

## **Division 26**

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SECTION 260221  
MOTORS AND MOTOR CONTROLLERS

PART 1 GENERAL

1.01 PRODUCTS FURNISHED BUT NOT INSTALLED

- A. Deliver the following items to the Electric Contractor for installation and connection to power wiring:
  - 1. Motor controllers.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Wiring, General – 600 Volts and Under: Section 260519.

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. Submittal Package: Submit the product data, and quality control submittals specified below at the same time as a package.
- B. 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.
  - 3. Additional Data for Motors Controlled by Solid State or Adjustable Speed Motor Controllers:

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- a. Data proving that the motor has been designed for use with associated controller.
4. Additional Data for Motors 50 HP and Larger: Certified report of manufacturer's routine tests for each motor (NEMA MG 1-12.54).
- C. Quality Control Submittals:
  1. Harmonic analysis report.
  2. 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.
- D. Contract Closeout Submittals:
  1. System acceptance test report.
  2. Certificate: Affidavit, signed by the Company Field Advisor, 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 Owner'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 Owner/Owner's Representative 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 Owner's Representative 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 Owner's Representative and the Company Field Advisor.
    - a. Make arrangements with the owners of 2 installations (selected by the Owner's Representative) for inspection of the installations by the Owner's Representative. Also obtain the services of the Company Field Advisor for the proposed products to be present. Notify the Owner's Representative 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.

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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 Owner'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 Owner's Representative 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. Harmonic Analysis:
1. The adjustable speed motor controller manufacturer shall perform a harmonic current magnitude and voltage distortion analysis and provide certified calculations specific to this installation, showing that the total harmonic distortion caused by the adjustable speed motor controller will be below the specified level. The analysis shall be accordance with IEEE 519.
  2. The results shall be based on a computer aided/model circuit from the controller to the distribution transformer supplying the controller, based upon the materials and equipment proposed to be furnished and installed, and associated portions of the existing electrical system. The secondary winding connection of the distribution transformer shall be considered the point of common coupling as described in IEEE 519.
    - a. Basic parameters relative to the existing system are specified herein. Additional information deemed necessary by the controller manufacturer to provide a certified harmonic analysis report shall be obtained by a field investigation of the existing system, at no additional cost to the Owner.
- C. Company Field Advisor: Secure the services of a Company Field Advisor from the Company providing the solid state controllers and 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.
- D. Service Availability: A fully equipped service organization shall be available to service the completed Work.

PART 2 PRODUCTS

2.01 MOTORS

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- 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 totally enclosed fan cooled (TEFC) machine unless otherwise specified or indicated on the drawings, or required to suit the application.
- 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	1200	1800	3600
HP			
1.0	80.0	82.5	
1.5	84.0	84.0	82.5
2.0	86.5	84.0	84.0
3.0	86.5	86.5	84.0
5.0	88.5	87.5	85.5
7.5	89.5	88.5	87.5
10	90.2	89.5	88.5
15	91.0	90.2	89.5
20	90.2	91.0	90.2
25	91.7	92.4	91.0
30	92.4	93.0	92.4
40	93.0	93.0	92.4
50	92.4	94.1	92.4
60	93.0	93.6	93.0
75	93.6	94.1	93.6
100	93.6	94.1	93.6
125	94.1	94.1	93.6
150	94.5	94.5	94.5
200	94.5	95.0	95.4

CLOSED MOTORS			
RPM	1200	1800	3600
HP			
1.0	81.5	84.0	
1.5	85.5	85.0	84.0
2.0	86.5	84.0	85.5

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CLOSED MOTORS			
RPM	1200	1800	3600
HP			
3.0	88.5	88.5	86.5
5.0	88.5	88.5	87.5
7.5	89.5	91.0	88.5
10	89.5	91.0	89.5
15	90.2	91.0	89.5
20	91.0	91.7	90.2
25	91.7	92.4	90.2
30	92.4	93.6	91.0
40	93.0	93.0	91.0
50	93.6	93.6	92.4
60	93.6	94.1	94.1
75	94.1	94.5	94.1
100	94.1	95.0	94.1
125	94.1	95.0	94.1
150	95.0	95.0	94.1
200	95.0	95.8	95.01

- C. Motor (Nameplate) Voltage: Provide motor voltage as specified for the individual equipment. Motors 1hp and larger shall be rated 460V, 3 phase.
- 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. Space Heaters: Equip motors rated 100hp and larger with space heaters and accessories to prevent condensation in the motor windings when motor is not operating.
- H. Motor Winding Protection: Equip motors with resistance temperature detectors imbedded in the windings (RTD's) with control unit and accessories for direct reading of

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stator temperatures. Alarm shall sound and motor controller trip at temperature recommended by motor manufacturer.

- I. Additional Requirements For Motors Used With Solid State and Adjustable Speed Motor Controllers:
  - 1. Designed specifically for use with type of controller required.

2.02 MANUAL AND MAGNETIC MOTOR CONTROLLERS

- A. Minimum Size: The minimum allowable size of single or three phase magnetic motor controller is NEMA size 0.
- B. Voltage Rating: To suit system voltage.
  - 1. For single phase motor controllers which are not produced to suit the system voltage and phases, furnish properly rated 3 phase motor controllers and utilize required number of poles for the single phase circuit.
- C. Enclosures:
  - 1. NEMA Type: Unless otherwise indicated, furnish NEMA 12 enclosures.
  - 2. Material: Steel construction unless otherwise indicated.
- D. Control Power: Furnish fused secondary control power transformer (maximum control voltage 120 volts) mounted within each magnetic motor controller enclosure.
- E. Local Control Devices:
  - 1. Manual Motor Controllers:
    - a. Type A1 Controller: In addition to the on/off switch function, furnish where indicated, a hand/auto switch or 3 position hand-off-auto switch mounted in the enclosure cover.
  - 2. Magnetic Motor Controllers: Equip controllers with push buttons, or 3 position hand-off-auto selector switch, (to suit operation) mounted in the enclosure cover.
    - a. For NEMA 1 enclosures furnish standard duty devices.
    - b. For other NEMA enclosures furnish heavy duty devices to suit the requirements of the NEMA enclosure.
- F. Pilot Lights:
  - 1. Manual Motor Controllers: Equip controllers with pilot lights (neon) mounted in the enclosure cover.
  - 2. Magnetic Motor Controllers: Equip controllers with pilot lights of the neon lamp type or transformer type, mounted in the enclosure cover.
- G. Space Heaters: Equip magnetic motor controllers which are installed outdoors, and indoors in unheated locations, with space heaters and humidistat to prevent condensation within the housing.
- H. Overload Devices: Equip motor controllers with manual reset melting type (eutectic), or manual reset bi-metallic type standard trip overload devices (NEMA Class 20, trips in 20 seconds or less when carrying a current equal to 600 percent of its current rating.



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1. Equip motor controllers with automatic reset overload devices only where indicated.
2. Equip motor controllers with fast trip overload devices when recommended by equipment manufacturer (NEMA Class 10, trips in 10 seconds or less when carrying a current equal to 600 percent of its current rating).
3. Equip motor controllers with slow trip overload devices when recommended by equipment manufacturer (NEMA Class 30, trips in 30 seconds or less when carrying a current equal to 600 percent of its current rating).
4. Equip motor controllers with ambient compensated overload protection where motor and relay are not in the same ambient.
5. Equip motor controllers with solid state overload relays where indicated.

K. Manual Motor Controller Types:

1. Type A (Full Voltage, Non-Magnetic): Allen-Bradley Co.'s Bulletin 609, Cutler-Hammer Products' File A/B300-9115, Furnas Electric Co.'s Class 11, General Electric Co.'s CR-1062, or Square D Co.'s Class 2510, Type M.
2. Type A1 (Full Voltage, Non-Magnetic Single Phase): Allen-Bradley Co.'s Bulletin 600, Cutler-Hammer Products' File B200-9101, Furnas Electric Co.'s class 10, General Electric Co.'s CR-101, or Square D Co.'s Class 2510, Type F.
3. Type A2 (2 Speed, 2 Winding, Full Voltage, Non-Magnetic): Allen-Bradley Co.'s Bulletin 609TS, Cutler-Hammer Products' File A700, General Electric Co.'s CR-1062, or Square D Co.'s Class 2512, Type M.
4. Type A3 (2 Speed, 2 Winding, Full Voltage, Non-Magnetic, Single Phase): Allen-Bradley Co.'s Bulletin 600, Cutler-Hammer Products' File B200-9106, General Electric Co.'s CR-101, or Square D Co.'s Class 2512, Type F.

L. Magnetic Motor Controller Types:

1. Type B (Full Voltage Magnetic): Allen-Bradley Co.'s Bulletin 509, Cutler-Hammer Products' File A10-9586, Furnas Electric Co.'s Class 14, General Electric Co.'s CR-306, or Square D Co.'s Class 8536.
2. Type B-COM (Combination Full Voltage, Magnetic/Safety Switch): Allen-Bradley Co.'s Bulletin 512, Cutler-Hammer Products' File A30-9589, Furnas Electric Co.'s Class 17, General Electric Co.'s, CR-308, or Square D Co.'s Class 8538.
3. Type B2 (2 Speed, 2 Winding, Full Voltage, Magnetic): Allen-Bradley Co.'s Bulletin 530, Cutler-Hammer Products' File A700, Furnas Electric Co.'s Class 30, General Electric Co.'s CR-309, or Square D Co.'s Class 8810.

M. Remote Control Stations:

1. Heavy Duty: Start-Stop with pilot light unless otherwise indicated, in NEMA enclosure to suit conditions; Allen-Bradley Co.'s Bulletin 800T, Cutler-Hammer Products' 10250T, Furnas Electric Co.'s Class 52, General Electric Co.'s CR104P, or Square D Co.'s Class 9001.

2.03 SOLID STATE MOTOR CONTROLLERS

- A. Type SS: Microprocessor controlled, solid state, stepless, reduced voltage motor controller:

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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. Rockwell Automation's SMC Flex Smart Motor Controller (5-1250A, 200-600V)
  - b. Safetronics IMS2 solid state starters (18-1574A, 200-690V).
  - c. Benshaw Model RSM7 (1 – 1200hp, 200-600V)
2. Operating Features And Accessories:
  - a. Single speed.
  - b. Constant current starting mode: Motor receives constant current within the current level limit adjustments. Once up to speed the current falls back to the motor running current.
  - c. Voltage limiter set to not exceed voltage rating of motor.
  - d. Ambient operating temperature range 0 to 40 degrees C. Maximum humidity 95 percent.
  - e. Digital display, or meters with switches, showing operational functions:
    - 1) Voltage.
    - 2) Current.
    - 3) Elapsed time.
  - f. Digital display, or LED's showing diagnostic functions, including:
    - 1) Phase loss.
    - 2) Phase reversal.
    - 3) Undervoltage.
    - 4) Overtemperature.
  - g. Trouble alarm contact for remote alarm to Owner's SCADA system.
  - h. Suitable for use on circuit capable of delivering 65,000amps RMS short circuit fault current.
  - i. Input voltage: Suitable for use on 480VAC, 3 phase circuit.
  - j. 100 percent continuous current rating, 300 percent for 30 seconds.
  - k. Local control panel for manual operation:
    - 1) Hand-Automatic selector switch, and start-stop pushbuttons.
    - 2) Run light.
  - l. Local programming panel or other control method for:
    - 1) Acceleration rate.
    - 2) Deceleration rate.
  - m. Fused secondary control power transformer.
  - n. Start/stop control voltage maximum 120 V, 3 wire.
  - o. Auxiliary output contacts, 120 VAC, 10A:
    - 1) Fault: 1 N.O., 1 N.O.
  - p. Overload Devices: Equip motor controller with manual reset solid state, manual reset melting type (eutectic), or manual reset bi-metallic type standard trip overload devices (NEMA Class 20, trips in 20 seconds or less when carrying a current equal to 600 percent of its current rating).
  - q. NEMA 12 enclosure.
  - r. Input circuit breaker/disconnect switch with external operator.
  - s. Transient protective devices on input terminals; Innovative Technology Inc.'s P-Plus Protector or approved equivalent.
  - t. Manual bypass switch to allow the motor to be operated either from the solid state motor controller or across the line.

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- u. Output isolation contactor to open circuit to motor whenever controller is in stop mode.
- v. Provide additional operating features and accessories as required by the manufacturer of the equipment which the motor controller is driving.

2.04 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. Square D Co.'s M Flex w/Altivar 61 or Engineer Approved equal.
  - 2. Operating Features And Accessories:
    - a. Suitable for variable torque load.
    - b. Soft start: Adjustable time range of 2 to 600 seconds.
    - c. Ground fault protection.
    - d. Ambient operating temperature range 0 to 40 degrees C. Maximum humidity 95 percent.
    - e. Digital display showing operational functions:
      - 1) Speed.
      - 2) Output voltage.
      - 3) Output current.
      - 4) Elapsed time.
      - 5) Provide all of these values via Ethernet IP to PLC.
    - f. Digital display, or LED's showing diagnostic functions, including:
      - 1) Overcurrent.
      - 2) Overvoltage.
      - 3) Undervoltage.
      - 4) Overtemperature.
      - 5) Ground fault.
      - 6) Overload.
      - 7) Moisture fault
      - 8) Provide all these values via Ethernet IP to the PLC.
    - g. Fault alarm contact for remote alarm to Owner's SCADA system.
    - h. Suitable for use on circuit capable of delivering 65,000 amps RMS short circuit fault current.
    - i. Input voltage: Suitable for use on 480VAC 3 phase circuit.
    - j. Output voltage 0 to 480 VAC, 3 phase.
    - k. 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.

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- l. 100 percent continuous current rating, 110 percent for one minute every 10 minutes.
- m. Local control panel for manual operation:
  - 1) Hand-Automatic selector switch, and start-stop pushbuttons.
- n. Local programming panel for:
  - 1) Acceleration rate.
  - 2) Deceleration rate.
  - 3) Start torque (boost).
  - 4) Maximum frequency.
  - 5) Volts/Hz pattern.
  - 6) Restart Mode: Manual reset/restart upon return of input power or overload.
  - 8) Start local or remote.
  - 9) Stop mode, ramp or coast.
- o. Interface Input For Automatic Speed Control: Ethernet Interface which accepts signals from programmable logic control, for automatic speed control when the controller is in the automatic mode of operation.
- p. Start/stop control voltage maximum 120 V.
- q. Programmable auxiliary output contacts, 120 VAC, 10A:
  - 1) Spares, for future use: 1 N.O., 1 N.C.
- r. Electronic overload device that monitors the motor function to provide motor overload protection at all speeds. Manual or automatic reset as specified under local programming panel.
- s. Motor winding protection, responsive to the motors' imbedded temperature measuring detectors for all VFD's.
- t. NEMA 12 enclosure with closed loop heat exchanger as provided by the drive manufacturer.
- u. Input circuit breaker/disconnect switch with external operator.
- v. Controller design shall include DC bus choke to reduce harmonic current induced on AC system supplying the drive due to drive operation.
- w. Line reactor on input terminals.
- x. Manual bypass switch to allow the motor to be operated either from the drive keypad or speed pot and push buttons on front of enclosure.
  - 1) Provide 30 mm Pilot lights for Power (white), Running (green), Fault (red), Auto (green) and Manual (amber) Status.
- y. Output isolation contactor to open circuit to motor whenever controller is in stop mode.
- z. Remote operator station, NEMA 1 enclosure:
  - 1) Start.
  - 2) Stop.
- aa. Moisture protection, responsive to the motors internal sensor measuring for all VFD's.
- bb. Provide additional operating features and accessories as required by the manufacturer of the equipment which the adjustable speed motor controller is driving.
- cc. Reference equipment specifications for thermal and moisture protection details.
- dd. Shall include two ethernet ports for connection to plant SCADA.

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2.05 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 (black lettering on white background).

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 REMOTE CONTROL STATION SCHEDULE

- A. Use heavy duty remote control stations in all locations.
- B. Control stations in hazardous areas shall be appropriately rated.

3.03 FIELD QUALITY CONTROL

- A. Preliminary System Test:
  - 1. Preparation: Have the Company Field Advisor program and adjust the completed solid state and 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 Owner'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 solid state and adjustable speed motor controller performs its intended function.

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- b. Use a preapproved harmonics meter to determine the total harmonic distortion caused by the adjustable speed motor controllers.
  - 1) While the motors are running, measure the total harmonic distortion at the distribution transformer supplying the controllers.
  - 2) If total harmonic distortion caused by the adjustable speed motor controllers exceeds specified limit, install additional equipment as necessary to keep the total harmonic distortion caused by the adjustable speed motor controllers under the IEEE 519 limit.
3. Supply all equipment necessary for system adjustment and testing.
4. Submit written report of test results signed by the Company Field Advisor and the Owner's Representative.

