SECTION 260502 BASIC ELECTRICAL MATERIALS AND METHODS FOR

DIRECT DIGITAL BUILDING CONTROL SYSTEM

ALWAYS INCLUDE SECTIONS 014100 - REGULATORY REQUIREMENTS, 014216 - DEFINITIONS, AND 078413 THROUGH-PENETRATION FIRESTOPS. INCLUDE SECTION 099102- PAINTING, WHEN APPLICABLE.

PART 1 GENERAL

1.1 REFERENCES

A. NEMA, ANSI, and UL.

1.2 SUBMITTALS

A. Product Data:

1. Catalog sheets, specifications and installation instructions.

2. Statement from the Company producing the system, for each size and type of cable proposed for communication bus use, indicating that the electrical characteristics meet the requirements of the Company.

3. For fire rated construction, prove that materials and installation methods proposed for use are in accordance with the listing requirements of the classified construction.

USE PARAGRAPH BELOW WITH EPD REQUIREMENT WHEN PROJECT ESTIMATE IS $1M OR MORE.

B. Submit an Environmental Product Declaration (EPD) from the manufacturer for steel this specification section, if available. A statement of the contractor’s good faith effort to obtain the EPD shall be provided if not available.

1. Manufacturer-provided EPDs must be Product Specific Type III (Third-Party Reviewed), in adherence with ISO 14025 *Environmental labels and declarations*, ISO 14044 *Environmental management – Life cycle assessment*, and ISO 21930 *Core rules for environmental product declarations of construction products and services.*

PART 2 PRODUCTS

2.1 RACEWAYS, FITTINGS AND ACCESSORIES

A. Rigid Ferrous Metal Conduit: Steel, hot dipped galvanized on the outside and inside, UL categorized as Rigid Ferrous Metal Conduit (identified on UL Listing Mark as Rigid Metal Conduit - Steel or Rigid Steel Conduit), by Allied Tube & Conduit Corp., LTV Copperweld, or Wheatland Tube Co.

B. Intermediate Ferrous Metal Conduit: Steel, galvanized on the outside and enameled on the inside, UL categorized as Intermediate Ferrous Metal Conduit (identified on UL Listing Mark as Intermediate Metal Conduit or IMC), by Allied Tube & Conduit Corp., LTV Copperweld, or Wheatland Tube Co.

C. Electrical Metallic Tubing: Steel, galvanized on the outside and enameled on the inside, UL categorized as Electrical Metallic Tubing (identified on UL Listing Mark as Electrical Metallic Tubing), by Allied Tube & Conduit Corp., LTV Copperweld, or Wheatland Tube Co.

D. Flexible Metal Conduit: Galvanized steel strip shaped into interlocking convolutions, UL categorized as Flexible Metal Conduit (identified on UL Listing Mark as Flexible Steel Conduit or Flexible Steel Conduit Type RW), by AFC Cable Systems Inc., Anamet Electrical Inc., Electri-Flex Co., or International Metal Hose Co.

E. Liquid-tight Flexible Metal Conduit: UL categorized as liquid-tight flexible metal conduit (identified on UL Listing Mark as Liquid-Tight Flexible Metal Conduit, also specifically marked with temperature and environment application data), by AFC Cable Systems Inc., Anamet Electrical Inc., Electri-Flex Co., or Universal Metal Hose Co.

F. Surface Metal Raceway, Fittings and Accessories: By Thomas & Betts Corp., Mono-Systems Inc. or Wiremold Co. Area and conductor capacity indicated for each size raceway is for reference. Follow manufacturer’s recommended raceway capacity for all types and sizes of conductors:

1. Size 1: Nominal area .3 sq. in. min., 4 No. 12 THW max.; Thomas & Betts B400, Mono-Systems SMS 700, or Wiremold’s V700.

2. Size 2: Nominal area .75 sq. in. min., 11 No. 12 THW max.; Thomas & Betts SR250, Mono-Systems SMS2100, Wiremold’s 2100.

3. Size 3: Nominal area 2.8 sq. in. min., 43 No. 12 THW max.; Thomas & Betts SR500, Mono-Systems SMS3200, or Wiremold’s G3000.

G. Wireways, Fittings and Accessories:

1. NEMA 1 (Without Knockouts): Hoffman Enclosures Inc. Bulletin F-40, Hubbell/Wegmann’s HSK, Lee Products Co.’s S Series, Rittal/Electromate’s EW & EWHC Lay-In Wireway System, or Square D Co.’s Square-Duct Class 5100.

H. Insulated Bushings, Plastic Bushings, Insulated Grounding Bushings: By Appleton Electric Co., Cooper/Crouse-Hinds, OZ/Gedney Co., or Thomas & Betts Corp.

I. Connectors and Couplings:

Locknuts: UL, steel/zinc electroplate; Appleton Electric Co.’s BL-50 Series, Cooper/Crouse-Hinds’ 11 Series, OZ/Gedney Co.’s 1-50S Series, Raco Inc.’s 1002 Series, Steel City/T&B Corp.’s LN-101 Series, or Thomas & Betts Corp.’s 141 Series.

Couplings (For Rigid Metal and IMC Conduit): Standard galvanized threaded couplings as furnished by conduit manufacturer, Allied Tube & Conduit Corp.’s Kwik-Couple, or Thomas & Betts Corp.’s Shamrock.

