material: Stainless steel.
 - b. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - 3. Other Available Features Required by the Project:
 - a. Colors: As indicated on the Drawings.
- B. UL FJMX - Steel Electrical Metal Tubing (EMT-S) and Elbows:
 - 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

- a. UL CCN FJMX; including UL 797.
2. Standard Features:
 - a. Material: Steel.
 - b. Exterior Coating: Zinc.
 - c. Interior Coating: Zinc with organic top coating.
 - d. Minimum Trade Size: Metric designator 21 (trade size 3/4).
3. Other Available Features Required by the Project:
 - a. Colors: As indicated on the Drawings.

2.3 TYPE ERM C DUCT RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

- A. UL DYWV - Stainless Steel Electrical Rigid Metal Conduit (ERM C-SS), Elbows, Couplings, and Nipples:
 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN DYWV; including UL 6A.
 2. Standard Features:
 - a. Material: Stainless steel.
 - b. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 3. Other Available Features Required by the Project:
 - a. Colors: As indicated on the Drawings.
- B. UL DYIX - PVC-Coated-Steel Electrical Rigid Metal Conduit (ERM C-S-PVC), Elbows, Couplings, and Nipples:
 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN DYIX; including UL 6.
 2. Standard Features:
 - a. Exterior Coating: PVC complying with NEMA RN 1.
 - b. Interior Coating: Zinc with organic top coating.
 - c. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 3. Other Available Features Required by the Project:

- a. Colors: As indicated on the Drawings.
- b. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

2.4 TYPE FMC DUCT RACEWAYS

A. UL DXUZ - Steel Flexible Metal Conduit (FMC-S):

- 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN DXUZ; including UL 1.
- 2. Standard Features:
 - a. Material: Steel.
 - b. Minimum Trade Size: Metric designator 21 (trade size 3/4).
- 3. Other Available Features Required by the Project:
 - a. Colors: As indicated on the Drawings.

2.5 TYPE IMC DUCT RACEWAYS

A. UL DYBY - Steel Intermediate Metal Conduit (IMC):

- 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN DYBY; including UL 1242.
- 2. Standard Features:
 - a. Exterior Coating: Zinc.
 - b. Interior Coating: Zinc with organic top coating.
 - c. Minimum Trade Size: Metric designator 21 (trade size 3/4).
- 3. Other Available Features Required by the Project:
 - a. Colors: As indicated on the Drawings.

2.6 TYPE LFMC DUCT RACEWAYS

A. UL DXHR - Steel Liquidtight Flexible Metal Conduit (LFMC-S):

- 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing

laboratory in accordance with guide information and standards specified for the following UL product categories:

- a. UL CCN DXHR; including UL 360.
 2. Standard Features:
 - a. Material: Steel.
 - b. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 3. Other Available Features Required by the Project:
 - a. Colors: As indicated on the Drawings.
- B. UL DXHR - Stainless Steel Liquidtight Flexible Metal Conduit (LFMC-SS):
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN DXHR; including UL 360.
 2. Standard Features:
 - a. Material: Stainless steel.
 - b. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 3. Other Available Features Required by the Project:
 - a. Colors: As indicated on the Drawings.

2.7 TYPE PVC DUCT RACEWAYS AND FITTINGS

- A. UL DZYR - Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN DZYR; including UL 651.
 2. Standard Features:
 - a. Dimensional Specifications: Schedule 40.
 - b. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - c. Markings: For use with maximum 90 deg C wire.

2.8 FITTINGS FOR CONDUIT, TUBING, AND CABLE

- A. UL DWTT - Fittings for Type ERM, Type IMC, Type PVC, Type HDPE, Type EPEC, and Type RTRC Duct Raceways:
 - 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN DWTT; including UL 514B.
 - 2. Standard Features:
 - a. Material: Steel.
 - b. Coupling Method: Setscrew coupling. Setscrew couplings with only single screw per conduit are unacceptable.
 - c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.
- B. UL FKAV - Fittings for Type EMT Duct Raceways:
 - 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN FKAV; including UL 514B.
 - 2. Standard Features:
 - a. Material: Steel.
 - b. Coupling Method: Setscrew coupling. Setscrew couplings with only single screw per conduit are unacceptable.
 - c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.
- C. UL ILNR - Fittings for Type FMC Duct Raceways:
 - 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN ILNR; including UL 514B.
- D. UL DXAS - Fittings for Type LFMC and Type LFNC Duct Raceways:
 - 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN DXAS; including UL 514B.

2.9 JOINT COMPOUNDS

- A. UL FOIZ - Electrically Conductive Corrosion-Resistant Compound for Threaded Conduit:
 - 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN FOIZ; including UL Subject 2419.

PART 3 - EXECUTION

3.1 SELECTION OF CONDUITS FOR ELECTRICAL SYSTEMS

- A. Unless more stringent requirements are specified in the Contract Documents or manufacturer's published instructions, comply with NFPA 70 for selection of duct raceways. Consult Architect for resolution of conflicting requirements.
- B. Outdoors:
 - 1. Exposed and Subject to Severe Physical Damage: ERMIC.
 - 2. Exposed and Subject to Physical Damage: IMC.
 - 3. Exposed and Not Subject to Physical Damage: ERMIC OR IMC.
 - 4. Concealed Aboveground: .
 - 5. Direct Buried: PVC-40.
 - 6. Concrete Encased in Trench: PVC-40.
 - 7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
- C. Indoors:
 - 1. Exposed and Subject to Severe Physical Damage: ERMIC.
 - 2. Exposed and Subject to Physical Damage: .
 - 3. Exposed and Not Subject to Physical Damage: EMT.
 - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 5. Damp or Wet Locations: ERMIC OR IMC.
 - 6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
- D. Duct Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.
 - 1. ERMIC and IMC: Provide threaded-type fittings unless otherwise indicated.

3.2 INSTALLATION OF CONDUITS FOR ELECTRICAL SYSTEMS

- A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFB, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Life Safety and Means of Egress Work: NFPA 101.
7. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
8. Work in Confined Spaces: NFPA 350.
9. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
10. Type EMT-A: Article 358 of NFPA 70 and NECA NEIS 102.
11. Type EMT-SS: Article 358 of NFPA 70 and NECA NEIS 101.
12. Type EMT-S: Article 358 of NFPA 70 and NECA NEIS 101.
13. Type ENT: Article 362 of NFPA 70 and NECA NEIS 102.
14. Type HDPE and Type EPEC: Article 353 of NFPA 70 and NECA NEIS 111.
15. Type ERMC-A: Article 344 of NFPA 70 and NECA NEIS 102.
16. Type ERMC-SS: Article 344 of NFPA 70 and NECA NEIS 101.
17. Type ERMC-S: Article 344 of NFPA 70 and NECA NEIS 101.
18. Type FMC-S: Article 348 of NFPA 70 and NECA NEIS 101.
19. Type FMC-A: Article 348 of NFPA 70 and NECA NEIS 102.
20. Type FMT: Article 360 of NFPA 70 and NECA NEIS 101.
21. Type IMC: Article 342 of NFPA 70 and NECA NEIS 101.
22. Type LFMC: Article 350 of NFPA 70 and NECA NEIS 101.
23. Type LFNC: Article 342 of NFPA 70 and NECA NEIS 111.
24. Type PVC: Article 356 of NFPA 70 and NECA NEIS 111.
25. Type RTRC: Article 355 of NFPA 70 and NECA NEIS 111.
26. Expansion Fittings: NEMA FB 2.40.
27. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. General Requirements for Installation of Duct Raceways:
 - a. Complete duct raceway installation before starting conductor installation.
 - b. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 ft above finished floor.
 - c. Install no more than equivalent of three 90-degree bends in conduit run for services and feeders. No more than four 90-degree bends in conduit runs for branch circuits. Support within 12 inch of changes in direction.
 - d. Make bends in duct raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed

- for material and size involved.
- e. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
 - f. Support conduit within 12 inch of enclosures to which attached.
 - g. Install duct sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed duct raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install duct sealing fittings in accordance with NFPA 70.
 - h. Install devices to seal duct raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of duct raceways at the following points:
 - 1) Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2) Where an underground service duct raceway enters a building or structure.
 - 3) Conduit extending from interior to exterior of building.
 - 4) Conduit extending into pressurized duct raceway and equipment.
 - 5) Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
 - 6) Where otherwise required by NFPA 70.
 - i. Do not install duct raceways or electrical items on "explosion-relief" walls or rotating equipment.
 - j. Do not install conduits within 2 inch of the bottom side of a metal deck roof.
 - k. Keep duct raceways at least 12 inch away from parallel runs of flues and steam or hot-water pipes. Install horizontal duct raceway runs above water and steam piping.
 - l. Cut conduit perpendicular to the length. For conduits metric designator 53 (trade size 2) and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
 - m. Install pull wires in empty duct raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inch of slack at both ends of pull wire. Cap underground duct raceways designated as spare above grade alongside duct raceways in use.
 - n. Install duct raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.
 - 1) Termination fittings with shoulders do not require two locknuts.
 - o. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to metric designator 35 (trade size 1-1/4) and insulated throat metal bushings on metric designator 41 (trade size 1-1/2) and larger conduits terminated with locknuts..

2. Types EMT-A, ERM-C-A, and FMC-A: Do not install aluminum duct raceways or fittings in contact with concrete or earth.
3. Types ERM-C and IMC:
 - a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of duct raceway and fittings before making up joints. Follow compound manufacturer's published instructions.
4. Type ERM-C-S-PVC:
 - a. Follow manufacturer's installation instructions for clamping, cutting, threading, bending, and assembly.
 - b. Provide PVC-coated sealing locknut for exposed male threads transitioning into female NPT threads that do not have sealing sleeves, including transitions from PVC couplings/female adapters to Type ERM-C-S-PVC elbows in direct-burial applications. PVC-coated sealing locknuts must not be used in place of conduit hub. PVC-coated sealing locknut must cover exposed threads on Type ERM-C-S-PVC duct raceway.
 - c. Coat field-cut threads on PVC-coated duct raceway with manufacturer-approved corrosion-preventing conductive compound prior to assembly.
5. Types FMC, LFMC, and LFNC:
 - a. Provide a maximum of 36 inch of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
6. Types PVC, HDPE, and EPEC:
 - a. Do not install Type PVC, Type HDPE, or Type EPEC conduit where ambient temperature exceeds 122 deg F. Conductor ratings must be limited to 75 deg C except where installed in a trench outside buildings with concrete encasement, where 90 deg C conductors are permitted.
 - b. Comply with manufacturer's published instructions for solvent welding and fittings.
 - c. Join joints with solvent cement in accordance with manufacturer's published instructions and allowed to cure before handling. Joints to be bent, pushed, or pulled must set for minimum 24 h after joining.
7. Type RTRC: Do not install Type RTRC conduit where ambient temperature exceeds 230 deg F.
8. Stub-ups to Above Recessed Ceilings:
 - a. Provide EMT, IMC, or ERM-C for duct raceways.
 - b. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
9. Duct Raceway Terminations at Locations Subject to Moisture or Vibration:

- a. Provide insulating bushings to protect conductors, including conductors smaller than 4 AWG. Install insulated throat metal grounding bushings on service conduits.
10. Duct Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.
- a. ERM-C-S-PVC: Provide only fittings listed for use with this type of conduit. Patch and seal joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Provide sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 - b. EMT: Provide setscrew, steel fittings. Comply with NEMA FB 2.10.
 - c. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.
11. Expansion-Joint Fittings:
- a. Install in runs of aboveground PVC that are located where environmental temperature change may exceed 30 deg F and that have straight-run length that exceeds 25 ft. Install in runs of aboveground ERM-C and EMT conduit that are located where environmental temperature change may exceed 100 deg F and that have straight-run length that exceeds 100 ft.
 - b. Install type and quantity of fittings that accommodate temperature change listed for the following locations:
 - 1) Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - 2) Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - 3) Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - c. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 - d. Install expansion fittings at locations where conduits cross building or structure expansion joints.
 - e. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's published instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
12. Duct Raceways Penetrating Rooms or Walls with Acoustical Requirements: Seal duct raceway openings on both sides of rooms or walls with acoustically rated putty or firestopping.
13. Identification: Provide labels for conduit assemblies, duct raceways, and associated electrical equipment.

- a. Provide warning signs.

D. Interfaces with Other Work:

- 1. Firestop penetrations of fire-rated floor and wall assemblies.
- 2. Provide conduit hangers and supports.

3.3 FIELD QUALITY CONTROL OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Administrant for Electrical Power Tests and Inspections:

- 1. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.

B. Administrant for Communications Tests and Inspections:

- 1. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.