3.04 MOTOR CONTROLLER SCHEDULE

- A. Types of Motor Controllers Required For Single Speed Motors, Unless Indicated Otherwise On Drawings:
1. Nominal 120/208 V, Single Phase, 3W, Premises Wiring System:
    - a. Single Phase Motors 5 hp or Less - Manually Operated: Type A. Exception: Type A1 may be used for motors 1 hp or less.
    - b. Single Phase Motors 5 hp or Less - Automatically Operated: Type B. Exception: Type A or Type A1 may be used for motors less than 1/2 hp when the automatic auxiliary controlling device (thermostat, pressure switch, etc.) is rated for the voltage and current requirements of the motor.
  2. 120/208 V, Three Phase, 4W, Premises Wiring System:
    - a. Single Phase Motor Less Than 1 hp - Manually Operated: Type A or Type A1.
    - b. Single Phase Motors Less Than 1 hp - Automatically Operated: Type B. Exception: Type A or Type A1 may be used for motors less than 1/2 hp when the automatic auxiliary controlling device (thermostat, pressure switch, etc.) is rated for the voltage and current requirements of the motor.
    - c. Three Phase Squirrel Cage Motors Less Than 1 hp - Manually or Automatically Operated: Type B-COM.
  3. 277/480 V, Three Phase, 4W, Premises Wiring System:
    - a. Single Phase Motors Less than 1/2 hp - Manually Operated: Type A or Type A1.
    - b. Single Phase Motors Less Than 1/2 hp - Automatically Operated: Type B. Exception: Type A or Type A1 may be used when the automatic auxiliary controlling device (thermostat, pressure switch, etc.) is rated for the voltage and current requirements of the motor.
    - c. Three Phase Squirrel Cage Motors Less than 15 hp - Manually or Automatically Operated: Type B-COM (B when indicated on drawings) or Type SS.
    - d. Three Phase Squirrel Cage Motors 15 hp and Larger - Manually or Automatically Operated: Type C-COM or Type SS.

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- B. Types of Motor Controllers Required For 2 Speed Motors, Unless Indicated Otherwise on Drawings:
1. Nominal 120/240 V, Single Phase, 3W, Premises Wiring System:
    - a. Single Phase Motors 5 hp or Less - Manually Operated: Type A2.  
Exception: Type A3 may be used for motors 1 hp or less.
    - b. Single Phase Motors 5 hp or Less - Automatically Operated: Type B2.
  2. 120/208 V, Three Phase, 4W, Premises Wiring System:
    - a. Single Phase Motors Less Than 1 hp - Manually Operated: Type A2.  
Exception: Type A3 may be used for motors 1/2 hp or less.
    - b. Single Phase Motors Less Than 1 hp - Automatically Operated: Type B2.
    - c. Three Phase Squirrel Cage Motors Less Than 7-1/2 hp - Manually or Automatically Operated: Type B2 or Type SS.
    - d. Three Phase Squirrel Cage Motors 7-1/2 hp and Larger: Type SS.
  3. 277/480 V, Three Phase, 4W, Premises Wiring System:
    - a. Single Phase Motors Less Than 1/2 hp - Manually Operated: Type A2 or Type A3.
    - b. Single Phase Motors Less Than 1/2 hp - Automatically Operated: Type B2.
    - c. Three Phase Squirrel Cage Motors Less Than 15 hp - Manually or Automatically Operated: Type B2 or Type SS.
    - d. Three Phase Squirrel Cage Motors 15 hp and Larger: Type B-COM or Motor Control Center.
- C. Types of Motor Controllers Required For Variable Speed Applications:
1. Three Phase Premises Wiring System:
    - a. Three Phase Motors 1 to 800 hp: Type AS-PWM.

END OF SECTION

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SECTION 260441  
SWITCHBOARDS

PART 1 GENERAL

1.01 REFERENCES

- A. NEMA, and UL.

1.02 SUBMITTALS

- A. Submittals Package: Submit the shop drawings, product data, and quality control submittals specified below at the same time as a package.
- B. Shop Drawings; include the following for each switchboard:
1. Front and plan view with overall dimensions.
  2. Details showing type of construction and available conduit space.
  3. Voltage rating, and continuous current rating of the through bus and distribution sections.
  4. Short-circuit current rating.
  5. Enumeration of each circuit breaker including frame size, ATE, number of poles, and interrupting capacity.
  6. Wiring and schematic diagrams.
  7. A coordinated selective scheme between the main device and feeder devices so that under fault conditions the feeder device clears the fault while the main device remains closed.
  8. A statement for each switchboard indicating that it will bear a UL label.
- C. Product Data:
1. Catalog sheets, specifications and installation instructions.
    - a. For devices equipped with ground fault protection, include information sheets describing system testing instructions and test form which comply with UL 891 requirements entitled "45. Field Testing of Ground Fault Protection of Equipment."
  2. Bill of materials.
  3. Name, address and telephone number of nearest fully equipped service organization.
- E. 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.
- F. Contract Closeout Submittals:
1. System acceptance test report.
  2. Certificate: Affidavit, signed by the Company Field Advisor, certifying that the system meets the contract requirements and is operating properly.

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3. Operation and Maintenance Data: Deliver 2 copies, covering the installed products, to the Owner 's Representative.

1.03 QUALITY ASSURANCE

- A. Equipment Qualifications For Products Other Than Those Specified:
  1. At the time of submission provide written notice to the Owner 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 Owner 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 Owner 's Representative and the Company Field Advisor.
    - a. Make arrangements with the owners of 2 installations (selected by the Owner) for inspection of the installations by the Owner 's Representative. Also obtain the services of the Company Field Advisor for the proposed products to be present. Notify the Owner 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 Owner '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 Owner 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 for a minimum of 8 working hours for the following:
  1. Render advice regarding switchboard installation, and final adjustment of the switchboard devices.
  2. Witness final system test and then certify with an affidavit that the switchboard is installed in accordance with the contract documents and is operating properly.
  3. Train facility personnel on the operation and maintenance of the switchboard devices (minimum of two 1 hour sessions).
  4. Explain available service programs to facility supervisory personnel for their consideration.

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

1.04 DELIVERY, STORAGE AND HANDLING

- A. Protection: Provide supplemental heating devices, such as incandescent lamps or low wattage heaters within the enclosure or under a protective cover to control dampness. Maintain this protection from the time equipment is delivered to the site until it is energized.

PART 2 PRODUCTS

2.01 SWITCHBOARD

- A. Cutler-Hammer/Eaton Corp.'s Pow-R-Line C, General Electric Co.'s AV-3 Line, Siemens Type SB or Square D Co.'s QED, having:
1. Ratings as indicated on drawings.
  2. UL label "SUITABLE FOR USE AS SERVICE EQUIPMENT".
  3. Front accessibility.
  4. Sections flush at rear (rear alignment).
  5. Main device: Stationary circuit breaker (see circuit breaker paragraph).
  6. Fully rated copper bus bars.
    - a. Ampere rating of through bus not less than frame size of main device.
  7. Full length copper ground bus.
  8. Sections that are designated "space" or "provision for future breaker" equipped with all accessories required to accept a future circuit breaker.
  9. Space heaters with thermostatic control.
  10. Circuit Breakers:
    - a. Mounting: Group mounted, or individually mounted as necessary to accommodate the circuit breaker style and switchboard construction.
    - b. Style: Molded case, or power circuit breakers, as required to accommodate the circuit breaker components.
    - c. Trip Device: Programmable solid state.
    - d. Interrupting Capacity: Equal to, or greater than, the short circuit rating required for the switchboard.
    - e. Component Description: See switchboard One Line Diagram for specific components required for each circuit breaker. In addition to the specific components, equip each circuit breaker with additional components as required to achieve a coordinated selective scheme between the main device and the feeder devices.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install switchboards in accordance with NEMA Publication No. PB2.1 "Instructions for Proper Handling, Installation, Operation and Maintenance of Deadfront Distribution Switchboards".

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1. Set and program the switchboard devices in accordance with the approved coordinated selective scheme.
- B. Install foundation channels for anchoring and leveling of each switchboard.
- C. Identification:
  1. Install on the front of each switchboard, a phenolic nameplate with ½" high lettering indicating the designation of the switchboard as indicated on the One Line Diagram (black lettering on a white background).
  2. Install on the front of each circuit breaker, a phenolic nameplate indicating load served by circuit breaker (black lettering on a white background).

3.02 FIELD QUALITY CONTROL

- A. Preliminary System Test:
  1. Preparation: Have the Company Field Advisor adjust the completed switchboard devices 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 the switchboard is 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 Owner'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. Test devices which have ground fault protection in accordance with the approved information sheets and test form.
    - b. Test programmable solid state trip devices in accordance with the manufacturer's recommendations.
  3. Supply all equipment necessary for system adjustment and testing.
  4. Submit written report of test results signed by the Company Field Advisor and the Owner's Representative.

END OF SECTION

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WIRING, GENERAL – 600 VOLTS AND UNDER

PART 1 GENERAL

1.01 SUBMITTALS

- A. Data: Catalog sheets, specifications and installation instructions.

1.02 PRODUCT DELIVERY

- A. Mark and tag insulated conductors and cables for delivery to the site, include:
1. Contractor's name.
  2. Date of manufacture (month & year).
  3. Manufacturer's name.
  4. Data which explains the meaning of coded identification (UL assigned electrical reference numbers, UL assigned combination of color marker threads, etc.).
  5. Environmental suitability information (listed or marked "sunlight resistant" where exposed to direct rays of sun; wet locations listed/marked for use in wet locations; other applications listed/marked suitable for the applications).

PART 2 PRODUCTS

2.01 INSULATED CONDUCTORS AND CABLES

- A. Date of Manufacture: No insulated conductor more than one year old when delivered to the site will be acceptable.
- B. Acceptable Companies: American Insulated Wire Corp., BICC General Cable Industries Inc., Cerro Wire & Cable Co. Inc., Pirelli Cable Corp., or Southwire Co.
- C. 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. Conductor sizes No. 8 and larger shall be stranded.
- D. Types:
1. Electric Light and Power Wiring:
    - a. General: Rated 600V, NFPA 70 Type FEP, THHN, THW, THW-2, THWN, THWN-2, XHH, XHHW, XHHW-2.
    - b. Metal-Clad Cable, NFPA 70 Article 334 Type MC:
      - 1) Interlocked flexible galvanized steel armor sheath, conforming to UL requirements for type MC metal clad cable.
      - 2) Insulated copper conductors, suitable for 600 volts, rated 90°C, one of the types listed in NFPA 70 Table 310-13 or of a type identified for use in Type MC cable.
      - 3) Internal full size copper ground conductor with green insulation.
      - 4) Acceptable Companies: AFC Cable Systems Inc., Coleman Cable Co.
      - 5) Connectors for MC cable: AFC Fitting Inc.'s AFC Series,

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Arlington Industries Inc.'s Saddle grip, or Thomas & Betts Co.'s Tite-Bite with anti-short bushings.

2. 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, PTF, 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.
3. 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.
4. 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.

2.02 CONNECTORS

- A. General:
  1. 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. Connectors shall be UL 486 A listed, or UL 486 B listed for combination dual rated copper/aluminum connectors (marked AL7CU for 75 degrees C rated circuits and AL9CU for 90 degrees C rated circuits).
- B. Splices:
  1. Spring Type:
    - a. 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.
    - b. Rated 150° C, 600V; Ideal Industries Inc.'s High Temperature Wire-Nut Model 73B, 59B.
  2. Indent Type with Insulating Jacket:
    - a. 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.
  3. Indent Type (Uninsulated): Anderson/Hubbell's Versa-Crimp, VERSAtile,

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- 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.
4. Connector Blocks: NIS Industries Inc.'s Polaris System, or Thomas & Betts Corp.'s Blackburn AMT Series.
  5. 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.
  6. Heat Shrinkable Splices: Electrical Products Div./3M's ITC SN, Raychem Corp.'s Thermofit Type WCS, or Thomas & Betts Corp.'s SHRINK-KON Insulators.
  7. Cold Shrink Splices: Electrical Products Div./3M's 8420 Series.
- C. Gutter Taps: Anderson/Hubbell's GP/GT with GTC Series Covers, Blackburn/T&B Corp.'s H-Tap Type CF with Type C Covers, Framatome Connectors/Burndy's Polytap KPU-AC, H-Crimpit Type YH with CF-FR Series Covers, ILSCO's GTA Series with GTC Series Covers, Ideal Industries Inc.'s Power-Connect GP, GT Series with GIC covers, NSI Industries Inc.'s Polaris System, OZ/Gedney Co.'s PMX or PT with PMXC, PTC Covers, Penn-Union Corp.'s CDT Series, or Thomas & Betts Corp.'s Color-Keyed H Tap CHT with HTC Covers.
- D. 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.
- E. Lugs:
1. Single Cable (Compression Type Lugs): Copper, 1 or 2 hole style (to suit conditions), long barrel; Anderson/Hubbell's VERSAtile VHCL, Blackburn/T&B Corp.'s Color-Coded CTL, LCN, Framatome Connectors/Burndy's Hylug YA, Electrical Products Div./3M Scotchlok 31036 or 31145 Series, Ideal Industries Inc.'s CCB or CCBL, NSI Industries Inc.'s L, LN Series, Penn-Union Corp.'s BBLU Series, or Thomas & Betts Corp.'s 54930BE or 54850BE Series.
  2. Multiple Cable (Mechanical Type Lugs): Copper, configuration to suit conditions; Framatome Connectors/Burndy's Qiklug Series, NSI Industries Inc.'s Type TL, Penn-Union Corp.'s VI-TITE Terminal Lug Series, or Thomas & Betts Corp.'s Color-Keyed Locktite Series.

2.03 TAPES

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

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- C. Electrical Filler Tape: Electrical Products Div./3M's Scotchfil, or Plymouth Rubber Co.'s Plymouth/Bishop 125 Electrical Filler Tape.
- D. Color Coding Tape: Electrical Products Div./3M's Scotch 35, or Plymouth Rubber Co.'s Plymouth/Bishop Premium 37 Color Coding.
- E. Arc Proofing Tapes:
  - 1. Arc Proofing Tape: Electrical Products Div./3M's Scotch 77, Mac Products Inc.'s AP Series, or Plymouth Rubber Co.'s Plymouth/Bishop 53 Plyarc.
  - 2. Glass Cloth Tape: Electrical Products Div./3M's Scotch 27/Scotch 69, Mac Products Inc.'s TAPGLA 5066, or Plymouth Rubber Co.'s Plymouth/Bishop 77 Plyglas.
  - 3. Glass-Fiber Cord: Mac Products Inc.'s MAC 0527.

2.04 WIRE-PULLING COMPOUNDS

- A. To suit type of insulation; American Polywater Corp.'s Polywater Series, Electric Products Div./3M's WL, WLX, or WLW, Greenlee Textron Inc.'s Y-ER-EAS, Cable Cream, Cable Gel, Winter Gel, Ideal Industries Inc.'s Yellow 77, Aqua-Gel II, Agua-Gel CW, or Thomas & Betts Corp.'s Series 15-230 Cable Pulling Lubricants, or Series 15-631 Wire Slick.

2.06 TAGS

- A. Precision engrave letters and numbers with uniform margins, character size minimum 3/16 inches high.
  - 1. Phenolic: Two color laminated engraver's stock, 1/16-inch minimum thickness, machine engraved to expose inner core color (white).
  - 2. Aluminum: Standard aluminum alloy plate stock, minimum .032 inches thick, engraved areas enamel filled or background enameled with natural aluminum engraved characters.

2.07 WIRE MANAGEMENT PRODUCTS

- A. Cable Clamps and Clips, Cable Ties, Spiral Wraps, etc: Catamount/T&B Corp., or Ideal Industries Inc.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install conductors in raceways after the raceway system is completed. Exceptions: Type MC, or other type specifically indicated on the drawings not to be installed in raceways.
- B. No grease, oil, or lubricant other than wire-pulling compounds specified may be used to facilitate the installation of conductors.



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3.02 CIRCUITING

- A. Do not change, group or combine circuits other than as indicated on the drawings.

3.03 COMMON NEUTRAL CONDUCTOR

- A. A common neutral shall not be used for 2 or 3 branch circuits.

3.04 CONDUCTOR SIZE

- A. Conductor Size:
1. For Electric Light and Power Branch Circuits: Install conductors of size shown on drawings. Where size is not indicated, the minimum size allowed is 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: Minimum No. 18 AWG.

3.05 COLOR CODING

- A. Color Coding for 208/120 Volt and 240/120 Volt Electric Light and Power Wiring:
1. Color Code:
    - a. 2 wire circuit - black, white.
    - b. 3 wire circuit - black, red, white.
    - c. 4 wire circuit - black, red, blue, white.
  2. White to be used only for an insulated grounded conductor (neutral). If neutral is not required use black and red, or black, red and blue for phase to phase circuits.
    - a. "White" for Sizes No. 6 AWG or Smaller:
      - 1) Continuous white outer finish, or:
      - 2) Three continuous white stripes on other than green insulation along its continuous length.
    - b. "White" for Sizes Larger Than No. 6 AWG:
      - 1) Continuous white outer finish, or:
      - 2) Three continuous white stripes on other than green insulation along its continuous length, or:
      - 3) Distinctive white markings (color coding tape) encircling the conductor, installed on the conductor at time of its installation. Install white color coding tape at terminations, and at 1' 0" intervals in gutters, pullboxes, and manholes.
  3. Colors (Black, Red, Blue):
    - a. For Branch Circuits: Continuous color outer finish.
    - b. For Feeders:
      - 1) Continuous color outer finish, or:
      - 2) Color coding tapes encircling the conductors, installed on the

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conductors at time of their installation. Install color coding tapes at terminations, and at 1' 0" intervals in gutter, pullboxes, and manholes.

