SECTION 260221

MOTORS AND MOTOR CONTROLLERS

PART 1 GENERAL

1.01 PRODUCTS FURNISHED BUT NOT INSTALLED

A. Deliver the following items to the Electrical Work Contractor for installation and connection to power wiring:
   1. Motor controllers including 2 copies of approved wiring diagrams.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Wiring for Motors and Motor Controllers: Section 260523.

1.03 REFERENCES

A. NEMA MG-1 - Motors and Generators.

B. NEMA ICS - General Standards for Industrial Control and Systems.

C. UL508 - Electric Industrial Control Equipment.

D. IEEE 519 - Recommended Practices and Requirements for Harmonic Control in Electric Power Systems.

1.04 SUBMITTALS

A. Waiver of Submittals: The "Waiver of Certain Submittal Requirements" in Section 013300 does not apply to this Section.

B. Submittal Package: Submit the product data, and quality control submittals specified below at the same time as a package.

C. Product Data:
   1. Motor Controllers: Catalog sheets, specifications, and installation instructions. Submit product data for motor controllers simultaneously with product data required for motors.
      a. Identify each controller for use with corresponding motor.
      b. Describe overload devices being supplied with each motor controller (include equipment manufacturer's recommendations).
      c. Enumerate and describe all accessories being supplied with each motor controller.
   2. All Motors:
      a. Catalog sheets, specifications and installation instructions.
      b. Data proving that voltage rating of each motor is in accordance with specified NEMA standard motor voltage.

c. Data proving that the service factor and temperature rise for the motor's insulation system conforms to NEMA standards for each motor's specific application.
d. Data proving that the motor efficiency rating conforms to NEMA testing and marking standards MG1-12.54 and 12.55.

D. Quality Control Submittals:
1. Company Field Advisor Data: Include:
a. Name, business address and telephone number of Company Field Advisor secured for the required services.
b. Certified statement from the Company listing the qualifications of the Company Field Advisor.
c. Services and each product for which authorization is given by the Company listed specifically for this project.

E. Contract Closeout Submittals:
1. System acceptance test report.
2. Certificate: Affidavit, signed by the Company Field Advisor and notarized, certifying that the system meets the contract requirements and is operating properly.
3. Operation and Maintenance Data: Deliver 2 copies, covering the installed products, to the Director's Representative.

1.05 QUALITY ASSURANCE

A. Equipment Qualifications For Products Other Than Those Specified:
1. At the time of submission provide written notice to the Director of the intent to propose an "or equal" for products other than those specified. Make the "or equal" submission in a timely manner to allow the Director sufficient time to review the proposed product, perform inspections and witness test demonstrations.
2. If products other than those specified are proposed for use furnish the name, address, and telephone numbers of at least 5 comparable installations that can prove the proposed products have performed satisfactorily for 3 years. Certify in writing that the owners of the 5 comparable installations will allow inspection of their installation by the Director's Representative and the Company Field Advisor.
a. Make arrangements with the owners of 2 installations (selected by the Director) for inspection of the installations by the Director's Representative. Also obtain the services of the Company Field Advisor for the proposed products to be present. Notify the Director a minimum of 3 weeks prior to the availability of the installations for the inspection, and provide at least one alternative date for each inspection.
b. Only references from the actual owner or owner's representative (Security Supervisor, Maintenance Supervisor, etc.) will be accepted. References from dealers, system installers or others, who are not the actual owners of the proposed products, are not acceptable.

1) Verify the accuracy of all references submitted prior to submission and certify in writing that the accuracy of the information has been confirmed.

3. The product manufacturer shall have test facilities available that can demonstrate that the proposed products meet the contract requirements.
   a. Make arrangements with the test facility for the Director's Representative to witness test demonstrations. Also obtain the services of the Company Field Advisor for the proposed product to be present at the test facility. Notify the Director a minimum of 3 weeks prior to the availability of the test facility, and provide at least one alternative date for the testing.
4. Provide written certification from the manufacturer that the proposed products are compatible for use with all other equipment proposed for use for this system and meet all contract requirements.

B. Company Field Advisor: Secure the services of a Company Field Advisor from the Company providing the adjustable speed controllers for a minimum of 8 working hours for the following:
   1. Render advice regarding installation, programming, final adjustment, and testing.
   2. Witness final system test and then certify with an affidavit that the motor controllers are installed in accordance with the contract documents and are operating properly.
   3. Train facility personnel on the operation and maintenance of the motor controllers (minimum of two 1 hour sessions).
   4. Explain available service programs to facility supervisory personnel for their consideration.

