

**HALLIBURTON ENERGY SERVICES
REAL ESTATE SERVICES
ENGINEERING DEPARTMENT
ELECTRICAL STANDARDS**

PART 1: GENERAL REQUIREMENTS

1.1. EXAMINATION OF DRAWINGS

- A. It shall be the responsibility of the Contractor to examine the Owner's Drawings for general construction in connection with this work. The Contractor shall carefully examine the Drawings to determine the general construction conditions, and shall familiarize himself with all limitations caused by such conditions and take cognizance of same in submitting his bid.

1.2. EXAMINATION OF SITE

- A. The Contractor shall visit the site of the proposed work and shall carefully examine the existing conditions and limitations thereof, and shall include in his bid all costs of any kind whatsoever which are incurred through limitations of existing conditions.

1.3. CODES, STANDARDS, AND PERMITS

- A. Unless specifically modified herein or superseded by local ordinances or other authority, the latest Edition of the National Electrical Code and supplements thereto shall be recognized as a **MINIMUM** acceptable standard for work under this Specifications. Where local ordinances or codes differ from the National Electrical Code, the code requiring the greater quality and/or quantity of work shall be followed.
- B. Where code requirements are less than those shown on the Plans or in this Specification, the Plans and Specifications shall be followed. Where applicable, **N.B.F.U., I.E.E.E., NEMA, and U.L.** requirements shall be met. Any discrepancy noted between the Plans and Specifications shall be called to the attention of the Electrical Engineer for his review.
- C. The Contractor shall obtain all permits, inspections and approvals as required by all authorities having jurisdiction. All fees and costs of any nature whatsoever incidental to these permits, inspections, and approvals must be assumed and paid by this Contractor, unless specifically stated otherwise.

1.4. Safety Standards

- A. Contractor shall comply with all OSHA safety standards.
- B. Contractor shall comply with the current version of NFPA 70E and with Halliburton's "**Electrical Safety Program NFPA 70E Compliance Manual**".
- C. Contractor shall comply with Halliburton Energy Services policies and procedures requiring the use of LOCKOUT/TAGOUT devices on **ALL** energy sources. Contractor's employees shall have training, provided by the

ELECTRICAL STANDARDS (cont'd)

contractor, in the proper use and application of LOCKOUT/TAGOUT devices. Each employee shall have his own Positive Lockout System.

- D. Positive Lockout System: consists of three or more locks, keyed alike, three or more lockout devices, and multiple tags. Each employee's locks shall have either the employee's name or an identifying number stenciled on the lock. Keys to each employee's locks shall not work any other employee's locks. Each employee's tags shall have the employee's name and contractor's name in permanent ink.

1.5. INSPECTION REQUIREMENTS

- A. It shall be the sole responsibility of the Electrical Contractor to notify local electrical inspection authorities of inspections needed. Any rework or costs incurred by failure to obtain required inspections shall be born solely by the Electrical Contractor.
- B. Contractor shall notify Real Estate Services' Master Electrician 24 hours prior to any scheduled inspection by local authorities.
- C. No inspection or installation shall be deemed complete until approval is received from both Real Estate Services' Master Electrician and local inspection authorities.
- D. Contractor shall promptly correct any code violation or deviation from the specifications noted by local inspection authorities or Facility Engineering's Master Electrician to the satisfaction of Facility Engineering's Master Electrician and local inspection authorities.

1.6. SHOP DRAWINGS AND PRODUCT DATA

- A. Shop Drawings are drawings, diagrams, schedules, and other data specifically prepared for the work by the Contractor or any subcontractor, manufacturer, supplier, or distributor to illustrate some portion of the work.
- B. Product Data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams and other information furnished by the Contractor to illustrate a material, product, or system for some portion of the work.
- C. The Contractor shall, prior to submittal to the Owner, review, approve, sign and date all Shop Drawings and Product Data. The Contractor's review of Shop Drawings and Product Data is not intended to take the place of the official review by the Owner, and Shop Drawings and Product Data which have not been reviewed by the Owner shall not be used in fabricating or installing any work.
- D. By approving and submitting Shop Drawings and Product Data, the Contractor represents that he has determined and verified all materials, field measurements, and field construction criteria related thereto, or will do so, and that he has checked and coordinated the information contained within such submittals with the requirements of the work and of the Contract Documents.

