

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope

1. Furnish and install all products as specified under this Section and other sections of Division 16, as indicated on the Drawings, and as required for the entire electrical requirements of this project
2. Install all electrical equipment specified under other sections
3. This section is intended to present minimum requirements for materials and installation. Where requirements are shown on the Drawings or specified under other sections, the most stringent shall apply

B. Related Work Specified Elsewhere

1. Section 02200: Earthwork
2. Section 02584: Underground Ducts and Utility Structures
3. Section 03300: Cast-in-Place Concrete
4. Section 03600: Grout
5. Section 05501: Anchor Bolts and Drilled-In Anchors
6. Section 07600: Flashing and Sheet Metal
7. Section 13100: Lightning Protection
8. Section 13300: Utility Control System
9. Division 11: Equipment
10. Division 14: Conveying Systems
11. Division 15: Mechanical
12. Division 16: Electrical

C. Utility Service Entrances

1. General
 - a. Schedule and coordinate with utility companies and other utility installing Contractors
 - b. Pay all inspection fees charged by utilities
 - c. Owner shall pay all service and construction charges
2. Electric power service
 - a. Utility: Mountain View Electric Association, 11140 East Woodmen Road, Falcon, CO 80831. Contact: Les Ulfers 719-495-2283
 - 1) Underground
 - 2) 480/277V, 3 phase, grounded wye
 - 3) Utility furnished items
 - a) Primary junction box
 - b) Service transformer
 - c) Transformer pad
 - d) Primary and secondary transformer connections

- 4) Contractor furnished items
 - a) Conductors and conduit from transformer to automatic transfer switch and all terminators not provided by utility
- 5) Other items as indicated on the Drawings
- 3. Telephone service
 - a. Utility: Qwest Communications, 7925 Industry Road, Colorado Springs, CO 80939. Contact: Sally Klein 719-636-4329
 - 1) Utility furnished items
 - a) Telephone pedestal
 - 2) Contractor furnished items
 - a) Telephone panel mounting board
 - b) In-plant conduit and wires
 - c) Telephone outlets
 - b. Owner furnished items
 - 1) Telephone instruments

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies

- 1. Arrange for, obtain and pay for all permits, inspections and approvals of local authorities except as noted in Section 01010 - Summary of Work
- 2. Comply with local electrical codes in force or in the absence of local electrical code, the latest edition of the National Electrical Code, ANSI C1

B. Reference Standards

- 1. All applicable standards of UL
- 2. All applicable standards of IEEE
- 3. All applicable standards of IPCEA
- 4. All applicable standards of NEMA

1.3 SUBMITTALS

A. Shop Drawings and Product Data

- 1. Descriptive literature on all products furnished hereunder in accordance with Section 01340

PART 2 - PRODUCTS

2.1 RACEWAYS

A. General Use

- 1. Conduit: Heavy wall, galvanized rigid steel conduit, GRC, ¾" minimum. Conduit in hazardous classified area shall be aluminum or PVC coated rigid steel
- 2. Boxes and fittings
 - a. Exposed, encased in concrete, in exterior faces of walls, in water or earth-bearing walls or for weatherproof devices: Threaded, malleable iron, Crouse-Hinds, Appleton or equal

- b. Other concealed locations: Galvanized or cadmium plated steel; in hazardous wiring area aluminum or PVC Coated steel to match conduit
 - c. Hub arrangements to avoid unnecessary bends and fittings
 - d. Seal fittings: Appleton ESU with Apelco fiber and compound, Crouse-Hinds EZS with Chico X fiber and Chico A compound, or equal
 - e. Deflection fittings: Weather-tight with bonding jumpers, O-Z Type DX, Crouse-Hinds Type XD, or equal
 - f. Expansion fittings: Weather-tight, 4" of movement with bonding jumper and clamps, Appleton Type XJ, Crouse-Hinds XJ or equal
3. Large junction boxes and wiring gutters
- a. Indoors: Sheet steel galvanized after fabrication
 - b. Outdoors: Weather-tight, stainless steel or corrosion resistant cast metal
 - c. Do not install aluminum boxes in concrete
 - d. Provide rigid handles for box covers larger than 9 sq ft or heavier than 25 lbs
 - e. Provide split covers for covers larger than 12 sq ft
 - f. Plastic and FRP boxes may be used in indoor locations where allowed by NEC

