GENERAL

1. Introduction

1.1.2 This specification is intended to describe the general requirements for workmanship, materials, inspection, and testing associated with the electrical construction.

1.1.3 This specification is intended to be used with other documents of the project. It is intended to provide an outline description of the electrical and instrumentation portion of the project to assist in the general understanding of what is involved. Wherever the drawings may be at variance with this specification, notify the Owner’s Representative for resolution.

1.1.4 The following documents are attached to this specification and are considered a part of it:

- Scope of Work
- Electrical Equipment List
- Standard Electrical Details
- Standard Instrumentation Details

2. Contractor Responsibility

The Contractor shall:

1.1.5 Contractor shall also provide appropriate insurance in accordance with requirements of the Owner.

1.1.6 Furnish all materials, tools and test equipment necessary to install and test all the electrical systems shown on the drawings and in the specifications.

1.1.7 Provide such electrical safety equipment as required. This is to be done in such a manner as to provide safety protection for all personnel in the area of work.

1.1.8 Provide adequate security of all electrical material, tools and equipment to prevent loss from pilferage, vandalism and the environment.

1.1.9 Consider the electrical systems complete when they are operable, tested and inspected as described on the drawings and in the specifications.
1.1.10 Provide all items not specifically mentioned herein, which are necessary to make a complete working installation, including any necessary field engineering and detail drawings required.

1.1.11 Provide all required construction power.

1.1.12 Provide all required potable water.

1.1.13 Provide sanitation facilities for workers.

1.1.14 Provide telephone service, if desired.

1.1.15 The Contractor shall provide all training required by the Mine Safety and Health Administration (MSHA) to perform work on the surface area of a coal mine.

1.1.16 The Contractor shall make arrangements with the Owner’s Safety Department to obtain training on the Owner’s safety policies and hazard training for all employees.

1.1.17 The Contractor shall assure that its employees comply with the Owner’s safety policies, including the using of required personal safety equipment, at all times while working on the Owner’s property.

1.1.18 The Contractor shall obtain their own MSHA identification number, and shall be responsible for legal compliance with MSHA mine law. Any citations received for non-compliance shall be the responsibility of the Contractor.

1.1.19 The Contractor shall maintain at least one MSHA-qualified (certified) electrician on the job site at all times. This qualified electrician shall be responsible for all legal aspects of the work performed; such as electrical lock-out, electrical inspections, electrical safety, and electrical installation oversight. Note that MSHA requires that all electrical equipment, including power tools, be inspected and recorded on at least a monthly basis.

3. Codes, Regulations and Standards
Reference to codes and authorities for equipment or installation shall be in accordance with applicable portions of the latest editions of the following codes or authorities.

- The National Electrical Code (NEC)
- The National Electrical Safety Code (ANSI C2)
- Institute of Electrical and Electronic Engineers (IEEE)
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- American National Standards Institute (ANSI)
- National Electrical Manufacturers Association (NEMA)
- Insulated Cable Engineers Association (ICEA)
- Mine Safety and Health Administration (MSHA)
- Illuminating Engineering Society (IES)
- Local and State Regulations

Any conflict between the above mentioned codes and standards and this specification shall be referred to the Engineer for clarification before proceeding.

4. Hazardous Classification

1.1.20 Areas above and below coal stockpiles are classified as Class I, Division I, Group C & D areas due to the possibility of the accumulation of methane gas. The coal stacking tubes and truck loadout are Class I, Division I, Group D locations.

1.1.21 The reclaim tunnel would normally be classified as Class I, Division I, Group C & D. However, since an exhaust fan and methane monitoring is provided, the tunnel classification can be derated to Class II, Division 2. Note that all electrical sources into the reclaim tunnel must be interlocked with the exhaust fan and methane monitoring system, and de-energized if the fan goes off or an excessive methane concentration is detected. The lighting circuit shall be installed in accordance with Class I, Division I, Group D criteria, and does not have to be de-energized.

1.1.22 Enclosed areas in which coal is processed or conveyed are classified as Class II, Division 2 locations due to the possibility of the accumulation of coal dust. The transfer tower and crusher building are Class II, Division 2 locations.

1.1.23 All outdoor wiring shall be installed to comply with outdoor and wet location criteria.

1.1.24 Consult the Hazardous Area Classification Drawings.

MATERIALS AND EQUIPMENT

5. Standards of Material
1. All material shall be new and free from defects. Materials shall be installed in accordance with manufacturer's instructions and recommendations.

6. Storage and Protection of Materials and Equipment

1.1.26 Storage facilities, warehouses, offices, racks, bins, shelves and all necessary accessories for the proper storage of electrical materials and equipment shall be furnished, installed and maintained by the Contractor.

1.1.27 Within twenty-four (24) hours after each piece of equipment equipped with a space heater has been placed in storage, it's space heater shall be connected to an appropriate power source, and kept energized continuously until the equipment is removed for installation. Remove all loose and foreign objects from inside of equipment before energizing.

1.1.28 Materials and equipment furnished by others for permanent installation shall not be used by the Contractor to fulfill any temporary construction requirements.

1.1.29 Spare parts shall not be used for repairs of equipment prior to plant installation.

1.1.30 Conduit, fittings, support material, unistrut, j-boxes, bolts, nuts, washers and all other miscellaneous material shall be stored off the ground and shall be protected from weather. Containers shall be racks, bins or shelves.

1.1.31 Ferrous items which have become corroded or rusted shall not be used for permanent installation unless they have been thoroughly cleaned and are acceptable as new.

1.1.32 The ends of medium voltage and multiconductor cables shall be completely sealed with heat shrink caps to prevent the entry of moisture.

7. Equipment Provided by Owner

1.1.33 All equipment provided by Owner is listed on the Electrical Equipment List, which is attached to this specification. Refer to the Equipment Specifications and Vendor Data Files which are identified on the Electric Equipment List for details of engineering and construction.
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8. Panelboards

1.1.34 Panelboards shall be provided by the Owner and installed and wired by the Contractor.

1.1.35 Panelboards shall be rated as indicated on the drawings and shall be complete with a hinged door.

1.1.36 Incoming feeders shall terminate with approved connectors, as hereinafter defined. Multiple lugs shall be provided for multiple feeder conductors.