C. Service Availability: A fully equipped service organization shall be available to service the completed Work.

PART 2 PRODUCTS

2.01 MOTORS

A. Classification:
   1. Classification According to Application: Comply with NEMA standards for general-purpose alternating-current squirrel-cage induction motors, except:
      a. Furnish NEMA definite-purpose or special-purpose motors when required to suit the application.
      b. Furnish NEMA type other than squirrel-cage construction when required to suit the application.
   2. Classification According to Environmental Protection and Methods of Cooling: Comply with NEMA requirements for a dripproof machine unless otherwise specified or indicated on the drawings, or required to suit the application.
      a. Provide enclosed TEFC motor type when indicated on drawings.

B. Efficiency: Motors shall be stamped with a NEMA nominal efficiency rating in accordance with NEMA testing and marking standards MG1-12.54 and 12.55.
1. Nominal full-load three phase motor efficiency:

OPEN MOTORS		
RPM	**1800**	**3600**
HP		
1.0	82.5	
1.5	84.0	82.5
2.0	84.0	84.0
3.0	86.5	84.0
5.0	87.5	85.5

CLOSED MOTORS		
RPM	**1800**	**3600**
HP		
1.0	84.0	
1.5	85.0	84.0
2.0	84.0	85.5
3.0	88.5	86.5
5.0	88.5	87.5

C. Motor (Nameplate) Voltage:
1. Nominal 120/240 V, Single Phase, 3W, Premises Wiring System:
a. Motors Less Than 1/2 hp: NEMA standard motor voltage 115 V, single phase, 60 Hz.
b. Motors 1/2 hp and Larger: NEMA standard motor voltage 230 V, single phase, 60 Hz.
2. 3. 277/480 V, Three Phase, 4W, Premises Wiring Systems:
a. Motors Less Than 1/2 hp: NEMA standard motor voltage 115 V, single phase, 60 Hz.
b. Motors 1/2 hp and Larger: NEMA standard motor voltage 460 V, three phase, 60 Hz. 440 V motors are not acceptable.

D. Horsepower Capacity:
1. Each motor shall not be overloaded by the apparatus it operates under every condition of operation.
2. The horsepower capacity shall be the continuous rating based on the nameplate horsepower rating. (The motor may not be overloaded up to the horsepower obtained by multiplying the rated horsepower by the service factor shown on the nameplate).
3. Where a minimum horsepower capacity is listed, furnish a motor larger than the minimum, if required in a particular case.
4. Pay additional cost due to necessary increase in feeder sizes, circuit breaker sizes, etc., provided under the Electric Contract.

E. Bearings: Equip motors 1/2 hp and larger with ball bearings unless otherwise specified or indicated on the drawings.

F. Speed: As required and approved to meet the requirements of the service for which motors are intended.

G. Additional Requirements For Motors Used With Adjustable Speed Motor Controllers:
   1. Designed specifically for use with type of controller required.

2.02 ADJUSTABLE SPEED MOTOR CONTROLLERS

A. Type AS-PWM for Motor: Microprocessor based, sine-coded pulse-width-modulation design variable frequency/variable voltage adjustable speed motor controller:
   1. Companies and Models: Furnish the Company's model which meets the requirements of the motor and driven equipment combination, suits the electrical system parameters, and accommodates the operating features and accessories:
      a. Allen-Bradley Co. Inc. 1333 (3/4-50 hp/230 V, 1-5 hp/460 V), 1336 (1-100 hp/230 V, 1-500 hp/460 V), 1352 (25-1400 hp/460 V).
      b. Asea Brown Boveri's ACH500 (2-25 hp/230 V, 3-400 hp/460 V), ACS 200 (2-3 hp/230 V, 1-5 hp/460 V), SAMI STAR 30-1300 hp/460 V).
      c. Eaton Corp.'s AF-1500 (1-20 hp/230 V, 1-30 hp/460 V, IS5000+ (5-600 hp/460 V).
      d. Furnas Electric Co.'s Micro 7000 (2-25 hp/230 V, 2-60 hp/460 V), Super 7000+ (75-200 hp/460 V).
      e. General Electric Co.'s AF-300B (3/4-30 hp/230 V, 1/4-300 hp/460 V).
      f. Reliance Electric Co.'s GP2000 (1/4-50 hp/230 V, 1/4-100 hp/460 V).
      g. Southcon Industrial Controls Inc.'s Magnum PWM (1/4-200 hp/230 V, 1/4 to 400 hp/460 V).
      h. Square D Co.'s Class 8804 Omegapak (1-150 hp/230 V, 1-300 hp/460 V).
      i. Westinghouse Electric Corp.'s Accutrol 110 (1-75 hp/230 V, 2-20 hp/460 V).
   2. Operating Features And Accessories:
      a. Suitable for variable torque load.
      b. Soft start: Adjustable time range of 2 to 600 seconds.
      c. Ambient operating temperature range 0 to 40 degrees C. Maximum humidity 95 percent.
      d. Digital display showing operational functions:
         1) Speed.
         2) Output voltage.
         3) Output current.
      e. Digital display, or LED's showing diagnostic functions, including:
         1) Overcurrent.
         2) Overvoltage.
         3) Undervoltage.
         4) Overtemperature.