B. Flexible Connections

- 1. Conduit: Vinyl jacketed, liquid-tight, flexible steel, Anaconda Type UA, Electroflex Type LA, or equal
- 2. Connectors: Water-tight, Appleton Type ST or STB, Crouse-Hinds Type LT or LTC, or equal

C. Underground Circuits, 120 V and Above

- 1. Duct: Thin walled, PVC duct, expressly for use as a concrete encased raceway, with end bells, couplings, and adapters, Type EB; heavy wall rigid PVC conduit, Schedule 40; or IMC or GRC conduit

D. Flexible Sealing Compound, Johns-Manville, "Duxseal", Inmount "Permagum", or equal

2.2 WIRE AND CABLE

A. Power, Control and Lighting Circuits, 600 V and Below

- 1. General Use
 - a. Conductors: Single, copper, 12 AWG minimum
 - b. Stranded where larger than 10 AWG, solid or stranded for 10 AWG and 12 AWG
 - c. Insulation: 600 V thermoplastic, UL Type THWN/THHN
 - d. Jacket: Nylon
 - e. Suitability: Wet or dry locations at 75C copper temp
 - f. Or as specified for service entrances
- 2. Service entrance and 4 AWG and above
 - a. Conductors: Single, stranded, copper
 - b. Insulation: 600 V cross-linked polyethylene, UL Type XHHW/USE
 - c. Suitability: Wet or dry locations at 75C copper temp

- d. Manufacturers: Okonite "X-Olene" 112-32; Anaconda "Durasheath" XLP; or equal
3. Terminations: Lugs, cup washers or pressure type; do not use wire nuts on stranded cable or wrap standard cable around screw type terminals

B. Millivolt or Milliampere Level Instrument Signal Cable

1. Conductors: 16 AWG stranded copper, 2 or 3 as required
2. Insulation: 15 mils, minimum 90C PVC or cross-linked polyethylene
3. Shield: Mylar aluminum tape with 18 AWG copper drain wire, fully covering conductors
4. Jacket: 20 mils, minimum, 80C PVC
5. Suitability: Wet or dry steel conduit
6. Manufacturers: Samuel Moor "Dekoron ICMX" No. 1852-686 and 1862-686, or equal

2.3 WIRING DEVICES

A. General

1. Specification grade
2. Brown with metal device plates
3. Brown or ivory to match device plates with phenolic plastic device plates

B. Receptacles

1. 120 V duplex outlets: NEMA 5-2OR, 3 wire, grounding, 20 amp, 125 V, Hubbell 5362, General Electric 4108-1 or equal
2. Auxiliary light outlets: NEMA L5-15R, simplex, 3 wire, grounding, locking, 15 amp, 125 V, Hubbell 4710, General Electric LD4710, or equal
3. Telephone: Modular telephone jacks

- C. Light Switches for 120 V lighting circuits: 20 amp, 120/227 V, Hubbell 1221 to 1224, General Electric 5159-1 to 5954-1, or equal

2.4 DEVICE PLATES

A. General

1. Mounting hardware countersunk and finished to match plate
2. Provide oversized plates where standard plates do not cover wall opening

B. Indoors

1. Surface mounted devices: Galvanized or cadmium plated steel
2. Flush mounted devices in finished areas: Phenolic plastic, brown or ivory as appropriate for adjacent wall
3. All other flush mounted devices: Type 302 stainless steel

- C. Outdoors and Indoors Identified on Drawings as Weatherproof

2.5 MAINTENANCE MATERIALS

A. Spare Parts

1. 10% replacement lamps for lighting fixtures
2. 10% replacement lamps for pilot lights
3. 10% replacement caps for pilot lights
4. 100% replacement fuses

B. Tools: Fuse puller of each size required

2.6 GROUNDING MATERIALS

A. Ground Conductors

1. Cable: Bare or green insulated, soft drawn copper, 12 AWG minimum

B. Ground Rods

1. $\frac{3}{4}$ " by 10' or as indicated on Drawings
2. Steel core with molten welded copper coating

C. Connections

1. Accessible: High conductivity, high strength copper alloy
2. Inaccessible: Exothermic copper welding

2.7 LUMINARIES

A. Provide as indicated on the Drawings

B. Provide complete with lamps

C. Provide swivel type box covers and threaded conduit pendants for pendant type fixtures, unless otherwise indicated on Drawings