C. Tests and Inspections:

- 1. Perform manufacturer's recommended tests and inspections.
- 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 minimum 12 inch long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
- 3. Conduit Placement:
 - a. Verify that center-line location and offsets are in accordance with the Drawings.
 - b. Verify that hangers and supports for conduits are attached to structure as directed by qualified structural engineer.
 - c. Verify that nuts on bolts or hanger rods are secure.
 - d. Verify that space between raceways and cored holes are filled with non-shrinking grout or other approved material indicated on the Drawings and the Specifications.
 - e. Verify that expansion devices are installed at locations indicated on the Drawings and the Specifications.
 - f. Verify that ends are cut square to provide flush-butting surfaces when spliced and inside edges are free of burrs that could impede installation of cables.
 - g. Verify minimum separation of utilities, or that approved mechanical protection has been provided to surrounding conduit(s) where minimum separation cannot be achieved.

- 4. Document all changes on Record Drawings.

D. Nonconforming Work:

1. Conduit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

- E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.4 CLEANING

- A. Verify that bentonite or other drilling fluids are contained and removed, and site is restored to its original or improved condition.

3.5 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and 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.

END OF SECTION 260533.13

SECTION 260533.16 - BOXES AND COVERS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metallic outlet boxes, device boxes, rings, and covers.
2. Junction boxes and pull boxes.
3. Cover plates for device boxes.
4. Hoods for outlet boxes.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
2. Section 078413 "Penetration Firestopping" specifies materials and methods for sealing penetrations of rated walls and partitions referenced by this Section.
3. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
4. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.

1.2 DEFINITIONS

- A. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.
- B. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:
1. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
 2. Concrete Box: A box intended for use in poured concrete.
 3. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
 4. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.

5. Cover Plate: A cover designed for protecting wiring devices installed in flush-mounted device boxes while permitting their safe operation; also called a faceplate or wallplate.
 6. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.
 7. Device Box: A box with provisions for mounting a wiring device directly to the box.
 8. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.
 9. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.
 10. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.
 11. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the entrance of scrub water at the floor level.
 12. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
 13. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.
 14. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.
 15. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.
 16. Raised-Floor Box: A floor box intended for use in raised floors.
 17. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.
 18. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.
 19. Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.
 20. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.
 21. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.
- C. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.

- D. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer's published instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

- A. UL QCIT - Metallic Outlet Boxes and Covers:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCIT; including UL 514A.
2. Standard Features:
 - a. Box having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.
 - b. Material: Sheet steel.
 - c. Sheet Metal Depth: Minimum 2.5 inch.

- B. UL QCIT - Metallic Device Boxes:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCIT; including UL 514A.

2. Standard Features:

- a. Box with provisions for mounting wiring device directly to box.
- b. Material: Sheet steel.
- c. Sheet Metal Depth: minimum 2.5 inch.

C. UL QCIT - Metallic Extension Rings:

- 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCIT; including UL 514A.
- 2. Standard Features: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.

2.3 NONMETALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Source Quality Control:

- 1. Samples:
 - a. Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
 - b. Raised Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
 - c. Recessed Access-Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
 - d. Concrete Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.

2.4 JUNCTION BOXES AND PULL BOXES

A. UL BGUZ - Indoor Sheet Metal Junction and Pull Boxes:

- 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN BGUZ; including UL 50 and UL 50E.
- 2. Standard Features:

- a. Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
- b. Degree of Protection: Type 1.

B. UL BGUZ - Outdoor Sheet Metal Junction and Pull Boxes:

- 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

- a. UL CCN BGUZ; including UL 50 and UL 50E.

- 2. Standard Features:

- a. Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
- b. Degree of Protection: Type 3R.

2.5 COVER PLATES FOR DEVICE BOXES

A. UL QCIT or QCMZ - Metallic Cover Plates for Device Boxes:

- 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

- a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.

- 2. Standard Features:

- a. Cover plate-Securing Screws: Metal with head color to match cover plate finish.
- b. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
- c. Cover Plate Material: As indicated on architectural Drawings.

2.6 HOODS FOR OUTLET BOXES

A. UL QCIT or QCMZ - Extra-Duty, While-in-Use Hoods for Outlet Boxes:

- 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

- a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.
- b. Receptacle, Hood, Cover Plate, Gaskets, and Seals: UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.

2. Standard Features:

- a. Mounts to box using fasteners different from wiring device.
- b. Marked "Extra-Duty" in accordance with UL 514D.
- c. Provides gray, weatherproof, "while-in-use" cover.
- d. Manufacturer may combine nonmetallic device box with hood as extra-duty rated assembly.

PART 3 - EXECUTION

3.1 SELECTION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.
- B. Degree of Protection:
 - 1. Outdoors:
 - a. Type 3 unless otherwise indicated.
 - b. Locations in-Ground or Exposed to Corrosive Agents: Type 4X.
 - 2. Indoors:
 - a. Type 1 unless otherwise indicated.
 - b. Damp or Dusty Locations: Type 12.
- C. Exposed Boxes Installed Less Than 2.5 m (8 ft) Above Floor:
 - 1. Provide cast-metal boxes.
 - 2. Provide exposed cover. Flat covers with angled mounting slots or knockouts are prohibited.

3.2 INSTALLATION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

- A. Comply with manufacturer's published instructions.
- B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:
 - 1. Electrical Construction: ICC IBC, ICC IFB, NFPA 1, NFPA 70, and NECA NEIS 1.
 - 2. Electrical Safety: NFPA 70E.
 - 3. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.

4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Life Safety and Means of Egress Work: NFPA 101.
7. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
8. Work in Confined Spaces: NFPA 350.
9. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
10. Outlet, Device, Pull, and Junction Boxes: Article 314 of NFPA 70.
11. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
2. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.
3. 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 surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box, whether installed indoors or outdoors.
4. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
5. Locate boxes so that cover or plate will not span different building finishes.
6. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
7. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
8. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
9. Set metal floor boxes level and flush with finished floor surface.
10. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
11. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
12. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
13. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:
 - a. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.
 - b. Provide gaskets for cover plates and covers.

D. Interfaces with Other Work:

1. Identification: Provide labels for boxes and associated electrical equipment.
 - a. Identify field-installed conductors, interconnecting wiring, and components.
 - b. Label each enclosure with engraved metal or laminated-plastic nameplate.

- c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

3.3 CLEANING

- A. Remove construction dust and debris from boxes before installing cover plates, covers, and hoods.

3.4 PROTECTION

- A. After installation, protect boxes from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260533.16

SECTION 260536 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal cable trays.
2. Cable tray accessories.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

C. Products Installed, but Not Furnished, under This Section:

1. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding products installed under this Section.
2. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Metal cable trays.
2. Nonmetallic cable trays.
3. Cable tray accessories.

B. Shop Drawings:

1. Cable tray fabrication drawings, diagrams, and supporting documents.

C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CABLE TRAYS

- A. Description: This product category covers metal cable trays and metal cable tray systems intended for field assembly and for use in accordance with Article 392 of

NFPA 70.

B. Performance Criteria:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN CYNW; including NEMA VE 1 and suitability for use as equipment grounding conductors in accordance with Sections 392.60(A) and 392.60(B) of NFPA 70.

C. UL CYNW - Wire-Mesh Cable Tray:

1. Source Limitations: Obtain products from single manufacturer.
2. General Characteristics:
 - a. Configuration: steel wire mesh, complying with NEMA VE 1.
 - b. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200 lb. concentrated load, when tested in accordance with NEMA VE 1.
 - c. Splicing Assemblies: Bolted type using serrated flange locknuts.
 - d. Splice-Plate Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.
3. Materials and Finishes (Steel):
 - a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A1008/A1008M, Grade 33, Type 2.
 - b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
 - c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.
 - d. Finish:
 - 1) Hot-dip galvanized after fabrication, complying with ASTM A123/A123M, Class B2, with galvanized, ASTM B633 hardware.
 - 2) Hot-dip galvanized after fabrication, complying with ASTM A653/A653M, G90, with galvanized, ASTM B633 hardware.
 - 3) Electrogalvanized after fabrication, complying with ASTM B633, with galvanized, ASTM B633 hardware.
 - 4) **[Epoxy-resin][Powder-coat enamel]** paint, with stainless steel, Type 316, ASTM F593 and ASTM F594 hardware.
 - a) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
 - b) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.

- c) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.
- 5) Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware in accordance with ASTM F1136.
- 6) Black oxide finish for support accessories and miscellaneous hardware in accordance with ASTM D769.

2.2 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Barrier Strips: Same materials and finishes as for cable tray.
- C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.3 SOURCE QUALITY CONTROL

- A. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
 - 1. Include data indicating dimensions and finishes for each type of cable tray indicated.
- B. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Shop Drawings: Prepare and submit the following for each cable tray system:
 - 1. Cable Tray Fabrication Drawings, Diagrams, and Supporting Documents:
 - a. 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.
 - b. Include load calculations to show that dead and live loads do not exceed manufacturer's rating for tray and its support elements.
 - c. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

- 1) Vertical and horizontal offsets and transitions.
- 2) Clearances for access above and to sides of cable trays.
- 3) Vertical elevation of cable trays above the floor or bottom of ceiling structure.

3.2 INSTALLATION OF CABLE TRAYS

- A. Install cable tray and support systems in accordance with NEMA VE 2.
- B. Install cable tray as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Install cable tray, so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.
- E. Join aluminum cable tray with splice plates; use four square-neck carriage bolts and locknuts.
- F. Fasten cable tray supports to building structure.
- G. Design fasteners and supports to carry cable tray, cables, and a concentrated load of 200 lb. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems."
- H. Place supports, so that spans do not exceed maximum spans on schedules, and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of tray rungs.
- I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- J. Support assembly to prevent twisting from eccentric loading.
- K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
- L. Do not install more than one cable tray splice between supports.
- M. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed recommended dimensions. Space connectors and set gaps in accordance with applicable standard.
- N. Make changes in direction and elevation using manufacturer's recommended fittings.
- O. Make cable tray connections using manufacturer's recommended fittings.

- P. Seal penetrations through fire and smoke barriers.
- Q. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- R. Install cable trays with enough workspace to permit access for installing cables.
- S. Install barriers to separate cables of different systems, such as power, communications, and data processing, or of different insulation levels, such as 600, 5000, and 15 000 V.
- T. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.3 CABLE TRAY GROUNDING

- A. Ground cable trays in accordance with NFPA 70 unless additional grounding is specified.
- B. Cable trays with electrical power conductors must be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Cable trays with single-conductor power conductors must be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72 inch intervals. The grounding conductor must be sized in accordance with Article 250 and Article 392 of NFPA 70.
- 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 in accordance with Article 250 of NFPA 70.

3.4 INSTALLATION OF CABLES

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
- C. Fasten cables on vertical runs to cable trays every 18 inch.
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or

between cable tray and enclosure must be no more than 72 inch.

- E. Tie mineral-insulated cables down every 36 inch where required to provide a two-hour fire rating and every 72 inch elsewhere.
- F. In existing construction, remove inactive or dead cables from cable trays.

3.5 FABRICATION OF CONNECTION POINTS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect raceways to cable trays in accordance with requirements in NEMA VE 2 and NEMA FG 1.

3.6 INSTALLATION OF CABLE TRAY MARKINGS AND SIGNS

- A. Trays Containing Cables Operating Over 600 V: Provide hazard markings in accordance with Section 392.18 of NFPA 70 and with NEMA Z535.4.
 - 1. Legend: "DANGER - HIGH VOLTAGE - KEEP AWAY."
- B. Ladder Cable Trays: Provide warning signs to prevent use as personnel ladder.
 - 1. Lettering: 1-1/2 inch high.
 - 2. Legend: "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."

3.7 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
 - 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
 - 3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
 - 4. Verify that there are no intruding items, such as pipes, hangers, or other equipment, in the cable tray.
 - 5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
 - 6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and

retorque in suspect areas.

7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 Ω .

B. Nonconforming Work:

1. Cable tray will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.8 PROTECTION

A. Protect installed cable trays and cables.

1. 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 must remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 260536

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Round sleeves.
2. Rectangular sleeves.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.
6. Pourable sealants.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

A. Steel Wall Sleeves:

1. General Characteristics: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

B. Cast-Iron Wall Sleeves:

1. General Characteristics: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.

C. PVC Pipe Sleeves:

D. Round, Galvanized-Steel, Sheet Metal Sleeves:

1. General Characteristics: Galvanized-steel sheet; thickness not less than 0.0239 inch; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 RECTANGULAR SLEEVES

A. Rectangular, Galvanized-Steel, Sheet Metal Sleeves:

1. General Characteristics:
 - a. Material: Galvanized sheet steel.
 - b. Minimum Metal Thickness:
 - 1) For sleeve cross-section rectangle perimeter less than 50 inch and with no side larger than 16 inch, thickness must be 0.052 inch.
 - 2) For sleeve cross-section rectangle perimeter not less than 50 inch or with one or more sides larger than 16 inch, thickness must be 0.138 inch.