- B. Color Coding For 277/480 Volt Electric Light and Power Wiring:
1. Color Code:
    - a. 2 wire circuit – brown, gray.
    - b. 3 wire circuit – brown, yellow, gray.
    - c. 4 wire circuit – brown, yellow, orange, gray.
  2. Gray to be used only for an insulated grounded conductor (neutral). If neutral is not required use brown and yellow, or brown, yellow and orange for phase to phase circuits.
    - a. "Gray" For Sizes No. 6 AWG or Smaller.
      - 1) Continuous gray outer finish.
    - b. "Gray" For Sizes Larger Than No. 6 AWG:
      - 1) Distinctive gray markings (color coding tape) encircling the conductor, installed on the conductor at time of its installation. Install gray color coding tape at terminations, and at 1' 0" intervals in gutters, pullboxes, and manholes.
    - c. Colors (Brown, Yellow, Orange):
    - d. For Branch Circuits: Continuous color outer finish.
    - e. For Feeders:
      - 1) Continuous color outer finish, or:
      - 2) Color coding tapes encircling the conductors, installed on the conductors at the time of their installation. Install color coding tapes at terminations, and at 1' 0" intervals in gutters, pullboxes, and manholes.
- C. More Than One Nominal Voltage System Within A Building: Permanently post the color coding scheme at each branch-circuit panelboard.
- D. Existing Color Coding Scheme: Where an existing color coding scheme is in use, match the existing color coding if it is in accordance with the requirements of NFPA 70.
- E. Color Code For Wiring Other Than Electric Light and Power: In accordance with ICEA/NEMA WC-30 "Color Coding of Wires and Cables". Other coding methods may be used, as approved.

3.06 IDENTIFICATION

- A. Identification Tags: Use tags to identify feeders and designated circuits. Install tags so that they are easily read without moving adjacent feeders or requiring removal of arc proofing tapes. Attach tags with non-ferrous wire or brass chain.
1. Interior Feeders: Identify each feeder in pullboxes and gutters. Identify by feeder number and size.
  2. Exterior Feeders: Identify each feeder in manholes and in interior pullboxes and gutters. Identify by feeder number and size, and also indicate building number and

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- panel designation from which feeder originates.
3. Street and Grounds Lighting Circuits: Identify each circuit in manholes and lighting standard bases. Identify by circuit number and size, and also indicate building number and panel designation from which circuit originates.

- B. Identification Plaque: Where a building or structure is supplied by more than one service, or has any combination of feeders, branch circuits, or services passing through it, install a permanent plaque or directory at each service, feeder and branch circuit disconnect location denoting all other services, feeders, or branch circuits supplying that building or structure or passing through that building or structure and the area served by each.

3.07 WIRE MANAGEMENT

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

3.08 EQUIPMENT GROUNDING CONDUCTOR

- A. Install equipment grounding conductor:
1. Where specified in other Sections or indicated on the drawings.
  2. In conjunction with circuits recommended by equipment manufacturers to have equipment grounding conductor.
- B. Equipment grounding conductor is not intended as a current carrying conductor under normal operating circumstances.
- C. Color Coding For Equipment Grounding Conductor:
1. Color Code: Green.
  2. "Green" For sizes No. 6 AWG or Smaller:
    - a. Continuous green outer finish, or:
    - b. Continuous green outer finish with one or more yellow stripes, or:
    - c. Bare copper (see exception below).
  3. "Green" For Sizes Larger Than No. 6:
    - a. Stripping the insulation or covering from the entire exposed length (see exception below).
    - b. Marking the exposed insulation or covering with green color coding tapes.
    - c. Identify at each end and at every point where the equipment grounding conductor is accessible.

3.09 SPECIAL GROUNDING CONDUCTORS

- A. Technical Power System Grounding (Equipment grounding conductor isolated from the premises grounded conductor except at a single grounded termination point): Install an insulated grounding conductor running with the circuit conductors for isolated receptacles or utilization equipment requiring an isolated ground:
1. Color Code: Green.
  2. "Green" For Isolated Grounding Conductor:

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- a. Continuous green outer finish, or:
  - b. Continuous green outer finish with one or more yellow stripes, and:
  - c. Different than the “green” used for the equipment grounding conductor run with the circuit (where required).
3. Install label at every point where the conductor is accessible, identifying it as an “Isolated Grounding Conductor”.

3.10 ARC PROOFING

- A. Arc proof feeders installed in a common pullbox or manhole as follows:
1. Arc proof new feeders.
  2. Arc proof existing feeders that are spliced to new feeders.
  3. Arc proof each feeder as a unit (except feeders consisting of multiple sets of conductors).
  4. Arc proof feeders consisting of multiple sets of conductors by arc proofing each set of conductors as a unit.
  5. Arc proof feeders with half-lapped layer of 55 mils thick arc proofing tape and random wrapped or laced with glass cloth tape or glass-fiber cord. For arc proofing tape less than 55 mils thick, add layers to equivalent of 55 mils thick arc proofing tape.

3.11 INSULATED CONDUCTOR AND CABLE SCHEDULE - TYPES AND USE

- A. Electric Light and Power Circuits:
1. 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).
  2. 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).
  3. THHN, THWN or THWN-2: Wiring installed in existing raceway systems (except where special type insulation is required).
  4. THHN, THW-2, THWN-2, XHHW, or XHHW-2: Wiring for electric discharge lighting circuits (fluorescent, HID), except where fixture listing requires wiring rated higher than 90° C.
  5. USE, or USE-2: Wiring indicated on the drawings to be direct burial in earth.
  6. USE, or USE-2 Marked “Sunlight Resistant”:
    - a. Service entrance wiring from overhead service to the service equipment.
    - b. Wiring exposed to the weather and unprotected (except where special type insulation is required).
  7. MC:
    - a. Branch circuit wiring in movable metal partitions.
      - 1) Install conductors in accordance with partition manufacturer’s recommendations.
- C. Class 1 Circuits: Use Class 1 wiring specified in Part 2 (except where special type insulation is required).

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

3.12 CONNECTOR SCHEDULE - TYPES AND USE

- A. 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.
- B. Splices: Splices shall be used in lighting and 120V receptacle wiring only, and shall only be made in junction boxes:
  - 1. Dry Locations:
    - a. 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. For Conductors No. 6 AWG or Larger: Use connector blocks or uninsulated indent type pressure connectors. Fill indentions in uninsulated connectors with electrical filler tape and apply insulation tape to insulation equivalent of the conductor, or insulate with heat shrinkable splices or cold shrink splices.
    - c. Gutter Taps in Panelboards: For uninsulated type gutter taps fill indentions with electrical filler tape and apply insulation tape to insulation equivalent of the conductor, or insulate with gutter tap cover.
  - 2. 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).
  - 3. 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.
- C. Terminations:
  - 1. For Conductors No. 10 AWG or Smaller: Use terminals for:
    - a. Connecting wiring to equipment designed for use with terminals.
  - 2. For Conductors No. 8 AWG or Larger: Use compression or mechanical type lugs for:
    - a. Connecting cables to flat bus bars.
    - b. Connecting cables to equipment designed for use with lugs.
  - 3. For Conductor Sizes Larger than Terminal Capacity on Equipment: Reduce the larger conductor to the maximum conductor size that terminal can accommodate (reduced section not longer than one foot). Use compression or mechanical type connectors suitable for reducing connection.

END OF SECTION

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SECTION 260526  
SERVICE GROUNDING AND BONDING

PART 1 GENERAL

1.01 SUBMITTALS

- A. Product Data: Catalog sheets, specifications and installation instructions.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Ground Clamps (Cable to Pipe): Blackburn/T&B Corp.'s GUV, Framatome Connectors/Burndy Corp.'s GAR, GD, GP, GK, or OZ/Gedney Co.'s ABG, CG.
- B. Ground Clamps (Cable to Rod): Blackburn/T&B Corp.'s GG, GGH, JAB, JABH, GUV, Dossert Corp.'s GN, GPC, Framatome Connectors/Burndy Corp.'s GP, GX, GRC, or OZ/Gedney Co.'s ABG.
- C. Ground Lugs: Copper, 1 or 2 hole style (to suit conditions), long barrel; Anderson/Hubbell's VERSAtile VHCL, Blackburn/T&B Corp.'s Color-Coded CTL, LCN, Framatome Connectors/Burndy's Hylug YA, Electrical Products Div./3M Scotchlok 31036 or 31145 Series, Ideal Industries Inc.'s CCB or CCBL, or Thomas & Betts Corp.'s 54930BE or 54850BE Series.
- D. Exothermic Type Weld: Erico Inc.'s Cadweld Process, or Furseweld/T&B Corp.'s Exothermic Welding System.
- E. Compression Connectors: Amp Inc.'s Ampact Copper Grounding System, or Burndy Corp.'s Hyground System.
- F. Rod Electrodes: Copper clad (minimum 0.010 jacket) ground rods minimum 3/4 inches diameter by 10'-0" long.
- G. Plate Electrodes: Copper plates minimum 0.06 inches thick by 2'-0" square feet of surface area.
- H. Grounding Electrode Conductors and Bonding Conductors: Copper conductors, bare or insulated with THW, THW-2, XHHW, XHHW-2, THWN, THWN-2 or THHN insulation.
- I. Hardware: Silicon-bronze bolts, nuts, flat and lock washers etc. as manufactured by Dossert Corp., Framatome Connectors/Burndy Corp., or OZ/Gedney Co.

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SERVICE GROUNDING AND BONDING

PART 3 EXECUTION

3.01 INSTALLATION

- A. Connections:
  - 1. Make grounding and bonding connections, except buried connections, with silicon-bronze hardware and ground clamps, ground lugs or compression connectors, to suit job conditions.
  - 2. For buried connections use exothermic type weld or compression connectors.

END OF SECTION



SECTION 260529  
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUBMITTALS

- A. Shop Drawings: Show support details if different from methods specified or shown on the drawings.
- B. Product Data: Catalog sheets, specifications and installation instructions.

PART 2 PRODUCTS

2.01 ANCHORING DEVICES

- A. Sleeve Anchors (FS FF-S-325 Group II, Type 3, Class 3): Molly/Emhart's Parasleeve Series, Phillips' Red Head AN, HN, FS Series, or Ramset's Dynabolt Series.
- B. Wedge Anchors (FS FF-S-325 Group II, Type 4, Class 1): Hilti's Kwik Bolt Series, Molly/Emhart's Parabolt Series, Phillips' Red Head WS, or Ramset's Trubolt Series.
- C. Self-Drilling Anchors (FS FF-S-325 Group III, Type 1): Phillips' Red Head Series S or Ramset's Ram Drill Series.
- D. Non-Drilling Anchors (FS FF-S-325 Group VIII, Type 1): Hilti's Drop-In Anchor Series, Phillips' Red Head J Series, or Ramset's Dynaset Series.
- E. Stud Anchors (FS FF-S-325 Group VIII, Type 2): Phillips' Red Head JS Series.

2.02 CAST-IN-PLACE CONCRETE INSERTS

- A. Continuous Slotted Type Concrete Insert, Galvanized:
  - 1. Load Rating 1300 lbs./ft.: Kindorf's D-986.
  - 2. Load Rating 2400 lbs./ft.: Kindorf's D-980.
  - 3. Load Rating 3000 lbs./ft.: Hohmann & Barnard Inc.'s Type CS-H.
  - 4. Load Rating 4500 lbs./ft.: Hohmann & Barnard Inc.'s Type CS-HD.
- B. Threaded Type Concrete Insert: Galvanized ferrous castings, internally threaded.
- C. Wedge Type Concrete Insert: Galvanized box-type ferrous castings, designed to accept bolts having special wedge-shaped heads.

2.03 MISCELLANEOUS FASTENERS

- A. Except where shown otherwise on the Drawings, furnish type, size, and grade required for proper installation of the Work, selected from the following: Furnish galvanized fasteners for exterior use, or for items anchored to exterior walls, except where stainless steel is indicated.

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HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

1. Standard Bolts and Nuts: ASTM A 307, Grade A, regular hexagon head.
2. Lag Bolts: FS FF-B-561, square head type.
3. Machine Screws: FS FF-S-92, cadmium plated steel.
4. Machine Bolts: FS FF-B-584 heads; FF-N-836 nuts.
5. Wood Screws: FS FF-S-111 flat head carbon steel.
6. Plain Washers: FS FF-W-92, round, general assembly grade carbon steel.
7. Lock Washers: FS FF-W-84, helical spring type carbon steel.
8. Toggle Bolts: Tumble-wing type; FS FF-B-588, type, class and style as required to sustain load.

- B. Stainless Steel Fasteners: Type 302 for interior Work; Type 316 for exterior Work; Phillips head screws and bolts for exposed Work unless otherwise specified.

2.04 TPR (THE PEEL RIVET) FASTENERS

- A. 1/4 inch diameter, threadless fasteners distributed by Subcon Products, 315 Fairfield Road, Fairfield, NJ 07004 (800) 634-5979.

2.05 POWDER DRIVEN FASTENER SYSTEMS

- A. Olin Corp.'s Ramset Fastening Systems, or Phillips Drill Company Inc.'s Red Head Powder Actuated Systems.

2.06 HANGER RODS

- A. Mild low carbon steel, unless otherwise specified; fully threaded or threaded each end, with nuts as required to position and lock rod in place. Unless galvanized or cadmium plated, provide a shop coat of red lead or zinc chromate primer paint.

2.07 "C" BEAM CLAMPS

- A. With Conduit Hangers:
1. For 1 Inch Conduit Maximum: B-Line Systems Inc.'s BG-8, BP-8 Series, Caddy/Erico Products Inc.'s BC-8P and BC-8PSM Series, or GB Electrical Inc.'s HIT 110-412 Series.
  2. For 3 Inch Conduit Maximum: Appleton Electric Co.'s BH-500 Series beam clamp with H50W/B Series hangers, Kindorf's 500 Series beam clamp with 6HO-B Series hanger, or OZ/Gedney Co.'s IS-500 Series beam clamp with H-OWB Series hanger.
  3. For 4 Inch Conduit Maximum: Kindorf's E-231 beam clamp and E-234 anchor clip and C-149 series lay-in hanger; Unistrut Corp.'s P2676 beam clamp and P-1659A Series anchor clip with J1205 Series lay in hanger.
- B. For Hanger Rods:
1. For 1/4 Inch Hanger Rods: B-Line Systems Inc.'s BC, Caddy/Erico Products Inc.'s BC, GB Electrical Inc.'s HIT 110, Kindorf's 500, 510, or Unistrut Corp.'s P1648S, P2398S, P2675, P2676.
  2. For 3/8 Inch Hanger Rods: Caddy/Erico Products Inc.'s BC, Kindorf's 231-3/8, 502,

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HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

- or Unistrut Corp.'s P1649AS, P2401S, P2675, P2676.
- 3. For 1/2 Inch Rods: Appleton Electric Co. BH-500 Series, Kindorf's 500 Series, 231-1/2, OZ/Gedney Co.'s IS-500 Series, or Unistrut Corp.'s P1650AS, P2403S, P2676.
- 4. For 5/8 Inch Rods: Unistrut Corp.'s P1651AS beam clamp and P1656A Series anchor clip.
- 5. For 3/4 Inch Rods: Unistrut Corp.'s P1653S beam clamp and P1656A Series anchor clip.

2.08 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: 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).
  - 5. Versabar Corp.'s VA-1 (1-5/8 x 1-5/8 inches), VA-3 (1-5/8 x 2-1/2 inches).

2.09 MISCELLANEOUS FITTINGS

- A. Side Beam Brackets: B-Line Systems Inc.'s B102, B103, B371-2, Kindorf's B-915, or Versabar Corp.'s VF-2305, VF-2507.
- B. Pipe Straps:
  - 1. Two Hole Steel Conduit Straps: B-Line Systems Inc.'s B-2100 Series, Kindorf's C-144 Series, or Unistrut Corp.'s P-2558 Series.
  - 2. One Hole Malleable Iron Clamps: Kindorf's HS-400 Series, or OZ/ Gedney Co.'s 14-G Series, 15-G Series (EMT).
- C. Deck Clamps: Caddy/Erico Products Inc.'s DH-4-T1 Series.
- D. Fixture Stud and Strap: OZ/Gedney Co.'s SL-134, or Steel City's FE-431.

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- E. Supporting Fittings for Pendent Mounted Industrial Type Fluorescent Fixtures on Exposed Conduit System:
  - 1. Ball Hanger: Appleton Electric Co.'s AL Series, or Crouse-Hinds Co.'s AL Series.
  - 2. Flexible Fixture Hanger: Appleton Electric Co.'s UNJ-50, UNJ-75, or Crouse-Hinds Co.'s UNJ115.
  - 3. Flexible (Hook Type) Fixture Hanger: Appleton Electric Co.'s FHMF, or Crouse-Hinds Co.'s UNH-1.
  - 4. Eyelet: Unistrut Corp.'s M2250.
  - 5. Eyelet with Stud: Kindorf's H262, or Unistrut Corp.'s M2350.
  - 6. Conduit Hook: Appleton Electric Co.'s FHSN, or Crouse-Hinds Co.'s UNH-13.
- F. Supporting Fasteners (Metal Stud Construction): Metal stud supports, clips and accessories as produced by Caddy/Erco Products Inc.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Where specific fasteners are not specified or indicated for securing items to in-place construction, provide appropriate type, size, and number of fasteners for a secure, rigid installation.
- B. Install anchoring devices and other fasteners in accordance with manufacturer's printed instructions.
- C. Make attachments to structural steel wherever possible.