Three Piece Conduit Coupling (For Rigid Metal and IMC Conduit): Steel, malleable iron, zinc electroplate; Allied Tube & Conduit Corp.’s Kwik-Couple, Appleton Electric Co.’s EC-50 Series, Cooper/Crouse-Hinds’ 190M Series, OZ/Gedney Co.’s 4-50 Series, Raco Inc.’s 1502 Series, Steel City/T & B Corp.s EK-401 Series, or Thomas & Betts Corp.’s 675 Series.

Electrical Metallic Tubing Couplings and Insulated Connectors: Compression type, steel/zinc electroplate; Appleton Electric Co.’s TW-50CS1, TWC-50CS Series, Cooper/Crouse-Hinds’ 1650, 660S Series, Raco Inc.’s 2912, 2922 Series, Steel City/T & B Corp.’s TC-711 Series, or Thomas & Betts Corp.’s 5120, 5123 Series.

Flexible Metal Conduit Connectors: Arlington Industries Inc.’s Saddle-Grip, OZ/Gedney Co.’s C-8T, 24-34T, ACV-50T Series, or Thomas & Betts Corp.’s Nylon Insulated Tite-Bite Series.

Liquid-tight Flexible Metal Conduit Connectors:

Dry, Damp Locations: Steel, malleable iron, zinc electroplate, insulated throat; Appleton Electric Co.’s STB Series, Cooper/Crouse-Hinds’ LTB Series, OZ/Gedney Co.’s 4Q-50T Series, Raco Inc.’s 3512 Series, Steel City/T & B Corp.’s LT-701 Series, or Thomas & Betts Corp.’s 5332 Series.

Wet Locations: OZ/Gedney Co.’s 4Q-TG Series (hot-dip/mechanically galvanized), or Thomas & Betts Corp.’s 3322 Series (PVC coated).

J. Conduit Bodies (Threaded):

1. Dry, Damp Locations: Zinc electroplate malleable iron or cast-iron alloy bodies with zinc electroplate steel covers; Appleton Electric Co.’s Unilets, Cooper/Crouse-Hinds’ Condulets, OZ/Gedney Co.’s Conduit Bodies, or Thomas & Betts Corp.’s Conduit Bodies.

2. Wet Locations: Malleable iron or cast-iron alloy bodies and covers with hot dipped galvanized or other specified corrosion resistant finish; Cooper/Crouse-Hinds’ Condulets (Corro-free epoxy powder coat), Thomas & Betts Corp.’s Conduit Bodies (hot dipped galvanized), or OZ/Gedney Co.’s Conduit Bodies (hot dipped galvanized). Stainless steel cover screws, covers gasketed to suit application.

K. Expansion Fittings:

1. Dry, Damp Locations:

a. Malleable iron, zinc electroplate finish: Appleton Electric Co.’s XJ or OZ/Gedney Co.’s AX (TX for EMT), with external bonding jumper.

b. Electrogalvanized Steel: Cooper/Crouse-Hinds’ XJG (XJG-EMT for EMT), or Thomas & Betts Corp.’s XJG, with internal grounding.

2. Wet Locations: Cooper/Crouse-Hinds XJG (Corro-free epoxy powder coat), OZ Gedney Co.’s AX, EXE (end type, hot dipped galvanized), or Thomas & Betts Corp.’s XJG (hot dipped galvanized).

L. Deflection Fittings:

1. Dry Locations: Appleton Electric Co.’s DF, Cooper/Crouse-Hinds’ XD, or OZ/Gedney Co.’s Type DX.

2. Wet Locations: Ductile iron couplings with hot dipped galvanized finish, neoprene sleeve, and stainless-steel bands, Appleton Electric Co.’s CF; or bronze couplings, neoprene sleeve, and stainless-steel bands, OZ/Gedney Co.’s Type DX.

M. Sealing Fittings:

1. Dry, Damp Locations: Appleton Electric Co.’s EYS, ESU w/Kwiko sealing compound and fiber filler, Cooper/Crouse-Hinds’ EYS, EZS w/Chico A sealing compound and Chico X filler, OZ/Gedney Co.’s EY, EYA with EYC sealing compound and EYF damming fiber, or Thomas & Betts Corp.’s. EYS w/Chico A sealing compound and Chico X filler.

a. Other Type Fittings: As required to suit installation requirements, by Appleton Electric Co., Cooper/Crouse-Hinds, OZ/Gedney Co, or Thomas & Betts Corp.

2. Wet Locations: Malleable iron body with hot dipped/mechanically galvanized finish, neoprene sleeve, and stainless-steel bands, Appleton electric Co.’s CF; or bronze couplings, neoprene sleeve, and stainless-steel bands, OZ/Gedney Co.’s Type DX.

a. Horizontal: Cooper/Crouse-Hinds’ EYS with Chico A sealing compound and Chico X filler, OZ/Gedney Co.’s EYD with EYC sealing compound and EYF damming fiber, or Thomas & Betts Corp.’s. EYS w/Chico A sealing compound and Chico X filler.

b. Vertical (with Drain): Cooper/Crouse-Hinds with Chico A sealing compound and Chico X filler, OZ/Gedney Co.’s EY, EYA with EYC sealing compound and EYF damming fiber, or Thomas & Betts Corp.’s. w/Chico A sealing compound and Chico X filler.

c. Other Type Fittings. As required to suit installation requirements, by Cooper/Crouse-Hinds, OZ/Gedney Co., or Thomas & Betts Corp. with hot dipped/mechanically galvanized finish or epoxy powder coat.

N. Sealant for Raceways Exposed to Different Temperatures: Sealing compounds and accessories to suit installation; Appleton Electric Co.’s DUC, or Kwiko Sealing Compound with fiber filler, Cooper/Crouse-Hinds’ Chico A Sealing Compound with Chico X fiber, Electrical Products Division 3M Scotch products, OZ Gedney Co.’s DUX or EYC sealing compound with EYF damming fiber, or Thomas & Betts Corp.’s Blackburn DX.