2.3 SLEEVE-SEAL SYSTEMS

- ### A. General Characteristics: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.

2.4 SLEEVE-SEAL FITTINGS

- ### A. General Characteristics: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit must have plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

- ### A. General Characteristics: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
 2. Design Mix: 5000 psi, 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

2.6 POURABLE SEALANTS

A. Performance Criteria:

1. General Characteristics: Single-component, neutral-curing elastomeric sealants

of grade indicated below.

- a. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. 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 space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 3. Size pipe sleeves to provide 1/4 inch annular clear space between sleeve and raceway or cable, unless sleeve-seal system 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.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:
 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for wall assemblies.
- C. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve-seal systems. Size sleeves to allow for 1 inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- E. Underground, Exterior-Wall and Floor Penetrations:
 1. Install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Install sleeve during construction of floor or wall.

3.2 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

- A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.
- B. Install conduits and cable with no crossings within the sleeve.
- C. Fill opening around conduits and cables with expanding foam without leaving voids.
- D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.3 INSTALLATION OF SLEEVE-SEAL SYSTEMS

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

END OF SECTION 260544

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Labels.
2. Bands.
3. Tapes and stencils.
4. Signs.
5. Cable ties.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

PART 2 - PRODUCTS

2.1 LABELS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN PGDQ2 for components; including UL 969.

B. UL PGDQ2 - Vinyl Wraparound Labels: Preprinted, flexible labels laminated with clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

2.2 EXTRUDED INSULATING TUBING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN YDPU2 for components; including UL 224.

2.3 BANDS

- A. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

2.4 TAPES AND STENCILS

- A. Underground-Line Warning Tape:

- 1. Tape:

- a. Recommended by manufacturer for method of installation and suitable to identify and locate underground electrical utility lines.
- b. Printing on tape must be permanent and may not be damaged by burial operations.
- c. Tape material and ink must be chemically inert and not be subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

- 2. Color and Printing:

- a. Comply with APWA Uniform Color Code using NEMA Z535.1 safety colors.
- b. Inscriptions for Red Tapes: "CAUTION BURIED ELECTRIC LINE BELOW".

- 3. Nonconducting Line-Warning Tape :

- a. Pigmented polyolefin, bright colored, compounded for direct-burial service.
- b. Width: 3 inch.
- c. Thickness: 4 mil.
- d. Weight: 18.5 lb/1000 sq. ft.
- e. Tensile in accordance with ASTM D882: 30 lbf and 2500 psi.

2.5 SIGNS

- A. Laminated Acrylic or Melamine Plastic Signs:

- 1. Engraved legend.
- 2. Thickness:

- a. For signs up to 20 sq. inch, minimum 1/16 inch thick.
- b. For signs larger than 20 sq. inch, 1/8 inch thick.
- c. Engraved legend with 1/4" high white lettering, background color to be coordinated with associated distribution branch.
- d. Engraved legend with 1/4" high white lettering, background color to be coordinated with associated distribution branch.
- e. Engraved legend with 1/4" high lettering. Color scheme based on

associated branch served or served by:

- 1) Normal Power: Black background with white lettering.
 - 2) Equipment Branch: Green background with white lettering.
 - 3) Life Safety Branch: Yellow background with white lettering.
 - 4) Critical Branch: Orange Background with white lettering.
- f. Punched or drilled for mechanical fasteners with 1/4 inch grommets in corners for mounting.
- g. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 CABLE TIES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN ZODZ; including UL 1565 or UL 62275.

B. UL ZODZ - 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.
2. Tensile Strength at 73 deg F in accordance with ASTM D638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 SELECTION OF COLORS AND IDENTIFICATION MARKINGS

- A. Comply with 29 CFR 1910.144 for color identification of hazards, and the following:

1. Fire-protection and fire-alarm equipment, including raceways, must be finished, painted, or suitably marked safety red.

- B. Pipe and Conduit Labeling: Comply with ASME A13.1 and IEEE C2.

- C. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
 - 1. Color must be factory applied.
 - 2. Colors for 208Y/120 V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - 3. Colors for 240 V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - 4. Colors for 480Y/277 V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Purple or Orange (Confirm with AHJ).
 - c. Phase C: Yellow.
 - 5. Color for Neutral (Grounded Conductor): White.
 - 6. Color for Equipment Ground: Green with yellow stripe.
 - 7. Color for Isolated Ground: Green with two or more yellow stripes.
- D. Color-Coding Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.
- E. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- F. Locations of Underground Lines: Underground-line warning tape for power and lighting.
- G. Accessible Raceways and Metal-Clad Cables, 1000 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft maximum intervals in straight runs, and at 25 ft maximum intervals in congested areas.
 - 2. Identify system voltage and system or service type with color scheme as indicated on drawings.
- H. Conductors to Be Extended in Future: Attach write-on tags to conductors and list source.
- I. Cover Plates: Label individual cover plates with self-adhesive labels. Place label at top of cover plate. Label cover plate with the following information, in the order listed:
 - 1. Panelboard designation.

2. Colon or dash.
3. Branch circuit number.

J. Workspace Indication: Apply tape and stencil to finished surfaces. Show working clearances in direction of access to live parts. Workspace must comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

K. Equipment Identification Labels:

1. Black letters on white field.
2. Indoor Equipment: Laminated acrylic or melamine plastic sign.
3. Outdoor Equipment: Laminated acrylic or melamine sign.
4. Refer to drawing details for equipment label formatting.
5. Equipment to Be Labeled:
 - a. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.
 - b. Panelboards: Typewritten directory of circuits in location provided by panelboard manufacturer. Panelboard identification must be in form of engraved, laminated acrylic or melamine label.
 - c. Enclosures and electrical cabinets.
 - d. Access doors and panels for concealed electrical items.
 - e. Switchboards.
 - f. Transformers: Label that includes tag designation indicated on Drawings for transformer, feeder, and panelboards or equipment supplied by secondary.
 - g. Enclosed switches.
 - h. Enclosed circuit breakers.
 - i. Enclosed controllers.
 - j. Variable-speed controllers.
 - k. Push-button stations.
 - l. Contactors.
 - m. Remote-controlled switches, dimmer modules, and control devices.
 - n. Monitoring and control equipment.

L. Cable Ties: General purpose, for attaching tags, except as listed below:

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

3.3 SELECTION OF SIGNS AND HAZARD MARKINGS

- A. Comply with 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs.
- B. Signs, labels, and tags required for personnel safety must comply with the following standards:

1. Safety Colors: NEMA Z535.1.
2. Facility Safety Signs: NEMA Z535.2.
3. Safety Symbols: NEMA Z535.3.
4. Product Safety Signs and Labels: NEMA Z535.4.
5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.

C. Electrical Hazard Warnings:

1. Arc-Flash Hazard Warning: Self-adhesive labels. Comply with NFPA 70E requirements for arc-flash hazard warning labels.
2. Raceways and Cables Carrying Circuits at More Than 1000 V:
 - a. Black letters on orange field.
 - b. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."
3. Multiple Power Sources Warning Legend: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
4. OSHA Workspace Clearance Warning Legend: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 3 FEET MINIMUM."

D. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.

1. Apply to exterior of door, cover, or other access.
2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
 - a. Power-transfer switches.
 - b. Controls with external control power connections.

E. Operating Instruction Signs: Self-adhesive labels.

F. Emergency Operating Instruction Signs: Laminated acrylic or melamine plastic signs with white legend on red background with minimum 3/8 inch high letters for emergency instructions at equipment used for power transfer.

3.4 INSTALLATION

- 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. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes typical for electrical equipment environments specified in Section 018116 "Facility Environmental Requirements" and Section 260010 "Supplemental Requirements for Electrical."
- C. 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).

- D. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.
- E. 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 Project.
- F. Install identifying devices before installing acoustical ceilings and similar concealment.
- G. Verify identity of item before installing identification products.
- H. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- I. Apply identification devices to surfaces that require finish after completing finish work.
- J. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from floor.
- L. Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at location with high visibility and accessibility.
 - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to location and substrate.
- M. Snap-Around Labels: Secure tight to surface at location with high visibility and accessibility.
- N. Self-Adhesive Wraparound Labels: Secure tight to surface at location with high visibility and accessibility.
- O. Snap-Around Color-Coding Bands: Secure tight to surface at location with high visibility and accessibility.
- P. Heat-Shrink, Preprinted Tubes: Secure tight to surface at location with high visibility and accessibility.
- Q. Marker Tapes: Secure tight to surface at location with high visibility and accessibility.
- R. Self-Adhesive Vinyl Tape: Secure tight to surface at location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for minimum distance of 6 inch where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- S. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- T. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's instructions.
- U. Underground Line Warning Tape:
 1. During backfilling of trenches, install continuous underground-line warning tape not less than 12 inch directly above cables or raceways buried 18 inch or more below grade. Use multiple tapes where width of multiple lines installed in common trench or concrete envelope exceeds 16 inch overall.
 2. Install underground-line warning tape for direct-buried cables and service cables in raceways.
- V. Metal Tags:
 1. Place in location with high visibility and accessibility.
 2. Secure using UV-stabilized cable ties.
- W. Baked-Enamel Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
- X. Metal-Backed Butyrate Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
- Y. Laminated Acrylic or Melamine Plastic Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

END OF SECTION 260553

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other requirements applicable to the Work for electrical, communications, and electronic safety and security systems on Project, including wiring methods.
2. Section 260529 "Hangers and Supports for Electrical Systems" specifies concrete bases and supports for panelboards installed by this Section.
3. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
4. Section 260913 "Electrical Power Monitoring" specifies power monitoring and control systems installed by this Section.
5. Section 264313 "Surge Protective Devices for Low-Voltage Electrical Power Circuits" specifies Type 1 and Type 2 surge protective devices installed by this Section.

1.2 DEFINITIONS

- A. MCCB: Molded-case circuit breaker.
- B. VPR: Voltage protection rating.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. In addition to information identified in Section 013300 "Submittal Procedures," submit the following:
 1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.
 2. Include manufacturer's sample extended warranty language.
- B. Shop Drawings: For each panelboard and related equipment:
 1. Include dimensioned plans, elevations, sections, and details.
 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
 3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and

- locks.
 - 4. Detail bus configuration, current, and voltage ratings.
 - 5. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 6. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for SPD as installed in panelboard.
 - 7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 8. Include wiring diagrams for power, signal, and control wiring.
 - 9. Key interlock scheme drawing and sequence of operations.
- C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

- A. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- B. Manufacturer's published instructions.
- C. Field Reports:
 - 1. Manufacturer's field reports for field quality-control support.
 - 2. Field reports for infrared scanning.

1.5 CLOSEOUT SUBMITTALS

- A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Spare parts.
- B. Special tools.

1.7 QUALIFICATIONS

- A. Low-Voltage Electrical Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - 1. On-site electrical testing supervisors must have documented certification and experience with testing electrical equipment in accordance with NETA testing standards.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Handle and prepare panelboards for installation in accordance with NECA 407.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- B. Fabricate and test panelboards in accordance with IEEE 344 to withstand seismic forces specified in Section 018123 "Facility Seismic and Wind Criteria."
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Comply with NEMA PB 1.
- E. Enclosures: Surface-mounted, dead-front cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: UL 50E, Type 1.
 - b. Outdoor Locations: UL 50E, Type 3R.
 - 2. Height: 7 ft maximum.
 - 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims must cover live parts and may have no exposed hardware.
 - 4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims must cover live parts and may have no exposed hardware.
- F. Phase, Neutral, and Ground Buses:
 - 1. Interiors must be factory assembled into unit. Replacing switching and protective devices may not disturb adjacent units or require removing main bus connectors.
 - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
- G. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Terminations must allow use of 75 deg C rated conductors without derating.
 - 2. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.

3. Main and Neutral Lugs: Mechanical type, with lug on neutral bar for each pole in panelboard.
 4. Ground Lugs and Bus-Configured Terminators: Mechanical type, with lug on bar for each pole in panelboard.
- H. Quality-Control Label: Panelboards or load centers must be labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers must have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
- I. Panelboard Short-Circuit Current Rating:
1. Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for 100 percent interrupting capacity.
 - a. Panelboards and overcurrent protective devices rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
 - b. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.