ELECTRICAL STANDARDS (cont'd)

- E. The review of Shop Drawings and Product Data by the Owner shall not relieve the Contractor from responsibility for deviations from the Plans and Specifications unless he has, in writing, specifically called attention to such deviations at the time of submission and has obtained the permission of the Owner thereon; nor shall it relieve him from responsibility for error of any kind in the Shop Drawings. When deviations are called to the attention of the Owner, the Contractor shall state, with the request, any change (addition to or deduction from) the contract price. If no change in contract price is required, this shall also be stated.
- F. The Product Data submitted shall reflect the actual equipment performance under the specified conditions and shall not be a copy of the scheduled data on the drawings.
- G. Official review of the submittals shall be done by the specifying engineer or designer in the Real Estate Services Group.
- H. Shop Drawings and Product Data will be returned without review unless the following are included:
 - 1. Reference to all pertinent data in the Specifications or on the Drawings.
 - 2. Size and characteristics of equipment.
 - 3. Name of the project.
 - 4. Signature of the Contractor indicating his review.

PART 2: PRODUCTS AND EXECUTION

2.1. MATERIALS AND WORKMANSHIP

- A. All materials shall be new, unless otherwise specified, and of quality grade standard manufacture and first class in every respect. All materials of a type for which the UL has established a standard shall be listed by the UL, Inc. and shall bear their label.
- B. All work shall be performed by competent mechanics, skilled in their trade, and shall be executed in a thorough, substantial and workmanlike manner.
- C. The Electrical Contractor shall be held responsible for the timely placing of all conduits, outlet boxes, cabinets and other wiring device in the walls, ceilings, slabs, beams, etc., as construction progresses.
- D. Cap all conduit ends with "pennies" until wire is installed to prevent foreign objects from entering conduit. Properly protect all outlet boxes to prevent plaster or any foreign matter from entering box. Thoroughly clean all foreign matter from all outlet and switch boxes before devices are installed.
- E. Remove all threading oils from conduit (inside and outside).

2.2. TRENCHES

- A. All excavation and backfill of all classes required to install the electrical work is included and shall be performed as a part of the work of the Electrical Contractor.

ELECTRICAL STANDARDS (cont'd)

- B. Trenches shall be excavated to the required depth that will allow the **top** of the pipe/electrical conduit to be 36" below finished grade unless otherwise specified on the plans. Trench depth shall include 3 inches of sand under pipe/electrical conduit.
- C. Trenches shall be back filled as follows:
 - 1. All electrical conduits shall have a minimum cover of six (6) inches of sand above conduit.
 - 2. A six-inch wide red ribbon stating "**Caution Electric Line Buried Below**" shall be installed a minimum of 12 inches above the top of the conduit for full length of ditch.
 - 3. One ribbon is required for every two feet of ditch width, i.e. a three foot wide ditch requires two ribbons.
- D. Trenches shall be back filled using backfill material free of roots, rocks, or foreign materials of any kind. Backfill material shall be placed in six (6) inch lifts, wetted and compacted to the density of the adjacent soil. This process shall be continued until the trenches are filled. All surplus materials shall be removed at the expense of this Contractor unless otherwise directed by Owners Representative.

2.3. RACEWAYS AND FITTINGS

- A. Halliburton Energy Services will not allow the use of **BX or MC** cable whether or not it is allowed by local codes unless specifically noted on the plans.
- B. All wiring unless specifically noted to the contrary, shall be installed in conduit. Conduits shall be run concealed in all finished areas. Conduit shall be run square to the building and held as tight as possible to the building construction. Horizontal runs shall be installed to provide a natural drain for condensation.
- C. The drawings indicate the required size of all conduits, except as hereinafter specified, and the points of termination. It shall be the responsibility of this contractor to install the conduit in proper coordination with the building structure and other mechanical trades, furnishing all required bends, fittings, junction and pull boxes, whether or not they are specifically shown on the drawings, to satisfy all codes and standards of good practice.
- D. Conduit System (shop areas)
 - 1. Install exposed conduit in the web of beams or similar locations that will provide protection from physical damage; EMT (unless otherwise specified) may be used in such locations.
 - 2. Where conduits are exposed to physical damage, IMC or rigid (unless otherwise specified) must be used to a point 10'-0" above floors if conduit is supported by conduit hangers fastened to building walls or columns.
 - 3. In open areas where conduit is not supported by conduit hangers fastened to walls or columns, conduit shall be rigid conduit (unless otherwise specified) to a rigidly mounted junction box in the ceiling.