2.8 POWER PANELS

A. General

1. Circuit breaker panelboard
2. With neutral
3. Dead front
4. Service entrance equipment

B. Enclosure

1. NEMA 1, surface unless noted otherwise
2. Door with latch and lock
3. Typewritten circuit directory

4. Ground stud bolt through cabinet with removable 1/0 AWG bond to the panel ground bus and an external clamp connector for a station ground conductor

C. Circuit Breakers

1. Molded case thermal magnetic
2. Common trip
3. Bolt-in
4. Individually front replaceable
5. Indicating "On", "Off", and "Tripped"
6. 600 V
7. 14,000 amp RMS symmetrical interrupting capacity or as noted on Drawings
8. Handle clips to prevent casual operation for all circuit breakers
9. Breakers, trip ratings and number of poles as indicated on the Drawings

D. Buses

1. Three phase buses and neutral bus insulated from cabinet
2. Ground bus
 - a. Connected to cabinet
 - b. Clamp type lug for supply circuit and each load circuit
 - c. Removable bond to neutral bus
3. Copper
4. Ampere and voltage ratings as indicated on the drawings
5. Bracing coordinated with circuit breaker interrupting capacity

E. Lightning Arrestor

1. Where indicated on Drawings
2. Lightning and surge arrestor
3. 3 phase for 277/480 Volt grounded wye system
4. Weatherproof

2.9 LIGHTING PANELS

A. General

1. Circuit breaker panelboard
2. With neutral
3. Dead front

B. Enclosure

1. General: NEMA 1, unless noted otherwise on Drawings
2. Door with latch and lock
3. 3. Typewritten circuit directory
4. Ground stud bolt through cabinet with removable I/O AWG bond to the panel ground bus and an external clamp connector for a station ground conductor

C. Circuit Breakers

1. Molded case thermal magnetic
2. Common trip
3. Bolt-in or plug-in
4. Individually front replaceable
5. Indicating "On", "Off", and "Tripped"
6. RMS symmetrical interrupting capacity as noted on Drawings
7. Handle clips to prevent casual operation for circuit breakers indicated on Drawings
8. Ground fault interrupting breakers with a sensitivity of 5mA for receptacle branch circuit and where indicated on drawings
9. Breakers, trip ratings and number of poles as indicated on the Drawings

D. Buses

1. Two phase and neutral bus insulated from cabinet
2. Ground bus
 - a. Connected to cabinet
 - b. Clamp type lug for supply circuit and each load circuit
 - c. Removable bond to neutral bus
3. Copper
4. Ampere and voltage ratings as indicated on the Drawings
5. Bracing coordinated with circuit breaker interrupting capacity

2.10 DRY-TYPE SPECIALTY TRANSFORMERS

- A. Phase, voltage, and current ratings as indicated on Drawings
- B. Two 2½% full capacity taps below normal voltage
- C. Dry type, wall or floor mounted, enclosed for wiring in conduit
- D. Self air cooled, 115°C temp rise

2.11 SEPARATELY ENCLOSED MOTOR STARTERS

A. General

1. Enclosure
 - a. General indoor use: NEMA 1, surface
 - b. Outdoor: NEMA 4, surface
 - c. Unless noted otherwise on Drawings
2. NEMA size as indicated on Drawings or as required for motor served
3. Pilot devices: Heavy-duty oil-tight with functions on Drawings and with engraved device escutcheons
4. Auxiliary relays, time delay relays, and timers as indicated on Drawings with 120V, ac coils and motors
 - a. Key reset
 - b. 5 digit minimum
 - c. Range: 9999.9 hours
 - d. Synchronous motor driven
 - e. Panel mount

5. Overload heaters sized to protect motor
6. Engraved phenolic nameplate identifying controlled motor
7. Three phase starters
 - a. Full voltage magnetic type
 - b. Non-combination
 - c. 480 V or 208 V, 3 phase, 3 pole, with 3 overload heaters
 - d. Control power transformers
 - 1) Both primary legs fused, 1 amp minimum
 - 2) 120 V secondary
 - 3) One secondary leg fused, the other grounded
 - 4) Sized for total load indicated on Drawings
8. Single phase starters
 - a. Where so indicated on the drawings: Non-combination full voltage magnetic type
 - b. General use: Full voltage manual type
 - c. Single phase, poles and voltages as indicated on the Drawings
 - d. Magnetic: 120 V ac operating coil
 - e. Overload heaters in each undergrounded lead

2.12 EQUIPMENT DISCONNECTS

A. General

1. General duty safety switches
2. Square D or equal

B. Enclosure

1. Indoor: NEMA 1 unless noted otherwise
2. Outdoor: NEMA 3R unless noted otherwise
3. Painted steel
4. Padlocked external operating handle