2.2 MAINTENANCE MATERIAL ITEMS

- A. Spare Parts: Furnish to Owner spare parts, for repairing panelboards and related equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:
1. Keys: Two spares for each type of panelboard cabinet lock.
- B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to panelboards and related equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:
1. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
 2. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards in accordance with NECA 407.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Reference Standards:
 - 1. Panelboards: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NECA 407.
 - 2. Consult Architect for resolution of conflicting requirements.
- C. Special Techniques:
 - 1. Equipment Mounting:
 - a. Install floor-mounted panelboards on cast-in-place concrete equipment base(s).
 - b. Attach panelboard to vertical finished or structural surface behind panelboard.
 - c. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.
 - 2. Mount panelboard cabinet plumb and rigid without distortion of box.
 - 3. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
 - 4. Install overcurrent protective devices and controllers not already factory installed.
 - a. Set field-adjustable, circuit-breaker trip ranges according to contract drawings or approved coordination study.
 - b. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver in accordance with manufacturer's

published instructions.

5. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
6. Install filler plates in unused spaces.
7. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

D. Interfaces with Other Work:

1. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components.
- B. Install warning signs.
- C. Panelboard Nameplates: Label each panelboard with nameplate.
- D. Device Nameplates: Label each branch circuit device in power distribution panelboards with nameplate.
- E. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles must be located on interior of panelboard door.
- F. Breaker Labels: Faceplate must list current rating, UL and IEC certification standards, and AIC rating.
- G. Circuit Directory:
 1. Provide computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
 - a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

3.4 FIELD QUALITY CONTROL

- A. Administrant for Low-Voltage Electrical Tests and Inspections:
 1. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each new panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Instruments and Equipment:
 - 1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Nonconforming Work:

1. Panelboards will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to support field tests and inspections.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges.

END OF SECTION 262416

SECTION 264313 - SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type 1 surge protective devices (SPDs).
2. Type 2 surge protective devices (SPDs).
3. Enclosures.
4. Conductors and cables.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 262413 "Switchboards" for integral SPDs installed by switchboard manufacturer.
3. Section 262416 "Panelboards" for integral SPDs installed by panelboard manufacturer.

1.2 DEFINITIONS

- A. In: Nominal discharge current.
- B. Maximum Continuous Operating Voltage (MCOV): The maximum designated RMS value of the power frequency voltage that may be continuously applied to the mode of protection of an SPD.
- C. Metal-Oxide Varistor (MOV): An electronic component with a significant bidirectional, nonlinear current-voltage characteristic.
- D. Mode(s), Modes of Protection, or Protection Modes: Electrical paths where the SPD offers defense against transient overvoltages. Examples include: line to neutral (L-N), line to ground (L-G), line to line (L-L), and neutral to ground (N-G).
- E. SCCR: Short-circuit current rating.
- F. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.
- G. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side

of the service disconnect overcurrent device, including SPDs located at the branch panel.

- H. Type 3 SPDs: Point of utilization SPDs.
- I. Type 4 SPDs: Component SPDs, including discrete components, as well as assemblies.
- J. Type 5 SPDs: Discrete component surge suppressors, such as MOVs that may be mounted on a printed wiring board, connected by its leads or provided within an enclosure with mounting means and wiring terminations.
- K. Voltage Protection Rating (VPR): A rating selected from UL 1449 list of preferred values assigned to each mode of protection.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of product.
 - a. Include electrical characteristics, specialties, and accessories for SPDs.
 - b. Certification of compliance with UL 1449 by qualified electrical testing laboratory recognized by authorities having jurisdiction including the following information:
 - 1) Tested values for VPRs.
 - 2) In ratings.
 - 3) MCOV, type designations.
 - 4) OCPD requirements.
 - 5) Manufacturer's model number.
 - 6) System voltage.
 - 7) Modes of protection.
- B. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's special warranty.

1.5 WARRANTY

- A. Special Manufacturer Extended Warranty: Manufacturer warrants that SPDs perform in accordance with specified requirements and agrees to provide repair or replacement of SPDs that fail to perform as specified within extended warranty period.
 - 1. Initial Extended Warranty Period: Five year(s) from date of Substantial

Completion, for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 TYPE 1 SURGE PROTECTIVE DEVICES (SPDs)

- A. Source Limitations: Obtain devices from single source from single manufacturer.
- B. General Characteristics:
 - 1. Reference Standards: UL 1449, Type 1.
 - 2. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
 - 3. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 250 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
 - 4. SCCR: Not less than 100 kA.
 - 5. In Rating: 20 kA.
- C. Options:
 - 1. Include integral disconnect switch.
 - 2. Include indicator light display for protection status.
 - 3. Include NEMA ICS 5, dry Form C contacts rated at 2 A and 24 V(ac) for remote monitoring of protection status.
 - 4. Include surge counter.

2.2 TYPE 2 SURGE PROTECTIVE DEVICES (SPDs)

- A. Source Limitations: Obtain devices from single source from single manufacturer.
- B. General Characteristics:
 - 1. Reference Standards: UL 1449, Type 2.
 - 2. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
 - 3. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 160 kA for distribution panel and 120kA for branch circuits or branch circuit panelboards. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
 - 4. SCCR: Equal or exceed 100 kA.
 - 5. In Rating: 20 kA.
- C. Options:

1. Include LED indicator lights for power and protection status.
2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include NEMA ICS 5, dry Form C contacts rated at 2 A and 24 V(ac) for remote monitoring of protection status.
4. Include surge counter.

2.3 ENCLOSURES

- A. Indoor Enclosures: Type 1.
- B. Outdoor Enclosures: Type 3R.

2.4 CONDUCTORS AND CABLES

- A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's instructions.
- B. Install leads between disconnects and SPDs short, straight, twisted, and in accordance with manufacturer's instructions. Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 1. Do not splice and extend SPD leads unless specifically permitted by manufacturer.
 2. Do not exceed manufacturer's recommended lead length.
 3. Do not bond neutral and ground.
- C. Use crimped connectors and splices only. Wire nuts are unacceptable.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 1. Compare equipment nameplate data for compliance with Drawings and the Specifications.
 2. Inspect anchorage, alignment, grounding, and clearances.
 3. Verify that electrical wiring installation complies with manufacturer's installation requirements.

B. Nonconforming Work:

1. SPDs that do not pass tests and inspections will be considered defective.
2. Remove and replace defective units and retest.

C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

- A. Complete startup checks in accordance with manufacturer's instructions.
- B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.
- C. Energize SPDs after power system has been energized, stabilized, and tested.

END OF SECTION 264313

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Selection and installation of communications busbars.
2. Selection and installation of communications bonding conductors.

B. Related Requirements:

1. Related Sections
2. Section 260526 "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS."
3. Equipment grounds shall be at least one size larger than NEC Table 250-95 and as much as three (3) times larger if a larger conduit is not required.
4. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

- A. BBC: Backbone bonding conductor, for connecting multiple TBBs serving the same floor.
- B. PBB: Primary bonding busbar (aka TMGBB), located in main distribution frame room, ideally near electrical service entrance.
- C. RBB: Rack bonding busbar, located in equipment cabinets and racks.
- D. SBB: Secondary bonding busbar, located in intermediate distribution frame rooms.
- E. TBB: (aka TGB - Telecommunications Grounding Busbar) Telecommunications bonding backbone, for connecting SBBs to PBB.
- F. TBC: Telecommunications bonding conductor, for connecting PBB to intersystem bonding termination device or busbar at electrical service entrance.
- G. TEBC: Telecommunications equipment bonding conductor, for connecting RBBs to SBBs or PBB.
- H. UBC: Unit bonding conductor, for connecting individual communications equipment to RBBs or SBBs.

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. For communications equipment room signal reference grid.
 - 2. Include plans, elevations, sections, details, and attachments to other work.
- B. Field Quality-Control Submittals:
 - 1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:
 - 1. Installing wire connector on conductor.
 - 2. Recommended torque values.

1.5 CLOSEOUT SUBMITTALS

- A. Record Documentation: Project record documents in accordance with Section 017839 "Project Record Documents" must include locations of PBB and SBBs, and routing of TBC, TBBs, and BBCs.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine facility's 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 electrical system.
- B. Inspect test results of grounding system measured at point of TBC connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of TBC only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF COMMUNICATIONS BUSBARS

- A. PBB:

1. Dimensions: 20" long, 4" high, 1/4" thick with pre-drilled 1/4" holes with standard lug size .
2. 3/8" (9.53 mm) diameter mounting holes spaced 5.75" (146.1 mm) apart.
3. Reference Chatsworth model number 40153-020.

B. SBB:

1. Dimensions: 12" long, 4" wide, 1/4" thick with pre-drilled 1/4" holes with standard lug size .
2. Reference Chatsworth model number 10622-012

3.3 SELECTION OF COMMUNICATIONS BONDING CONDUCTORS

A. Communications Busbar Connections:

1. TBC, TBB, BBC, TEBC, UBC, TMGB, and TGBs:
2. Bonding Conductors to Structural Steel: :

B. Cable Tray Connections:

1. Reference Chatsworth Runway Ground Strap Kit model number 40164-025
2. Reference Chatsworth Equipment Ground Jumper Kit model number 40159-010

3.4 INSTALLATION OF BONDING FOR COMMUNICATIONS

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Bonding of Communications: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with BICSI N3.
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. The grounding bus shall be connected to the main building ground referencing the electrical panel that services that room, using #2 or greater AWG copper wire with a maximum resistance of 3/0 OHms for hospital type buildings.
2. Busbars:
 - a. Install busbars horizontally, on insulated spacers above finished floor per drawings and Owner standards, unless otherwise indicated.
3. Cable Trays and Sleeves
 - a. All cable tray and sleeves within the Telecommunications Service Entry Room (TSER/TEC) and Telecommunications Distribution Room (TDR)

shall be grounded to the main building grounding system with a wire no smaller than #6 AWG copper.

- b. Ground wire and clamps shall be installed on the exterior of the cable tray and sleeves using double lug type connectors.
- c. All painted surfaces at the contact point will be removed to assure proper grounding with a conductive grease coating applied at each connection point.
- d. Each section and sleeve shall be grounded individually.

1) Daisy chaining is not permitted.

4. Conduits at cable trays

- a. Conduit ends at cable tray shall have plastic bushings installed, and be wire bonded to the cable tray.

1) A minerallic strap is not acceptable as a means of grounding the conduit to the cable tray.

- b. Exception: Sleeves and conduits entering a TSER and TDR shall have plastic bushings installed and be wire bonded with a minimum #6 AWG copper conductor, green insulation, to the grounding bus bar located within that/those rooms.

5. Conductors:

- a. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
- b. Assemble wire connector to conductor, complying with manufacturer's published instructions and as follows:

- 1) Use crimping tool and die specific to connector.
- 2) Pretwist conductor.
- 3) Apply antioxidant compound to bolted and compression connections.

- c. Install in straightest and shortest route between origination and termination point, and no longer than required. Bend radius must not be smaller than 10 times diameter of conductor. No single bend may exceed 90 degrees.
- d. Install without splices.
- e. Support conductors at not more than 36 inch intervals.
- f. Outside telecommunications rooms, install conductors in metric designator 21 (trade size 3/4) PVC-80 conduit until conduit enters telecommunications room. Install bonding conductors in EMT-A or EMT-SS when routed through plenum. Do not install bonding conductors in EMT-S unless otherwise indicated on Drawings.

1) If bonding conductor must be installed in EMT-S or other ferrous metallic raceway, bond conductor to raceway using grounding bushing that complies with Section 270528 "Pathways for

Communications Systems," and bond both ends of raceway to SBB.

6. Provide TBC and terminate ends to PBB and intersystem bonding busbar at electrical service entrance in accordance with Section 250.94, "Bonding for Communication Systems," of NFPA 70.
7. Busbar Interconnections: Bond SBBs to PBB with TBBs. If more than one TBB is installed, bond TBBs together BBCs where required by TIA-607.
8. Structural Steel: Where structural steel of steel frame building is readily accessible within room or space, bond each SBB and PBB to vertical steel of building frame.
9. Primary Protector: Bond to PBB with insulated bonding conductor.
10. Ladder Racks: Provide continuous electrical path by installing bonding clips and jumpers. Bond each end to nearest bus bar.

3.5 INSTALLATION OF GROUNDING AND BONDING FOR TOWERS AND ANTENNAS

A. Special Techniques:

1. Special Requirements for Roof-Mounted Towers:
 - a. Roof Ring: Meet requirements for ring electrode except conductors must comply with NFPA 780.
 - b. Bond tower base footings steel, SBB in equipment room, and antenna support guys to roof ring.
 - c. Connect roof ring to perimeter conductors of lightning protection system.
2. Special Requirements for Waveguides and Coaxial Cable:
 - a. Bond cable shields at point of entry into building to nearest SBB and to cable entrance plate, using 2 AWG bonding conductors.
 - b. Bond coaxial cable surge arrester to ring electrode or roof ring using bonding conductor size recommended by surge-arrester manufacturer.