ELECTRICAL STANDARDS (cont'd)

Conduit drops to machines shall be rigid conduit for the entire length from machine to busway.

- E. Conduit system (office areas)
 - 1. Within the building and above floors use EMT (unless otherwise specified) with setscrew or compression fittings.
- F. Conduit system (outside and underground)
 - 1. All exposed conduit shall be rigid conduit.
 - 2. All conduits in concrete slabs or below grade shall be Schedule 80 PVC with solvent welded socket fittings.
 - 3. Provide PVC coated or tape wrapped (minimum of 2 each ½ lap layers) rigid steel elbows for underground conduits 2" or larger.
- G. Flexible conduit
 - 1. Use Carlon Carflex Liquid tight outdoor/direct burial type R flexible non-metallic conduit in all sizes up to and including 2 inch.
 - 2. Use PVC compression fittings.
 - 3. All flexible conduits larger than 2 inch shall be PVC coated metallic liquid tight.
 - 4. In existing walls, steel flexible metallic conduit may be used in lieu of Carlon Carflex. All fittings for flexible metallic conduit shall be equal to T&B **steel** flexible metallic conduit fittings.
- H. Conduit terminations in slabs or equipment pads shall be made using bell ends designed for the purpose of providing a smooth edge at the transition point from conduit to air.
- I. All fittings for EMT, IMC, and Rigid conduit systems shall be steel. Malleable iron or cast fittings are not approved.
- J. Conduit Sizing
 - 1. Conduit sizes as shown on the Drawings are the minimum size allowed. Conduit where sizes are not shown shall be in accordance with NEC, using 1/2" conduit as minimum size. Do not install conduit larger than 1" horizontally in concrete slabs without written approval from the Owner. Conduit shall not be installed across expansion joints without written approval.
 - 2. Use large radius sweep elbows for all conduits under ground, all conduits 2-1/2" or larger and for all conduits that are to contain fiberoptic wiring.
 - 3. Provide PVC coated or tape wrapped (minimum of 2 each ½ lap layers) rigid steel elbows for underground conduits 2" or larger.
- K. Conduit support system:
 - 1. All conduits shall be supported to comply with the requirements of the current edition of the NEC.
 - 2. All conduits shall be rigidly attached to building surfaces or roof structure using clips and/or attachment devices specifically designed for this purpose. Support spacing shall be as required by the NEC.

ELECTRICAL STANDARDS (cont'd)

3. Where groups of conduit are run together, the conduit system may use trapezes. Conduit shall be rigidly attached to the trapeze by use of clips and/or attachment devices made for that purpose.
 4. In areas where conduit is run above suspended ceilings, flexible conduit can be attached to the ceiling support wires by use of properly sized Caddy clips (type KX KON) or equal. Conduit shall be a minimum of 1'-0" above the top of the suspended ceiling tee bars.
 5. Non-flexible conduit and pull boxes installed above suspended ceilings shall be installed on Caddy "Floor Mounted Box Supports" mounted to the top plate of walls. Bottom of pull boxes and conduit shall have a minimum of 4" clearance to wall top plate.
 6. Conduit support devices that attach to the tee bars of a suspended ceiling such as Caddy Acoustical Tee Bar Clips **ARE NOT APPROVED AND SHALL NOT BE USED TO SUPPORT CONDUIT SYSTEM.** Fixture supporting devices that attach to tee bars are acceptable.
- L. Where this Contractor is installing luminaires or power/communication poles, he shall refer to the standard installation details on the drawings. At a minimum, Contractor shall install junction boxes in these areas and supply flexible conduit, in proper lengths, to be used to supply light/power pole. Contractor shall not be allowed to use flex from pole to pole or luminaire to luminaire. Each device must have its own whip connected to the junction box.