3.02 FASTENER SCHEDULE

- A. Material:
  - 1. Use cadmium or zinc coated anchors and fasteners in dry locations.
  - 2. Use hot dipped galvanized or stainless-steel anchors and fasteners in damp and wet locations.
  - 3. For corrosive atmospheres or other extreme environmental conditions, use fasteners made of materials suitable for the conditions.
  - 4. Fasteners in process areas or areas subject to corrosive fumes or process liquids shall be PVC coated.
- B. Types and Use: Unless otherwise specified or indicated use:
  - 1. Cast-in-place concrete inserts in fresh concrete construction for direct pull-out loads such as shelf angles or fabricated metal items and supports attached to concrete slab ceilings.
  - 2. Anchoring devices to fasten items to solid masonry and concrete when the anchor is not subjected to pull out loads, or vibration in shear loads.
  - 3. Toggle bolts to fasten items to hollow masonry and stud partitions.
  - 4. TPR fasteners to fasten items to plywood backed gypsum board ceilings.

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HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

5. Metallic fasteners installed with electrically operated or powder driven tools for approved applications, except:
  - a. Do not use powder driven drive pins or expansion nails.
  - b. Do not attach powder driven or welded studs to structural steel less than 3/16 inch thick.
  - c. Do not support a load, in excess of 250 lbs from any single welded or powder driven stud.
  - d. Do not use powder driven fasteners in precast concrete.

3.03 ATTACHMENT SCHEDULE

- A. General: Make attachments to structural steel or steel bar joists wherever possible. Provide intermediate structural steel members where required by support spacing. Select steel members for use as intermediate supports based on a minimum safety factor of 5.
  1. Make attachments to steel bar joists at panel points of joists.
  2. Do not drill holes in main structural steel members.
  3. Use "C" beam clamps for attachment to steel beams.
- B. Where it is not possible to make attachments to structural steel or steel bar joists, use the following methods of attachment to suit type of construction unless otherwise specified or indicated on the drawings:
  1. Attachment to Steel Roof Decking (No Concrete Fill):
    - a. Decking With Hanger Tabs: Use deck clamps.
    - b. Decking Without Hanger Tabs:
      - 1) Before Roofing Has Been Applied: Use 3/8 inch threaded steel rod welded to a 4 x 4 x 1/4 inch steel plate and installed through 1/2 inch hole in roof deck.
      - 2) After Roofing Has Been Applied: Use welding studs, or self-drilling/tapping fasteners. Exercise extreme care when installing fasteners to avoid damage to roofing.
  2. Attachment to Concrete Filled Steel Decks (Total thickness, 2-1/2 inches or more):
    - a. Before Fill Has Been Placed:
      - 1) Use thru-bolts and fish plates.
      - 2) Use welded studs. Do not support a load in excess of 250 pounds from a single welded stud.
    - b. After Fill Has Been Placed: Use welded studs. Do not support a load in excess of 250 lbs from a single welded stud.
  3. Attachment to Cast-In-Place Concrete:
    - a. Fresh Concrete: Use cast-in-place concrete inserts.
    - b. Existing Concrete: Use anchoring devices.
  4. Attachment to Cored Precast Concrete Decks:
    - a. New Construction: Use thru-bolts and fish plates before Construction Work Contractor has placed roofing insulation over the decks. Contractor shall not drill into or power fasten to bottom of precast plank.
  5. Attachment to Hollow Block or Tile Filled Concrete Deck:
    - a. New Construction: Use cast-in-place concrete inserts by having Construction Work Contractor omitting blocks and pouring solid blocks with insert where

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- required.
6. Attachment to Waffle Type Concrete Decks:
    - a. New Construction:
      - 1) Use cast-in-place concrete inserts in fresh concrete.
      - 2) If concrete fill has been applied over deck, thru-bolts and fish plates may be used where additional concrete or roofing is to be placed over the deck.
  7. Attachment to Precast Concrete Planks: Use anchoring devices, except do not make attachments to precast concrete planks less than 2-3/4 inches thick.
  8. Attachment to Precast Concrete Tee Construction:
    - a. New Construction:
      - 1) Use tee hanger inserts between adjacent flanges.
      - 2) Use thru-bolts and fish plates, except at roof deck without concrete fill.
    - b. Existing Construction:
      - 1) Use anchoring devices installed in webs of tees. Install anchoring devices as high as possible in the webs.
    - c. Do not use powder driven fasteners.
    - d. Exercise extreme care in drilling holes to avoid damage to reinforcement.
  9. Attachment to Wood Construction: Use side beam brackets fastened to the sides of wood members to make attachments for hangers.
    - a. Under 15 lbs Load: Attach side beam brackets to wood members with 2 No. 18 x 1-1/2 inch long wood screws, or 2 No. 16 x 1-1/2 inch long drive screws.
    - b. Over 15 lbs Load: Attach side beam brackets to wood members with bolts and nuts or lag bolts. Do not use lag bolts in wooden members having a nominal thickness (beam face) under 2 inches in size. Install bolts and nuts or lag bolts in the side of wood members at the mid-point or slightly above. Install plain washers under all nuts.

LOAD	LAG BOLT SIZE	BOLT DIA.
15 lbs to 30 lbs	3/8 x 1-3/4 inches	3/8 inch
31 lbs to 50 lbs	1/2 x 2 inches	1/2 inch
Over 50 lbs to load limit of structure.	Use bolt & nut	5/8 inch

- c. Bottom chord of wood trusses may be utilized as structural support, but method of attachment must be specifically approved.
  - d. Do not make attachments to the diagonal or vertical members of wood trusses.
  - e. Do not make attachments to the nailing strips on top of steel beams.
10. Attachment to Metal Stud Construction: Use supporting fasteners manufactured specifically for the attachment of raceways and boxes to metal stud construction.
  - a. Support and attach outlet boxes so that they cannot torque/twist. Either:
    - 1) Use bar hanger assembly, or:
    - 2) In addition to attachment to the stud, also provide far side box support.

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HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

3.04 CONDUIT SUPPORT SCHEDULE

- A. Provide number of supports as required by National Electrical Code.
- B. Use pipe straps and specified method of attachment where conduit is installed proximate to surface of wood or masonry construction.
  - 1. Use hangers secured to surface with specified method of attachment where conduit is suspended from the surface.
- C. Use "C" beam clamps and hangers where conduit is supported from steel beams.
- D. Use deck clamps and hangers where conduit is supported from steel decking having hanger tabs.
  - 1. Where conduit is supported from steel decking which does not have hanger tabs, use clamps and hangers secured to decking, utilizing specified method of attachment.
- E. Use channel support system supported from structural steel for multiple parallel conduit runs.
- F. Where conduits are installed above ceiling, do not rest conduit directly on runner bars, T-Bars, etc.
  - 1. Conduit Sizes 2-1/2 Inches and Smaller: Support conduit from ceiling supports or from construction above ceiling.
  - 2. Conduit Sizes Over 2-1/2 Inches: Support conduit from beams, joists, or trusses above ceiling.

3.05 LIGHTING FIXTURE SUPPORT SCHEDULE

- A. General: Do not support fixtures from ceilings or ceiling supports unless it is specified or indicated on the drawings to do so.
  - 1. Support fixtures with hanger rods attached to beams, joists, or trusses. Hanger rod diameter, largest standard size that will fit in mounting holes of fixture.
    - a. Where approved, channel supports may span and rest upon the lower chord of trusses and be utilized for the support of lighting fixtures.
    - b. Where approved, channel supports may span and be attached to the underside of beams, joists, or trusses and be utilized for the support of lighting fixtures.
  - 2. Use 2 nuts and 2 washers on lower end of each hanger rod to hold and adjust fixture (one nut and washer above top of fixture housing, one nut and washer below top of fixture housing).
    - a. Where specified that an adequately supported outlet box is to support a fixture or be utilized as one point of support, support the box so that it may be adjusted to bring the face of the outlet box even with surface of ceiling.
- B. Specific Installations Where Fixtures May Be Supported From New Ceilings Being Installed By Construction Work Contractor:
  - 1. Support surface mounted fluorescent fixtures and incandescent fixtures directly from plywood backed gypsum board ceilings.

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2. Support surface mounted fluorescent fixtures and incandescent fixtures directly from framing or furring members of fire rated suspended ceilings (double gypsum board).
  3. Support recessed mounted fluorescent fixtures and incandescent fixtures directly from furring members of furred gypsum board ceilings.
  4. Support recessed mounted fluorescent fixtures and incandescent fixtures directly from the suspension system of suspended acoustical ceilings. Exception: Support each fixture weighing more than 50 pounds (including lamps) independent of the suspended ceiling grid.
  5. Deliver documents which state actual fixture weights and indicate fixture locations to the Construction Work Contractor (thru the Owner's Representative).
- C. Number of Supports For Ceiling Mounted Lighting Fixtures: Provide at least the following number of supports. Provide additional supports when recommended by fixture manufacturer or shown on the drawings.
1. Commercial and Industrial Fluorescent Fixtures:
    - a. Support individual fluorescent fixtures less than 2 feet wide at 2 points.
    - b. Support continuous row fluorescent fixtures less than 2 feet wide at points equal to the number of fixtures plus one. Uniformly distribute the points of support over the row of fixtures.
    - c. Support individual fluorescent fixtures 2 feet or wider at 4 corners.
    - d. Support continuous row fluorescent fixtures 2 feet or wider at points equal to twice the number of fixtures plus 2. Uniformly distribute the points of support over the row of fixtures.
    - e. An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.
  2. Vandal Resistant, and Minimum Security Fluorescent Fixtures:
    - a. Support individual fluorescent fixtures less than 2 feet wide at 4 corners.
    - b. Support continuous row fluorescent fixtures less than 2 feet wide at points equal to twice the number of fixtures. Uniformly distribute the points of support.
    - c. Support individual fluorescent fixtures 2 feet or wider at each corner and one support midway along each side of longest axis (6 supports total).
    - d. Support continuous row fluorescent fixtures 2 feet or wider at points equal to 4 times the number of fixtures. Uniformly distribute the points of support.
    - e. An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.
  3. Medium Security Fluorescent Fixtures: Support each fixture at minimum of 6 points (each corner and midway along each side of longest axis). Outlet box shall not be counted as a point of support.
  4. Maximum Security Fluorescent Fixtures: Support each fixture at minimum of 8 points (each corner, and 2 supports spaced equally along each side of longest axis). Outlet box shall not be counted as a point of support.
  5. Mercury Vapor, Metal Halide, and High-Pressure Sodium Fixtures:
    - a. Commercial Style: Support fixture at 2 points.
    - b. Industrial Style: Support individual fixtures at one point.
    - c. Vandal Resistant Style: Support fixture at 4 points.
    - d. An adequately supported outlet box may be utilized as one point of support



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- for fixtures weighing less than 50 pounds.
6. Commercial and Industrial Incandescent Fixtures: Support fixture from adequately supported outlet box, to suit fixture design (fixture weight less than 50 pounds).
  7. Vandal Resistant Incandescent Fixtures: Support fixture from adequately supported outlet box to suit fixture design, plus 2 fasteners through back of fixture into suitable construction behind fixture.
- D. Number of Supports For Wall Mounted Lighting Fixtures: Provide at least the following number of supports. Provide additional supports when recommended by fixture manufacturer or shown on the drawings.
1. Commercial and Industrial Fluorescent Fixtures:
    - a. Support individual fluorescent fixtures 2 feet long or less at 2 points.
    - b. Support individual fluorescent fixtures over 2 feet long at 3 points.
    - c. Support continuous row fluorescent fixtures at points equal to twice the number of fixtures. Uniformly distribute the points of support.
    - d. An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.
  2. Vandal Resistant, and Minimum Security Fluorescent Fixtures:
    - a. Support individual fluorescent fixtures 2 feet long or less at 4 points (each corner).
    - b. Support individual fluorescent fixtures over 2 feet long at 6 points (each corner and midway along each side of longest axis).
    - c. Support continuous row fluorescent fixtures at points equal to 6 times the number of fixtures. Uniformly distribute the points of support.
    - d. An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.
  3. Medium Security, and Maximum Security Fluorescent Fixtures:
    - a. Support each fluorescent fixture 2 feet long or less at minimum of 4 points (each corner).
    - b. Support each fluorescent fixture over 2 feet long, to 3 feet long at a minimum of 6 points (each corner and midway along each side of longest axis).
    - c. Support each fluorescent fixture over 3 feet long, to 8 foot long at minimum of 8 points (each corner, and 2 supports spaced equally along each side of longest axis).
    - d. Outlet box shall not be counted as a point of support.
  4. Metal Halide, and High-Pressure Sodium Fixtures:
    - a. Commercial and Industrial Style: Support fixture at 2 points (Support arm mounted style at 4 points).
    - b. An adequately supported outlet box may be used as one point of support for fixtures weighing less than 50 pounds.
  5. Commercial and Industrial Incandescent Fixtures: Support fixture from adequately supported outlet box, to suit fixture design (fixture weight less than 50 pounds).

3.06 CHANNEL SUPPORT SYSTEM SCHEDULE

- A. Use channel support system where specified or indicated on the drawings.

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- B. Channel supports may be used, as approved, to accommodate mounting of equipment.
- C. Material and Finish:
  - 1. Dry Locations: Use 12 gage steel channel support system having any one of the specified finishes.
  - 2. Damp Locations: Use 12 gage steel channel support system having any one of the specified finishes except green epoxy/enamel.
  - 3. Wet Locations: Use 12 gage steel channel support system having hot dipped galvanized, or PVC finish.

END OF SECTION

SECTION 260533  
INTERIOR RACEWAYS, FITTINGS, AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

- A. NEMA, ANSI, and UL.

1.02 SUBMITTALS

- A. Product Data: Catalog sheets, specifications and installation instructions.

1.03 MAINTENANCE

- A. Spare Parts: Furnish the following items in the manufacturer's original containers labeled with the names of the items and locations where the items would be used. Store them at the site where directed:
  - 1. Touch up coating compound for plastic coated rigid metal conduit (one spray type can and one non-spray can with brush top).

PART 2 PRODUCTS

2.01 RACEWAYS

- 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

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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.
4. Size 4: Nominal area 7.5 sq. in. min., 119 No. 12 THW max.; Thomas & Betts SR600, Mono-Systems SMS4200, or Wiremold's G4000.
5. Size 5: Nominal area 15.9 sq. in. min., 252 No. 12 THW max.; Thomas & Betts SR700, Mono-Systems SMS4400, or Wiremold's G6000.

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. Plastic Coated Rigid Metal Conduit, Fittings, and Accessories: Rigid ferrous metal conduit, fittings, and accessories coated with 40 mils thick polyvinylchloride coating; Ocal/T&B Corp.'s Ocal-Blue System, PCD Inc.'s KorKap, KorKap XL, or Robroy Industries' Plasti-bond or Perma-Cote System.

2.02 FITTINGS AND ACCESSORIES

A. Insulated Bushings:

1. Threaded, malleable iron/zinc electroplate with 105 degrees C minimum plastic insulated throat; Appleton Electric Co.'s BU50I Series, Cooper/Crouse-Hinds' 1031 Series, OZ/Gedney Co.'s IBC-50 Series, Racor Inc.'s 1132 Series, Steel City/T & B Corp.'s BI-901 Series, or Thomas & Betts Corp.'s 1222 Series.
2. Threaded malleable iron with 150 degrees C plastic throat; Appleton Electric Co.'s BU501 Series, Cooper/Crouse-Hinds' H1031 Series, or OZ/Gedney Co.'s IBC-50 Series.

B. Plastic Bushings for 1/2 and 3/4 Inch Conduit:

1. 105 degrees C minimum temperature rating; Appleton Electric Co.'s BBU50, BBU75, Blackburn (T & B Corp.'s) 50 BB, 75 BB, Cooper/Crouse-Hinds' 931, 932, or OZ/Gedney Co.'s IB-50, IB-75, Racor Inc.'s 1402, 1403, Steel City/T & B Corp.'s BU-501, BU-502, or Thomas & Betts Corp.'s 222, 223.
2. 150 degrees C temperature rating; Appleton Electric Co.'s BBU50H, BBU75H, Cooper/Crouse-Hinds' H-931, H-932, or OZ/Gedney Co.'s A-50, A-75.

C. Insulated Grounding Bushings:

1. Threaded, malleable iron/zinc electroplate with 105 degrees C minimum plastic insulated liner, and ground lug; Appleton Electric Co.'s GIB-50 Series, Cooper/Crouse-Hinds' GLL Series, OZ/Gedney Co.'s IBC-50L Series, Racor Inc.'s 1212 Series, Steel City/T & B Corp.'s BG-801 (1/2 to 2") Series, or Thomas & Betts Corp.'s 3870.