3.6 IDENTIFICATION

A. Comply with Section 270553 "Identification for Communications Systems."

B. Labels must be preprinted or computer-printed type.

1. Label PBB(s) with "ts-PBB," where "ts" is telecommunications space identifier for location of PBB.
2. Label SBB(s) with "ts-SBB," where "ts" is telecommunications space identifier for location of SBB.
3. Label TBC, TBBs, and BBCs at attachment points with legend: "WARNING! COMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

C. Coordinate with FDVA IT/CE for labeling scheme prior to work.

3.7 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by FDVA IT/CE .
- B. Tests and Inspections:
 - 1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench according to manufacturer's published instructions.
 - 2. Test bonding connections of system using AC earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing PBB or SBB, using process recommended by BICSI N1. Conduct tests with facility in operation.
 - a. Measure resistance between PBB and electrical service intersystem termination point. Maximum acceptable value is 100 m Ω .
 - 1) If measured resistance from electrical service equipment to ground exceeds 5 Ω , notify Architect and include recommendations to reduce resistance to ground.
 - b. Measure resistance between SBBs and PBB. Maximum acceptable value is 100 m Ω .
 - 3. Test for ground loop currents using digital clamp-on ammeter, with full scale not more than 10 A, displaying current in increments of 0.01 A at accuracy of plus or minus 2.0 percent.
 - a. With grounding infrastructure completed and communications system electronics operating, measure current in bonding conductors connected to PBB and to SBBs. Maximum acceptable AC current level is 1 A.
- C. Nonconforming Work:
 - 1. Communications bonding will be considered defective if it does not pass tests and inspections.
 - 2. Remove and replace defective units and retest.
- D. Collect, assemble, and submit test and inspection reports.

3.8 PROTECTION

- A. After installation, protect busbars and conductors from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 270526

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

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.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings.
 - 2. Nonmetallic conduits and fittings.
 - 3. Optical-fiber-cable pathways and fittings.
 - 4. Boxes, enclosures, and cabinets.
 - 5. Polymer-concrete handholes and boxes for exterior underground cabling.

1.3 RELATED REQUIREMENTS

- A. 260010 "SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL."
- B. 260536 – "CABLE TRAYS FOR ELECTRICAL SYSTEMS"

1.4 DEFINITIONS

- A. EMT: Electrical Metallic Tubing.
- B. GRC: Galvanized rigid conduit.
- C. IMC: Intermediate metal conduit.

1.5 ACTION SUBMITTALS

- A. Product data for the following:
 - 1. Surface pathways
 - 2. Wireways and fittings.
 - 3. Tele-power poles.
 - 4. Boxes, enclosures, and cabinets.
 - 5. Underground handholes and boxes.

- B. Shop Drawings: For custom enclosures and cabinets and custom underground handholes and boxes. Include plans, elevations, sections, and attachment details.
- C. Samples: For wireways surface pathways and for each color and texture specified, 12 inches long.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of pathway groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
 - 3. Underground ducts, piping, and structures in location of underground enclosures and handholes.
- B. Qualification Data: For professional engineer.
- C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.
- B. 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-D.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. IMC: Comply with ANSI C80.6 and UL 1242.
- E. EMT: Comply with ANSI C80.3 and UL 797.
- F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous Locations: Comply with UL 1203 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel .

- b. Type: compression.
- 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
- 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- G. 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.

2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.
- B. General Requirements for Nonmetallic Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- C. Outdoor RNC: Type Schedule 80, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. Indoor RNC: Type Schedule 40 PVC, complying with NEMA TC2 and UL 651 unless otherwise indicated.
- E. Continuous HDPE: Comply with UL 651A.
- F. Fittings: Comply with NEMA TC 3; match to conduit or tubing type and material.
- G. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for general-use installation unless otherwise indicated.
- B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- C. Comply with TIA-569-D.

2.4 HOOKS

- A. Erico/Caddy .
- B. Comply with TIA-569-D.
- C. J shape.

2.5 BOXES, ENCLOSURES, AND CABINETS

- A. Description: Enclosures for communications.
- B. General Requirements for Boxes, Enclosures, and Cabinets:
 - 1. Comply with TIA-569-D.
 - 2. Comply with Project drawings for indoor and outdoor applications.
 - 3. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
 - 4. Faceplate Box Dimensions: 5-inches by 5-inches by 2.87 inches deep .
 - 5. Pull boxes - comply with ANSI/TIA-569 D.
 - 6. Gangable boxes are prohibited.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Metal Floor Boxes:
 - 1. Material: sheet metal.
 - 2. Type: Semi-adjustable.
 - 3. Shape: Rectangular.
 - 4. Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Outdoor 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. Nonmetallic Enclosures:
 - a. Material: Plastic .
 - b. Finished inside with radio-frequency-resistant paint.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

- A. Indoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT .
 - 2. Concealed in Ceilings and Interior Walls and Partitions: EMT .
 - 3. Damp or Wet Locations: GRC .
 - 4. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: EMT .
 - a. Comply with OH IT/CE standards for optical fiber armor types.
 - 5. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: EMT .
- B. Minimum Pathway Trade size per drawings on all pathways for copper and aluminum cables.
- C. 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 compression , steel fittings. Comply with NEMA FB 2.10.
- D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- E. Install surface pathways only where indicated on Drawings.
- F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F .

3.2 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
 - 1. NECA 1.
 - 2. NECA/BICSI 568.
 - 3. TIA-569-D.
 - 4. NECA 101
 - 5. NECA 102.
 - 6. NECA 105.

7. NECA 111.

- B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- D. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems" for hangers and supports.
- E. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.
- F. Keep pathways at least 6 feet away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- G. Complete pathway installation before starting conductor installation.
- H. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- I. 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.
- J. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within 12 inches of enclosures to which attached.
- L. Pathways Embedded in Slabs:
 - 1. Run conduit 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. Comply with requirements for expansion joints specified in this article.
 - 3. Arrange pathways to keep a minimum of 3 inches of concrete cover for sides and top, 6-inches for bottom.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 - 5. Install metal locator tape above conduit duct banks.
 - 6. Change from nonmetallic conduit and fittings to GRC and fittings before rising above floor.
- M. Stub-ups to Above Recessed Ceilings:

1. Use EMT for pathways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. 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.
- O. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- P. 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.
- Q. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.
- R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.
- S. 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.
- T. Install pull wires in empty pathways. Use 3/8 inch polypropylene or monofilament plastic line with not less than 2400-lb tensile strength. Leave at least 24 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- U. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
1. Comply with OH IT/CE standards and Section 271323 for optical fiber armor type/s.
 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 necessary to comply with these requirements.
- V. 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.
- W. 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.
- X. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- Y. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC that is located where environmental temperature change may exceed 100 deg F, and that has straight-run length that exceeds 100 feet.
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- Z. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to bottom of box unless otherwise indicated.
- AA. 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.
- BB. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- CC. 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.

- DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- EE. Set metal floor boxes level and flush with finished floor surface.
- FF. 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. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cables."

3.4 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.

END OF SECTION 270528

SECTION 270529 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel slotted support systems.
2. Aluminum slotted support systems.
3. Conduit and cable support devices.
4. Support for conductors in vertical conduit.
5. Mounting, anchoring, and attachment components.
6. Fabricated metal equipment support assemblies.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical."
2. Section 260536 – "Cable Tray for Electrical Systems."

1.2 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 the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: For fabrication and installation details for communications hangers and support systems.

1. Trapeze hangers. Include product data for components.
2. Steel slotted-channel systems.
3. Aluminum slotted-channel systems.
4. Equipment supports.

5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Suspended ceiling components.
 2. Ductwork, piping, fittings, and supports.
 3. Structural members to which hangers and supports will be attached.
 4. Size and location of initial access modules for acoustical tile.
 5. Items penetrating finished ceiling, including the following:
 - a. Speakers.
 - b. Access panels.
 - c. Wireless Access Points .
 - d. Operating Room booms.
 - e. Telemetry.
 - f. Distributed antenna systems for emergency radio, cell repeater, and facility radio systems.

PART 2 - PRODUCTS

2.1 STEEL SLOTTED SUPPORT SYSTEMS

- A. For cable tray, ladder rack, wire mesh, and other communications conveyance, comply with Section 260536 - CABLE TRAYS FOR ELECTRICAL SYSTEMS
- B. Failure to comply will result in contractor removal of system/components and re-installation of correct system/components at no additional expense to Owner.
- C. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface.
 1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 2. Material for Channel, Fittings, and Accessories: Galvanized steel .
 3. Channel Width: Selected for applicable load criteria .
 4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 5. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 6. Channel Dimensions: Selected for applicable load criteria.

2.2 SLOTTED SUPPORT SYSTEMS

- A. Slotted Support Systems: channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface.
 - 1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 2. Channel Width: Selected for applicable load criteria .
 - 3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 4. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 - 5. Channel Dimensions: Selected for applicable load criteria.

2.3 CONDUIT AND CABLE SUPPORT DEVICES

- A. Conduit and Cable Support Devices: Steel and malleable-iron clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.

2.4 SUPPORT FOR CONDUCTORS IN VERTICAL CONDUIT

- A. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

2.5 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 - 1. NECA 1.
 - 2. NECA/BICSI 568.

3. TIA-569-D.
4. NECA 101.
5. NECA 102.
6. NECA 105.

- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps .
- F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 INSTALLATION OF SUPPORTS

- A. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, according to NFPA 70.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69 .
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor communications materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

- A. Touchup:
 - 1. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - a. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

END OF SECTION 270529

SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Labels.
2. Underground-line warning tape.
3. Signs.
4. Miscellaneous identification products.

1.2 RELATED REQUIREMENTS:

- A. Section 260010 "SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL."

1.3 ACTION SUBMITTALS

A. Product Data:

1. Labels.
2. Bands and tubes.
3. Underground-line warning tape.
4. Signs.
5. Cable ties.
6. Voice / Data Jack Inserts (color code)
7. Miscellaneous identification products.

B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for communications identification products.

C. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

D. 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 PERFORMANCE REQUIREMENTS

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

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Equipment Identification Labels:
 - 1. All cables entering and leaving a maintenance vault and/or handhole shall be labeled at both ends using aluminum or stainless steel tags containing the following: .
 - a. Cable Number.
 - b. Cable Type.
 - c. Strand Count.
 - d. Termination Points.
 - 1) Example: FDVA IT/CE, Cable 05, SMFIBER 24, APH-MDA.
 - 2. All racks, distribution frames, connecting blocks, patch panels, optical fiber panels, and grounding bus bars shall be properly labeled.

2.3 LABELS

- A. 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.

2.4 UNDERGROUND-LINE WARNING TAPE

- A. 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 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.

B. 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" as per the situation .

C. Tag, Detectable: :

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.
3. Overall Thickness: 5 mils.
4. Foil Core Thickness: 0.35 mil.
5. Weight: 28 lb/1000 sq. ft..
6. Tensile According to ASTM D882: 70 lbf and 4600 psi.

D. Tag, Detectable, Reinforced: :

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.
3. Overall Thickness: 8 mils.
4. Foil Core Thickness: 0.35 mil.
5. Weight: 34 lb/1000 sq. ft..
6. Tensile According to ASTM D882: 300 lbf and 12,500 psi.

2.5 SIGNS

A. Laminated-Acrylic or Melamine-Plastic Signs:

1. Engraved Legend: With black letters on white face .
2. Thickness:
 - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
 - b. For signs larger than 20 sq. in., 1/8 inch thick.
3. Attachment: Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting .
4. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

- B. Plastic cable ties shall not be used on any unshielded twisted pair cabling.

- 1. Only Velcro-type straps are permitted.

2.6 Voice / Data Jack Inserts

- A. CommScope wall jack inserts

- 1. Confirm with FDVA IT/CE that the below color code is still in effect prior to procurement of colored inserts.
 - a. White for voice/data.
 - b. Green for BioMedical equipment.
 - c. Orange for Nurse Call.

2.7 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. Paint - Underground pathway concrete encasement:
 - 1. A yellow coloring agent shall be used in the top three inches (3") of concrete used for telecommunications ducts.
- C. 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 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 manufacturer of identification product.

3.2 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 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 surface of 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 from cable end.
- I. Self-Adhesive Wraparound Labels:
 - 1. Secure tight to surface at a location with high visibility and accessibility.
 - 2. Provide label 6 inches from cable end.
- J. Self-Adhesive Labels:
 - 1. On each item, install 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- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
- K. Snap-Around, Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- L. 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 below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
 - 2. Install underground-line warning tape for direct-buried cables and cables in raceways.
- M. Underground concrete encasement for telecommunications:
 - 1. Add yellow coloring agent to the top three inches (3") of concrete encasing communications conduits.