1.1.37 Circuit breakers shall be the plug-in type with thermal magnetic trips and shall comply with NEMA Standard AB 1. The number and rating of circuit breakers shall be as shown on the panelboard schedule or the one-line diagram. Circuit breakers marked "Spare" shall be furnished in sizes designated on the panelboard schedule. Circuit breaker positions marked "Space" shall be bussed for future breakers and shall be provided with removable 1-pole fillers in spaces as shown on the panelboard schedule.

1.1.38 Provide 6-inch additional gutter space in panelboards where double lugs are required or where cable ampacity exceeds bus rating. Minimum bottom gutter space shall be 6 inches high.

1.1.39 Circuits shall be permanently numbered. Plastic or steel buttons secured by means of rivets or grommets are acceptable. Circuit number tabs shall not be attached to, or be a part of, the circuit breaker.

1.1.40 Panelboards shall have a typewritten directory which shall be mounted behind a transparent protective cover and set in a metal frame on the inside of the cabinet door. The directory shall contain the following information:

- Panelboard designation.
- Panelboard power source.
- Identification of circuit functions.
- Locations and loads for each circuit breaker.

1.1.41 Each panelboard enclosure shall have a nameplate, engraved with the panelboard designation shown on the drawings. The nameplate shall be fastened to the outside of the panel door.
9. Transformers, General Purpose

1.1.42 General purpose transformers shall be supplied by the Owner and installed and wired by the Contractor.

1.1.43 General purpose transformers shall be dry type, K-13 rated, 60 Hertz, of the KVA rating indicated on the drawings. Transformers shall have two 2-1/2% taps above and two 2-1/2% taps below the normal rated primary voltage. The insulation system shall be rated with a 150 degree C winding temperature rise above ambient in accordance with NEMA Standard ST20. (ANSI C89.2). Sound levels must fall within ANSI-NEMA Standards levels according to KVA size.

10. Safety Switches

Safety switches, if required, shall be fusible NEMA heavy duty type HD and shall be horsepower rated for 600 VAC as noted on the drawings. The switch enclosure shall be NEMA Type 13 for indoor use or NEMA Type 4 for outdoor use, and shall be provided with a means for padlocking the handle in the "Off" position. The switches shall conform to NEMA Standard KS 1. Fuses shall be the cartridge type and shall be dual element, UL Class K5 and shall conform to ANSI C97.1.

11. Lighting Fixtures

1.1.44 All lighting fixtures shall be as specified on the drawings and shall be UL approved for the area in which they are used.

1.1.45 Ballasts and lamps are specified on the drawings. Protection from excessive ballast temperature shall be provided by a thermal fuse, automatic thermostatic reset device or other type of thermal protector that will interrupt the circuit to the ballast. Ballasts shall be solid fill type.

1.1.46 Fluorescent fixtures shall be equipped with cool white lamps.

1.1.47 All lighting fixtures shall have a plastic lens cover.

1.1.48 Metal Halide fixtures and High Pressure Sodium fixtures shall be as specified on the drawings and as specified herein. Fixtures shall be UL approved for the area in which they are used.
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2. Receptacles

1.1.49 Duplex receptacles shall be ivory, specification grade, rated 20 amp, 120 volt, 3 wire, grounding type, conforming to NEMA WD 1 Designation 5-20R and shall have screw terminals arranged for side wiring.

3. Toggle Switches

1.1.50 Toggle switches shall be ivory, specification grade, rated 20 amps, 277 volts, with conventional handles and with screw terminals arranged for side wiring.

4. Conduit & Fittings

1.1.51 Hot-dipped galvanized rigid steel conduit shall be used in all areas above ground. Exception: Electrical metallic conduit may be used in office areas.

1.1.52 Conduit fittings for rigid steel conduit and electrical metallic tubing shall conform to the NEC.

1.1.53 Flexible metal conduit shall have an internal bonding conductor. Fittings shall be the squeeze type. Fittings which use a screw to bind against the conduit shall not be used.

1.1.54 Conduit entries into the sides or tops of NEMA 13 and NEMA 4 enclosures shall be made with "Myers" type watertight fittings.

1.1.55 All single and miscellaneous underground conduit placed in concrete slabs shall be hot-dipped galvanized rigid steel conduit.

1.1.56 Underground distribution systems of duct banks and manholes shall consist of schedule 40 PVC conduit in sizes 2" or larger. Conduit less than 2" shall be RGS. No conduit underground shall be smaller than 1". All underground duct banks shall be encased in suitably reinforced red concrete with a 3" minimum cover all around.

5. Wire and Cable

1.1.57 Conductors shall be copper and shall be of the type and AWG size specified herein or as shown on the drawings.
1.1.58 Single conductors shall be readily identified by continuous, permanent marking on the insulation to indicate the type, voltage, gauge, and manufacturer.

1.1.59 Conductor sizes No. 6 AWG and larger shall be Type XHHW. Size No. 8 AWG and smaller shall be Type THWN/THHN.

1.1.60 All cable installed in cable trays shall be TC rated.

1.1.61 All medium voltage cable shall be EPR, stranded copper, shielded.

1.1.62 Instrumentation cables will be single pair, multi-pair, or triad twisted copper conductors, with each individual pair or triad having a metallic shield with drain wire. Multi-pair cables shall have an overall metallic shield with drain wire. Conductor size shall be #16 AWG cable and shall be TC rated.

6. Solderless Connectors and Terminals - 600 Volts and Less
Pressure type, solderless connector, and terminal lugs shall be rated for use with copper conductors, and shall be used in installations not exceeding 600 volts between conductors. Connectors with insulating caps or covers shall be rated for the system utilization voltage. Connectors shall be of types as specified below:

1.1.63 For conductors No. 8 AWG and smaller:
  - Ideal Industries, Inc. - Wire-Nuts
  - Thomas and Betts Company - Sta-Kon
  - 3M Company - Scotchlock

1.1.64 For conductors No. 6 AWG through #1:
  - Burndy Engineering Company or HyPRESS
  - Thomas and Betts Company - Lock-tite

7. Medium Voltage Terminations

1.1.65 Stress relief termination kits shall be Raychem heat shrinkable type HVT for single conductor and HVT-3 for three conductor cable.