5) Ground fault.
6) Overload.

f. Suitable for use on circuit capable of delivering 42,000AIC RMS short circuit fault current.

g. Input/ output voltage: Suitable for use on 480 V ac 3 phase circuit.

h. Frequency:
1) Input: 60 Hz.
2) Selectable Output: 3 to 60 Hz, with separately adjustable min/max frequency limits and capability to lock these limits so that they cannot be exceeded.
3) Frequency Reject: Programmable (both the width and the midpoint of up to 3 bands, or end points) to reject operation within the selected bands.
4) Output regulation: + .06 percent.

i. 100 percent continuous current rating, 150 percent for one minute every 10 minutes.

j. Front panel controls for manual operation:
1) Hand-Automatic selector switch, and start-stop pushbuttons.
2) Manual speed adjustment controls.
3) Pilot lights for: Power on, & Run light.

k. Local programming panel for:
1) Acceleration rate.
2) Deceleration rate.
3) Start torque (boost).
4) Maximum frequency.
5) Volts/Hz pattern.
6) Restart Mode: Automatic restart upon return of input power, manual reset/restart on overload.

l. Interface Input For Automatic Speed Control: Isolated, direct proportional automatic speed follower which responds to an externally supplied signal from the speed reference signal source for automatic motor speed control when the controller is in the automatic mode of operation.
1) 0-10 V dc. And/or 4-20mA dc.

m. Interface Output To Indicate Speed: Interface which follows motor speed, enabling the motor speed to be displayed at the Direct Digital Building Control System primary operator station.

n. Auxiliary output contacts, 120 V ac, 1 amp:
1) Spares, for future use: 1 N.O., 1 N.C.

o. NEMA 1 enclosure.

p. Input disconnect switch with external operator.

q. Controllers designed, equipped, and installed such that the controllers reflect 5 percent or less total harmonic distortion at the source. Equip controller with:
1) Line reactor (swing choke filters) as recommended by the adjustable speed motor controller manufacturer to maintain total harmonic distortion below specified level.

2.03 NAMEPLATES

A. General: Precision engrave letters and numbers with uniform margins, character size minimum 3/16 inch high.
   1. Phenolic: Two color laminated engraver's stock, 1/16 inch minimum thickness, machine engraved to expose inner core color (white).

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the Work of this Section in accordance with the manufacturer's printed instructions.

B. Nameplates: Identify each remote control station, indicating motor controlled. Identify each interlock switch, indicating purpose of switch:
   1. NEMA 1 Enclosures: Rivet or bolt nameplate to the cover.
   2. NEMA 12 Enclosures: Rivet or bolt and gasket nameplate to the cover.
   3. NEMA 3R, 4, 4X, 7, or 9 Enclosures: Attach nameplates to the cover using adhesive specifically designed for the purpose, or mount nameplate on wall or other conspicuous location adjacent to switch. Do not penetrate enclosure with fasteners.

3.02 FIELD QUALITY CONTROL

A. Preliminary System Test:
   1. Preparation: Have the Company Field Advisor program and adjust the completed adjustable speed motor controllers and then operate them long enough to assure that they are performing properly.
   2. Run a preliminary test for the purpose of:
      a. Determining whether motor controllers are in a suitable condition to conduct an acceptance test.
      b. Checking instruments and equipment.
      c. Training facility personnel.