- N. Cable Ties: General purpose, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.
- O. CAT-6a Wall Jack Inserts:
 - 1. Per drawings, install CommScope jack inserts per color code in Section 2 and per drawings for jack-use.

3.3 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. No labeling for anything shall be done without first coordinating with the FDVA IT/CE Department.
- 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. Coordinate with FDVA IT/CE prior to work. .
- E. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, composed of the following, in the order listed:
 - 1. MDF/ER or IDF/TR designation.
 - 2. Outlet Type.
 - 3. Port or Position.
 - 4. Where multiple outlets are in a single room, label left to right as you enter the room.
 - 5. Confirm with FDVA IT/CE prior to work.
- F. 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. Label individual rows and outlets, starting at to left and working down, with self-adhesive labels.
 - 3. Data Outlets: Label each outlet with a self-adhesive label indicating the following, in the order listed:

- a. Room number being served.
 - b. Colon.
 - c. Faceplate number.
- G. Backbone Cables: Label each cable with a vinyl-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.
- H. Horizontal Cables: Label each cable with a vinyl-wraparound label self-adhesive wraparound label indicating the following, in the order listed, and in numeric order:
 - 1. Room number.
 - 2. Outlet Type.
 - 3. Port or Position.
- I. Locations of Underground Lines: Underground-line warning tape for copper, coaxial, hybrid copper/fiber, and optical-fiber cable.
- J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Metal-backed, butyrate warning signs.
 - 1. Apply to exterior of door, cover, or other access.
- K. Equipment Identification Labels:
 - 1. Indoor Equipment: Self-adhesive label Metal-backed butyrate signs Laminated-acrylic or melamine-plastic sign.
 - 2. Outdoor Equipment: Laminated-acrylic or melamine-plastic sign Stenciled legend 4 inches high.
 - 3. Equipment to Be Labeled:
 - a. Communications cabinets.
 - b. Uninterruptible power supplies.
 - c. Power distribution components.

END OF SECTION 270553

SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Category 6a twisted pair cable.
2. Twisted pair cable hardware.
3. Cable management system.
4. Copper Patch Cords.
5. Identification products.

B. Related Requirements:

1. Section 260010 "SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL."

1.2 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. 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. Shield: A metallic layer, either a foil or braid, placed around a pair or group of

conductors.

- 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.

1.3 COPPER HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. 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. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
 - 2. FDVA IT/CE Low Voltage Standards define a standard outlet as two (2) 4 pair Cat 6A or higher unshielded twisted pair cable (UTC).
 - 3. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
 - 4. Bridged taps and splices shall not be installed in the horizontal cabling.
- B. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. Category 6a twisted pair cable.
 - 2. Twisted pair cable hardware.
 - 3. Cable management system.
 - 4. Identification products.
- B. Shop Drawings: Reviewed and stamped by RCDD.
 - 1. System Labeling Schedules:
 - a. Electronic copy of labeling schedules, in software and format selected by Owner.
 - b. Electronic copy of labeling schedules that are part of cabling and asset identification system of software.

2. Cabling administration Drawings and printouts.
3. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
 - a. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system.
 - e. Telecommunications conductor drop locations.
 - f. Typical telecommunications details.
 - g. Mechanical, electrical, and plumbing systems.

C. Twisted pair cable testing plan.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For installation supervisor, and field inspector.
- B. Product Certificates: For each type of product.

1.6 CLOSEOUT SUBMITTALS

1.7 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: One of each type.
 2. Cover Plates: One of each type.
 3. Jacks: Ten of each type.
 4. Patch-Panel Units: One of each type.
 5. Plugs: Ten of each type.

1.8 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 Level 2 Installer, at a minimum, 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: Testing agency must have personnel certified by BICSI on staff.

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

1.9 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.

1.10 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.

PART 2 - PRODUCTS

2.1 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-B.

2.2 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:

- a. Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway .
- 2. Communications, Non-Plenum Rated:
 - a. Type CMP or Type CMR in listed plenum or riser communications raceway.
- B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. RoHS compliant.

2.3 CATEGORY 6a TWISTED PAIR CABLE

- A. Category 6a Twisted Pair Cable: Four-pair, balanced twisted pair cable, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500 MHz.
- B. Standard: Comply with TIA-568-C.2 for Category 6a cables.
- C. Conductors: 100-ohm, 23 AWG solid copper.
- D. Shielding/Screening: Unshielded twisted pairs (UTP) .
- E. Cable Rating: Riser .
- F. Jacket: thermoplastic colors:
 - 1. Red - for Fire Alarms and Life Safety. Blue - for all other Cat 6A communications cables.

2.4 TWISTED PAIR CABLE HARDWARE

- A. Twisted Pair Cable Hardware: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. General Requirements for Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 6a .
 - 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.
- C. Source Limitations: Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.

D. Connecting Blocks:

1. 110-style IDC for Category 5e.
 - a. Wall mounted voice blocks, secured to plywood backer board, D-ring wire management, 100 pair Cat-5s terminated on patch panels on each row for voice backbone cable terminations not requiring protection.
2. Angled 110-style IDC for Category 6a.
3. Provide blocks for the number of cables terminated on the block, plus 20 percent spare for station cable, and 20 percent for backbone cabling, integral with connector bodies, including plugs and jacks (keystone modules) for all Category of cabling.

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

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

1. Patch panels shall be installed with horizontal wire management panels above, below, and in between every three (3) angled panels.
 - a. Approved manufacturer for horizontal wire management: Chatsworth 2U CPI35441-702
 - b. Approved manufacturer for patch panels: CommScope Systimax 48-port Angled Patch Panel 760051185.
2. Features:
 - a. T568B wiring labels.
 - b. Labeling areas adjacent to conductors.
 - c. Replaceable connectors.
 - d. 48 ports.
3. Construction: 16-gauge steel and mountable on 19-inch equipment racks.

G. Patch Cords: Factory-made, four-pair cables in seven (7) and five (5) foot 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 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.
3. Provide four (4) Cat-6A patch cords for each individual drop.
 - a. Patch cord color: Black
 - b. Patch cord lengths: Two (2) at seven feet (7') and two (2) at five feet (5').

4. Approved manufacturer: CommScope

H. Plugs and Plug Assemblies:

1. Standard: Comply with TIA-568-C.2.
2. Marked to indicate transmission performance.

I. Jacks and Jack Assemblies:

1. Female; four position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
 - a. Follow color code requirements in Section 270553 "IDENTIFICATION FOR COMMUNICATIONS SYSTEMS."
2. Designed to snap-in to a patch panel or cover plate.
3. Standard: Comply with TIA-568-C.2.
4. Approved manufacturer for jacks: CommScope.
5. Marked to indicate transmission performance.

J. Cover Plate:

1. 4-port, vertical double gang cover plates designed to mount to double gang wall boxes.
2. Four port, vertical double gang cover plates designed to mount to double gang wall boxes.
3. Wall phones shall be a single gang cover plate.

K. Legend:

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

2.5 COPPER PATCH CORDS:

- A. Manufacturer: CommScope
- B. Part Number: CO199K2-01F005 MiNo6A Series.
- C. Description: Category 6A U/UTP Reduced Diameter LS-CM Dual Rated Cord, Black, 5 ft.
 1. Verify with FDVA IT/CE prior to procurement in the event this part has changed.

2.6 IDENTIFICATION PRODUCTS

- A. Comply with Section 270553 Identification for Communications Systems.

- B. Coordinate numbering system with FDVA prior to work.
- C. 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.
- D. Refer to ANSI/TIA 606-B.
- E. Refer to BICSI TDMM for recommended standards.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Routing:
 - 1. Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters. Conceal raceway and cables, except in unfinished shell spaces and with FDVA IT/CE pre-approval.
 - a. Install plenum cable in environmental air spaces, including plenum ceilings.
 - b. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."
 - 2. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- B. 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.

3.2 INSTALLATION OF PATHWAYS

- A. Comply with Section 270528 "Pathways for Communications Systems."
- B. Comply with Section 260529 "Hangers and Supports for Communications Systems."
- C. Comply with Section 260536 "Cable Trays for Electrical Systems."
- D. Drawings indicate general arrangement of pathways and fittings.

3.3 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 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 from communications equipment room.
8. 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.
9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by 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 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 dereeling. Heat lamps shall not be used for heating.
13. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
14. 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.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspending twisted pair cabling, not in a wireway or pathway, is not permitted. above ceilings by cable supports not more than above ceilings by cable supports not more than
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. 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 communications cables, 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.
 - 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. 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.
 - 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. 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.
 - 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: A minimum of 5 inches.
7. Separation for crossing perpendicular to steam pipes and condensate lines: A minimum of 24 inches.
8. Separation when running parallel to steam lines: A minimum of six feet.

3.4 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."
- C. Comply with TIA-569-D, Annex A, "Firestopping."
- D. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

3.5 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" and with Section 2 of this specification.
 - 1. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
 - 2. All racks, distribution frames, connecting blocks, patch panels, optical fiber panels, and grounding bus bars shall be properly labeled.
 - 3. Coordinate with FDVA IT/CE prior to work.
- B. Cable Schedule: Install in a prominent location in each MDF (ER) and IDF (TR). 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.
- C. 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.
- D. 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 the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. 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.
 - 4. 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.
- E. 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.

3.6 FIELD QUALITY CONTROL

- A. Field tests and inspections must be coordinated with FDVA IT/CE prior to work. .
- B. 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.1.
 - 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.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.
- C. 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.
- D. Nonconforming Work:
 - 1. End-to-end cabling will be considered defective if it does not pass tests and inspections.
 - 2. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- E. Collect, assemble, and submit test and inspection reports.

END OF SECTION 271513

SECTION 275223 - NURSE CALL/CODE BLUE SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Audiovisual/voice nurse-call system.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Audiovisual/voice nurse-call system.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment cabinets and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Cabling Diagrams: Single-line block diagrams showing cabling interconnection of all components for this specific equipment. Include cable type for each interconnection.
3. Station Installation Details: For built-in equipment, dimensioned and to scale.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For nurse-call equipment to include in emergency, operation, and maintenance manuals.

1.5 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. Lamps and/or LED modules: Spare LED modules or devices as recommended by manufacturer.
2. Fuses: One for every 10 of each type and rating, but no fewer than 5 of each.
3. Printed Circuit Boards: Each kind, equal to 10 percent of amount installed, but no fewer than one unit.
4. Master-Station Privacy Handset: One .
5. System program backup software.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Compatibility: System shall be capable of integration with any brand of phone system (wired or wireless), staff locating system, CCTV, and fire-alarm system.
- C. Electrical Components, Devices, and Accessories: Listed and labeled according to UL 1069 as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace batteries that fail in materials or workmanship within specified warranty period. Special warranty for batteries applies to materials only, on a prorated basis for specified period.
 1. Warranty Period: Include the following warranty periods, from date of Substantial Completion:
 - a. Nickel-Cadmium Batteries, Lithium Batteries, and Wet-Cell Batteries:
 - 1) Full Warranty: Five years.
 - 2) Pro Rata: 15 years.

1.8 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 NURSE-CALL SYSTEM GENERAL REQUIREMENTS

- A. Subject to compliance with requirements, provide products by the following:
 - 1. Rauland-Borg Corporation
- B. System shall support programmable care groups/zones sufficient for project requirements, with multiple priority levels and addressable annunciation.
- C. System shall provide integrated staff emergency call capability with centralized annunciation at master stations and routing to assigned staff, including priority escalation and visual/audible indication.
- D. System shall be expandable to accommodate future stations without requiring replacement of head-end equipment. Provide spare network capacity, power, and infrastructure as required for future expansion.
- E. Resistance to Electrostatic Discharge: System shall comply with IEC 61000-4 for electrostatic discharge immunity..
- F. Equipment: Microprocessor, electronic, modular.
- G. Master Nurse-Call Station: Programmed via a PC.
- H. Wall-Mounted Component Connection Method: Components connect to system wiring in back boxes with factory-wired plug connectors.
- I. Telephone Interface: System shall interface with wired and wireless communication devices, including VoIP telephones and mobile devices, to permit execution of nurse call master station functions.
- J. System shall provide integration with third-party communication platforms to transmit notifications to mobile devices, including tone, numeric, and alphanumeric messaging via IP-based protocols.