2.4. OUTLET BOXES

- A. Outlets for concealed wiring shall be flush with the finished wall or ceiling surfaces. Pull boxes, junction boxes and all others to which no luminaire or device is to be attached, shall be fitted with blank cover plates and painted to match surroundings. In order to reduce noise transmission between rooms, outlet boxes shall not be installed back to back. Where outlets are side by side and faced into opposite rooms, the boxes shall be at least 6" apart. If the boxes are connected together, the connection shall be flexible and shall have openings packed with fiberglass.
- B. The Electrical Contractor shall inform himself of wall thickness throughout the building and shall provide outlet boxes of suitable depth that can be flush mounted and yet will be deep enough to contain the particular apparatus involved. Location of exposed pull or junction boxes will be subject to the Owner's approval.
- C. Outlet boxes in new sheetrock construction
 1. All boxes shall be 4 square drawn types (non-welded) and be a minimum of 1-1/2" deep.
 2. All boxes shall have 4 square raised covers in single or dual gang depending on device requirements. All raised covers shall be 1/2", 5/8", 3/4", 1", 1-1/4", 1-1/2", or 2" to match sheetrock thickness.
 3. Provide box dividers as required by the NEC.

ELECTRICAL STANDARDS (cont'd)

- D. Mounting of outlet boxes in new construction
 1. All boxes shall be installed using Caddy TSGB16 or TSGB24 "Screw Gun Box Brackets".
 2. Boxes shall be mounted to Caddy brackets using two (2) 3/8" zinc coated Pan Head Tek Screws.
 3. Caddy brackets shall be mounted to studs using screws designed for the application.
- E. Outlet boxes installed in existing sheetrock walls
 1. All boxes shall be 2-1/2" deep single gang, gangable, equal to PACO 500 or 503.
 2. Mounting holes in the sheetrock shall be cut to proper size using tool(s) designed for cutting sheetrock.
 3. Boxes shall be installed in openings using Caddy "Old Work Box Mounts" catalog number DSI2 or DSI2A. Install mounts with long leg up as recommended by Caddy.
- F. Outlets from which lights are suspended shall have approved 3/8" fixture studs fastened through from back of box. All outlet boxes and particularly those supporting luminaires shall be securely anchored in place in an approved manner. Support outlet boxes and luminaires in acoustic ceiling areas from building structures, not from acoustic ceilings. All luminaire outlets shall be co-ordinated with mechanical, architectural, or other equipment to eliminate conflicts and provides a workable, neat installation. Clip (Do not screw) lay-in luminaires to ceiling grids per NEC using acoustical Tee Bar clips as manufactured by Caddy (Cat. No. 515) or equal.
- G. Where more than one switch occurs at the same location, use multiple gang outlet boxes covered by a single plate; provide box partitions as required by N.E.C.

2.5. LOCATIONS OF OUTLETS

- A. The Owner reserves the right to make reasonable changes in the indicated locations before work is roughed in without additional charge to the Owner.
- B. Unless otherwise shown or specified, wall switches shall be mounted 4'-0" above finished floor to comply with the "ADA Forward Reach" requirement. Where wainscot occurs at the 4'-0" level, the switch shall be mounted in the wall as near the 4'-0" maximum height as possible, but in no case, shall the switch be partially in the wainscot and partially in the wall. Where switches are located adjacent to the thermostats, conduits and boxes shall be located so that a neat appearance results. Conduits shall be routed so as not to interfere with thermostat or thermostat operation. It shall be the Electrical Contractor's responsibility to verify all door swings. Switches, unless specifically noted, shall be on the strike side of the door. If switch is indicated on hinged side of door, verify location with Owner.
- C. Convenience outlets and telephone outlets shall be mounted 18" from floor (to comply with the "ADA Forward Reach" requirement) or as noted on the

ELECTRICAL STANDARDS (cont'd)

Electrical Drawings. Receptacles at cabinets shall be just above the backsplash level.

- D. Luminaires or other outlets in ceilings shall be located to harmonize with ceiling patterns.