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2. Threaded malleable iron/zinc electroplate with 150 degrees C plastic insulated liner, and ground lug; Appleton Electric Co.'s GIB Series, Cooper/Crouse-Hinds' HGLL Series, or OZ/Gedney Co.'s IBC-50L Series, or Thomas & Betts Corp.'s 3870.
- D. 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, Racor Inc.'s 1002 Series, Steel City/T&B Corp.'s LN-101 Series, or Thomas & Betts Corp.'s 141 Series.
  2. Grounding Wedge: Thomas & Betts Corp.'s 3650 Series.
  3. 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.
  4. 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, Racor Inc.'s 1502 Series, Steel City/T & B Corp.'s EK-401 Series, or Thomas & Betts Corp.'s 675 Series.
  5. 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, Racor Inc.'s 2912, 2922 Series, Steel City/T & B Corp.'s TC-711 Series, or Thomas & Betts Corp.'s 5120, 5123 Series.
  6. 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.
  7. Liquid-tight Flexible Metal Conduit Connectors: 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, Racor Inc.'s 3512 Series, Steel City/T & B Corp.'s LT-701 Series, or Thomas & Betts Corp.'s 5332 Series.
- E. Conduit Bodies (Threaded):
1. Malleable Iron/Zinc Electroplate: 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.
- F. Expansion Fittings:
1. Malleable Iron, Zinc Electroplate Finish: Appleton Electric Co.'s XJ or OZ/Gedney Co.'s AX (TX for EMT), with external bonding jumper.
  2. Electro-galvanized Steel: Cooper/Crouse-Hinds' XJG (XJG-EMT for EMT), or Thomas & Betts Corp.'s XJG, with internal grounding.
- G. Deflection Fittings: Appleton Electric Co.'s DF, Cooper/Crouse-Hinds' XD, or OZ/Gedney Co.'s Type DX.
- H. Hazardous Location Fittings:
1. Sealing Fittings: Appleton Electric Co.'s EYS, ESU w/Kwikol sealing compound and fiber filler, Cooper/Crouse-Hinds' EYS, EZS w/Chico A sealing compound

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- 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.
2. Other Type Fittings: As required to suit installation requirements, by Appleton Electric Co., Cooper/Crouse-Hinds, OZ/Gedney Co, or Thomas & Betts Corp.
- I. 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.
- J. Vertical Conductor Supports: Kellems/Hubbell Inc.'s Conduit Riser Grips, or OZ/Gedney Co.'s Type M, Type R.
- K. Pulling-In-Line For Installation in Spare and Empty Raceways: Polypropylene monofilament utility line; Greenlee Textron Inc.'s Poly Line 430, 431, or Ideal Industries Powr-Fish Pull-Line 31-340 Series.

PART 3 EXECUTION

3.01 RACEWAY INSTALLATION - GENERAL

- A. Number of Raceways: Do not change number of raceways to less than the number indicated on the drawings.
1. Each raceway shall enclose one circuit unless otherwise indicated on the drawings.
- B. Number of Raceways: Do not change number of raceways to less than the number indicated on the drawings except when appropriate for advantageous reuse of existing exposed and concealed raceways (the contract documents do not indicate location, number, size or condition of existing raceways). Existing raceways may be reused if the following conditions are met:
1. The existing raceway must be of adequate size for the new conductors to be installed therein (NFPA 70 Chapter 9, Tables 1, 4, & 5; Appendix C, Tables C1-C12a). More circuits may be enclosed by existing raceways than the circuiting shown on the drawings provided conductor sizes are increased to compensate for derating (adjustment factors) and other considerations required by NFPA 70 Article 310-15.
2. Remove existing conductors.
3. Demonstrate to the Owner's Representative that the existing raceway is clear of obstructions and in good condition.
4. Check ground continuity. When ground continuity of existing raceway is inadequate install insulated grounding bushings, grounding wedges, bonding straps, grounding jumpers or equipment grounding conductors to establish effective path to ground.
5. Install insulated bushings to replace damaged or missing bushings. Replace non-insulated bushings with insulated bushings on raceway sizes 1 inch and larger.

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6. Install vertical conductor supports to replace existing or missing vertical conductor supports.
  7. Install extension rings on existing boxes when the number of new conductors installed therein exceeds NFPA 70 requirements.
  8. Furnish the Owner's Representative with marked up drawings showing size and routing of existing raceways with number and size of new conductors installed therein.
- C. Raceways for Future Use (Spare Raceways and Empty Raceways): Draw fish tape through raceways in the presence of the Owner's Representative to show that the raceway is clear of obstructions.
1. Leave a pulling-in line in each spare and empty raceway.
- D. Conduit Installed Concealed:
1. Where possible 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. New Construction:
    - a. Run conduit in the ceilings, walls, and partitions.
    - b. Install conduit under slabs on grade or under slabs above finished ceilings where indicated on the drawings. Concrete slabs that are both ceilings and floors shall be treated as floor slabs.
      - 1) Conduit Under Slab on Grade:
        - a) Run conduit under vapor barrier, if any.
        - b) Install equipment grounding conductor in each conduit. Bond at boxes and equipment to which conduit is connected.
      - 2) Conduit Under Slab, Above Finished Ceiling:
        - a) Attach conduit to bottom of slab or structure supporting the slab.
        - b) Firestop through-penetrations of the slab.
  4. 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.
- E. 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.
- F. Conduit Installed Exposed:
1. Install conduit exposed where indicated on the drawings.
  2. Install conduit tight to the surface of the building construction unless otherwise indicated or directed.
  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.

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6. Do not run conduits near heating pipes.
  7. Installation of conduit directly on the floor will not be permitted.
- F. Conduit Size: Not smaller than 1/2 inch electrical trade size. Where type FEP, THHN, THWN, THWN-2, XHH, XHHW, or XHHW-2 conductors are specified for use under Section 16121, the minimum allowable conduit size for new Work shall be based on Type THW conductors.
- G. Conduit Bends: For 1/2 and 3/4 inch conduits, bends may be made with manual benders. For all conduit sizes larger than 3/4 inch, manufactured or field fabricated offsets or bends may be used. Make field fabricated offsets or bends with an approved hydraulic bender.

3.02 RACEWAY INSTALLATION - SPECIAL AREAS

- A. Conduit in Hazardous Areas: Install Work in hazardous areas in accordance with the NFPA 70. The hazardous areas and the degree of hazard for each area are indicated on the drawings.
1. Install sealing fittings in concealed conduit runs in a recessed box with blank face plate to match other face plates in the area.

3.03 RACEWAY SCHEDULE

- A. Rigid Ferrous Metal Conduit: Install in all locations unless otherwise specified or indicated on the drawings.
- B. Intermediate Ferrous Metal Conduit: May be installed in all dry and damp locations except:
1. Hazardous areas.
  2. Where other type raceways are specified or indicated on the drawings.
- C. Electrical Metallic Tubing:
1. May be installed concealed as branch circuit conduits above suspended ceilings where conduit does not support fixtures or other equipment.
  2. May be installed concealed as branch circuit conduits in hollow areas in dry locations, including:
    - a. Hollow concrete masonry units, except where cores are to be filled.
    - b. Drywall construction with sheet metal studs, except where studs are less than 3-1/2 inches deep.
- D. Flexible Metal Conduit: Install equipment grounding conductor in the flexible metal conduit and bond at each box or equipment to which conduit is connected:
1. Use for final conduit connection to recessed lighting fixtures in suspended ceilings. Use 4 to 6 feet of flexible metal conduit, minimum size 1/2 inch, between junction box and fixture. Locate junction box at least 1 foot from fixture and accessible if the fixture is removed.
  2. Use 1 to 3 feet of flexible metal conduit for final conduit connection to:
    - a. Dry type transformers.
    - b. Non-Process Equipment subject to vibration (dry locations).



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- c. Non-Process Equipment requiring flexible connection for adjustment or alignment (dry locations).
  - 3. Use for concealed branch circuit conduits above existing non-removable suspended ceilings where rigid type raceways cannot be installed due to inaccessibility of space above ceiling.
  - 4. May be installed concealed as branch circuit conduits in drywall construction with sheet metal studs, except where studs are less than 3-1/2 inches deep.
- E. 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:
  - 1. 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:
    - a. Motors with weather-protected or totally enclosed housings.
    - b. Equipment subject to vibration (damp and wet locations).
    - c. Equipment requiring flexible connection for adjustment or alignment (damp and wet locations).
- F. Surface Metal Raceway: Use as exposed raceway system in finished spaces at locations indicated on the drawings.
  - 1. Use surface metal raceway system of size required for number of wires to be installed therein. Use specific size when indicated on the drawings.
  - 2. 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.
  - 3. Secure raceway at intervals not exceeding 36 inches.
  - 4. Install separate equipment grounding conductor for grounding of equipment. The raceway alone will not be considered suitable for use as an effective path to ground.
  - 5. Outlet box covers for pendant mounted fluorescent fixtures may be omitted if the fixture canopy is notched to receive the raceway and the canopy fits snugly against the ceiling.
  - 6. 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:
    - a. 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.
    - b. 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 NFPA 70, including provision for mounting and knockouts for entrance of raceway.

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- G. Wireways: May be used indoors in dry locations for exposed raceway between grouped, wall mounted equipment.
- H. Plastic Coated Rigid Metal Conduit: Use at locations indicated on drawings.

3.04 FITTINGS AND ACCESSORIES SCHEDULE

- A. General:
  - 1. Use fittings and accessories that have a temperature rating equal to, or higher than the temperature rating of the conductors to be installed within the raceway.
  - 2. Use zinc electroplate or hot dipped galvanized steel/malleable iron or cast-iron alloy fittings and accessories in conjunction with ferrous raceways in dry and damp locations unless otherwise specified or indicated on the drawings.
  - 3. Use insulated grounding bushings or grounding wedges on ends of conduit for terminating and bonding equipment grounding conductors, when required, if cabinet or boxes are not equipped with grounding/bonding screws or lugs.
  - 4. Use caps or plugs to seal ends of conduits until wiring is installed to exclude foreign material.
  - 5. 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.
  - 6. Use expansion fittings where raceways cross expansion joints (exposed, concealed, buried).
  - 7. Use deflection fittings where raceways cross expansion joints that move in more than one plane.
  - 8. Use 2 locknuts and an insulated bushing on end of each conduit entering sheet metal cabinet or box in dry or damp locations.
    - a. Plastic bushing may be used on 1/2 and 3/4 inch conduit in lieu of insulated bushing.
    - b. Terminate conduit ends within cabinet/box at the same level.
- B. For Rigid and Intermediate Metal Conduit: Use threaded fittings and accessories. Use 3 piece conduit coupling where neither piece of conduit can be rotated.
- C. For Electrical Metallic Tubing: Use compression type connectors and couplings.
- D. For Flexible Metal Conduit: Use flexible metal conduit connectors.
- E. For Liquid-tight Flexible Metal Conduit: Use liquid-tight connectors.
- F. For Surface Metal Raceway: Use raceway manufacturer's standard fittings and accessories.
- G. For Wireways: Use wireway manufacturer's standard fittings and accessories.
- H. For Plastic Coated Rigid Metal Conduit: Use conduit manufacturer's PVC coated fittings and accessories.

END OF SECTION

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OUTLET, JUNCTION, AND PULL BOXES

PART 1 GENERAL

1.01 REFERENCES

- A. NEMA, and UL.

1.02 SUBMITTALS

- A. Product Data: Catalog sheets, specifications and installation instructions.
  - 1. For fire rated construction, prove that materials and installation methods proposed for use are in accordance with the listing requirements of the classified construction.

PART 2 PRODUCTS

2.01 GALVANIZED STEEL OUTLET BOXES

- A. 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.

2.02 GALVANIZED STEEL JUNCTION AND PULL BOXES

- A. Code gage, galvanized steel screw cover boxes by Delta Metal Products Inc., Hoffman Enclosures Inc., Hubbell Wiegmann, Lee Products Co., or Rittal/Electromate.

2.03 THREADED TYPE BOXES:

- A. Outlet Boxes:
  - 1. For Dry, Damp Locations: Zinc electroplate malleable iron or cast-iron alloy boxes by Appleton Electric Co., Cooper/Crouse-Hinds Co., or OZ/ Gedney Co., with zinc electroplate steel covers to suit application.
  - 2. 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), or OZ/Gedney Co. (hot dipped galvanized), with stainless steel cover screws, and malleable iron covers gasketed to suit application.
- B. Junction And Pull Boxes:
  - 1. For Dry, Damp Locations: Zinc electroplate cast iron boxes by Appleton Electric Co., Cooper/Crouse-Hinds, or OZ/Gedney Co., with zinc electroplate steel or cast-iron cover.
  - 2. For Wet Locations: Cast iron boxes by Cooper/Crouse-Hinds' (hot dipped galvanized or Corro-free epoxy powder coat), or OZ/Gedney Co. (hot dipped galvanized), with stainless steel cover screws and cast-iron cover gasketed to suit application.
- C. Conduit Bodies, Threaded (Provided with a Volume Marking):

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1. 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, or OZ/Gedney Co.'s Conduit Bodies.
2. 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), or OZ/Gedney Co.'s Conduit Bodies (hot dipped galvanized) with stainless steel cover screws and malleable iron covers gasketed to suit application.

2.04 CORROSION RESISTANT BOXES

- A. Plastic Coated Outlet and Junction Boxes: Threaded type malleable iron boxes coated with 40 mils thick polyvinylchloride coating; Ocal/T&B Corp.'s Ocal-Blue System, PCD Inc.'s KorKap, KorKap XL, or Robroy Industries' Plastibond or Perma-Cote System.
- B. Non-Metallic Junction and Pullboxes: Glass fiber reinforced polyester; Carlon/Div. of Lamon and Sessions' Himeline Series, Cooper/Crouse-Hinds' Krydon Products, or Robroy Industries' Stahlin Enclosures.

2.05 SPECIFIC PURPOSE OUTLET BOXES

- A. As fabricated by manufacturers for mounting their equipment.

2.06 FINISHING COLLAR OR COMBINATION FINISHING COLLAR/OUTLET BOX  
(SURFACE MOUNTED EQUIPMENT USED WITH EXPOSED RACEWAY):

- A. 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.
- B. Combination Finishing Collar/Outlet Box: Same finish and peripheral dimensions as the equipment base, gage or thickness of metal as required by National Electrical Code, including provisions for mounting, and knockouts or threaded bosses for entrance of raceway.

PART 3 EXECUTION

3.01 PREPARATION

- A. Before proceeding with the installation of junction and pull boxes, check the locations with the Owner's Representative and have same approved.

3.02 INSTALLATION

- A. Mounting Position of Wall Outlets For Wiring Devices: Unless otherwise indicated, install boxes so that the long axis of each wiring device will be vertical.
- B. Height of Wall Outlets: Unless otherwise indicated, locate outlet boxes with their center lines at the following elevations above finished floor:

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Lighting Fixtures	As Indicated on Drawings"
Lighting Fixtures in Stairway	As Indicated on Drawings"
Exit Lights	8'-0" where ceiling height allows a minimum of 6 inch clearance between ceiling and top of exit light. Otherwise mount exit light so that it's top is 6 inches below finished ceiling. Adjust height and clearances as required to suit installation over doors.
Switches	4'-0"
Single & Duplex Receptacles	1'-6"* or as indicated.
Water Cooler Receptacles	2'-0"
Range Receptacle	1'-6"
Special Purpose Receptacles	4'-0"
Thermostats	5'-0"
Manual Fire Alarm Boxes	4'-0"
Audible Notification Appliances	8'-0" where ceiling height allows a minimum of 6 inch clearance between ceiling and top of appliance. Otherwise mount appliance so that it's top is 6 inches below finished ceiling.
Visible Notification Appliances	Install outlet so that the bottom of the visible lens will be 6'-8" AFF.
Combination Audible/Visible Notification Appliances	Install outlet so that the bottom of the visual lens will be 6'-8" AFF, and the audible section will be above the visible section.
Telecommunications	2'-0"
Telephone	2'-0"

\*In areas containing heating convectors, install outlets above convectors at height indicated on drawings.

- C. Supplementary Junction and Pull Boxes: In addition to junction and pull boxes indicated on the drawings and required by NFPA 70, provide supplementary junction and pull boxes as follows:
1. When required to facilitate installation of wiring.
  2. At every third 90 degree turn in conjunction with raceway sizes over 1 inch.
  3. At intervals not exceeding 100 feet in conjunction with raceway sizes over 1 inch.

### 3.03 OUTLET, JUNCTION, AND PULL BOX SCHEDULE

- A. Boxes For Concealed Conduit System:
1. Non-Fire Rated Construction:
    - a. Depth: To suit job conditions and comply with NFPA 70 Article 370.
    - b. For Lighting Fixtures: Use galvanized steel outlet boxes designed for the purpose.
      - 1) For Fixtures Weighing 50 lbs. or Less: Box marked "FOR FIXTURE SUPPORT".
      - 2) For Fixtures More Than 50 lbs: Box listed and marked with the weight of the fixture to be supported (or support fixture independent of the box).

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- c. For Junction and Pull Boxes: Use galvanized steel boxes with flush covers.
  - d. For Switches, Receptacles, Etc:
    - 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 switch boxes. The surface area of individual outlet or switch 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. Boxes 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 allowed (specified) to be 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.
    - a. Use corrosion resistant boxes in conjunction with plastic coated rigid ferrous metal conduit.
  - 3. Finishing Collar or Combination Finishing Collar/Outlet Box (Surface Mounted Equipment Used With Exposed Raceway):

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- 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.