O. Vertical Conductor Supports:

a. Dry, Damp Locations: Kellems/Hubbell Inc.’s Conduit Riser Grips, or OZ/Gedney Co.’s Type M, Type R.

b. Wet Locations: Kellems/Hubbell Inc.’s Conduit Riser Grips (stainless steel or tin coated bronze), or OZ/Gedney Co.’s hot dipped galvanized finish Type CMT or Type W.

2.2 OUTLET, JUNCTION AND PULL BOXES

A. Galvanized Steel Boxes For Concealed Work: Standard galvanized steel boxes and device covers by Appleton Electric Co., Beck Mfg./Picoma Industries, Cooper/Crouse-Hinds, Raco/Div. of Hubbell , or Steel City/T & B Corp.

* + - * 1. Galvanized Steel Junction and Pull Boxes For Exposed Work: Code gage, galvanized steel screw cover boxes by Delta Metal Products Inc., Hoffman Enclosures Inc., Hubbell Wiegmann, Lee Products Co., or Rittal/Electromate.
				2. Threaded Type Boxes For Exposed Work:

1. Outlet Boxes:

For Dry, Damp Locations: Zinc electroplate malleable iron or cast-iron alloy boxes by Appleton Electric Co., Cooper/Crouse-Hinds Co., OZ/ Gedney Co., or Thomas & Betts Corp. with zinc electroplate steel covers to suit application.

For Wet Locations: Malleable iron or cast-iron alloy boxes with hot dipped galvanized or other specified corrosion resistant finish as produced by Cooper/Crouse-Hinds (hot dipped galvanized or Corro-free epoxy powder coat), OZ/Gedney Co. (hot dipped galvanized), or Thomas & Betts Corp. (hot dipped galvanized) with stainless steel cover screws, and malleable iron covers gasketed to suit application.

Junction And Pull Boxes:

For Dry, Damp Locations: Zinc electroplate cast iron boxes by Appleton Electric Co., Cooper/Crouse-Hinds, OZ/Gedney Co., or Thomas & Betts Corp. with zinc electroplate steel or cast-iron cover.

For Wet Locations: Cast iron boxes by Cooper/Crouse-Hinds’ (hot dipped galvanized or Corro-free epoxy powder coat), OZ/Gedney Co. (hot dipped galvanized), or Thomas & Betts Corp. (hot dipped galvanized) with stainless steel cover screws and cast-iron cover gasketed to suit application.

Conduit Bodies, Threaded (Provided with a Volume Marking):

For Dry, Damp Location: Zinc electroplate malleable iron or cast-iron alloy bodies with zinc electroplate steel covers; Appleton Electric Co.’s Unilets, Cooper/Crouse-Hinds’ Condulets, OZ/Gedney Co.’s Conduit Bodies, or Thomas & Betts Corp.’s Conduit Bodies.

For Wet Locations: Malleable iron or cast-iron alloy bodies with hot dipped galvanized or other specified corrosion resistant finish; Cooper/Crouse-Hinds’ Condulets (hot dipped galvanized or Corro-free epoxy power coat), OZ/Gedney Co.’s Conduit Bodies (hot dipped galvanized), or Thomas & Betts Corp.’s Conduit Bodies (hot dipped galvanized) with stainless steel cover screws and malleable iron covers gasketed to suit application.

* + - * 1. Specific Purpose Outlet Boxes: As fabricated by manufacturers for mounting their equipment.
				2. Outlet Boxes and Related Products for Fire Rated Construction:

Parameters For Use of Listed Metallic Outlet or Device Boxes: UL Electrical Construction Equipment Directory - Metallic Outlet Boxes (QCIT).

Wall Opening Protective Materials: As listed in UL Fire Resistance Directory - Wall Opening Protective Materials (CLIV), or UL Electrical Construction Equipment Directory - Wall Opening Protective Materials (QCSN).

2.3 CONDUCTORS AND ACCESSORIES

A. Date of Manufacture: No insulated conductor over one year old when delivered to the site will be acceptable.

B. Conductors: Annealed uncoated copper or annealed coated copper in conformance with the applicable standards for the type of insulation to be applied on the conductor.

C. Types for Power and Class 1, 2 and 3 Circuits:

1. Power Wiring:

a. General: Rated 600V, NFPA 70 Type FEP, THHN, THW, THW-2, THWN, THWN-2, XHH, XHHW, XHHW-2.

2. Class 1 Wiring:

No. 18 and No. 16 AWG: Insulated copper conductors suitable for 600 volts, NFPA 70 types KF-2, KFF-2, PAFF, PF, PFF, PGF, PGFF, PTFF, SF-2, SFF-2, TF, TFF, TFN, TFFN, ZF, or ZFF.

Larger than No. 16 AWG: Insulated copper conductors suitable for 600 volts, in compliance with NFPA 70 Article 310.

Conductor with other types and thickness of insulation may be used if listed for Class 1 circuit use.

Class 2 Wiring:

Multiconductor Cables: NFPA 70 Article 725, Types CL2P, CL2R, CL2.

Other types of cables may be used in accordance with NFPA 70 Table 725-61 “Cable Uses and Permitted Substitutions”, as approved.

Class 3 Wiring:

a. Single Conductors No. 18 and No. 16 AWG: Same as Class 1 No. 18 and No. 16 AWG conductors, except that:

1) Conductors are also listed as CL3.