1.1.66 Indoor termination kits shall include a 24 inch ground braid with clamp type GCA and a cable preparation kit type CPK.
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1.1.67 All outdoor termination kits shall include skirts, a 60 inch ground braid with clamp type GCA and a cable preparation kit type CPK.

1.1.68 Splice kits shall be type HVS with a 36 inch ground braid with clamp type GCA and cable preparation kit type CPK.

8. Terminal Blocks

1.1.69 Terminal blocks for No. 10 AWG conductors and smaller shall be tubular, screw type with pressure plate. Terminal ampacities shall be equal to or greater than conductor ampacities. Terminal blocks shall be Marathon.

1.1.70 Terminal blocks for No. 8 AWG conductors and larger shall be either one-piece or factory assembled sectional barrier type with box lug terminals, having a pressure plate between the screw and the conductor. Terminals shall be sized to accommodate the conductors to be connected.

1.1.71 Terminal block covers shall be furnished to cover live parts of terminations for circuits of more than 150 volts to ground. Covers shall be provided with means for ready inspection and shall have full width marking areas.

9. Anchors
Concrete anchors and masonry anchors shall be Phillips Company "Red Head".

10. Conduit Hangers
Pipe hangers for individual conduit shall be factory made and shall consist of a pipe ring and threaded 3/8” or 1/2” suspension rod. Rings shall be bolted to, or interlocked with, the suspension rod socket.

11. Device Plates

1.1.72 Plates shall be furnished and installed for every wiring and control device.

1.1.73 All plates for surface outlets shall be stainless steel.

12. Sealants
Sealant for conduit wall penetrations shall be "KBS" Fire Protection System.
2. Insulating Putty
Insulating putty shall be "Scotch-fill" as manufactured by 3M Company, or G.E. No. 8389 as manufactured by General Electric Company.

3. Duct Sealing Compound
Duct sealing compound shall be "Ductseal" as manufactured by Porcelain Products Company or "Kerite" manufactured by the Kerite Company.

4. Tape
1.1.74 Plastic insulating tape shall be Scotchrap No. 33+ as manufactured by 3M Company.
1.1.75 Conduit protection tape shall be Scotchrap No. 50 as manufactured by 3M Company.

5. Wiremarkers
Individual conductors shall be identified by commercial plastic markers as manufactured by the E.C.P. Corporation, Cleveland, Ohio.

6. Wire Pulling Compound
Wire pulling compound shall be "Y-er Eas" as manufactured by Electro Compound Co.

EXECUTION

7. General Requirements
1.1.76 Interpretation of Drawings and Specifications
The drawings indicate the general layout of the complete electrical system including the arrangement of feeders, circuits, outlets, switches, controls, panelboards, service equipment, and other equipment. Verify the scale dimensions on the drawings since actual locations, distances, and levels will be governed by actual field conditions. Perform all work in accordance with NEC. Should any conflicts arise between the drawings and specifications, and the requirement of NEC (or ANSI C2) notify the Owner's Representative and cease work on all affected parts of the contract until the conflicts are resolved.

1.1.77 Installation Instructions
Install all equipment and materials as indicated on the drawings and as specified. Fasten equipment and materials securely to the structural members of the building or to metal supports attached to the structure. Attach supports to structural steel by clamping or welding. Do not drill or cut holes in structural steel unless prior written approval of the Owner’s Representative is given.

1.2.1.1 Where typical installation details are shown on the drawings or attached to this specification, such details shall be followed as to materials and methods of installation.

1.2.1.2 Concealed work shall be left open for inspection and test until approved by the regulating authority.

1.2.1.3 The Contractor shall be responsible for checking the drawings of other trades and installing work in a manner that will avoid interferences.

1.1.78 Items of general nature which are not specified shall be of a quality and workmanship that is normal in industrial use.

1.1.79 The work includes all cutting and patching required to install the electrical systems. All sleeves for the passage of conduit and ducts shall be furnished and installed in the forms of walls, floor slabs and partitions.

1.1.80 The electrical plan drawings are diagrammatic in nature, and indicate the approximate routes of raceways, conduits and wiring. The approximate routes are to be followed as close as possible.

1.1.81 Contractor shall follow the manufacturer’s installation manuals’ instruction guidelines in storing, installing, and testing the equipment. Contractor shall refer to vendor drawings to ensure proper installation.

1.1.82 "Parabond Capsul" anchors as manufactured by Molly shall be used to anchor electrical equipment to concrete bases.

1.1.83 All penetrations in building walls shall be sealed.
1.1.84 The Contractor shall coordinate his work with all other contractors on site to avoid any interference with piping, HVAC duct, process equipment, etc. Fasten equipment to concrete with concrete anchors. Locate equipment, boxes and conduit approximately where shown in relation to equipment served. Do not install conduit raceways and boxes in positions that interfere with the work of other trades. Identify electrical power and control equipment by number and function as indicated on the drawings.

1.1.85 As-Built Drawings
One complete set of drawings ("as-built" drawings) shall be marked up in red to show changes made in the field. They shall be kept exclusively in the Contractor's job-site office, and shall be kept clean, complete, legible, and available for Owner or Engineer inspection at all times. "As-Built" drawings shall be kept current on a daily basis. At the completion of the project, the "as-builts" shall be conveyed to the Owner so that the original drawings can be up-dated to "as-built" status.

8. Grounding Systems

1.1.86 System Grounding
Solidly ground the neutral conductor of single phase three wire systems at the transformer, only. For three phase four wire wye-connected solidly grounded distribution systems, ground at the transformer neutral bushing only. For three phase four wire wye-connected resistance grounded systems, ground at the grounding resistor only.

1.1.87 Motor Grounding
Run a green copper ground wire from the ground bus in the MCC to the connection box on each motor and connect to the motor frame inside the connection box. Wire size shown on drawings.

1.1.88 Static Grounding
Ground the steel columns in the building to the grid as shown on the drawings.
Ground every metal tank, metal vessel, pump housing, and all other housings of mechanical equipment to the ground grid. See standard details attached to this specification.
1.1.89 General

1.2.1.4 The grounding system shall be installed according to the grounding plans and detail drawings and shall comply with Article 250 of the NEC and local codes.

1.2.1.5 Install all above grade grounding into a complete system with the below grade grounding grid as indicated on the electrical drawings.