C. Switch

1. Poles to match equipment served
2. 600 volts ac
3. Continuous current rating not less than the serving branch circuit overcurrent protection
4. Non-fusible except where fusing is required by the served equipment

2.13 TERMINAL CABINETS

A. Enclosure

1. Indoors: NEMA 1 steel or aluminum enclosures
2. Sized for the terminals to be installed
3. Wall mounting
4. Front cover hinged
5. Finish
 - a. Aluminum, natural finish

- b. Steel: ANSI Z55.1, No. 61, light grey

B. Wiring

1. Wiring grouped or cabled and firmly fastened to panel
2. Terminal blocks
 - a. Provide for external wiring
 - 1) Power supply circuits
 - 2) Signal circuits
 - 3) Wire-through circuits
 - 4) Shielded cable shields
 - 5) 20% additional
 - b. Suitable for 20 AWG to 12 AWG copper conductors
 - c. Pressure connector type with marking strips and covers
3. Accessories
 - a. 120 V duplex outlets: NEMA 5-2R, 3-wire, grounding, 20 amp, 125 V, Hubbell 536Z, General Electric 4108-1 or equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. Install all equipment level and plumb
2. Separate sheet metal junction boxes, equipment enclosures, sheet metal raceways, etc., mounted on water or earth-bearing walls or wall-mounted outdoors ¼" from wall by corrosion resistant spacers
3. Seal the base of all outdoor substation, switchgear, motor control center, and similar equipment with grout
4. Screen or seal with flexible sealing compound all openings into outdoor equipment to prevent the entrance of rodents, wasps, and mud-daubers

B. Raceways

1. General
 - a. Except as otherwise indicated on the Drawings, conduit shall be concealed in finished areas and exposed in unfinished areas
 - b. IMC and GRC conduit connections and terminations shall be reamed, deburred, threaded and provided with bushings
 - c. Securely fasten conduit connections to sheet metal enclosures with locknuts inside and out
 - d. Provide deflection fittings across structural joints where structural movement is allowed
 - e. Keep conduit clear of structural openings and indicated future openings
 - f. Provide flashing and seal watertight conduits through roofs and metal walls
 - g. Neatly grout conduit into any opening cut into structure
 - h. Cap or plug conduits during construction to prevent the entrance of trash, dirt and water
 - i. Except ½" luminaire pendants, ¾" minimum

- j. Seal conduits with flexible sealing compound forced to a minimum depth equal to the conduit diameter after cable is installed
 - 1) At handholes, manholes, and vaults
 - 2) Building entrance junction boxes
 - 3) One inch or larger connections to equipment
 - k. Seal conduits with sealing fittings and hardening sealing compound
 - 1) Entering submersible enclosures
 - 2) Entering hazardous and/or classified areas
 - l. Provide flexible conduit where flexible connections are necessary, including dry type transformers and each motor without flexible cord
 - 1) Length kept to a minimum, 6' maximum
 - 2) No sharp bends
 - m. Repair damage to coating on PVC coated steel conduit in accordance with manufacturer's instructions
2. Conduit exposed in structure
 - a. Install parallel to structural members and surface
 - b. Install conduits of the same general routing parallel with symmetrical bends
 - c. Maintain 6" clearance to high temp ducts, piping and flues
 - d. Support rigidly with galvanized or cadmium plated hardware and framing materials, including nuts and bolts
 - e. Allow 7' headroom for horizontal conduit runs, except along structures, piping equipment or where not possible
 - f. Except as otherwise indicated, do not install exposed conduit in water chambers
 3. Conduit concealed in structure
 - a. Install between reinforcing steel in slabs with reinforcing in both fences
 - b. Install under reinforcing steel in slabs where only a single layer is provided
 - c. As detailed on the Drawings
 4. Underground
 - a. One inch minimum
 - b. Except as otherwise indicated, encased in concrete
 - 1) Two inches between conduits
 - 2) Three inches over conduit where not reinforced
 - 3) Three inches over reinforcing
 - 4) Reinforced at and 5' past portions on disturbed earth or subject to traffic
 - 5) Reinforced within 5' of a structure, manhole or vault
 - 6) Reinforced for entire length and 2' beyond each adapter to steel conduit if non-metallic is used in duct bank
 - 7) Where capped underground, reinforce the last 2' and extend steel and conduit 2' past end of duct bank. Paint all unencased metal with 2 coats of coal tar paint
 - 8) Continue encasement on outdoor risers to 3" above grade and crown and chamfer top
 - 9) Reinforcement details as indicated on the Drawings
 - c. Two foot minimum bend radius at vertical risers, 3' elsewhere
 - d. Install underground conduit so that it does not drain to cable pulling access in buildings; where necessary, provide a handhole or manhole near or adjacent to building
 - e. Provide 2' minimum earth cover
 - f. Isolate telephone raceways from raceways, conduits, boxes, handholes, manholes, and vaults for other circuits