2) Voltage rating not marked on cable except where cable has multiple listings and voltage marking is required for one or more of the listings.

b. Multiconductor Cables: NFPA 70 Article 725, Types CL3P, CL3R, CL3.

c. Other types of cables may be used in accordance with NFPA 70, Table 725-61 “Cable Uses and Permitted Substitutions”, as approved.

D. Types for Interior Communication Bus Circuits:

1. Number of conductors and conductor size as recommended by the Company producing the system, except that conductor size shall not be less than No. 18 AWG.

2. Multiconductor Cables NEC Type PLTC:

Insulated copper conductors.

Cable shall have a voltage rating of not less than 300 volts.

3. Conductors twisted, shielded and jacketed as recommended by the Company producing the system.

4. All electrical characteristics shall meet the requirements of the Company producing the system (conductor to conductor capacitance, dc resistance, velocity of propagation, etc.).

E. Types for Underground Communication Bus Circuits:

1. Electronic Cable:

a. IMSA Style: International Signal Association Inc. (IMSA) Specification 19-1, 19-2, 20-1, 20-2, or 50-2.

b. All electrical characteristics shall meet the requirements of the Company producing the system (conductor to conductor capacitance, dc resistance, velocity of propagation, etc.).

Type TC: UL listed cable assembly Type TC power and control tray cable:

Conductors: Minimum No. 18 AWG copper, stranded, Class B.

Insulation: PVC/nylon, THHN or TFFN, rated 600V, 90 degrees C dry and 75 degrees C wet.

Outer jacket minimum 0.45 mils thick, identified for direct burial use.

Shielding of twisted pairs as recommended by the Company producing the system.

Where IMSA style cables are used and individually twisted and shielded conductor pairs are required, each pair shall be a cable in accordance with IMSA 19-2, 20-2, or 50-2.

Number of conductors and conductor size as recommended by the Company producing the system, except that conductor size shall not be less than No. 18 AWG.

2. Optical Fiber Cable: See Section 271525.

* + - * 1. Types for Aerial Communication Bus Circuits:

Electronic Cable:

IMSA Style: International Signal Association Inc. (IMSA) Specification 19-1, 19-2, 20-1, or 20-2.

All electrical characteristics shall meet the requirements of the Company producing the system (conductor to conductor capacitance, dc resistance, velocity of propagation, etc.).

Type TC: UL listed cable assembly Type TC power and control tray cable:

Conductors: Copper, concentric stranded, Class B.

Insulation (14, 12, and 10 AWG): THHN/THWN, rated 600V, 90 degrees C dry and 75 degrees C wet.

Outer jacket sunlight resistant polyvinyl chloride, minimum 0.60 mils thick.

Shielding of twisted pairs as recommended by the Company producing the system.

Where IMSA style cables are used and individually twisted and shielded conductor pairs are required, each pair shall be a cable in accordance with IMSA 19-2 or 20-2.

Number of conductors and conductor size as recommended by the Company producing the system, except that conductor size shall not be less than No. 14 AWG.

Minimum 1/2 inch diameter, 7 strand utility grade messenger, 25,000 pound breaking strength, galvanized steel strand ASTM A 475, galvanized coating weight B.

Lash cables to messenger with .045 stainless steel Alloy 430 lashing wire.

Optical Fiber Cable: See Section 271525.

* + - * 1. Connectors:

General: Connectors specified are part of a system. Furnish connectors and components, and use specific tools and methods as recommended by connector manufacturer to form complete connector system.

Splices:

Spring Type:

Rated 105° C, 600V: Buchanan/Ideal Industries Inc.’s B-Cap, Electrical Products Div./3M’s Scotchlok Type Y, R, G, B, O/B+, R/Y+, or B/G+, or Ideal Industries Inc.’s Wing Nuts or Wire Nuts.

Rated 150° C, 600V; Ideal Industries Inc.’s High Temperature Wire-Nut Model 73B, 59B.

Indent Type with Insulating Jacket:

Rated 105° C, 600V: Buchanan/Ideal Industries Inc.’s Crimp Connectors, Ideal Industries Inc.’s Crimp Connectors, Penn-Union Corp.’s Penn-Crimps, or Thomas & Betts Corp.’s STA-KON.

Indent Type (Uninsulated): Anderson/Hubbell’s Versa-Crimp, VERSAtile, Blackburn/T&B Corp.’s Color-Coded Compression Connectors, Electrical Products Div./3M’s Scotchlok 10000, 11000 Series, Framatome Connectors/Burndy’s Hydent, Penn-Union Corp.’s BCU, BBCU Series, or Thomas & Betts Corp.’s Compression Connectors.

Connector Blocks: NIS Industires Inc.’s Polaris System, or Thomas & Betts Corp.’s Blackburn AMT Series.

Resin Splice Kits: Electrical Products Div./3M’s Scotchcast Brand Kit Nos. 82A Series, 82-B1 or 90-B1, or Scotchcast Brand Resin Pressure Splicing Method.

Heat Shrinkable Splices: Electrical Products Div./3M’s ITCSN, Raychem Corp.’s Thermofit Type WCS, or Thomas & Betts Corp.’s SHRINK-KON Insulators.

Cold Shrink Splices: Electrical Products Div./3M’s 8420 Series.

* + - * 1. Terminals: Nylon insulated pressure terminal connectors by Amp-Tyco/Electronics, Electrical Products Div./3M, Framatome Connectors/Burndy, Ideal Industries Inc., Panduit Corp., Penn-Union Corp., Thomas & Betts Corp., or Wiremold Co.
				2. Insulation Tapes:

Plastic Tape: Electrical Products Div./3M’s Scotch Super 33+ or Scotch 88, Plymouth Rubber Co.’s Plymouth/ Bishop Premium 85CW.