1.2.1.6 Ground cable shall be stranded bare copper conductor as sized on drawings and standard details.

1.2.1.7 Ground cables shall be run at a minimum depth of 24" below finished grade. Underground taps or splices shall be made using heavy duty exothermic welds. Ground grid connections to buried ground rods shall be by exothermic welds. Connections to ground test wells shall have mechanical connections.

1.2.1.8 For ground wires that penetrate a concrete slab, install a sleeve made of 1" rigid PVC conduit, with a bushing on the top side. The sleeve shall be long enough to penetrate the full thickness of the slab.

1.2.1.9 All conduit stubups in equipment are to be terminated with grounding bushings, bonded together with bare stranded wires sized per NEC Table 250-95 and connected to the equipment ground buss using a Burndy Quicklug.

1.2.1.10 All ground conductors shall be routed and protected to avoid any physical damage. All underground connections shall be approved by the Owner’s Representative before backfilling.

1.2.1.11 Ground loops around buildings, tanks, and vessels may be buried in the backfill for the column footings and foundation walls. Ground loops shall be located at a minimum of 18 inches outside building walls. The cable shall be installed with sufficient slack so that the movement due to backfilling or soil movement will not stress the cable.
1.2.1.12 Power cable trays shall have a No. 4/0 AWG grounding conductor along the entire system. Trays for control and instrumentation shall have a No. 2 AWG grounding conductor along the entire system. Each tray section shall be connected to the grounding conductor which shall be grounded at both ends and terminated at the equipment ground bus.

1.2.1.13 Motor frames and all electrical equipment metal enclosures shall be connected to the grounding system per drawings and details.

1.2.1.14 Ground the neutral of the secondary winding of all lighting, instrument, and control transformers at the transformer only.

1.2.1.15 The ground grid resistance to earth shall be 5 ohms or less when tested in accordance with IEEE 81.

1.2.1.16 Shields and drain wires on instrumentation and control cables shall be grounded on one end only, preferably at the marshalling cabinet or I/O cabinet. The ungrounded ends of instrumentation and control cables shall be insulated.

1.2.1.17 Shields on medium voltage cables shall be grounded at each termination and each splice.

9. Above Ground Conduit Systems

1.1.90 General

1.2.1.18 Conduit runs shall be installed to minimize the accumulation of moisture at low points and pockets. A conduit fitting with a drain hole shall be located where such accumulation may be expected.

1.2.1.19 Conduit installations shall be dust tight, insofar as practicable, with sealed threaded joints and gasketed covers. Exceptions shall be as required herein or on the drawings.
1.2.1.20 The ends of all conduit runs shall be closed immediately after installation, with metal caps to prevent the entrance of water or other foreign material. Conduits shall be swabbed out where necessary before conductors are pulled in. Conduits and conductors exposed to the weather shall be sealed with RTV/silicone to prevent moisture entering the opening.

1.2.1.21 Conduit shall be rigidly supported between couplings, on either side of bends, at terminations and fittings on 10’ or shorter centers for 1” and larger conduit.

1.2.1.22 Conduit shall not interfere with the use of aisles, passageways, doorways, overhead cranes, monorails, equipment removal areas, or working areas.

1.2.1.23 Conduit systems shall be exposed or concealed as indicated on the drawings.

1.2.1.24 Conduits shall have a proper seal-off fitting installed where the NEC dictates.

1.2.1.25 Conduits installed on conveyor structures shall be located on the outside of the handrail to avoid any interference with conveyor system maintenance and the walkway. The conduits must be mounted a minimum of three inches below the top bar or vail.

1.2.1.26 Proper conduit expansion joints shall be provided for all conduit mounted on conveyor structures. They shall be located at intervals not to exceed 100 feet along the length of the conveyor. Proper conduit anchors or supports shall be provided in conjunction with the expansion joints to achieve the desired expansion capability.
1.1.91 Cutting and Threading

1.2.1.27 Conduit cut-offs shall be square and made by hacksaw or other approved means which does not deform the conduit. Ends shall be reamed and burred after cutting and threading.

1.2.1.28 Threads, including factory-cut threads, shall be painted with Crouse-Hinds Type STL, metal-bearing conducting grease, immediately prior to assembly.

1.1.92 Pulling Bends and Boxes

1.2.1.29 The maximum number of 90 degree bends or equivalent fittings between pulling points in any conduit run shall be three. Pull and junction fittings and/or boxes shall be provided as necessary to satisfy this requirement.

1.2.1.30 Bends may be either factory or field made. The radii of field bends shall be not less than those established by the National Electric Code.

1.2.1.31 Junction boxes for general purpose use in protected areas shall be NEMA Type 13, general purpose enclosures without knockouts and with hinged covers.

1.2.1.32 NEMA Type 4 water-tight enclosures shall be sheet steel with hinged covers.

1.2.1.33 On exposed conduit runs, all device boxes or pulling boxes shall be Crouse-Hinds "FS" or "FD" type with gasketed covers.

1.1.93 Housing and Outlet Boxes

1.2.1.34 Boxes or plaster rings in concealed work shall be flush and square with finished surfaces.

1.1.94 Locknuts and Bushings

1.2.1.35 Bushings shall be steel.
1.2.1.36 Insulating bushings shall ordinarily be of all plastic type, (except grounding bushings) as manufactured by the Thomas & Betts Company or the O.Z. Electrical Manufacturing Company.

1.2.1.37 Locknuts shall be steel made for the purpose for which used.

1.2.1.38 Locknut and bushing conduit entrances shall be of the double locknut type. Bushings shall be provided with caps to protect the interior of the conduit system during the construction.

1.1.95 Unions, Couplings and Fittings

1.2.1.39 Union fittings may be installed at threaded hub conduit terminations and elsewhere as needed to facilitate the installation of conduit runs.

1.2.1.40 Conduit entrances to motor junction boxes shall be made with "Sealtite" liquid-tight flexible steel conduit. Flexible connections shall be made to all motors and adjustable or removable devices. Install bonding jumper in all flexible steel conduit.

1.2.1.41 The use of threadless couplings and connectors on steel conduit will not be permitted.

1.2.1.42 Conduit fittings of the condulet and unilet type shall be steel with threaded hubs.

1.2.1.43 Gaskets shall be solid sizes 1-1/2 inches and below. All conduit fittings with blank covers shall have rubber gaskets except in clean, dry areas or at lowest point of a conduit run where drainage is required.