END OF SECTION

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OUTLET, JUNCTION, AND PULL BOXES

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SECTION 260534  
CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

- A. NEMA, ANSI, and UL.

1.02 SUBMITTALS

- A. Product Data: Catalog sheets, specifications and installation instructions.

1.03 MAINTENANCE

- A. Spare Parts: Furnish the following items in the manufacturer's original containers labeled with the names of the items and locations where the items would be used. Store them at the site where directed:
  - 1. Touch up coating compound for plastic coated rigid metal conduit (one spray type can and one non-spray can with brush top).

PART 2 PRODUCTS

2.01 RACEWAYS

- 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. 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.
- C. Plastic Coated Rigid Metal Conduit, Fittings, and Accessories: Rigid ferrous metal conduit, fittings and accessories coated with 40 mils thick polyvinylchloride coating; Ocal/T&B Corp.'s Ocal-Blue System, PCD Inc.'s KorKap, KorKap XL, or Robroy Industries' Plastibond or Perma-Cote System.

2.02 FITTINGS AND ACCESSORIES

- A. Connectors and Couplings:
  - 1. Couplings (For Rigid Metal Conduit): Standard threaded couplings as furnished by conduit manufacturer.
  - 2. Watertight Conduit Hubs: Cooper/Crouse Hinds' Myers Hubs (stainless steel), OZ/Gedney Co.'s Type CH-T (hot dipped galvanized finish).
  - 3. Liquid-tight Flexible Metal Conduit Connectors: OZ/Gedney Co.'s 4Q-TG Series (hot-dip/mechanically galvanized), or Thomas & Betts Corp.'s 3322 Series (PVC coated).

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- B. Conduit Bodies (Threaded): 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.
- C. Expansion Fittings: 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).
- D. Deflection Fittings: 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.
- E. Sealing Fittings: 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.
  - 1. 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.
  - 2. 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.
  - 3. 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.
- F. Conduit Clamps and Back Spacers: Malleable iron, hot dipped/mechanically galvanized finish; Cooper/Crouse-Hinds' 510 and CB1 Series, OZ/Gedney Co.'s 14-G and 141G Series, or Thomas & Betts Corp.'s 1275 and 1350 Series.
- G. Drains and Breathers: Stainless steel; Appleton Electric Co.'s ECBD, Cooper/Crouse-Hinds' ECD, OZ/Gedney Co.'s Type DB, or Thomas & Betts Corp.'s Type ECD.

### PART 3 EXECUTION

#### 3.01 RACEWAY INSTALLATION - GENERAL

- A. Number of Raceways: Do not change number of raceways to less than the number indicated on the drawings.
  - 1. Each raceway shall enclose one circuit unless otherwise indicated on the drawings.
- B. Conduit Size: Not smaller than 1/2 inch electrical trade size. Where type THWN, THWN-2, XHHW, or XHHW-2 conductors are specified for use under Section 16121,

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the minimum allowable conduit size for new Work shall be based on Type THW conductors.

- C. Conduit Bends: For 1/2 and 3/4 inch conduits, bends may be made with manual benders. For all conduit sizes larger than 3/4 inch, manufactured or field fabricated offsets or bends may be used. Make field fabricated offsets or bends with an approved hydraulic bender.
- D. Conduit Exposed In Indoor Wet Locations: Install entire wiring system including conduit, boxes, and fittings so that there is a 1/4 inch air space between it and the wall or supporting surface.
- E. Conduit in Hazardous Areas: Install Work in hazardous areas in accordance with NFPA 70. The hazardous areas and the degree of hazard for each area are indicated on the drawings.

3.02 RACEWAY SCHEDULE - TYPES & USE

- A. Rigid Ferrous Metal Conduit: Install in all wet locations unless otherwise specified or indicated on the drawings.
- B. 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:
  - 1. Use 1 to 3 feet of liquid-tight flexible metal conduit (UL listed and marked for the installation's temperature and environmental conditions) for final conduit connection to:
    - a. Motors with weather-protected or totally enclosed housings.
    - b. Equipment subject to vibration.
    - c. Equipment requiring flexible connection for adjustment or alignment.
- C. Plastic Coated Rigid Metal Conduit: Use in all process areas.
- D. PVC Conduit: Use for buried conduit. No concrete casing is required.

3.03 FITTINGS AND ACCESSORIES SCHEDULE

- A. General:
  - 1. 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 unless otherwise specified or indicated on the drawings.
  - 2. Use caps or plugs to seal ends of conduits until wiring is installed (to exclude foreign material).
  - 3. Use expansion fittings:
    - a. Where raceways cross expansion joints.
    - b. At intervals not exceeding 75 feet in straight runs (outside installations).
    - c. Between fixed equipment (outside installations).

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4. Use deflection fittings where raceways cross expansion joints that move in more than one plane.
  5. Use watertight hub on end of each conduit entering cabinets or boxes that are not constructed with integral threaded hubs.
  6. Use back spacers behind each conduit clamp to keep raceway off surface to which it is attached and arranged to allow raceway to move due to expansion and contraction (outside installations).
  7. Use drains in low points of the system to drain condensation, keeping interior of raceway system free of moisture. Also use breather at high point of the system for outside installations.
- B. For Rigid Metal Conduit: Use threaded fittings.
- C. For Liquid-tight Flexible Metal Conduit: Use liquid-tight connectors.
- D. For Plastic Coated Rigid Metal Conduit: Use conduit manufacturer's PVC coated fittings and accessories.

END OF SECTION

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UNDERGROUND CONDUIT, DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Earthwork: Section 310000.
- B. Cast-In-Place Concrete: Section 033000.

1.02 SUBMITTALS

- A. Product Data: Catalog sheets, specifications and installation instructions.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Rigid Ferrous Metal Conduit: Steel, galvanized on the outside and inside (conduit enameled on the inside will not be accepted), UL categorized as Rigid Ferrous Metal Conduit (identified on UL Listing Mark as Rigid Metal Conduit-Steel or Rigid Steel Conduit), as manufactured by Allied Tube & Conduit Corp., LTV Steel Tubular Products Co., Triangle Wire & Cable Inc., or Wheatland Tube Co.
- B. Rigid Nonmetallic Conduit And Fittings (Concrete Encased): Cantex, Inc.'s Schedule 40, Carlon Electrical Products Inc.'s Plus 40, CertainTeed Corp.'s Schedule 40, Omni/Opti-Com Manufacturing Network, Inc.'s Schedule 40 or Queen City Plastic Inc.'s Schedule 40.
- C. Plastic Coated Rigid Metal Conduit, Fittings and Accessories: Rigid ferrous metal conduit, fittings and accessories coated with 40 mils thick polyvinylchloride coating; Occidental Coating Co.'s Ocal 40, Protective Coatings Developments Inc.'s Kor-Kap, or Robroy Industries' Plastibond System.
- D. Conduit Spacers and Levelers: Commercially manufactured type to suit conduit, installation and spacing requirements.
- E. Duct Seal: Appleton Electric Co.'s DUC Weatherproof Compound, Manville Corp.'s Duxseal, OZ/Gedney Co.'s DUX, or Thomas & Betts Corp.'s DX.
- F. Drag Line: Minimum 1/8 inch polypropylene monofilament utility rope; American Synthetic Ropes' Flotorope, Greenlee Tool Co.'s 2 ply Rope 431, or Thomas Industries/Jet Line Products' Rope 232.
- G. Thru Wall Sealing Bushings:
  - 1. For Walls Which Have or Will Have Membrane Waterproofing:
    - a. Cast-In-Place Installations: OZ/Gedney Co.'s Type FSK thruwall seal and Type FSKA membrane clamp adapter.
    - b. Core Drilled or Sleeved Installations: OZ/Gedney Co.'s Type CSM and Type CSMC with membrane clamp adapter.
  - 2. For Walls Which Will Not Have Membrane Waterproofing:

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- a. Cast-In-Place Installations: OZ/Gedney Co.'s Type FSK.
  - b. Core Drilled or Sleeved Installations: OZ/Gedney Co.'s Type CSM, or Thunderline Corp.'s Link-Seal.
- H. End Bells:
- 1. For Rigid Ferrous Metal Conduit: OZ/Gedney Co.'s Type TNS.
  - 2. For Rigid Nonmetallic Conduit: Conduit manufacturer's standard end bells.
- I. Insulated Grounding Bushings: Appleton Electric Co.'s GIB-50 Series, Crouse Hinds GLL Series, OZ/Gedney Co.'s IBC-50L Series, Raco Inc.'s 1212 Series, or Thomas & Betts Corp.'s 3870 or BG Series.

PART 3 EXECUTION

3.01 PREPARATION

- A. Before installing any Work, lay out the proposed course for the conduits, location of manholes, etc. and have same approved by the Owner's Representative.

3.02 INSTALLATION

- A. Spacing:
- 1. Arrangement for Power and Signal Service: Separate power system conduits from signal system conduits with minimum 6 inches thick concrete wall or 12 inches of earth.
  - 2. Conduit Bank: Separate individual conduits a minimum of 3 inches. Use spacers and levelers located no more than 8 feet apart.
- B. Depth:
- 1. Existing Grade To Remain: Unless otherwise indicated or directed, install conduit more than 18 inches below existing finished grade.
  - 2. Existing Grade To Be Altered: Unless otherwise indicated or directed, install conduit more than 18 inches below the existing grade where the finished grade is to be higher than the existing grade. Where the finished grade is to be lower than the existing grade, install conduit more than 18 inches below finished grade.
  - 3. Under Roads and Parking Lots:
    - a. Rigid Ferrous Metal Conduit: Unless otherwise indicated or directed, install rigid ferrous metal conduit more than 24 inches below top surface of roads and parking lots.
    - b. Rigid Nonmetallic Conduit (Concrete Encased): Unless otherwise indicated or directed, install concrete encased rigid nonmetallic conduit more than 30 inches below top surface of roads and parking lots.
  - 4. Crossing Obstructions: Use rigid ferrous metal conduit where top of conduit system is less than 18 inches below finished grade when crossing obstructions (heating tunnels, etc.).
  - 5. In Rock:
    - a. Unless otherwise indicated on the drawings install rigid ferrous metal conduit or concrete encased rigid nonmetallic conduit at depths previously specified.

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UNDERGROUND CONDUIT, DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

Backfill with suitable material in accordance with SECTION 02300 - EARTHWORK.

- b. Where conduit is indicated to be installed at lesser depths, use rigid ferrous metal conduit. Cover conduit with minimum 2 inches of concrete. In exposed rock area fill trench with concrete to surface level of rock. Where rock is not exposed, complete backfill in accordance with SECTION 02300 - EARTHWORK.
- C. Pitch:
1. Pitch conduit away from buildings.
  2. Pitch conduit toward manhole a minimum of 12 inches per 100 feet. On runs where it is impossible to maintain the grade all one way, grade from center so that conduits pitch both directions down toward manholes.
- D. Concrete Encasement for Rigid Non-Metallic Conduit Using Either of the Two Methods Indicated Below: (Concrete Encasement for Rigid Ferrous Metal Conduit is not Required):
1. Single Pour Method.
  2. Two Pour Method:
    - a. Lay rigid nonmetallic conduits on a continuous concrete footing not less than 3 inches thick and as wide as the encasement. Install footings straight and true both in line of run and transversely and finished with an even surface. Incorporate anchoring devices into the footing for use in tying down the conduits. Grade footings so that conduits maintain required pitch. Before installing spacers, levelers, and conduits, let concrete footings harden as required to prevent damage to the footings.
      - 1) Where conduits enter building or manhole wall, reinforce footings for 10 feet with No. 4 rods, 4 inches on center.
      - 2) Footings are not required for rigid ferrous metal conduit.
    - b. After rigid nonmetallic conduits have been laid on footing with spacers and levelers (located no more than 8 feet apart), tie conduits down to the footing, then surround the conduits by concrete not less than 2 inches thick on top and 2 inches on each side. Separate individual conduits a minimum of 3 inches so that each conduit is completely enveloped in concrete.
      - 1) Where conduits enter building or manhole walls, reinforce encasement for 10 feet with No. 4 rods, 4 inches on center.
      - 2) Encasement is not required for rigid ferrous metal conduit.
    - c. Form sides of the concrete encasement. Exception: Earth cuts will be permitted as the form where trenches are neatly excavated in stable soils.
- E. Jacking Conduits: Rigid ferrous metal conduit may be jacked under roads, parking lots, etc. Submit jacking details for approval.
- F. Conduits in Filled Ground: Where indicated reinforce the footing and encasement for rigid nonmetallic conduits 10 feet beyond limits of fill. Reinforcement, footing or encasement is not required for rigid ferrous metal conduit.
- G. Conduits Entering Buildings and Manholes:
1. Seal conduit entrances into manholes watertight.
  2. Seal conduit entrances into building walls watertight. Exception: Seal is not required

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UNDERGROUND CONDUIT, DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

- in below grade foundation walls associated with slab on grade construction.
3. Install end bells at conduit entrances into manholes.
  4. Install end bells at conduit entrances into buildings. Exceptions:
    - a. Install insulated grounding bushing on conduit entrance stub up associated with slab on grade construction.
    - b. Install insulated grounding bushing and 2 locknuts on conduit where conduit is terminated in cabinet, junction or pull box.
- H. Cleaning Conduits: Take precautions to prevent foreign matter from entering conduits during installation. After installation clean conduits with tools designed for the purpose.
- I. Conduit for Future Use (Spare Conduit and Empty Conduit): Demonstrate to the Owner's Representative that conduits installed for future use are clear of obstructions (draw mandrel 1/2 inch less in diameter than conduit). Install a drag line in each conduit.
- J. Sealing Ends of Conduits:
1. Occupied Conduits: Seal ends of conduits to be used for Work of this contract until cables are to be installed. After cable installation, seal conduits at building entrances and first manhole outside building. Seal with duct seal.
  2. Conduits For Future Use: Seal the ends of spare and empty conduits at building entrances and manholes. Seal with plastic plugs or a contrasting color cement/sand mixture.
- K. Using Existing Underground Conduits: Clean the conduits with tools designed for the purpose. The condition of conduits after cleaning may be determined with a mandrel 1/2 inch less in diameter than the conduit, with the sheath painted with black lacquer. Pull mandrel through conduit. Conduit is acceptable when there are no roller marks or scratches on the mandrel. Other methods may be used if approved. Report and demonstrate to the Owner's Representative any defect found in the conduit system that cannot be eliminated. The Contractor is held responsible for any damage to cables resulting from imperfections in the conduit.

3.03 CONDUIT SCHEDULE - TYPES AND USE

- A. Rigid Ferrous Metal Conduit: Install in all locations unless otherwise specified or indicated on the drawings.
- B. Rigid Nonmetallic Conduit (Concrete Encased): May be installed in all locations except:
1. Where conduit stubs up or rises through slab or finished grade.
  2. Where other type raceways are specified or indicated on the drawings.
- C. Plastic Coated Rigid Metal Conduit: Use at locations indicated on drawings.

END OF SECTION



SECTION 262416  
PANELBOARDS

PART 1 GENERAL

1.01 REFERENCES

- A. NEMA, UL.

1.02 SUBMITTALS

- A. Submittal Packages: Submit the shop drawings, product data, and the quality control submittals specified below at the same time as a package.
- B. Shop Drawings; include the following for each panelboard:
1. Cabinet and gutter size.
  2. Voltage and current rating.
  3. Panelboard short circuit rating. Indicate if rating is Fully Rated Equipment Rating, or where acceptable, UL listed Integrated Equipment Short Circuit Rating.
  4. Circuit breaker enumeration (frame, ATE, poles, I.C.).
    - a. Indicate if circuit breakers are suitable for the panelboards' Fully Rated Equipment Rating, or where acceptable, are series connected devices which have been test verified and listed with UL (include documentation proving the compatibility of the proposed circuit breaker combinations). Circuit breakers do not have to be listed as series connected devices when all of the circuit breaker interrupting ratings are equal to, or greater than, the short circuit rating of the panelboard.
  5. When indicated on the panelboard schedule, a coordinated selective scheme between the main circuit breaker and branch/feeder circuit breakers so that under fault conditions the branch/feeder circuit breaker clears the fault while the main circuit breaker remains closed.
  6. Accessories.
- C. Product Data:
1. Catalog sheets, specifications and installation instructions.
  2. Bill of materials.
- D. Quality Control Submittals:
1. List of Completed Installations: If brand names other than those specified are proposed for use, furnish the name, address, and telephone number of at least 5 comparable installations which can prove the proposed products have operated satisfactorily for one year.
  2. 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.

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- E. Contract Closeout Submittals:
1. System acceptance test report.
  2. Certificate: Affidavit, signed by the Company Field Advisor.
  3. Operation and Maintenance Data: Deliver 2 copies, covering the installed products, to the Owner's Representative.

1.03 QUALITY ASSURANCE

- A. Company Field Advisor: Secure the services of a Company Field Advisor from the manufacturer of the programmable solid state circuit breakers for a minimum of 8 working hours for the following:
1. Render advice regarding final adjustment and programming of the circuit breakers.
  2. Witness final system test and then certify with an affidavit that the circuit breakers are installed in accordance with the contract documents and are operating properly.
  3. Train facility personnel on the operation and maintenance of the circuit breakers (minimum of two 1 hour sessions).
  4. Explain available service programs to facility supervisory personnel for their consideration.