Rubber Tape: Electrical Products Div./3M’s Scotch 130C, or Plymouth Rubber Co.’s Plymouth/Bishop W963 Plysafe.

* + - * 1. Moisture Sealing Tape: Electrical Products Div./3M’s Scotch 2200 or 2210, or Plymouth Rubber Co.’s Plymouth/Bishop 4000 Plyseal-V.
				2. Wire Management Products: Cable clamps and clips, cable ties, spiral wraps, etc., by Catamount/T&B Corp., or Ideal Industries, Inc.

2.4 SUPPORTING DEVICES

A. “C” Beam Clamps:

For 1 Inch Conduit Maximum: B-Line Systems Inc.’s BG-8-C2, BP-8-C1 Series, or Caddy/Erico Products Inc.’s BC-8P and BC-8PSM Series.

For 3 Inch Conduit Maximum: Appleton Electric Co.’s BH-500 Series beam clamp with H50WB Series hangers, Kindorf/T&B Corp.’s 500 Series beam clamp with 6HO-B Series hanger, or OZ/Gedney Co.’s IS-500 Series beam clamp with H-OWBS Series hanger.

For 1/4 Inch Hanger Rods: B-Line Systems Inc.’s BC, Caddy/Erico Products Inc.’s BC, Kindorf/T&B Corp.’s 500, 510, or Unistrut Corp.’s P1648S, P2398S, P2675, P2676.

For 3/8 Inch Hanger Rods: Caddy/Erico Products Inc.’s BC, Kindorf/T&B Corp.’s 231-3/8, 502, or Unistrut Corp.’s P1649AS, P2401S, P2675, P2676.

B. Pipe Straps: Two-hole steel conduit straps; Kindorf/T&B Corp.’s C-144 Series, or Unistrut Corp.’s P-2558 Series.

C. Pipe Clamps: One-hole malleable iron clamps; Kindorf/T&B Corp.’s HS-400 Series, or OZ/ Gedney Co.’s 14-G Series.

D. Supporting Fastener (Metal Stud Construction): Metal stud supports, clips and accessories as produced by Caddy/Erico Products Inc.

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL

A. Provide wiring for the Direct Digital Building Control System.

1. Provide Class 1, 2, and 3 wiring, communication bus wiring and connections.

COORDINATE SUBPARAGRAPH BELOW WITH ELECTRICAL DESIGNER.

2. Provide power wiring from DDC System equipment to nearest electrical panelboard connected to the emergency power supply and UPS System. Coordinate source with Electrical Work Contractor.

3.2 RACEWAY INSTALLATION

A. Conduit Installed Concealed:

1. Install conduit concealed unless otherwise indicated on the drawings.

USE THREE SUBPARAGRAPHS BELOW IN CONJUNCTION WITH EXISTING CONSTRUCTION.

2. Existing Construction:

Run conduit in existing chases and hung ceilings.

If conduit cannot be installed concealed due to conditions encountered in the building, report such conditions and await approval in writing before proceeding.

3. New Construction:

a. Run conduit in the ceilings, walls, and partitions.

USE SUBPARAGRAPH BELOW IF PROJECT REQUIREMENTS DO NOT ALLOW CONDUIT TO BE RUN EMBEDDED IN CONCRETE SLAB.

b. Conduit may not be installed in concrete floor slab (concrete slabs that are both ceilings and floors shall be treated as floor slabs).

USE SUBPARAGRAPHS BELOW IF CONDUIT MAY BE RUN IN SLABS AND MODIFY TO SUIT TYPE OF CONCRETE FLOOR SLABS. AS WRITTEN, IT IS USUALLY APPROPRIATE FOR NON-STRUCTURAL SLABS. IT MAY NOT BE APPROPRIATE FOR STRUCTURAL SLABS. COORDINATE WITH STRUCTURAL ENGINEERS.

c. Install conduit in concrete slabs, under slabs (on grade), or under slabs (above finished ceilings) as approved. Concrete slabs that are both ceilings and floors shall be treated as floor slabs.

1) Conduit in Slab: Run 1/2- and 3/4-inch conduit in the slab where placement of reinforcement and slab thickness is sufficient to allow 1-1/2 inches of concrete cover over conduit, otherwise run conduit under slab. Run conduit one inch and larger in the slab in the specific location(s) where it is indicated on the drawing to be run in the slab, otherwise run conduit under slab.

Run conduit under reinforcement where reinforcement is in upper portion or middle of slab.

Run conduit over reinforcement where reinforcement is in lower portion of slab.

Run conduit between reinforcement where reinforcement is in upper and lower portions of slab.

Separate parallel conduits minimum of 2 inches so that each conduit will be enveloped in concrete.

Pass conduit over steel beams, if any, parallel with the reinforcement.

Tie down conduit to avoid movement during placement of concrete.

Demonstrate to the Director’s Representative that conduit has been placed to allow minimum of 1-1/2 inches of concrete cover.

Conduit Under Slab on Grade:

Run conduit under vapor barrier (if any).

Install equipment grounding conductor in each conduit. Bond at boxes and equipment to which conduit is connected.

Conduit Under Slab, Above Finished Ceiling:

Attach conduit to bottom of slab or structure supporting the slab.

Firestop through-penetrations of the slab.

If any portions of the conduit system cannot be installed concealed due to conditions encountered in the building, report such conditions, and await approval in writing before proceeding.