2.2 AUDIOVISUAL/VOICE NURSE-CALL SYSTEM

- A. Manufacturers: Subject to compliance with requirements, provide products by the following :
 - 1. Rauland-Borg Corporation
- B. Operational Requirements:
 - 1. Station Selection from Master Station: Capable of selectively communicating with other stations or groups of stations on its system by touch screen, mouse click,

- or manual switch; and capable of programming the project-required number of stations for each master station in the network.
2. Master Station Privacy: Capable of conversing with individual stations in complete privacy.
 3. Called Station:
 - a. Capable of hands-free and two-way conversation.
 - b. Pressing "talk/listen" key shall cause the annunciation tone to cease.
 - c. Pressing "cancel" key terminates normal calls and conversations.
 - d. System shall provide configurable behavior for high-priority calls such that call cancellation and reset functions are restricted based on call type and location. System shall provide automatic reminder or escalation of unacknowledged or unresolved calls based on programmed time intervals.
 4. Annunciation:
 - a. At the master station, a programmable tone announces an incoming call; an annunciator light or digital display identifies the calling station and indicates the priority of the call.
 - b. Call type indications include patient call, staff assist, emergency, code blue, bath, and system fault conditions. Fire alarm annunciation shall be by the fire alarm system.
 - c. Memory lamps or lighted displays identify stations selected for outgoing calls.
 5. System Reset at Master Station: A normal, incoming call can be canceled, associated lights and audible tones extinguished, and the system reset when the station switch is returned to the normal position.
 6. Patient Station Calls:
 - a. Lights the call-placed lamp at patient station, zone, and corridor dome lights.
 - b. Sounds a tone and lights the call lights at staff/duty stations and actuates annunciation at the master station.
 - c. When the calling station is selected at the master station, the patient can converse with the master station without moving and without raising or directing the voice.
 - d. During voice communications, entertainment audio at the calling station is automatically muted.
 7. Pull-Cord-Call Station Calls and Emergency-Call Station Calls:
 - a. Lights call-placed lamp and corridor dome light and flashes zone light.
 - b. Master station tone pulses and annunciator light for that room flashes.
 - c. When master station acknowledges the call by touch screen or switch, the tone stops but lights continue to flash until the call is canceled at the initiating point.
 8. Staff/Duty Station Calls:

- a. Lights the call-placed lamp at the station and actuates annunciation at the master station.
 - b. When the called station is selected at the master station, the caller and the master station operator can converse.
 - c. Staff Station: Unique sound and light pattern indicating an emergency.
 - d. Duty Station: Sound and light pattern indicating a call to the nurse station.
- 9. Handset Operation: Lifting the handset on master station disconnects speaker/microphone and transfers conversation to the handset.
- 10. Station Privacy: System shall provide configurable privacy features with visual indication when audio communication is active
- 11. Patient Station Cord-Set Removal:
 - a. A patient station call is initiated as described above when a patient station cord-set plug is removed from the jack in the station faceplate.
 - b. Tone stops but lights continue to flash until the call is canceled at the initiating point or the plug is reinserted or replaced with a dummy plug when the master station call button for the station is pressed.
- 12. Patient Control Unit:
 - a. Controls entertainment volume and channel selection.
 - b. Speaker is used for both nurse communication and entertainment sound.
 - c. Entertainment sound is automatically muted when station is communicating with master station.
 - d. Nurse button on the unit initiates a patient station call.
- 13. Selective Paging: Master station is capable of initiating a message to selected groups of stations or speakers simultaneously by using station group switches.
- 14. Staff Reminder:
 - a. Master station can initiate a staff reminder that a patient requires direct staff response by operating a reminder control while in contact with the patient station.
 - b. This reminder will light a distinctive-color lamp in the corridor dome light at the patient's room and in the appropriate zone lights.
 - c. Reminder calls are canceled by operating a staff reminder cancel switch in the patient's room.
- 15. Call Priority Indication:
 - a. System shall support multiple programmable call priority levels with distinct visual and audible annunciation for each priority.
- 16. Additional Call:
 - a. Waiting display window on the master station similar to current call window displays incoming calls.
 - b. System shall support storage and management of multiple simultaneous

calls without loss of system functionality.

- c. System shall display and prioritize incoming calls based on programmed priority levels.

17. Calling Intercom Stations:

- a. Master station shall be capable of calling any intercom station using the handset or the hands-free speaker/microphone.
- b. Receipt of a call at the intercom station shall be preceded by an optional pre-announce tone.
- c. If there is a call in process, system shall place the active call on automatic hold while the new call is placed, then reestablish the previous call when the new call has ended.

18. Privacy Override:

- a. Temporarily deactivates the "Privacy" mode of a called station by calling the station and instructing the called party to press the call-cord button.
- b. On completion of the conversation, the called station shall automatically return to the "Privacy" mode.
- c. When in "Privacy" mode, a called station shall be capable of hearing the master station; however, the master station shall not be capable of hearing the called station; a privacy message shall be indicated on the master station display.

19. Master-Station-to-Master-Station Calls:

- a. Master stations shall be capable of calling other master stations using the handset.
- b. Calls from master stations shall be answered using the handset only.
- c. Busy master stations shall be indicated by a master station intercom busy tone.

20. Voice Paging:

- a. Capable of voice paging to all stations using a single "All Call" key.
- b. Capable of voice paging to eight user-defined groups of stations by selecting the group and then the "All Call" key.
- c. Capable of voice paging to all staff/duty stations and all patient stations where staff has registered presence using a single "Public Address (PA)/Staff" key.
- d. Capable of voice paging through a third-party PA system.
- e. Capable of including or excluding any station from the voice paging function(s).
- f. Automatically places an active station call on hold during any page and reestablishes the connection at the end of the page.
- g. Automatically cancels a page if the talk mode is inactive for more than 15 seconds.

21. Night Service:

- a. Functions shall be adaptable for nighttime staffing levels, patient traffic, and day/night operations.
- b. Staff Follow:
 - 1) Capable of locating roving staff; forwarding visual and audible annunciation of incoming calls to station(s) where personnel have registered presence.
 - 2) Master station shall display locations where staff have registered presence.
 - 3) Incorporates a programmable timer that automatically cancels a forgotten staff presence registration.
- c. Tones:
 - 1) Deactivates audio signals from a duty station and mini-master display telephones.
 - 2) Capable of changing the tone volume at the master and duty stations.
 - 3) Satellite function shall permit the user to deactivate audio signals from duty stations and other remote annunciator devices.
- d. Day/Night Transfer:
 - 1) Permits one nurse station to take control of all or individually selected bed call cords from another nurse station. It shall be possible to view transfer status of a nurse station.
 - 2) Transfer Modes: As a minimum, include the following three transfer modes to allow one nurse station to take control or share calls and operations from another nurse station:
 - a) Parallel Transfer Mode: Permits both nurse stations to share all calls and operations.
 - b) Supervised Transfer Mode: Permits the transferred nurse station to share all calls and operations with the controlling nurse station; however, the controlling nurse station calls are not shared with the transferring station.
 - c) Capture Transfer Mode: Transfers all calls and operations from the transferred nurse station to the controlling nurse station.
 - d) Transferred station shall have no control over calls, and its display shall indicate calls have been transferred to another station.
 - 3) Patient Swing Modes: As a minimum, include the following two patient swing modes to allow one nurse station to take control or share calls from one or many calls from another nurse station:
 - a) Supervised Transfer Mode: Permits the transferred calls to be

- shared with the controlling nurse station.
- b) Capture Transfer Mode: Transfers all calls from the call cord from the transferred nurse station to the controlling nurse station.
- c) Transferred station has no control over those transferred calls.

22. Service Request:

- a. Permits users to assign a service request to a substation, at programmable priority level.
- b. Displays service request on the nurse station display and light the green flashing corridor lamp at the respective substation and automatically generate a service reminder request.
- c. Cancels service requests only at the initiating point.
- d. Recall calls shall sound and be displayed at the master station if the service request has not been cancelled at the initiating point within the programmed period of time.

23. Call Reminder Function:

- a. System shall provide a configurable call reminder function that automatically re-annunciates unanswered or unacknowledged calls based on programmed priority levels and time intervals.
- b. Regenerated calls shall display the same tones and visual indications and priority as the original call and shall also display a "regenerated call" message.
- c. Capable of manually adding low-priority calls to the reminder list.
- d. "Call Reminder" function and reminder timer shall be programmable by call priority.

24. Hide Function: Prevents a selected station from displaying calls or generating tones on the nurse station.

25. Door Control Function: Capable of being programmed to enable the user to remotely activate electric door locks where required by project.

26. Test and Diagnostics Feature:

- a. Able to automatically diagnose system faults and categorize them as warnings, communication errors, or fatal errors.
- b. Warnings shall indicate possible system problems.
- c. Communication errors shall indicate the inability of the master station to communicate with a substation or another nurse-call station.
- d. Fatal errors shall indicate a major hardware or software failure.

27. User-Configured System Programming - Access Code Not Required:

- a. Patient call-cord priority levels.
- b. Monitor list.
- c. "All Call" list.
- d. Master station communication parameters (volume, filtering, talk/listen,

- sensitivity).
- e. Master and duty station call annunciation tone volume.
- f. Date/time.
- g. Staff-follow operating mode.
- h. Transfer type.
- i. Mobile device or communication platform assignment.
- j. Presence mode.

28. User-Configured System Programming - Access Code Required:

- a. Master station number.
- b. Room device type.
- c. Room number.
- d. Bed number.
- e. Bed alpha or numeric.
- f. Reminder duration.
- g. Staff presence registration cancel duration.
- h. Display language.
- i. Zone group assignments.
- j. Monitoring duration.
- k. Call tone assignment by priority.
- l. Pretone activation.
- m. Call tones minimum volume.
- n. Clock mode (12 h/24 h).

C. Master Station:

- 1. Speaker/microphone unit with operating controls.
- 2. Indicator lamps with legends or by digital display designate identification and priority of calling stations and called stations.
- 3. Pulse rate of incoming-call lights denotes priority of calls awaiting response.
- 4. Station Selection Controls: Touchpad select stations for two-way voice communications.
- 5. Signal Tones: Programmable to announce incoming calls.
- 6. Pulse rate and frequency of tone identify the highest priority call awaiting response at one time.
- 7. Volume Control: Regulates incoming-call volume.
- 8. Privacy Handset with Hook Switch: Of the type that does not require push-to-talk switch attached to each station unless otherwise indicated.
- 9. Staff Reminder Control: Initiates flashing of corresponding corridor dome lights for patients requiring service. Permits scanning equipment to indicate which patients are currently in reminder status.
- 10. Call Priority Selection: Controls associated with patient-station selection switches determine the priority displayed when a call is initiated at a patient station.

D. Central Equipment Cabinet:

- 1. Lockable metal.
- 2. Power supplies, controls, terminal strips, and other components.

3. System Power Supply:
 - a. Low-voltage DC power as required by manufacturer.
 - b. Equipment Rating: Suitable for continuous operation between 32 and 120 deg F, from a primary line voltage between 105- to 125-V ac, 60 Hz.
 - c. Output: Output voltage and regulation shall be as required by the manufacturer for proper system operation.
 - d. Overload Protection: Electronic fold-back circuit set to limit the volt-ampere output to less than 100 VA during overloaded or shorted output. Restore power output automatically on removal of overload without resetting circuit breakers or replacing fuses.
4. Power-on indicator lamp.
5. Surge Protector Device: Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits" for auxiliary panel suppressors, with digital indicator lights for power and protection status .
6. Battery Backup Unit: Sealed, maintenance-free battery integrated within system power supply through an automatic switch when normal power fails, capable of maintaining system operation during temporary loss of normal power, with minimum 3 -minute hold-up time under typical load conditions.
 - a. Power supply shall automatically transfer to battery upon loss of normal power and automatically restore operation upon return of normal power.
 - b. Battery charging and management shall be integral to the power supply.

E. Speaker/Microphones:

1. Type: Permanent-magnet, dynamic or ceramic, protected against dust and humidity.
2. Power Handling Capacity: Not susceptible to damage from overdriving within the range of power available from the amplifier.
3. Impedance Matching: Coordinated and matched to the input and output circuits of the amplifier, both for single connection and for group monitoring, to provide the sound reproduction specified. Subsystems or components shall not be combined, which could cause unacceptable distortion such as feedback between pillow speakers and unmuted room speaker/microphone combinations. This protection shall extend throughout the entire range of operation (volume control) of all components.

- F. Single-Patient Station: Provide patient stations with integral speaker/microphone, call initiation, call reset capability, and visual annunciation. Stations shall support connection of patient call cords or pillow speakers and enable hands-free two-way voice communication.
- G. Dual-Patient Station: Dual-patient stations shall provide independent call initiation and annunciation for each bed location, including separate call assurance indicators and connection points for pillow speakers or call cords.
- H. Staff/Duty Stations: Provide staff/duty stations with audible and visual call

annunciation, call initiation, reset capability, and two-way voice communication where applicable.