PART 2 PRODUCTS

2.01 PANELBOARDS

- A. As produced by Cutler-Hammer/Eaton Corp., Challenger Electrical Equipment Corp. General Electric Co., Siemens, or Square D Co., having:
1. Flush or surface type cabinets as indicated on the drawings.
  2. Increased gutter space for gutter taps, sub-feed wiring, through-feed wiring, oversize lugs.
  3. UL label "SUITABLE FOR USE AS SERVICE EQUIPMENT" where used as service equipment.
    - a. Where indicated, equip panelboards used as service equipment with secondary surge arresters; GE's Tranquell Series, Joslyn's Mfr. Co.'s Surge Tec Series, Intermatic Incorp.'s AG2401 or AG6503, Square D Co.'s SDSA 1175 or SDSA 3650, to suit system primary (transformer size, available current) and secondary characteristics.
  4. Door and one piece trim. Door fastened to trim with butt or piano hinges. Trim fastened to cabinet with devices having provision for trim adjustment.
  5. Door lock. 2 keys with each lock (Exception: Not more than 7 keys, total).
  6. Solid tinned copper bus bars. Ampere rating of bus bars not less than frame size of main circuit breaker.
  7. Full capacity copper neutral bus in panelboards where neutrals are required.
  8. Copper equipment grounding bus in panelboards where equipment grounding conductors are required.
  9. Sections designated "space" or "provision for future breaker" equipped to accept future circuit breakers.
  10. Lock on devices for exit light, fire alarm, stair well circuits.
  11. Provisions for padlocking circuit breaker handle in OFF position where indicated.

SECTION 262416  
PANELBOARDS

12. Directory.
13. Short circuit rating not less than indicated on panelboard schedule. Furnish panelboards having Fully Rated Equipment Rating (the short circuit rating of the panelboard is equal to the lowest interrupting rating of any device installed in the panelboard). Exception:
14. Molded case, bolt-on circuit breakers:
  - a. Mounting: Individually mounted main circuit breaker (when MCB is required), and group mounted branch/feeder circuit breakers to accommodate the circuit breaker style and panelboard construction.
  - b. Components: See panelboard schedule for specific components required for each circuit breaker. In addition to the specific components, equip each circuit breaker with additional components as required to achieve a coordinated selective scheme between the main circuit breaker and the branch/feeder circuit breakers when indicated on the panelboard schedule that a coordinated selective scheme is required.
  - c. Single pole 15 ATE and 20 ATE circuit breakers marked SWD where used as switches.
  - d. Single pole and two pole 15, 20, and 30 ATE circuit breakers rated for high intensity discharge lighting loads when applicable.

2.02 NAMEPLATES

- A. General: Precision engrave letters and numbers with uniform margins, character size minimum 3/16 inch high.
  1. Phenolic: Two color laminated engravers stock, 1/16 inch minimum thickness, machine engraved to expose inner core color (black lettering on a white background).
  2. Materials for Outdoor Applications: As recommended by nameplate manufacturer to suit environmental conditions.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install panelboards in accordance with NEMA Publication No. PB1.1 "General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less".
  1. Set/program the circuit breakers.
- B. Flush Cabinets: Set flush cabinets so that edges will be flush with the finished wall line. Where space will not permit flush type cabinets to be set entirely in the wall, set cabinet as nearly flush as possible, and cover the protruding sides with the trim extending over the exposed sides of the cabinet and back to the finished wall line.
- C. Directory: Indicate on typewritten directory the equipment controlled by each circuit breaker, and size of feeder servicing panelboard. For power panelboards also include ATE rating and feeder size for each breaker.

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PANELBOARDS

D. Identification:

1. Provide nameplates corresponding to panelboard designations on the drawings, and electrical parameters (phase, wire, voltage).
2. Install a nameplate on each panelboard which explains the means of identifying each ungrounded system conductor by phase and system. Examples of nameplate statements:
  - a. Identification of 120/208 Volt Circuit Conductors:  
2 wire circuit - white\*, black.  
3 wire circuit - white\*, black, red.  
4 wire circuit - white\*, black, red, blue.

\*White is used only as neutral. Where neutral is not required, black, red, or black, red, blue is used for phase to phase circuits.

- b. Identification of 277/480 Volt Circuit Conductors:  
2 wire circuit - natural gray\*\*, brown.  
3 wire circuit - natural gray\*\*, brown, yellow.  
4 wire circuit - natural gray\*\*, brown, yellow, orange.

\*\*Natural gray is used only as neutral. Where neutral is not required, brown, yellow, or brown, yellow, orange is used for phase to phase circuits.

3.02 FIELD QUALITY CONTROL

A. Preliminary System Test:

1. Preparation: Have the Company Field Advisor adjust the completed circuit breakers 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 the circuit breakers 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 Owner'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. Test circuit breakers which have ground fault protection in accordance with the approved information sheets and test form.
  - b. Test programmable solid state trip devices in accordance with the manufacturer's recommendations.
3. Supply all equipment necessary for system adjustment and testing.
4. Submit written report of test results signed by the Company Field Advisor and the Owner's Representative. Mount a copy of the final report in a conspicuous location on, or inside, the panelboard door.

END OF SECTION

**SECTION 262417**  
**CIRCUIT BREAKERS FOR EXISTING PANELBOARDS**

**PART 1 GENERAL**

**1.01 SUBMITTALS**

- A. Not required.

**PART 2 PRODUCTS**

**2.01 CIRCUIT BREAKERS**

- A. Similar to existing circuit breakers.
- B. Compatible with existing panelboard.
- C. Number of poles and ampere trip rating as indicated on drawings.
- D. Complete with accessories required for installation.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A. Install new circuit breakers in existing panelboards where indicated.
- B. Add new circuits equally across phases to prevent overloading any phase in the panelboard. After new and existing circuits are energized, take current reading on panelboard feeder during a heavy usage time period. If phases are substantially unbalanced, rearrange both new and existing circuits in panelboard to equally distribute load between all phases, and provide new typewritten directory indicating equipment controlled by each circuit breaker.

END OF SECTION 262417

**SECTION 262417**  
**CIRCUIT BREAKERS FOR EXISTING PANELBOARDS**

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SECTION 262726  
WIRING DEVICES

PART 1 GENERAL

1.01 SUBMITTALS

- A. Product Data: Catalog sheets, specifications and installation instructions.

PART 2 PRODUCTS

2.01 SWITCHES

A. Local Switches, Single Pole:

1. 15A, 120/277 V ac; Bryant's 4801, Crouse-Hinds/AH's 1891, General Electric's GE5931-1G, Hubbell's 1201/1101, Leviton's 1201/1101, Pass & Seymour's 15AC1, or Woodhead's 1891.
2. 20A, 120/277 V ac; Bryant's 4901, Crouse-Hinds/AH's 1991, General Electric's GE 5951-1G, Hubbell's 1121/1221, Leviton's 1121/1221, Pass & Seymour's 20AC1, or Woodhead's 1991.
3. 30A, 120/277 V ac; Bryant's 3001, Crouse-Hinds/AH's 3991, General Electric's GE 5991-1G, Hubbell's 3031, Leviton's 3031, or Pass & Seymour's 30AC1.

B. Local Switches, Double Pole:

1. 15A, 120/277 V ac; Bryant's 4802, Crouse-Hinds/AH's 1892, General Electric's GE5932-1G; Hubbell's 1202/1102, Leviton's 1202/1102, Pass & Seymour's 15AC2, or Woodhead's 1892.
2. 20A, 120/277 V ac; Bryant's 4902, Crouse-Hinds/AH's 1992, General Electric's GE5952-1G, Hubbell's 1222/1122, Leviton's 1222/1122, Pass & Seymour's 20AC2, or Woodhead's 1992.
3. 30A, 120/277 V ac; Bryant's 3002, Crouse-Hinds/AH's 3992, General Electric's GE5992-1G, Leviton's 3032, or Pass & Seymour's 30AC2.

C. Local Switches, Three-Way:

1. 15A, 120/277 V ac; Bryant's 4803, Crouse-Hinds/AH 1893, General Electric's GE5933-1, Hubbell's 1203/1103, Leviton's 1203/1103, Pass & Seymour's 15AC3, or Woodhead's 1893.
2. 20A, 120/277 V ac; Bryant's 4903, Crouse-Hinds/AH's 1993, General Electric's GE5953-1G, Hubbell's 1223/1123, Leviton's 1223-2/1123-2, Pass & Seymour's 20AC3, or Woodhead's 1993.
3. 30A, 120/277 V ac; Bryant's 3003, Crouse-Hinds/AH's 3993, General Electric's GE5993-1G, Leviton's 3033, or Pass & Seymour's 30AC3.

D. Local Switches, Four-Way:

1. 15A, 120/277 V ac; Bryant's 4804, Crouse-Hinds/AH's 1894, General Electric's GE5934-1G, Hubbell's 1204/1104, Leviton's 1204-2/1104-2, Pass & Seymour's 15AC4, or Woodhead's 1894.
2. 20A, 120/277 V ac; Bryant's 4904, Crouse-Hinds/AH's 1994, General Electric's GE5954-1G, Hubbell's 1224/1124, Leviton's 1224-2/1124-2, Pass & Seymour's 20AC4, or Woodhead's 1994.

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3. 30A, 120/277 V ac; Crouse-Hinds/AH's 3994, or General Electric's GE5994-1G.
- E. Local Switches, Key-Operated:
  1. Similar to toggle type local switches except operated by removable key instead of lever. Furnish 2 keys with each switch.
- F. Motor Switch:
  1. Toggle type, fractional hp Manual Starter with Melting Alloy Type Thermal Overload Relay, 115/230 V, 16A, Square D Class 2510 or approved equivalent.

2.02 RECEPTACLES

- A. Specification Grade Receptacles:
  1. Single receptacle, NEMA 5-15R (15A, 125 V, 2P, 3W); Bryant's 5251, Crouse-Hinds/AH's 5251, General Electric's 5251-1, Hubbell's 5251, Leviton's 5251, or Pass & Seymour's 5251.
  2. Duplex receptacle, NEMA 5-15R (15A, 125 V, 2P, 3W); Bryant's 5252/5242, Crouse-Hinds/AH's 5252/5242, General Electric's GEN5252-1, Hubbell's 5252/5242, Leviton's 5252/5242, Pass & Seymour's 5252/5242.
  3. Single receptacle, NEMA 5-20R (20A, 125 V, 2P, 3W); Bryant's 5361/5351, Crouse-Hinds/AH's 5361/5351, General Electric's GE4103-1, Hubbell's 5361/5351, Leviton's 5361/5351, or Pass & Seymour's 5351.
  4. Duplex receptacle, NEMA 5-20R (20A, 125 V, 2P, 3W); Bryant's 5362, Crouse-Hinds/AH's 5352/5342, General Electric's GE5352-1, Hubbell's 5352, Leviton's 5352, or Pass & Seymour's 5352.
- B. Ground Fault Interrupter Receptacles:
  1. Duplex receptacle rated 15A (NEMA 5-15R), circuit-ampacity 20A; Bryant's GFR52FT, Crouse-Hinds/AH's GF5242, General Electric's GF5242, Hubbell's GF5252, Leviton's 6599, Pass & Seymour's 1591S, or Daniel Woodheads 5252GF.
  2. Duplex receptacle rated 20A (NEMA 5-20R), circuit ampacity 20A; Bryant's GFR53FT, Crouse-Hind/AH's GF5342, General Electric's GF5342, Hubbell's GF 5352, Leviton's 6899, Pass & Seymour's 2091S, or Daniel Woodheads 5352GF.
- C. Isolated Ground Receptacles:
  1. Single receptacle, NEMA 5-15R (15A, 125 V, 2P, 3W); Hubbell's IG5261, Leviton's 5261-IG, Cooper Wiring Devices IG5261.
  2. Duplex receptacle, NEMA 5-15R (15A, 125 V, 2P, 3W); Hubbell's IG-5262, Leviton's 5262-IG, Cooper Wiring Devices IG5262.
  3. Single receptacle, NEMA 5-20R (20A, 125 V, 2P, 3W); Hubbell's IG5361, Cooper Wiring Devices IG5361.
  4. Duplex receptacle, NEMA 5-20R (20A, 125 V, 2P, 3W); Hubbell's IG5362, Leviton's 5362-IG, Cooper Wiring Devices IG5362.
- D. Corrosion Resistant Receptacles:
  1. Duplex receptacle, NEMA 5-15R (15A, 125 V, 2P, 3W): Bryant's 5262-CR, Crouse-Hinds/AH's 5262CR, General Electric's GE5262-C, Hubbell's 5262-ILH or Pass & Seymour's CR6200.



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- E. Special Purpose Receptacles: Furnish matching nylon, polycarbonate or armored plug with each receptacle as specified as follows or on the drawing.
  - 1. Dryer Outlet: NEMA 10-30R (3P, 3W, 30A, 125/250 V); Bryant's 9303, Crouse-Hinds/AH's 9344N, General Electric's GE4132-3, Hubbell's 9350, Leviton's 5207, or Pass & Seymour's 3860.
  - 2. Range Outlet: NEMA 10-50R (3P, 3W, 50A, 125/250 V); Bryant's 9306, Crouse-Hinds/AH's 7985N, General Electric's GE4152-3, Hubbell's 7962, Leviton's 5206GR, or Pass & Seymour's 3890.
  - 3. Other Types: As produced by Bryant, Crouse-Hinds/AH, General Electric, Hubbell, or Pass & Seymour. NEMA configuration and ratings to suit requirements.

2.03 WALL PLATES

- A. Stainless Steel Wall Plates: Type 302 stainless steel with satin finish; Hubbell's 97000 Series, Leviton's 84000 Series, or Cooper Wiring Devices 93000 Series.
- B. Covers for Threaded Type Boxes: Stamped sheet steel, gasketed device covers as produced by Crouse-Hinds Co., or OZ/Gedney Co.

2.04 EMERGENCY SHUTDOWN SWITCHES

- A. Emergency Shutdown Pushbutton Switch: Square D. Co.'s Class 9001, Type K, pushbutton operator with the following:
  - 1. Red mushroom button.
  - 2. Transformer type red pilot light.
  - 3. Legend red plate with words "Emerg. Stop".
  - 4. NEMA 13 oil tight enclosure with cover riveted to body.

2.05 NAMEPLATES

- A. Phenolic Type: Standard white phenolic nameplates with 3/16 inch minimum size black lettering engraved thereon.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install wiring devices in outlet boxes.
- B. Local Switches:
  - 1. Install local switches rated 15A, 120/277 V ac for switches unless otherwise shown on the drawings or specified.
  - 2. Install switches indicated Sa, Sb, Sc, etc, for control of outlets or fixtures with corresponding letters on the same circuit.
  - 3. Where more than one switch occurs at same location in a 120 volt system, arrange

SECTION 262726  
WIRING DEVICES

- switches in gangs and cover with one face plate.
4. Install switches in a 277 volt system in separate single boxes if voltage between exposed live metal parts of adjacent switches exceeds 300 volts.
  5. Install single and double pole switches so that switch handle is up when switch is in the "On" position.
- C. Receptacles:
1. Install Specification Grade receptacles, NEMA 5-15R, 15A, 125 V, 2P, 3W, for duplex receptacles and single receptacles unless otherwise shown on the drawings or specified.
  2. Install receptacles with ground pole in the down position.
- D. Wall Plates:
1. Install wall plates on all wiring devices in dry locations, with finish to match hardware in each area.
  2. Install blank wall plates on outlet boxes which are for future equipment except telephone outlets.
  3. Install 5/8 inch bushed wall plates on telephone outlets.
- E. Weatherproof Covers: Install weatherproof covers on wiring devices in damp and wet locations.
- F. Nameplates: Provide phenolic or embossed aluminum nameplate for each special purpose receptacle indicating phase, ampere and voltage rating of the circuit. Attach nameplate with rivets or tamperproof fasteners to wall plate or to wall above receptacle. Wall plates may be engraved with required data in lieu of separate nameplates.
- G. Mats: Where flush plates are required over outlet boxes that cannot be set deep enough for the plates to fit closely over the finished wall surfaces, provide oak mats to fill the space between the finished wall surface and the plate.

END OF SECTION

SECTION 262813  
FUSES

PART 1 GENERAL

1.01 SUBMITTALS

- A. Product Data: Catalog sheets, specifications and installation instructions.

1.02 MAINTENANCE

- A. Spare Parts:
1. Six spare fuses of each size and category, including any accessories required for a complete installation.
  2. Special tools if required for installation or removal of fuses.

PART 2 PRODUCTS

2.01 FUSEHOLDERS

- A. Equipment provided shall be furnished with fuseholders to accommodate the fuses specified.