B. Conduits Penetrating Concrete Floor Slabs (Concrete slabs that are both ceilings and floors shall be treated as floor slabs):

 1. Provide a minimum of 2 inches between conduits that vertically penetrate elevated concrete slabs.

 2. Provide firestopping and spray on fireproofing at locations where conduits penetrate surface of floor slab and slab is part of fire rating required for construction.

C. Conduit Installed Exposed:

1) Install conduit exposed where indicated on the drawings. If not indicated, conduit may be installed exposed, as approved, in:

a. Unfinished spaces, and finished spaces housing mechanical or electrical equipment that is generally accessible only to facility maintenance personnel.

b. Areas where existing conduits have been installed exposed.

c. Areas where conduit cannot be installed concealed.

2) Install conduit tight to the surface of the building construction. Exceptions:

a. Where otherwise indicated or directed.

b. Where conduit is exposed in wet locations. Install entire wiring system including conduit, boxes, and fittings so that there is 1/4-inch air space between it and the wall or supporting surface.

3) Install vertical runs perpendicular to the floor.

4) Install runs on the ceiling perpendicular or parallel to the walls.

5) Install horizontal runs parallel to the floor.

6) Do not run conduits near heating pipes.

7) Installation of conduit directly on the floor will not be permitted.

D. Conduit Size: Not smaller than 1/2-inch electrical trade size.

E. Raceways Exposed to Different Temperatures: Where portions of an interior raceway system are exposed to widely different temperatures, seal interior and exterior of raceway to prevent circulation of air from a warmer to a colder section through the raceway installation.

1. Refrigerated Rooms: Install conduit body or junction box in the raceway system on warm side of refrigerated room. After conductors are installed, seal interior of the raceway at the conduit body or junction box.

2. Heated Areas to Unheated Areas: After conductors are installed, seal interior of the raceway at the nearest conduit body, outlet or junction box in the heated area adjoining the unheated area.

F. Conduit for Prefabricated Walk-In Refrigeration Boxes:

1. Install box wiring in conduit. Run conduit exposed on exterior of box unless project conditions require conduit to be run exposed on interior of box.

a. Install rigid ferrous metal conduit and galvanized fittings where the metal surfaces are galvanized steel.

b. Install rigid stainless-steel conduit and fittings where the metal surfaces are stainless steel.

2. Create a thermal break where penetrating the box by installing maximum of 12 inches of Schedule 40 high density polyethylene conduit within the conduit run at the penetration. Seal the penetration.

3. Install equipment grounding conductor in each conduit.

4. Seal raceway as specified for raceways exposed to different temperatures.

G. Conduits in Heating Tunnels: Install rigid ferrous metal conduit exposed in the tunnel and run conduit to avoid manhole entrances and other obstructions. Install equipment grounding conductor in each conduit.

H. Conduit in Waterproofed Floors: Install conduit runs in waterproof floors to avoid penetrating the waterproofing. Avoid penetration of waterproofing with conduit risers so far as practicable.

1. Where it is necessary to puncture the waterproofing for a conduit riser, install a standard weight steel pipe sleeve extending one inch above the finished floor level. Flash the steel pipe sleeve to the waterproofing with 16-ounce copper. Construct the flashing with a copper tube extending the full height of the sleeve, soldered to a copper base extending 6 inches in all directions from the sleeve.

2. The flashing will be integrated into the waterproofing by the Construction Contractor. Provide solid cast brass floor plates with chromium finish where pipe sleeves are exposed in rooms.

I. Conduit in Hazardous Areas: Install Work in hazardous areas in accordance with NFPA 70.

1. Install sealing fittings in concealed conduit runs in a recessed box with blank face plate to match other face plates in the area.

J. Raceway Schedule:

1. Rigid Ferrous Metal Conduit: Install in all locations unless otherwise specified or indicated on the drawings.

2. Intermediate Metal Conduit: May be installed in all locations except:

a. Hazardous areas.

b. Where other type raceways are specified or indicated on the drawings.

3. Electrical Metallic Tubing:

a. May be installed concealed above suspended ceilings where conduit does not support equipment.

b. May be installed concealed in hollow areas in dry locations, including:

1) Hollow concrete masonry units, except where cores are to be filled.

2) Drywall construction with sheet metal studs, except where studs are less than 3-1/2 inches deep.

May be installed exposed in dry non-hazardous locations at elevations over 10’-0” above finished floor where conduit does not support equipment.

4. Flexible Metal Conduit: Install equipment grounding conductor in the flexible metal conduit and bond at each box or equipment to which conduit is connected:

a. Use 1 to 3 feet of flexible metal conduit for final conduit connection to:

1) Equipment subject to vibration (dry locations)

2) Equipment requiring flexible connection for adjustment or alignment (dry locations).

b. Use above existing non-removable suspended ceilings where rigid type raceways cannot be installed due to inaccessibility of space above ceiling.

May be installed concealed in drywall construction with sheet metal studs, except where studs are less than 3-1/2 inches deep.

5. Liquid-tight Flexible Metal Conduit: Install equipment grounding conductor in liquid-tight flexible metal conduit and bond at each box or equipment to which conduit is connected:

a. Use 1 to 3 feet of liquid-tight flexible metal conduit (UL listed and marked suitable for the installation’s temperature and environmental conditions) for final conduit connection to:

Equipment subject to vibration (damp and wet locations).

Equipment requiring flexible connection for adjustment or alignment damp and wet locations).