- g. Isolate intercommunication and milliamperere level instrumentation circuits from all power wiring raceways, conduits, boxes, vaults, manhole, and handhole
- 5. Junction boxes, wiring gutters, terminal boxes, equipment enclosures
 - a. Install level and plumb
 - b. At least code size including space for full size continuation of any conduit not originally continued
 - c. Arrange conduit for maximum space for future conduits

C. Wire and Cable

- 1. General
 - a. Protect the cable and avoid kinking conductors, cutting or puncturing jackets, contaminating by oil or grease or damaging in any manner
 - b. Terminate stranded cable with lugs, cup washers or pressure type connectors; do not wrap stranded cable around screw type terminals
 - c. Splice stranded cable with pressure type connectors; do not use wire nut type connectors on stranded cable
 - d. Splice cables only at readily accessible locations
 - e. Do not pull cable tight against bushings or press heavily against enclosures
 - f. Use cable pulling lubricants as recommended by the cable manufacturer
 - g. Where necessary to prevent heavy loading of cable connectors due to cable weight, support cables in vertical risers with woven cable grips
 - h. Coil and tape spare cable ends
- 2. Special cables
 - a. Isolate telephone cables from all other circuits
 - b. Isolate intercommunication and milliamperere level instrumentation cables from all power circuits
- 3. Conductor identification
 - a. Color code all service, feeder, and branch circuit conductors in accordance with Section 16075
 - b. Identify single control conductors by color coding orange and by labeling each end conductor with adhesive labels, Brady "Quicklabel" or equal
 - c. Contractor shall establish a control and instrumentation conductor and cable identification system acceptable to Engineer

D. Wiring Devices

1. Flush mount wiring devices in concealed conduit system
2. Surface mount wiring devices in exposed conduit systems

E. Grounding materials

1. Install ground cable through building walls within 3' below finish grade and prepare a waterstop
 - a. Place 12" copper disc over the cable
 - b. Fill the spaces between strands with solder
2. Install ground rods and cables as deep in earth as possible and as far from structure as possible, but not closer than 6"
3. All branch circuit and feeder circuits to include a copper ground conductor in addition to the conduit ground connection
4. Connect ground conductors to equipment by ground lugs or clamps
 - a. If no ground bus or terminal is provided and enclosure is not explosion-proof or submersible provide a clamp type lug under a permanent assembly bolt or by grounding locknuts or bushings
 - b. If an explosion-proof or submersible enclosure is not provided with grounding means provide an adjacent junction box with a ground lug
 - c. Do not make ground connections to anchor bolts; against gaskets, paint or varnish; or to bolts holding removable access covers
5. Form ground conductors on equipment to the contours of the equipment
6. Bond building structural system to grounding system

F. Luminaires

1. Install in the general locations and arrangement indicated on Drawings
2. Align luminaires in rows vertically and horizontally except as otherwise required
3. Install clear of pipes, mechanical equipment, structural openings, indicated future equipment and structural openings, and other obstructions

G. Panelboards

1. Wall mount
2. Top of panelboard 6'-6" above floor

H. Dry Type Specialty Transformers

1. 25 kVA and below: Wall mount
2. 30 kVA and above: Floor mount immediately adjacent to associated panelboard

I. Separately Enclosed Motor Starters

1. Provide where indicated on Drawings and for each motor not indicated to be controlled from a motor control center and not provided with a separately enclosed motor starter under another section of these specifications
2. Mount enclosure top 5'-4" above the floor or finished grade

3.2 FIELD QUALITY CONTROL

A. Low Voltage Cable Testing

1. Test 600 V power cables for continuity and freedom from short circuits and ground, except where grounding is intentional immediately after installation
2. Test all circuits with a 500 V megger or its equivalent
3. Replace conductors which read less than 1.5 Megohms between conductors and ground

END OF SECTION