2.02 FUSES RATED 600V OR LESS

- A. Fuses for Safety Switches (Motor Circuits) and Service Disconnects:
1. Cartridge Type (250 Volts, 600 Amperes or Less): Dual element time-delay, UL Class RK-5, 200,000 amperes R.M.S. symmetrical interrupting capacity:
    - a. Cooper Industries Inc.'s/Bussman Div. Type FRN-R.
    - b. Gould Inc.'s/Circuit Protection Div. (Shawmut) Type TR-R.
    - c. Littlefuse Inc.'s Type FLN-R.
  2. Cartridge Type (600 Volts, 600 Amperes or Less): Dual element time-delay, UL Class RK-5, 200,000 amperes R.M.S. symmetrical interrupting capacity:
    - a. Cooper Industries Inc.'s/Bussmann Div. Type FRS-R.
    - b. Gould Inc.'s/Circuit Protection Div. (Shawmut) Type TRS-R.
    - c. Littlefuse Inc.'s Type FLS-R.
  3. Cartridge Type (600 Volts or Less - Above 600 Amperes): Current limiting, UL Class L, 200,000 amperes R.M.S. symmetrical interrupting capacity:
    - a. Cooper Industries Inc.'s/Bussmann Div. Type KTU.
    - b. Gould Inc.'s Circuit Protection Div. (Shawmut) Type A4BY.
    - c. Littlefuse Inc.'s Type KLP-C.
- B. Fuses for Safety Switches (Lighting and Heating Circuits):
1. Cartridge Type (250 Volts): Single element, UL Class RK-1, 200,000 amperes R.M.S. symmetrical interrupting capacity:
    - a. Cooper Industries Inc.'s/Bussmann Div., Type KTN-R.
    - b. Gould Inc.'s/Circuit Protection Div. (Shawmut) Type A2K-R.
    - c. Littlefuse Inc.'s Type KLN-R.
  2. Cartridge Type (600 Volts): Single element, UL Class RK-1, 200,000 amperes

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FUSES

R.M.S. symmetrical interrupting capacity:

- a. Cooper Industries Inc.'s/Bussmann Div. Type KTS-R.
- b. Gould Inc.'s/Circuit Protection Div. (Shawmut) Type A6K-R.
- c. Littlefuse Inc.'s Type KLS-R.

2.03 FUSES RATED OVER 600V

- A. Fuses for Metal Enclosed Interrupter Switchgear:
  - 1. Current Limiting, Silver-Sand Type: General Electric Co.'s Type EJ.
  - 2. Boric-Acid Type: S & C Electric Co.'s Type SM with snuffler, or Westinghouse Elec. Corp.'s Type RBA with condenser.
- B. Fuses for Fused Load Break Interrupter Switches: General Electric Co. Type EJ, or S & C Electric Co.'s Type SM.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install fuses in respective equipment.

END OF SECTION

SECTION 262816  
ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SUBMITTALS

- A. Product Data: Catalog sheets, specifications and installation instructions.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Enclosed Circuit Breakers: As produced by Square D Co., General Electric Co., or Westinghouse/Cutler Hammer Corp. having:
1. NEMA 1 enclosure unless otherwise indicated on the drawings.
  2. Solid neutral.
  3. Voltage rating, current rating, symmetrical current interrupt rating as indicated on drawing and number of poles as indicated on the drawings.
  4. Circuit breakers to suit requirements.
  5. Under 50 ampere trip element, enclosure has means to lock circuit breaker position on or off using standard padlock.
  6. Ampere trip elements 50 and above have industrial type enclosure with door and side handle. Handle position is lockable using standard padlock.

2.02 NAMEPLATES

- A. Phenolic: Engraved plates, minimum 3/4" wide and length as required by inscription: Seton Name Plate Corp.
- B. Stamped Metal: Standard stamped or embossed aluminum tags, minimum 3/4" wide and length as required by inscription: Tech Products, Inc.; Seton Name Plate Corp.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Mount enclosed circuit breakers on wall so that maximum height above the floor to the center of operating handle does not exceed 6-1/2'.
- B. Provide phenolic or stamped metal nameplates on cover of each enclosed circuit breaker indicating purpose or load served by the circuit breaker.

END OF SECTION

SECTION 262816  
ENCLOSED CIRCUIT BREAKERS

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SECTION 262817  
SAFETY SWITCHES

PART 1 GENERAL

1.01 SUBMITTALS

- A. Product Data: Catalog sheets, specifications and installation instructions.

PART 2 PRODUCTS

2.01 SAFETY SWITCHES (SINGLE THROW)

- A. NEMA 1, 3R, 4 (Stainless Steel), 12: Challenger's Heavy Duty Series, Cutler-Hammer Inc.'s DH, General Electric Co.'s Type TH, or Square D Co.'s Heavy Duty Series, having:
1. Fuses, or unfused as indicated on drawings.
  2. Fused switches equipped with fuseholders to accept only the fuses specified in Section 16416 (UL Class RK-1, RK-5, L).
  3. NEMA 1 enclosure unless otherwise indicated on drawing.
  4. 240V rating for 120V, 208V, or 240V, circuits.
  5. 600V rating for 277V, or 480V circuits.
  6. Solid neutral bus when neutral conductor is included with circuit.
  7. Ground bus.
  8. Current rating and number of poles as indicated on drawings.
- B. NEMA 4X: Crouse-Hinds Co.'s NST, or Square D Co.'s Special Application Safety Switches; having:
1. Fuses, or unfused as indicated on drawings.
  2. Fused switches equipped with fuseholders to accept only the fuses specified in Section 16416 (UL Class RK-1, RK-5, L).
  3. Molded fiberglass-reinforced polyester NEMA 4X enclosure.
  4. 240V rating for 120V, 208V, or 240V, circuits.
  5. 600V rating for 277V, or 480V circuits.
  6. Solid neutral bus when neutral conductor is included with circuit.
  7. Ground bus.
  8. Current rating and number of poles as indicated on drawings.

2.02 NAMEPLATES

- A. General: Precision engrave letters and numbers with uniform margins, character size minimum 3/16 inch high.
1. Phenolic: Two color laminated engravers stock, 1/16 inch minimum thickness, machine engraved to expose inner core color (white).
  2. Aluminum: Standard aluminum alloy plate stock, minimum .032 inches thick, engraved areas enamel filled or background enameled with natural aluminum engraved characters.
  3. Materials for Outdoor Applications: As recommended by nameplate manufacturer to suit environmental conditions.

SECTION 262817  
SAFETY SWITCHES

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install switches so that the maximum height above the floor to the center of the operating handle does not exceed 6'-6".
- B. Identify each safety switch, indicating purpose or load served:
  - 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 Enclosures: Attach nameplate 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.

END OF SECTION



SECTION 265119  
LIGHT-EMITTING DIODE (LED) FIXTURES

PART 1        GENERAL

1.01    SUBMITTALS

- A.    Product Data: Catalog sheets, specifications and installation instructions, including:
  - 1.    Technical information for each fixture that proves that it meets specified requirements. Include data which proves proposed lamp and ballast combinations do not exceed specified total harmonic distortion.
  - 2.    Candlepower distribution curves for each type fixture if different from Company or catalog number specified.
- B.    Samples: One of each product if requested.
- C.    Quality Control Submittals:
  - 1.    List of Installations for Electronic Ballasts: If brand names other than those specified are proposed for use, furnish the name, address, and telephone number of at least 5 comparable installations which can prove the proposed products have operated satisfactorily for 1 year. The installations shall present a grand total of at least 5000 ballasts.

1.02    QUALITY ASSURANCE

- A.    Equipment Qualifications For Products Other Than Those Specified:
  - 1.    At the time of submission provide written notice to the Owner's Representative of the intent to propose and "or equal" for products other than those specified. Make the "or equal" submission in a timely manner to allow the Owner's Representative 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 Owner's Representative and the Company Field Advisor.
    - a.    Make arrangements with the owners of 2 installations (selected by the Owner's Representative) for inspection of the installations by the Owner's Representative. Also obtain the services of the Company Field Advisor for the proposed products to be present. Notify the Owner's Representative 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.

SECTION 265119  
LIGHT-EMITTING DIODE (LED) FIXTURES

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 Owner'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 Owner's Representative 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.

PART 2 PRODUCTS

2.01 LUMINAIRES

- A. Type High Bay LED: Full metal fixture liner inside reinforced fiberglass housing: Cooper Metalux Skybar LED:
  1. Lamp Type: LED.
  2. Fixture Length: 4'
  3. Luminaire to operate at 120 - 277V and connected for operation on 120V circuit, unless otherwise indicated on drawing.
  4. Mounting:
    - a. Ceiling Surface mounted.
  5. Housing:
    - a.
  6. Fixture is suitable for operation from -20 degrees C to 25 degrees c ambient conditions.
  7. Wet location Listed.
  8. IP56
  9. LED lamp listed IESNA LM79/LM80
  10. 5 year warranty.
- B. Type Wall Mount Luminaire. Area Light: Rugged, Five stage super TGIC polyester powder coat paint aluminum housing. McGraw-Edison Impact Elite LED
  1. Lamp Type: Solid State LED.
  2. Luminaire to operate at 120 - 277V and connected for operation on 120V circuit, unless otherwise indicated on drawing.
  3. Mounting:
    - a. Wall mounted.
  4. Housing:
    - a. Five stage super TGIC polyester powder coat paint aluminum housing.
  5. Fixture is suitable for operation from -40 degrees C to 40 degrees c ambient conditions.
  6. Wet location Listed.
  7. IP66
  8. LED lamp listed UL 8750, LM79, LM80, ISO 9001

SECTION 265119  
LIGHT-EMITTING DIODE (LED) FIXTURES

- C. Type LED Parking Garage, Canopy, Low-bay Luminaire: Rugged, die-cast, aluminum housing. all polycarbonate one piece McGraw-Edison TT toptier LED
1. Lamp Type: Solid State LED.
  2. Luminaire to operate at 120V circuit, unless otherwise indicated on drawing.
  4. Mounting:
    - a. Wall mounted.
  5. Housing:
    - a. low copper die-cast, single piece aluminum.
  6. Glass lens, reflective backing plates
  7. Fixture is suitable for operation from -40 degrees C to 40 degrees c ambient conditions.
  9. IP66, ISO 9001
  10. LED lamp listed UL 8750
- D. Type LED Wall, Wall mount battery backup. Nominal 2-3/4" x10" housing constructed form extruded aluminum and die-formed 20 gauge cold rolled steel. Corelite Divide
1. Lamp Type: LED.
  2. Luminaire to operate at 120V circuit, unless otherwise indicated on drawing.
  4. Mounting:
    - a. Wall mounted.
  5. Housing:
    - a. extruded aluminum and die-formed 20 gauge
  6. Direct/indirect light
  7. Damp location Listed.
  8. LM79/LM90
  9. LED lamp listed UL 1598
- E. Type LED suspended, suspended. Nominal 2-1/4" x12" housing constructed form extruded aluminum and die-formed 20 gauge cold rolled steel. Corelite Divide
1. Lamp Type: LED.
  2. Luminaire to operate at 120V circuit, unless otherwise indicated on drawing.
  3. Mounting:
    - a. Suspended by aircraft cable.
  4. Housing:
    - a. extruded aluminum and die-formed 20 gauge
  5. Direct/indirect light
  6. Damp location Listed.
  7. LM79/LM90
  8. LED lamp listed UL 1598
- E. Type LED grid ceiling 2'x2' troffer housing constructed form code guage prime cold rolled steel. Metalux Cruze
1. Lamp Type: LED 4.0
  2. Luminaire to operate at 120V circuit, unless otherwise indicated on drawing.
  3. Mounting:
    - a. 4 grid clips per fixture.

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LIGHT-EMITTING DIODE (LED) FIXTURES

4. Housing:
  - a. extruded aluminum and die-formed 20 gauge
5. Direct/indirect light
6. Damp location Listed.
7. LM79/LM90
8. LED lamp listed UL 1598

F. Type LED wall mound scone Scott Arc Lighting

1. Lamp Type: LED
2. Luminaire to operate at 120V circuit, unless otherwise indicated on drawing.
3. Mounting:
  - a. wall mounted scone
4. Housing:
  - a. Brushed Nickel

2.02 LIGHTING CONTROLS AND COMMUNICATION

- A. Summary – The lighting in the locker room, truck room, vestibules, training space, and the exterior of the building shall be on a lighting controllers. The lighting controllers for the locker room, truck room, vestibule, and exterior shall be connected to the fire siren control panel. Whenever a fire siren is activated a relay in the fire siren control panel will close sending a signal to the lighting controllers to turn on the lights in the locker room, truck room, vestibule, and exterior. The training space controller shall be configured to power and dim lights in the training space.
- B. Lighting Controllers - LMRC
1. Dimming room controller On/Off/0-10V
  2. Single Phase 120VAC 60Hz input.
  3. Three relay room controller
  4. Each relay rated for 120V, 20A ballast or incandescent.
  5. Class 2 output to DLM local network:24VDC, up to 250mA across 4 RJ45 ports.
  6. UL and cUL listed
  7. Five year warranty
  8. Wattstopper LMRC-210 Series model number LMRC-213 or engineer approved equal.
  9. Locations: Locker Room, Truck Bay, Vestibule, Exterior Lighting, Training Space. Quantity five (5).
- C. Input Output Interface - LMIO
1. Input/output voltage:24VDC from the digital lighting management DLM network.
  2. Max Current consumption 20mA
  3. DLM local network connection shall be two RJ45 ports.
  4. Removable terminal block for connections to isolated relay output and third party inputs.
  5. Isolated relay ratings:
    - a. 24VDC/VAC, 1A, SPDT

SECTION 265119  
LIGHT-EMITTING DIODE (LED) FIXTURES

- b. Normally open (N/O), normally closed (N/C) and common outputs.
  - 6. UL listed
  - 7. 5 year warranty
  - 8. The input output interface shall be a Wattstopper model LMIO-101 or approved equal.
  - 9. Quantity one (1)
- D. Control Switches – LMSW
  - 1. Input voltage – 24VDC from DLM network
  - 2. Current consumption 5mA
  - 3. Connection to DLM network through two RJ45 ports
  - 4. UL listed
  - 5. Five year warranty
  - 6. Control Switches shall be Wattstopper LMSW-100 Series
    - a. LMSW-KIT-101 1 button kit for the locker room and vestibule quantity two (2).
    - b. LMSW-KIT-102 2 button kit for training space quantity four (4).
    - c. LMSW-KIT-103 3 button kit for Locker Room, Truck Bay, Vestibule, Exterior Lighting quantity two (2).
    - d. LMSW-KIT-104 4 button kit for Locker Room, Truck Bay, Vestibule, Exterior Lighting quantity three (3).
    - e. LMSW-KIT-108 8 button kit for training space quantity four (4).
- E. Software
  - 1. Contractor shall furnish and install all software for a complete and functional digital lighting management system.
  - 2. This shall include programming all lighting circuits.
  - 3. Contractor shall furnish and install startup and testing of all hardware and software in the digital lighting management network.
  - 4. Contractor shall furnish training for the digital lighting management network. This shall include eight (8) hours of training.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General: Install fixtures at locations indicated on the drawings.
- B. Finishing Collar or Combination Finishing Collar/Outlet Box (Surface Mounted Fixture Used With Exposed Raceway):
  - 1. Provide finishing collar where surface mounted fixture is installed on an exposed raceway outlet box and the fixture base is larger than the outlet box.
  - 2. Provide combination finishing collar/outlet box where surface mounted fixture is not indicated to be installed on an exposed raceway outlet box, but raceway cannot be run directly into fixture body due to fixture design.

END OF SECTION

SECTION 265119  
LIGHT-EMITTING DIODE (LED) FIXTURES

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SECTION 265213  
EMERGENCY LIGHTING – UNIT EQUIPMENT

PART 1 GENERAL

1.01 SUBMITTALS

- A. Submittal Package: Submit the product data items specified below at the same time as a package.
- B. Product Data:
  - 1. Catalog sheets, specifications and installation instructions.
  - 2. Battery warranty.
  - 3. Name, address and telephone number of nearest fully equipped service organization.
- C. Project Closeout Submittals:
  - 1. Operation and Maintenance Data: Deliver 2 copies, covering the installed products, to the Owner's Representative. Include name, address and telephone number of the nearest fully equipped service organization.

1.02 QUALITY ASSURANCE

- A. List of Completed Installations: If brand names other than those specified are proposed for use, furnish the name, address, and telephone number of at least 5 comparable installations which can prove the proposed products have operated satisfactorily for 3 years.
- B. Service Availability: A fully equipped service organization shall be available to service the completed Work.

PART 2 PRODUCTS

2.01 EMERGENCY LIGHTING UNITS

- A. Refer to the Lighting Fixture Schedule on the drawings for emergency fixtures required for the project.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install the Work of this Section in accordance with the manufacturer's printed instructions.
- B. Insert a copy of the battery warranty in each unit and mark on batteries the date placed in service.

END OF SECTION

SECTION 265213  
EMERGENCY LIGHTING – UNIT EQUIPMENT

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SECTION 265214  
EXIT LIGHT FIXTURES

PART 1 GENERAL

1.01 SUBMITTALS

- A. Product Data: Catalog sheets, specifications and installation instructions.
- B. Samples: One of each product if different from Company or catalog number specified.

1.02 QUALITY ASSURANCE

- A. List of Installations: If brand names other than those specified are proposed for use, furnish the name, address, and telephone number of at least 5 comparable installations which can prove the proposed products have operated satisfactorily for one year.

PART 2 PRODUCTS

2.01 EXIT LIGHT FIXTURES

- A. Refer to the Lighting Fixture Schedule on the drawings for description of Exit Fixtures required for the project.

PART 3 EXECUTION

3.01 INSTALLATION

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

END OF SECTION

SECTION 265214  
EXIT LIGHT FIXTURES

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