6. Surface Metal Raceway: Use as exposed raceway system in finished spaces at locations, when approved, where raceways cannot be installed concealed:

a. Use surface metal raceway system of size required for number of wires to be installed therein.

b. Do not run raceway through walls that have a plaster finish nor through masonry walls or floors. Install a pipe sleeve, or a short length of conduit with junction boxes or adapter fittings for raceway runs through such areas. Run raceway along top of baseboards, care being taken to avoid telephone and other signal wiring. Where raceway crosses chair railing or picture molding, cut the chair railing or picture molding to permit the raceway to lie flat against the wall. Run raceway around door frames and other openings. Run raceway on ceiling or walls perpendicular to or parallel with walls and floors.

c. Secure raceway at intervals not exceeding 36 inches.

d. Where equipment is mounted on an outlet box and the equipment base is larger than the outlet box, provide finishing collar around equipment base and outlet box or provide finishing collar/outlet box:

1) Finishing Collar: Same finish and peripheral dimensions as the equipment base, including provisions for mounting, slots to fit over raceway and of depth to cover outlet box and extend back to ceiling or wall.

2) Combination Finishing Collar/Outlet Box: Same finish and peripheral dimensions as the equipment base to be mounted thereon, gage or thickness of metal as required by National Electrical Code, including provision for mounting and knockouts for entrance of raceway.

7) Wireways: May be used indoors in dry locations for exposed raceway between grouped, wall mounted equipment.

K. Fittings and Accessories Schedule:

1. General:

a. Use zinc electroplate or hot dipped galvanized steel/malleable iron or cast alloy fittings and accessories in conjunction with ferrous raceways in dry and damp locations unless otherwise specified or indicated on the drawings.

b. Use malleable iron or cast iron alloy fittings and accessories having hot dipped/mechanically galvanized finish or other specified corrosion resistant finish in conjunction with ferrous raceways in wet locations unless otherwise specified or indicated on the drawings.

c. Use caps or plugs to seal ends of conduits until wiring is installed (to exclude foreign material).

d. Use insulated grounding bushings on the ends of conduits that are not directly connected to the enclosure (such as stub-ups under equipment, etc.) and bond between bushings and enclosure with equipment grounding conductor.

e. Use expansion fittings where raceways cross expansion joints.

f. Use deflection fittings where raceways cross expansion joints that move in more than one plane.

g. Use 2 locknuts and an insulated bushing on end of each conduit entering sheet metal cabinet or box in dry or damp locations.

1) Plastic bushing may be used in lieu of insulated bushing on 1/2- and 3/4-inch conduit.

2) Terminate conduit ends within cabinet/box at the same level.

h. Use watertight hub on end of each conduit entering cabinets or boxes (in wet locations) that are not constructed with integral threaded hubs.

2. For Rigid and Intermediate Metal Conduit: Use threaded fittings and accessories. Use 3-piece conduit coupling where neither piece of conduit can be rotated.

3. For Electrical Metallic Tubing: Use compression type connectors and couplings.

4. For Flexible Metal Conduit: Use flexible metal conduit connectors.

For Liquid-tight Flexible Metal Conduit: Use liquid-tight connectors.

For Surface Metal Raceway: Use raceway manufacturer’s standard fittings and accessories.

For Wireways: Use wireway manufacturer’s standard fittings and accessories.

3.3 OUTLET, JUNCTION AND PULLBOX INSTALLATION

A. Box Schedule For Concealed Conduit System:

1. Non-Fire Rated Construction:

Depth: To suit job conditions and comply with NFPA 70 Article 370.

For Junction and Pull Boxes: Use galvanized steel boxes with flush covers.

For Devices:

Plaster or Cast-In-Place Concrete Walls: Use 4 inch or 4-11/16 inch galvanized steel boxes with device covers.

Walls Other Than Plaster or Cast-In-Place Concrete: Use type of galvanized steel box which will allow wall plate to cover the opening made for the installation of the box.

2. Recessed Boxes in Fire Rated (2 hour maximum) Bearing and Nonbearing Wood or Steel Stud Walls (Gypsum Wallboard Facings):

a. Use listed single and double gang metallic outlet and device boxes. The surface area of individual outlet or device boxes shall not exceed 16 square inches.

b. The aggregate surface area of the boxes shall not exceed 100 square inches per 100 square feet of wall surface.

c. Securely fasten boxes to the studs. Verify that the opening in the wallboard facing is cut so that the clearance between the box and the wallboard does not exceed 1/8 inch.

Separate boxes located on opposite sides of walls or partitions by a minimum horizontal distance of 24 inches. This minimum separation distance may be reduced when wall opening protective materials are installed according to the requirements of their classification.

Use wall opening protective material in conjunction with boxes installed on opposite sides of walls or partitions of staggered stud construction in accordance with the classification requirements for the protective material.

3. Other Fire Rated Construction: Use materials and methods to comply with the listing requirements for the classified construction.

B. Box Schedule For Exposed Conduit System:

1. Dry and Damp Locations: Use zinc electroplate or hot dipped galvanized threaded type malleable iron or cast-iron alloy outlet, junction, and pull boxes or conduit bodies provided with a volume marking in conjunction with ferrous raceways unless otherwise specified or indicated on the drawings.

a. Galvanized steel boxes may be used in conjunction with conduit sizes over 1 inch in non-hazardous dry and damp locations.

b. Galvanized steel boxes may be used in conjunction with electrical metallic tubing where it is installed exposed as branch circuit conduits at elevations over 10’-0” above finished floor.