1.2.1.44 Fittings shall be installed with covers having captive screws and shall be accessible after the work is completed.
1.2.1.45 Conduit expansion fittings, unless otherwise required, shall be O.Z. Type "AX" or "EX" with bonding jumpers. Fittings may be used for 90 degree turns at circuit voltages of 480 volts and below, except that conductors 4/0 AWG and larger may require junction boxes in order to allow sufficient cable bending radius.

1.1.96 Conduit Supports

1.2.1.46 The Contractor shall install all necessary conduit supports.

1.2.1.47 Conduit shall be supported in such a manner as to offer minimum interference to other installations.

1.2.1.48 Supports shall not form pockets that can hold liquid spills.

1.2.1.49 Insulated equipment shall not be used to anchor supports.

1.2.1.50 Acceptable supporting and clamping materials for exposed conduit include one hole clamps and clamp backs suspension pipe rings; Korns or Kindorf/Steel City clamps in sizes 1-1/2" and smaller; "J" and "U" bolts; structural steel frames and trapezes; concrete inserts; and Unistrut and similar materials.

1.2.1.51 One hole conduit clamps and clamp backs, and suspension pipe rings shall be of galvanized malleable iron.

1.2.1.52 Straps for conduits above 1-1/2" shall be two-hole extra strength steel. Steel galvanized bolts of appropriate size to fill holes of the straps shall be used.

1.2.1.53 Korns or Kindorf/Steel City clamps shall be of galvanized iron.

1.2.1.54 "J" and "U" bolts shall be of steel, hot-dip galvanized.

1.2.1.55 Strut and similar framing and supporting materials shall be hot-dip galvanized steel. Strut shall be Kindorf, or approved equal.
2. Underground Conduit Banks

1.1.97 Locations indicated for conduit, manholes, handholes, junction boxes and pull boxes will be approximate only and shall be altered, as directed, to avoid local obstructions except for conduit terminating at specific equipment which shall be placed in accordance with tolerances shown.

1.1.98 Depths shown for trenches and conduit will be minimum requirements, unless otherwise noted for coordination with other underground utilities. In areas where conduit crosses, conduit shall be laid deeper than the nominal depths shown to maintain adequate clearance as directed.

1.1.99 All vertical 90° risers shall be rigid galvanized steel.

1.1.100 Conduit cuts shall be made square with an approved cutting tool. Plastic conduit cuts shall be made using a miter box with a fine tooth handsaw.

1.1.101 Inside and outside of cut conduit shall be carefully reamed and trimmed to eliminate internal burrs. Sharp and rough edges shall then be wiped clean of dust, dirt and shavings.

1.1.102 Joints between lengths of conduit and between conduit and coupling fittings and boxes shall be made by a method specifically approved for the purpose and as follows:

1.2.1.56 Where a conduit enters a box or other fitting, a bushing or adapter shall be provided to protect wires from abrasion unless the design of the box or fitting is such as to provide equivalent protection.

1.2.1.57 Tapered ends on cut lengths of non-metallic conduit shall be made with an approved type of tapering tools.

1.2.1.58 Field threading of metallic conduits shall be done with a standard conduit cutting die providing 3/4 inch taper per foot. Running threads shall not be used on conduit.
**Electrical Construction**

1.2.1.59 Threaded connections of metallic conduit shall be treated with red lead and screwed up so that the ends of joining conduit or the end of the conduit and shoulder of the fitting butt tightly together.

1.2.1.60 Conduit shall be accurately spaced on conduit spacers in accordance with the conduit bank cross-sections shown. Conduit shall be securely tied in place to prevent displacement or floating while being encased. Conduits shall slope toward the manholes. There shall be no low points in conduit, in which water may stand.

### 3. Wire & Cable

1.1.103 Certain equipment is pre-wired and has electrical components mounted. The Contractor shall make connections to terminals and/or leads as shown on the drawings and/or indicated on the Vendor’s drawings.

1.1.104 The Contractor, for the purpose of standardizing and simplifying procurement on cable and conductors may, at his option, increase the number of conductors or the size of wires in control and power cable. The Contractor shall increase conduit size to accommodate any changes he makes to cable or wire for the purpose of standardizing. The above shall not constitute justification for additional charges to the Owner.

1.1.105 Wire and cable shall be as described on drawings.

1.1.106 Wires with green color shall be used as ground wires only.

1.1.107 Wires with white or slate color shall be used as neutral conductors only.

1.1.108 Control circuit conductors shall be color coded in accordance with NEC practice and as specified herein.

1.1.109 For installation of cables in conduit systems, wire pulling compounds approved by cable manufacturers such as Burndy “Slikon: or Owner approved equal may be employed. Mixtures containing soap or detergent shall not be used.
1.1.110 Conductors shall be a single continuous length between pull points. Splices will not be permitted between pull points.

1.1.111 Splices in all wire for 480 volts and lower shall be taped with 3M No. 33+ Scotch Tape.

1.1.112 Compression type connectors shall be used on all circuits except lighting circuits, where spring connectors similar to 3M "Scotchlock" may be used.

1.1.113 Compression type connectors size #1/0 and above shall be crimped with a hydraulic tool. All crimping shall be done with the die size recommended by the connector manufacturer.

1.1.114 Maintain the wire insulation to within one-eighth of one inch to a clamp type terminal or a box type connector.

1.1.115 Control, thermocouple and alarm wires terminating at junction boxes, relay panels, control panels, etc., shall be installed to break out of the bundle adjacent to the terminal. Bundles shall be laced with T&B Tyraps or approved equal.

1.1.116 Motor runs shall not be spliced.

1.1.117 All cables and individual wiring leads shall carry cable and wire numbers at the origination and termination and all junction points in between, as shown on the cable schedules and schematic diagrams.

1.1.118 All conductors run but not connected shall be taped and tagged as spare at each end.

1.1.119 Wires and cables shall not be pulled in conduit when the ambient temperature is lower than +37F (+3C).

1.1.120 Pulling tensions on medium voltage cable shall be continuously observed. A written report of such pulling tensions shall be delivered to the Owner’s Representative.