B. System Acceptance Test:
   1. Preparation: Notify the Director's Representative at least 3 working days prior to the test so arrangements can be made prior to the test to have a Facility Representative witness the test.
   2. Make the following tests:
      a. Demonstrate that each adjustable speed motor controller performs its intended function.

3.03 MOTOR CONTROLLER SCHEDULE

A. See drawings for schedules of motor controllers

END OF SECTION

SECTION 260502

BASIC ELECTRICAL MATERIALS AND METHODS FOR DIRECT DIGITAL BUILDING CONTROL SYSTEM

PART 1 GENERAL

1.01 REFERENCES

A. NEMA, ANSI, and UL.

1.02 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.

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

2.01 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. 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.

C. 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.

D. 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.

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

F. Connectors and Couplings:
   1. 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.
   2. 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.
   3. 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.
   4. 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.

G. 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.

H. 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).

I. 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.

J. 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.

K. 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.

L. Vertical Conductor Supports:

1. Dry, Damp Locations: Kellems/Hubbell Inc.'s Conduit Riser Grips, or OZ/Gedney Co.'s Type M, Type R.
2. 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.

2.02 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.

B. 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.

C. Threaded Type Boxes For Exposed Work:
   1. Outlet Boxes:
      a. 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.
      b. 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.
   2. Junction And Pull Boxes:
      a. 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.
      b. 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.
   3. Conduit Bodies, Threaded (Provided with a Volume Marking):
      a. 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.
      b. 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.

D. Specific Purpose Outlet Boxes: As fabricated by manufacturers for mounting their equipment.

E. Outlet Boxes and Related Products for Fire Rated Construction:
1. Parameters For Use of Listed Metallic Outlet or Device Boxes: UL Electrical Construction Equipment Directory - Metallic Outlet Boxes (QCIT).
2. 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).

2.03 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. Class 1 Wiring:
   a. 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.
   b. Larger than No. 16 AWG: Insulated copper conductors suitable for 600 volts, in compliance with NFPA 70 Article 310.
   c. Conductor with other types and thickness of insulation may be used if listed for Class 1 circuit use.
2. Class 2 Wiring:
   a. Multiconductor Cables: NFPA 70 Article 725, Types CL2P, CL2R, CL2.
   b. Other types of cables may be used in accordance with NFPA 70 Table 725-61 "Cable Uses and Permitted Substitutions", as approved.
3. 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:
a. Insulated copper conductors.
b. 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. Connectors:
1. 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.
2. Splices:
a. Spring Type:
1) 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.
2) Rated 150° C, 600V; Ideal Industries Inc.'s High Temperature Wire-Nut Model 73B, 59B.
b. Indent Type with Insulating Jacket:
1) 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.
c. 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.
d. Connector Blocks: NIS Industires Inc.'s Polaris System, or Thomas & Betts Corp.'s Blackburn AMT Series.
e. 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.
f. Heat Shrinkable Splices: Electrical Products Div./3M's ITCSN, Raychem Corp.'s Thermofit Type WCS, or Thomas & Betts Corp.'s SHRINK-KON Insulators.
g. Cold Shrink Splices: Electrical Products Div./3M's 8420 Series.

F. 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.

G. Insulation Tapes:
1. Plastic Tape: Electrical Products Div./3M's Scotch Super 33+ or Scotch 88, Plymouth Rubber Co.'s Plymouth/ Bishop Premium 85CW.
2. Rubber Tape: Electrical Products Div./3M's Scotch 130C, or Plymouth Rubber Co.'s Plymouth/Bishop W963 Plysafe.

H. Moisture Sealing Tape: Electrical Products Div./3M's Scotch 2200 or 2210, or Plymouth Rubber Co.'s Plymouth/Bishop 4000 Plyseal-V.

I. Wire Management Products: Cable clamps and clips, cable ties, spiral wraps, etc., by Catamount/T&B Corp., or Ideal Industries, Inc.

2.04 SUPPORTING DEVICES

A. "C" Beam Clamps:
1. 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.
2. 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.
3. 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.
4. 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.

2.05 CHANNEL SUPPORT SYSTEM

A. Channel Material: 12 gage steel.

B. Finishes:
1. Phosphate and baked green enamel/epoxy.
2. Pre-galvanized.
3. Electro-galvanized.
4. Hot dipped galvanized.