2. Wet Locations: Use threaded type malleable iron or cast-iron alloy outlet junction and pull boxes or conduit bodies (provided with a volume marking) with hot dipped galvanized or other specified corrosion resistant coating in conjunction with ferrous raceways unless otherwise specified or indicated on the drawings.

3. Finishing Collar or Combination Finishing Collar/Outlet Box (Surface Mounted Equipment Used With Exposed Raceway):

a. Use finishing collar where surface mounted equipment is installed on an exposed raceway outlet box and the equipment base is larger than the outlet box.

b. Use combination finishing collar/outlet box where surface mounted equipment is not indicated to be installed on an exposed raceway outlet box, but raceway cannot be run directly into equipment body due to equipment design.

C. Specific Purpose Outlet Boxes: Use to mount equipment when available and suitable for job conditions. Unless otherwise specified, use threaded type boxes with finish as specified for exposed conduit system, steel (painted) for surface metal raceway system and galvanized steel for recessed installations.

3.4 CONDUCTOR INSTALLATION

A. Install conductors in raceways.

CHECK WITH HEATING DESIGNER AND ELECTRICAL DESIGNER FOR USE OF SUBPARAGRAPH BELOW. MATCH METHOD USED BY THE ELECTRICAL DESIGNER FOR FIRE ALARM WIRING.

1. Exceptions:

a. Raceway is not required for plenum rated Class 2, or Class 3 circuits, or communication bus circuits installed above suspended ceilings.

B. Conductor Size: Install conductors of size shown on drawings or specified. Where conductor size is not indicated, the minimum size allowed is:

1. For Power Circuits: No. 12 AWG.

2. For Class 1 Circuits:

a. No. 18 and No. 16 AWG may be used provided they supply loads that do not exceed 6 amps (No. 18 AWG), or 8 amps (No. 16 AWG).

b. Larger than No. 16 AWG: Use to supply loads not greater than the ampacities given in NFPA 70 Section 310-15.

3. For Class 2 Circuits: Any size to suit application.

4. For Class 3 Circuits: No. 18 AWG.

5. For Communication Bus Circuits: No. 18 AWG.

C. Color Code for Wiring: In accordance with ICEA/NEMA WC-30 “Color Coding of Wires and Cables”. Other coding methods may be used, as approved.

D. Use wire management products to bundle, route, and support wiring in junction boxes, pullboxes, wireways, gutters, channels, and other locations where wiring is accessible.

E. Insulated Conductor Schedule:

1. Power Circuits:

a. FEP, THHN, THW, THW-2, THWN, THWN-2, XHH, XHHW, or XHHW-2: Wiring in dry or damp locations (except where special type insulation is required).

b. THWN, THWN-2, XHHW, XHHW-2, USE, or USE-2: Wiring in wet locations (except where type USE or USE-2 insulated conductors are specifically required, or special type insulation is required).

2. Class 1 Circuits: Use Class 1 wiring specified in Part 2 (except where special type insulation is required).

3. Class 2 Circuits: Use Class 2 wiring specified in Part 2 (except where special type insulation is required).

4. Class 3 Circuits: Use Class 3 wiring specified in Part 2 (except where special type insulation is required).

5. Interior Communication Bus Circuits: Use multiconductor cable PLTC.

6. Exterior Communication Bus Circuits:

SELECT ONE OF THE NEXT TWO SUBPARAGRAPH TO SUIT.

a. Underground Cables:

Use IMSA style cable or direct burial type TC cable in underground conduit.

Use optical fiber cable in underground conduit.

b. Aerial Cables:

SELECT ONE OF NEXT TWO SUBPARAGRAPHS TO SUIT.

1) Use messenger supported IMSA style cable, or jacketed sunlight resistant type TC cable on pole line.

2) Use messenger supported optical fiber cable on pole line.

F. Connector Schedule:

1. Temperature Rating: Use connectors that have a temperature rating, equal to, or greater than the temperature rating of the conductors to which they are connected.

2. Splices:

a. Dry Locations:

1) For Conductors No. 8 AWG or Smaller: Use spring type pressure connectors, indent type pressure connectors with insulating jackets, or connector blocks (except where special type splices are required).

b. Damp Locations: As specified for dry locations, except apply moisture sealing tape over the entire insulated connection (moisture sealing tape not required if heat shrinkable splices or cold shrink splices are used).

c. Wet Locations: Use uninsulated indent type pressure connectors and insulate with resin splice kits, cold shrink splices or heat shrinkable splices. Exception: Splices above ground which are totally enclosed and protected in NEMA 3R, 4, 4X enclosures may be spliced as specified for damp locations.

3. Terminations:

a. For Conductors No. 10 AWG or Smaller: Use terminals for connecting wiring to terminal strips, and to equipment designed for use with terminals.

3.5 SUPPORTING DEVICE INSTALLATION

A. Attachment of Conduit System:

1. Wood Construction: Attach conduit to wood construction by means of pipe straps or pipe clamps and wood screws or lag bolts.

2. Masonry Construction: Attach conduit to masonry construction by means of pipe straps or pipe clamps and masonry anchorage devices.

3. Steel Beams: Attach conduit to steel beams by means of “C” beam clamps and hangers.

4. Conduit Above Suspended Ceiling: Do not rest conduit directly on runner bars, T-bars, etc. Support conduit from ceiling supports or from construction above suspended ceiling.

B. Metal Stud Construction: Attach raceways and boxes to metal studs by means of supporting fasteners manufactured specifically for the purpose.

1. Support and attach outlet boxes so that they cannot torque/twist. Either:

a. Use bar hanger assembly, or:

b. In addition to attachment to the stud, also provide far side box support.

**END OF SECTION**