1.1.121 Medium voltage power cables in manholes & handholes shall be individually arc-proofed by wrapping with arc-proof tape.
Electrical Construction

2. Motors and Control

1.1.122 Motor control centers and starters will be provided by the Owner and installed and field-wired by the Contractor.

1.1.123 Motor starters will include overloads. Contractor shall determine that the overloads provided do not exceed the motor full load nameplate rating amperes by more than 15 percent. Any incorrect sizing of overloads shall be called to the attention of the Engineer.

1.1.124 Owner furnished motor starters shall be wired according to the motor schematic diagrams.

1.1.125 Push button or selector stations mounted in the field shall be heavy duty, NEMA 4.

3. Lighting

1.1.126 The Contractor shall install lighting fixtures to avoid conflicts with piping or other items which would prevent proper utilization of light or cause deep shadow areas.

1.1.127 All fixtures shall be well secured and properly located and aligned in a neat and workmanlike manner. Upon completion of the installation, they must be in first class operating condition and must be complete with required glassware, reflectors, fittings, etc., and must be clean and free from defects, scratches, dirt, dents, etc..

1.1.128 The Contractor shall leave all lighting fixtures completely lamped and in working order. If permanent lighting is to be used during construction, the Electrical Contractor shall make his own arrangements with other contractors for replacement of damaged, burned out, or missing equipment. Lamps shall be General Electric, Westinghouse, or Sylvania.

1.1.129 Lighting systems shall include all light fixtures for normal and emergency lighting, both indoors and outdoors, all light switches and controls, all convenience receptacles, all lighting transformers and panelboards, and all wiring and conduit associated with the lighting systems.

1.1.130 Short runs (maximum length 6 feet) of flexible conduit may be used for recessed lighting from a junction box to a fixture. Install bonding jumper in flexible conduit.
1.1.131 The color code for lighting branch circuits from a 3-phase, 4-wire system shall be black, red, and blue for the phase conductors, with white for the neutral conductor; from a 3-phase, 3-wire system shall be black, red and blue for the phase conductors.

1.1.132 Fractional horsepower motors or other power devices connected to lighting panels are shown on the panel schedule. If motors are 3-phase, a 3-pole breaker must be used in the panel. Clip-on breaker tie-bars shall not be used.

1.1.133 The mounting height or elevation of lighting fixtures, as indicated on the drawings, is to bottom of fixture.

1.1.134 20 A branch circuit breakers shall have a connected load not to exceed 16 A; 30 A circuits not to exceed 24 A.

1.1.135 Receptacles in locations, other than offices and hollow partitioned rooms, shall be surface mounted in FD boxes with spring covers suitable for use in wet locations.

1.1.136 The mounting height of lighting equipment & receptacles, unless otherwise noted, shall be as follows:

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Height or Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Switches</td>
<td>4'-6&quot; to centerline</td>
</tr>
<tr>
<td>Office &amp; Control Room Receipts</td>
<td>1'-6&quot; to centerline</td>
</tr>
<tr>
<td>Other Receptacles</td>
<td>3'-6&quot; to centerline</td>
</tr>
<tr>
<td>Lighting Panels</td>
<td>6'-0&quot; to top</td>
</tr>
<tr>
<td>Lights over doors</td>
<td>1'-0&quot; above door opening</td>
</tr>
<tr>
<td></td>
<td>to bottom of fixture</td>
</tr>
</tbody>
</table>

1.1.137 The minimum conductor size for lighting circuits and convenience receptacle circuits shall be #12 AWG solid copper wire with 600 volt THWN/THHN insulation.

2. Heating, Ventilation and Air Conditioning

1.1.138 Contractor shall furnish and install 480 and 120V VAC power hookups to heating, air handlers, and air conditioning equipment where required.

1.1.139 Contractor shall install raceways for thermostats and low voltage controls.

1.1.140 Contractor shall furnish and install combination starters when not furnished with HVAC equipment.
1.1.141 Contractor shall furnish and install fused or non-fused disconnect switches as required by NEC, in NEMA 4 enclosure, for all air conditioning units.

3. Installing Boxes, Enclosures & Wiring Devices

1.1.142 Install and size junction and pull boxes in accordance with the NEC unless otherwise shown on the drawings.

1.1.143 Install pipe plugs and knockout seals in all unused openings of enclosures.

1.1.144 Install boxes firmly secured in position and plumb.

1.1.145 Install an extension ring with blank cover on all flush mounted junction boxes where the junction box serves permanently installed equipment.

1.1.146 Flush mount junction boxes served by concealed conduit unless otherwise noted.

1.1.147 Install dust covers on junction boxes, pull boxes, outlet boxes, and any other type of wiring outlet on initial installation. Do not remove dust covers until wires are installed and a permanent cover or device is placed on the box or wiring outlet.

4. Identification Marking

1.1.148 Legends
Contractor shall install for each motor, solenoid, limit switch, transformer instrument, sensor, panel board and similar field-mounted component, a permanent nameplate, label or tag which identifies the device by the equipment number or diagram symbol. Each pushbutton station, disconnect switch and similar control device shall be identified with the name or function of the motor, equipment, or circuit it controls.
Switchgear and control equipment should be identified by the manufacturer. Marking by the Contractor is not required unless indicated otherwise.
1.1.149 Location
In general, identification labels shall not be attached to equipment or components subject to occasional removal or replacement, such as pushbutton stations, limit switches, smaller motors, removable covers and similar items. The normal, preferred location for labels, is on a permanent part of the equipment or on an adjacent permanent surface or support.

1.1.150 Nameplates
Nameplates for general use shall be at least one-sixteenth inch thick, laminated plastic, engraved with letters or numerals easily legible from a normal and convenient viewing distance.

Except in offices and control rooms supplied with clean, filtered air and in similar relatively clean locations, the nameplates shall have white (or light-colored) surface with black core.

Each nameplate shall be secured to the mounting surface with not less than two screws or rivets.

1.1.151 Signs/Vinyl Cloth
Contractor shall label all electrical equipment with appropriate voltage classification sign.
Signs shall be Brady-B-500 vinyl cloth.

2. Instrumentation
1.1.152 The instrumentation system consists of all instruments as listed in the Instrument List and shown on the P&IDs which includes mounting, instrument air and wiring.