5. Polyvinyl chloride (PVC), minimum 15 mils thick.

C. Fittings/Accessories: Same material and finish as channel.

D. UL Listed Systems:
1. B-Line Systems Inc.'s B-22 (1-5/8 x 1-5/8 inches), B-12 (1-5/8 x 2-7/16 inches), B-11 (1-5/8 x 3-1/4 inches).
2. Grinell Corp.'s Allied Power-Strut PS 200 (1-5/8 x 1-5/8 inches), PS 150 (1-5/8 x 2-7/16 inches), PS 100 (1-5/8 x 3-1/4 inches).
3. Kindorf's B-900 (1-1/2 x 1-1/2 inches), B-901 (1-1/2 x 1-7/8 inches), B-902 (1-1/2 x 3 inches).
4. Unistrut Corp.'s P-3000 (1-3/8 x 1-5/8 inches), P-5500 (1-5/8 x 2-7/16 inches), P-5000 (1-5/8 x 3-1/4 inches)., P-1000 (1-5/8 x 1-5/8 inches), P-1001 (1-5/8 x 3-1/4 inches)
5. Versabar Corp.'s VA-1 (1-5/8 x 1-5/8 inches), VA-3 (1-5/8 x 2-1/2 inches).

PART 3 EXECUTION

3.01 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.

3.02 RACEWAY INSTALLATION

A. Conduit Installed Concealed:
1. Install conduit concealed unless otherwise indicated on the drawings.
2. Existing Construction:
a. Run conduit in existing chases and hung ceilings.
b. If conduit cannot be installed concealed due to conditions encountered in the building, report such conditions and await approval in writing before proceeding.
3. 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. Raceway Schedule:
1. Rigid Ferrous Metal Conduit: Install in all locations unless otherwise specified or indicated on the drawings. Exterior conduit shall be rigid medal conduit.
2. 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.
    c. May be installed exposed in dry non-hazardous mechanical rooms at elevations over 10'-0" above finished floor where conduit does not support equipment.

G. 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.

3.03 OUTLET, JUNCTION AND PULLBOX INSTALLATION

A. Box Schedule For Concealed Conduit System:
1. Non-Fire Rated Construction:
a. Depth: To suit job conditions and comply with NFPA 70 Article 370.
b. For Junction and Pull Boxes: Use galvanized steel boxes with flush covers.
c. For Devices:
1) Plaster or Cast-In-Place Concrete Walls: Use 4 inch or 4-11/16 inch galvanized steel boxes with device covers.
2) 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.
d. 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.
e. 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 pullboxes 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 pullboxes 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.

3.04 CONDUCTOR INSTALLATION

A. Install conductors in raceways.

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 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.
   2. For Class 2 Circuits: Any size to suit application.
   3. For Class 3 Circuits: No. 18 AWG.
   4. 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. Class 1 Circuits: Use Class 1 wiring specified in Part 2 (except where special type insulation is required).
   2. Class 2 Circuits: Use Class 2 wiring specified in Part 2 (except where special type insulation is required).
   3. Class 3 Circuits: Use Class 3 wiring specified in Part 2 (except where special type insulation is required).
   4. Interior Communication Bus Circuits: Use multiconductor cable PLTC.
   5. Exterior Communication Bus Circuits:

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.

3.05 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.

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

SECTION 260523

WIRING FOR MOTORS AND MOTOR CONTROLLERS

PART 1 GENERAL

1.01 SUBMITTALS

A. Shop Drawings: Complete wiring diagrams of all power and control connections (Standard diagrams will not be accepted). Deliver 2 copies of approved wiring diagrams to the Electrical Work Contractor for installation of power wiring and connections required under the Electrical Work Contract.

PART 2 PRODUCTS

2.01 BASIC ELECTRICAL MATERIALS FOR CONTROL WIRING

A. See Section 260502 - Basic Electrical Materials and Methods for Direct Digital Building Control Systems.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. Power Wiring: Not included in this Contract (provided by Electrical Work Contractor). Exception:
   1. Where a power source (at junction box, enclosed circuit breaker, safety switch, or panelboard) is provided by the Electrical Work Contractor, provide power wiring from the power source to the equipment.

B. Control Wiring: Provide control wiring. See Section 260502 for basic installation methods.

END OF SECTION