- I. Ambulatory Patient Station: Provide patient stations with integral speaker/microphone, call initiation, reset capability, and visual annunciation. Stations shall support hands-free two-way communication.
- J. Selective Paging Speakers: System shall support integration with facility paging system where required.
- K. Staff Reminder Cancel Switch Station: Momentary contact.

2.3 SYSTEM COMPONENTS

- A. Emergency-Call Station: Locking-type push button, labeled "Push to Call Help"; reset trigger to release push button and cancel call; and call-placed lamp, mounted in a single faceplate.
- B. Emergency-Bath Station:
 - 1. Provide emergency and bath call stations with push button and/or pull cord activation, LED annunciation, and compatibility with nurse call system.
- C. Staff, Emergency Station:
 - 1. Provide staff emergency call stations with clearly identified activation device (push button and/or pull cord) suitable for healthcare environments.
 - 2. Activation shall initiate a high-priority emergency call with distinct visual and audible annunciation at master stations and assigned staff devices.
 - 3. Station shall provide local visual indication (LED) confirming call placement.
- D. Pull-Cord-Call Station:
 - 1. Pull-Down Switch: Lever-locking type, labeled "Pull Down to Call Help."
 - 2. Reset trigger.
 - 3. Call-placed lamp.
 - 4. Water-resistant construction.
- E. Patient Control Unit:
 - 1. Equipped with plug and 96-inch- long white cord.
 - 2. Ethylene oxide, sterilizable.
 - 3. Light-Control Switch: Arranged for independent on-off control of patient's up and down light.
 - 4. Integral Speaker: Speaker shall provide clear and intelligible audio for patient communication and entertainment functions.
 - 5. Controls: Speaker volume, TV control, and nurse call.
 - 6. Housing: High-impact white plastic.
 - 7. Attachment: Stainless steel bed clamp with permanently attached polyester film

- strap.
- 8. Quantity: 12 units for every 10 patient beds.

F. Call-Button Cord Set:

- 1. Plug and 72-inch white cord; cord set shall be resistant to medical gas environment equipped with momentary-action, call-button switch.
- 2. Ethylene oxide, sterilizable.
- 3. Washable cord.
- 4. Palladium switch contacts in high-impact white housing with cord-set strain relief.
- 5. Attachment: Stainless steel bed clamp with permanently attached polyester film strap.
- 6. Quantity: Three cord sets for every 10 patient beds.

G. Geriatric Call-Button Cord Set:

- 1. Plug and 72-inch white cord.
- 2. Resistant to medical gas environment equipped with momentary-action, light-pressure switch in soft outer jacket.
- 3. Ethylene oxide, sterilizable.
- 4. Washable cord.
- 5. Palladium switch contacts in high-impact white housing with cord-set strain relief.
- 6. Attachment: Stainless steel bed clamp with permanently attached polyester film strap.
- 7. Quantity: Two cord sets for every 10 patient beds.

H. Squeeze-Bulb Switch Cord Set:

- 1. Plug and 72-inch washable tube with white cord set.
- 2. Resistant to medical gas environment; washable; equipped with neoprene squeeze-bulb activator, and plug-mounted, momentary contact switch.
- 3. Ethylene oxide, sterilizable.
- 4. Attachment: Stainless steel bed clamp with permanently attached polyester film strap.
- 5. Quantity: Two cord sets for every 10 patient beds.

I. Breath Call Cord:

- 1. Flexible PVC jacketed cable and a momentary contact air-pressure sensitive switch.
- 2. Cord: 108 inches long.
- 3. Include an adjustable arm for clamping and suitable for use in oxygen atmospheres.
- 4. Include 12 replacement straws.

J. Pillow Speakers:

- 1. Eight-conductor, DIN, flexible PVC jacketed cable.
- 2. Provide pillow speakers with nurse-call button, speaker, volume control, and

channel control where required. Devices shall be compatible with patient stations and nurse call system.

3. Contain nurse-call button, volume control, speaker, and channel control in molded flame-retardant ABS housing.
4. Cord: 96 inches long with sheet clip.

K. Call-Button Plug:

1. Designed to plug into patient station cord-set receptacle.
2. Button switches call circuit.
3. Two plugs for every 10 patient beds.

L. Indicator Lamps: Digital type with rated life of 20 years unless otherwise indicated.

M. Station Faceplates, Stainless Steel:

1. Minimum of 0.0375 inch thick.
2. Finish: Brushed.
3. Machine-engraved labeling identifies indicator lamps and controls.

N. Station Faceplates, High-Impact Plastic:

1. Color: Coordinate with facility .
2. Molded or machine-engraved labeling identifies indicator lamps and controls.

O. Corridor Dome Lights and Zone Lights:

1. Three Multicolor LED corridor lights.
2. Lamps: LED. Front replaceable without tools, low voltage with rated life of 7500 hours. Barriers are such that only one color is displayed at a time.
3. Lenses: Heat-resistant, shatterproof, translucent polymer that will not deform, discolor, or craze when exposed to hospital cleaning agents.
4. Filters: Two per unit, amber and red.

P. Cable:

1. Conductors: Jacketed single and multiple, twisted-pair copper cables.
2. Sizes and Types: As recommended by equipment manufacturer.
3. Cable for Use in Plenums: Listed and labeled for plenum installation.

Q. Grounding Components: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

2.4 SOFTWARE REQUIREMENTS

A. Telephone System Interface:

1. Permits use of wired and/or wireless telephones to execute nurse-call master station.

2. Two-way communication with patient and staff stations.
3. Two-way communication with the master nurse station.
4. "All Call," group call, and staff call paging.
5. Capable of being programmed to forward calls destined for a master nurse station to any connected telephone.
6. Telephones connected to the telephone interface shall have the same call tone ring patterns as those generated at the master nurse station.
7. Telephones having a display shall indicate the call type, priority code, and the calling station number of incoming calls.
8. Telephones shall be capable of initiating a service request for a particular patient station, logging calls on the master station's reminder list, and activating door lock mechanisms associated with a call station.
9. Capable of routine setup and configuration changes using the keypads on display telephone and/or the master station.

B. Display Telephones:

1. Digital telephones for use as mini-master nurse-call stations.
2. Digital display shall indicate the call type, priority code, and calling station number of incoming calls.
3. Ring patterns shall be identical to those generated at the master station.
4. Capable of two-way communication with patient and staff stations and the master station, and other telephones interfaced with the system.
5. Capable of placing or answering outside calls when interfaced with the facility telephone system.
6. Capable of "All Call," group call, and staff call paging and of initiating service requests, logging calls to the reminder list, and activating optional door controls.

C. System shall support integration with third-party communication platforms for notification via IP-based systems

D. Statistical Software:

1. Includes a data statistical software package that stores, sorts, and analyzes activities occurring on the nurse-call system network.
2. Windows based and operated on a PC that is connected to the nurse-call system network.
3. Stores events on the PC's hard disk. Accumulation of these stored events shall make up the database that is used to generate reports and statistics.
4. Events stored by the software shall include date, day of week, time, ward, priority, and room number.
5. Capable of assigning a patient name to bed number.
6. Stored events shall include, but not be limited to, calls placed, call priority, calls cancelled at the nurse station, calls cancelled at the point of origin, regenerated calls, calls answered, calls sent to pager interface, staff presence registration, staff presence cancellation, service request, service cancellation, and system and network error messages.

E. Data Analysis Software:

1. Capable of analyzing the stored information and generating computed analysis.
2. Analysis of the database can be conducted by specifying one, many, or all of the following parameters of the database: date, day of week, time, wards, priority, and room number.
3. Analysis shall include, but not be limited to, total number of calls placed, average call response time (from call placed to call cancellation), total number of presence registrations, average presence time in a room, total number of service requests, average response time (from audio answer to call cancellation), and average ring time (from call placed to audio answer).

F. Statistical Software Package:

1. Capable of displaying multiple calls/events on a PC monitor or on a RS-485 data-bus-driven digital display panel.
2. Calls from patient or staff stations and associated devices shall be displayed by priority. Display shall be customizable as follows:
 - a. Choice of color by type of call.
 - b. Choice of display size (character size).
 - c. Choice of priority levels, type of events, points of origin.
 - d. Identification of facility.
 - e. Identification of ward.
 - f. Identification of patient with specific patient information.

2.5 CONDUCTORS AND CABLES

A. Audio Cables:

1. Conductors: Jacketed, twisted-pair and twisted-multipair, untinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.
2. Insulation: Thermoplastic, not less than 1/32 inch thick.
3. Shielding: For speaker/microphone leads and elsewhere where recommended by manufacturer; No. 34 AWG, tinned, soft-copper strands formed into a braid or equivalent foil.
4. Minimum Shielding Coverage on Conductors: 60 percent.
5. Plenum Cable: Listed and labeled for plenum installation.

B. Data Cable and Hardware: Category 5e balanced twisted-pair cabling and hardware. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

C. Power Conductors and Cables: Copper, solid, No. 20 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Grounding Conductors and Cables: Copper, stranded, No. 16 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wiring Method:

1. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used .
 - a. Install plenum cable in environmental air spaces, including plenum ceilings.
 - b. Conceal raceway and cables except in unfinished spaces.
2. Cable Trays: Comply with requirements in Section 260536 "Cable Trays for Electrical Systems."
3. Conduit and Boxes: Comply with requirements in Section 270528 "Pathways for Communications Systems."
 - a. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

B. Install cables without damaging conductors, shield, or jacket.

C. Do not bend cables, while handling or installing, to radii smaller than as recommended by manufacturer.

D. Pull cables without exceeding cable manufacturer's recommended pulling tensions.

1. Pull cables simultaneously if more than one is being installed in same raceway.
2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
3. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage media or raceway.

E. Install exposed raceways and cables parallel and perpendicular to surfaces or exposed structural members, and follow surface contours. Secure and support cables by straps, staples, or similar fittings designed and installed so as not to damage cables. Secure cable at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, or fittings.

F. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

G. Separation of Wires: Separate speaker/microphone, line-level, speaker-level, and power-wiring runs. Run in separate raceways or, if exposed or in same enclosure, provide 12-inch minimum separation between conductors to speaker/microphones and adjacent parallel power and telephone wiring. Provide separation as recommended by equipment manufacturer for other conductors.

- H. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Install terminal cabinets where there are splices, taps, or terminations for eight or more conductors.
- I. Impedance and Level Matching: Carefully match input and output impedances and signal levels at signal interfaces. Provide matching networks if required.
- J. Identification of Conductors and Cables: Comply with requirements in Section 260553 "Identification for Electrical Systems" for cable administration, cable schedule, and cable and wire identification.
- K. Equipment Identification:
 - 1. Comply with requirements in Section 260553 "Identification for Electrical Systems" for equipment labels and signs and labeling installation requirements.
 - 2. Label stations, controls, and indications using approved consistent nomenclature.

3.2 GROUNDING

- A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other signal impairments.
- B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding except at connection to main building ground bus.
- C. Grounding Provisions: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service Assistance: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Schedule tests a minimum of seven days in advance.
 - 2. Report: Submit a written record of test results.
 - 3. Operational Test: Perform an operational system test and demonstrate proper operations, adjustment, and sensitivity of each station. Perform tests that include originating station-to-station and "All Call" messages and pages at each nurse-

call station. Verify proper routing, volume levels, and freedom from noise and distortion. Test each available message path from each station on the system. Meet the following criteria:

- a. Speaker Output: 90 dB plus or minus 3 dB, 300 to 3000 Hz, reference level threshold of audibility 0 dB at 0.02 mPa of sound pressure.
- b. Gain from patient's bedside station to nurse station, with distortion less than 65 dB (plus or minus 3 dB, 300 to 3000 Hz).
- c. Signal-to-Noise Ratio: Hum and noise level at least 45 dB below full output.

4. Test Procedure:

- a. Frequency Response: Determine frequency response of two transmission paths by transmitting and recording audio tones.
- b. Signal-to-Noise Ratio: Measure the ratio of signal to noise of the complete system at normal gain settings using the following procedure: Disconnect a speaker/microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure the ratio of signal to noise and repeat the test for four speaker microphones.
- c. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 300, 400, 1000, and 3000 Hz into each nurse-call equipment amplifier, and measure the distortion in the amplifier output.

- D. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify, by the system test, that the total system meets these Specifications and complies with applicable standards. Report results in writing.
- E. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
- F. Prepare test and inspection reports.

3.4 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sound levels and controls to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal operating hours for this purpose.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel and caregiver staff to adjust, operate, and maintain nurse-call equipment.

END OF SECTION 275223