1.1.153 Install all instruments and connect local power (if required).

1.1.154 Verify that instruments are calibrated properly

1.1.155 Confirm instruments' ranges and provide documentation to PLC engineer.

1.1.156 Ring out wiring from field instrument to PLC for continuity, and verify for correct termination to PLC marshalling panels.

1.1.157 Stroke all control valves and verify failsafe position. Verify wiring for continuity and proper termination to marshalling panels.
1.1.158 Verify discrete valves (solenoids) for failsafe position (unpowered) and ring out wiring for continuity and correct termination to marshalling panels.

TESTING

3. General

1.1.159 The Contractor shall conduct such operational and electrical acceptance tests as may be required by the Engineer. These tests will be designed to insure that the equipment and systems have been installed in accordance with the drawings and specifications, that the systems are operational and that the electrical integrity of the equipment has been maintained. All tests will be performed before the Contractor leaves the site.

1.1.160 The Contractor shall provide assistance to the various electrical manufacturer's field engineers as required in the testing and adjusting of the electrical equipment. Cooperation of the Contractor shall be such that a minimum of time is required for equipment testing.

1.1.161 After conductor installation, all circuits and equipment shall be tested for grounds, short-circuits, and proper operations as follows:

1.1.162 All medium voltage cable, motors, instrument transformers, and dry type transformers shall be meggered.

1.1.163 All medium voltage equipment and circuits shall be given insulation resistance tests.

1.2.1.61 All 480 volt switchgear, main 480 volt feeders, busduct, 480 volt cable to motors, and any other specified low-voltage circuits or pieces of equipment designated by the Engineer, shall be given insulation resistance tests.

1.2.1.62 All testing equipment shall be furnished by the Contractor. Testing equipment shall be approved by the Engineer.

1.2.1.63 The Contractor shall notify the Engineer before performing any test, and at least 24 hours prior to performing final equipment operation tests.
1.2.1.64 The Contractor shall make all electrical connections and the equipment being tested shall be isolated by suitable barriers and warning signs to protect workmen in the immediate vicinity.

1.2.1.65 All insulation resistance tests on 600 volt equipment shall be made with a minimum of 500 volt constant voltage megger. Megger reading shall be at least one minute duration.

1.2.1.66 In general, services, circuits, wire, cable and equipment shall be tested phase to phase and phase to ground.

1.2.1.67 Energizing - All major equipment such as medium voltage transformers, switchgear, grounding resistor equipment, substations, motor control centers, and motors shall be energized initially in the presence of the Engineer.

1.2.1.68 The Contractor shall notify the Engineer as soon as possible of failure of any material, equipment or system to pass a test.

4. Electrical Testing - Instrument and Signal Cable

1.1.164 Cable shall be disconnected before testing.

1.1.165 Continuity and identification of all single and multi-conductor cables and thermocouple wires shall be checked by means of a D-C test device using a bell or buzzer to "ring-out" the wires.

1.1.166 Polarity, point-to-point continuity and identification checks of instrument and electronic cable shall be made.

1.1.167 Continuity testing of wiring to instruments and electronic devices by the Contractor is required.

5. Electrical Testing - 600 Volt Power and Lighting Conductors

1.1.168 All cables and leads, except 120 volt lighting branch circuits, shall be tested for continuity with a 500 volt megger.
1.1.169 Lighting branch circuits shall be tested during construction only for continuity and identification and shall pass operational tests to see that the circuits perform all functions for which they are designed.

1.1.170 Each phase shall be tested between phase conductor and ground and between phases, except when the test includes windings (motors & transformers). In these cases, the test may be applied between all phases and ground.

1.1.171 Minimum megger readings at 60 degrees F ambient temperature shall be five (5) megohms for 600 V conductors.

1.1.172 Each 480 volt feeder and branch circuit cable from the motor control center or 480 volt switchgear shall be meggered with the cable connected and the disconnect open or with the breaker racked in and open. Connections at the other end of each of these cables shall be as follows:

1.2.1.69 Test cables to individual motors with motor leads disconnected at motors.

1.2.1.70 Test cables connected to lighting transformers.

6. Electrical Testing - 480 Volt Motor Control

1.1.173 Manually operate all starters, breakers, relays, etc., to determine satisfactory mechanical operating condition and that electrical clearances are adequate for service.

1.1.174 A visual check shall be made of the following:

1.2.1.71 All auxiliary contacts

1.2.1.72 Phasing of buses and breakers

1.2.1.73 Proper operation of all control and interlocks with control circuits properly energized.

1.1.175 With all feeder breakers closed and no external power cables connected, megger (with 500-volt megger) each 480 volt bus between phase and ground, with the other phases, not under test, grounded. The minimum acceptable reading will be five (5) megohms at level-off.
1.1.176  Set adjustable overload relays and time delay undervoltage relays in accordance with instructions from the Engineer.

7. Electrical Testing - Motors

1.1.177  All motors shall pass a minimum megger reading at ambient temperature. Any machine not passing this test shall be called to the attention of the Engineer.

1.1.178  Prior to installation, all motors shall be inspected for cleanliness, damage, moisture, proper lubrication, oil leaks, and phase identification. Tests shall be made for proper rotation.

1.1.179  All motors received by Contractor shall be tested for minimum megger readings upon receipt and again before connecting them to their respective feeder cables.

1.1.180  Specified megger tests shall be made in the following manner with all cables connected to the motors: Motors, 460 and below, shall be tested with a 500 volt megger to obtain a minimum of 10 MEGOHMS.

1.1.181  Before starting motors, the following shall be confirmed:

   1.2.1.74  Coordinate with other contractors to insure all bearings are properly lubricated.

   1.2.1.75  Coordinate with other contractors to insure the correct coupling alignment and shaft end play.

   1.2.1.76  Equipment dependent on the proper rotation of the motor shall not be coupled to the motor until shaft rotation is confirmed.

   1.2.1.77  Heaters, breakers, and/or fuses for proper motor and circuit protection.

   1.2.1.78  Proper voltage to motors and related controls and control circuits tested per Section 4.8.

1.1.182  During or immediately after starting motors, the following shall be checked:

   1.2.1.79  Shaft Rotation

   1.2.1.80  Bearing Lubrication and Temperature
Electrical Construction

1.2.1.81 Verify that field motor control stations function properly and operates the correct motor. Ring out wiring for continuity and correct termination to PLC marshalling panels.

1.1.183 Tests for proper rotation, lubrication, and alignment shall be made with each motor uncoupled. Machines shall be checked for excessive vibration.

1.1.184 Final acceptance of rotating equipment cannot be made until the equipment is energized during operational tests.

1.1.185 Contractor shall be responsible for testing and documenting any tests required by MSHA Standards, such as motor ground to earth resistance measurements. For any earth resistance measurement, Biddle earth resistance test equipment shall be used.

8. Electrical Testing - Transformers

1.1.186 Dry type 480 volt primary, or less. Lighting transformers and all other small transformers (480 volt primaries shall be meggered with the load breaker open after cable connections to the primary and secondary windings have been made).

1.1.187 Continuity and correctness of all windings and their connections shall be checked.

1.1.188 Minimum allowable megger readings shall be as follows:

<table>
<thead>
<tr>
<th></th>
<th>MEGOHMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>480 &amp; 240 Secondary to Ground</td>
<td>20</td>
</tr>
<tr>
<td>Primary to Secondary</td>
<td>150</td>
</tr>
<tr>
<td>Secondary to Ground</td>
<td>20</td>
</tr>
<tr>
<td>480 Volt Primary to Ground</td>
<td>20</td>
</tr>
<tr>
<td>Primary to Secondary</td>
<td>20</td>
</tr>
<tr>
<td>Secondary to Ground</td>
<td>5</td>
</tr>
</tbody>
</table>

1.1.189 Oil-filled transformers to be tested per manufacturer’s recommendations.

9. Lighting Fixtures & Panelboards

1.1.190 Inspect and verify that all lighting fixtures are mounted as specified, equipped with the size of lamps or tubes specified, are clean, and in satisfactory operating condition.
1.1.191 Inspect panelboards for cleanliness, tightness of connections, filling of all open knockout holes, security of mounting, mechanical damage, identification of panelboard and circuits therein, and fuse size of overcurrent protection device ratings.

10. Motor Control Center

1.1.192 Check each compartment for nameplate identification.

1.1.193 Check all equipment and devices against the drawings to assure that they are correctly mounted, wired and installed in the designated compartment. Verify the size and rating of breakers, fuses and overload heaters.

1.1.194 Check wire tag numbers, terminal strip markings and wiring against the drawings. Check wiring for standard color coding of phases.

1.1.195 Check vertical and horizontal bus supports and insulator bolts for tightness. Inspect bus-to-bus, bus-to-lugs and bus-to-stab connections to determine that they are silver plated, tight, and corrosion free. Check busses for correct bus phase arrangement.

1.1.196 Remove each unit assembly in the Motor Control Center and check for horizontal and vertical alignment of unit and guides, and for alignment of stabs with busses. Any tendency to twist, turn out of position or fit loosely is unacceptable. Verify that the unit stabs make contact automatically upon insertion of unit and disconnect upon removal of unit.

1.1.197 Inspect compartment door fit and door handle interlock to assure that the door cannot be opened when the housed unit is energized. Verify that operating handle linkages have a minimum of slack or play, and that handle is lockable in either the "On" or "OFF" position. Check the switch or breaker position marker for correct indication.

1.1.198 Inspect breakers, switches and controller mechanism to verify that nuts and bolts are in place and tight, no pins or keys have worked out of place and all cotter pins have sufficient spread.

1.1.199 Check control transformers for voltage ratio and secondary fuse rating. Check for ground on one side of transformer secondary. Check for tightness of all connections and mounting bolts.
1.1.200 Check pilot light to assure correct indication of motor operation.

1.1.201 Make insulation tests before energizing the Motor Control Center by meggering all busses, internal cabling, breakers and starters, phase-to-phase and phase-to-ground.

1.1.202 Inspect painted surfaces for scratches and blemishes and, if found, repair in a manner equal to undamaged area.

11. Transformer Substation

1.1.203 Inspect the high and low-voltage bushings for tightness, cleanliness and freedom from flaws.

1.1.204 Inspect the high voltage stress cones for grounding and connection tightness.

1.1.205 Inspect the low-voltage bus connections for tightness.

1.1.206 Inspect oil gauges and thermometers for tightness, indication of function and freedom from damage.

1.1.207 Check the oil level.

1.1.208 Inspect the case and fittings for oil leaks.

1.1.209 Check the breather for obstructions.

1.1.210 Verify the operation of the relief diaphragm.

1.1.211 Check the tank ground for continuity and tightness of connections.

12. Switchgear

1.1.212 Inspect the switchgear, auxiliaries and conduits for workmanship and general appearance. Note and correct any external factors such as moisture, chemicals, dust and oil that are detrimental to the switchgear.

1.1.213 Check breakers and compartments for identification according to the drawings.

1.1.214 Inspect switchgear for missing covers, loose or missing parts, and dirt on relays, feeders, or other devices. Check doors and locks for correct fit.

1.1.215 Inspect the overcurrent tripping devices and trip latches for freedom of movement.
1.1.216 Check the control transformer for correct voltage ratio and for correct primary and secondary fuse size.

1.1.217 "Rack Out" breakers from the enclosures and verify correct functioning of the mechanisms. Inspect all readily accessible parts for insulation from live parts of the breaker.

1.1.218 Verify provisions for locking the breaker in the trip position and locking of the lift mechanism or door.

1.1.219 Inspect busses, incoming lines, feeders and tie connections for phase sequence, identification and color coding.

1.1.220 Make insulation tests before energizing the switchgear by meggering all busses, internal cabling, and breakers, phase-to-phase and phase-to-ground.

1.1.221 Close and open manually-operated breakers three times, and verify correct operation. Check over-current trip elements for correct ratings and settings.

1.1.222 Check voltmeters and ammeters for correct indication on each phase by operating the meter switches.

1.1.223 Check painted surfaces for scratches and repair as necessary.

13. Special Systems

1.1.224 All testing to be per manufacturer’s recommendations and special instructions on drawings.

14. Electrical Testing Results

1.1.225 All tests made on electrical equipment shall be entered on OWNER’s "Electrical Testing Report".

1.1.226 Test results shall be given to Engineer immediately after completion.