2.6. WIREWAYS, JUNCTION AND PULL BOXES

- A. Furnish and install all wireways, junction and pull boxes required whether or not they are indicated on the Drawings. Wireways, junction and pull boxes shall bear a UL label and be sized per NEC unless otherwise noted on the Drawings.
- B. Electrical boxes exposed to the weather shall be NEMA 3R.
- C. Buried pull boxes outside the building shall be NEMA 3R cast iron, set in a concrete base.

2.7. CONDUCTORS FOR 600 VOLT SYSTEM

- A. All conductors shall be made of soft-drawn annealed copper with conductivity not less than that of 98% pure copper. All wire size #10 AWG and smaller shall be solid or stranded conductor type (contractor's option); all wire #8 AWG and larger shall be stranded conductor type.
- B. Use THHN insulated copper conductors for indoor dry location branch circuits and short feeders. Use THW or THWN/THWN-2 insulated copper conductors for branch circuits or short feeders installed in wet location, underground or outdoors. Use "gasoline resistant" THWN insulated copper conductors at Fuel Island.
- C. Minimum wire size shall be #12 for power circuits; however, #14 may be used for control circuits.
- D. All wire #6 gauge and smaller shall be factory color-coded. Where factory color is not available on larger sizes, mark conductors on each end and at all junction and/or pull boxes with three (3) each 1" wide bands of colored pressure-sensitive plastic tape. For isolated ground wires, mark with a 1" band of green tape, followed by a 1" band of yellow tape, followed by a 1" band of green tape. Colors for each phase and the neutral shall be consistent throughout the system. Refer to the tables section for the **Halliburton Standard Wiring Color Code**.
- E. Conductors having white, gray or green covering shall not be used to indicate other than neutral or grounding. This limitation applies to all power, lighting, and control circuits.
- F. Circuits used for general power receptacles (120 Volt single phase loads) and for lighting (277 Volt single phase loads) shall have neutrals as follows:
 - 1. one neutral per phase or
 - 2. one shared neutral per three phase with neutral being one size larger than power conductors (i.e. use #10 neutral for #12 power conductor).
- G. Installation of conductors

ELECTRICAL STANDARDS (cont'd)

1. Shall be made in a neat and workmanlike manner to meet Code requirements and shall be run continuous without weld, splice or joint between boxes.
 2. Do not install wires in conduit unless the entire system of conduit and outlet boxes is permanently in place.
 3. All conductors shall be pulled using a UL approved wire lubricant.
 4. Do not mix voltages in raceway systems (i.e.: 480Y/277 shall not be installed in same raceway as 208Y/120 or any other voltage).
- H. Make connections using pressure type connectors. All joints in conductors shall be made by first twisting the conductors and then applying a UL approved insulated, cadmium plated, live steel, spring type connector in all sizes up to the catalog capacity of the connectors. On sizes larger than catalog capacity of the connectors listed above, joints shall be made with NSI Polaris connectors: type IPL, IPLD, or IPLM. Connectors shall be supplied in the proper orientation, wire size and with the required number of terminations.
- I. Terminations of wire made with compression connectors shall use the correct size for the wire being terminated and shall be long barrel type. All long barrel lugs shall have two or more hydraulic crimps per lug
- J. Make all terminations at motors using NSI Polaris connectors: type IPL, IPLD, or IPLM.
- K. Bolted Electrical Connections
1. Use Belleville (conical) washers under the bolt head and under the nut.
 2. Torque all bolted connections to the recommend torque level of the manufacturer.
 3. Where manufacturer recommendations are not available, use the recommended torque as listed in the "US STANDARD BOLT TORQUES FOR BOLTED CONNECTIONS" at the end of the tables section.
 4. After connections have been torqued; draw a match line across washer and nut to indicate possible loosening of the connection in the future.
- L. Homeruns longer than 100' on 120-volt or 200' on 277-volt circuits shall use next larger size than required by NEC to the first outlet.
- 2.8. GROUNDING: (SYSTEM WITH NO ISOLATED GROUND CIRCUITS)**
- A. All conduits, motors, cabinets, outlets, appliances, transformers, and other equipment shall be grounded in accordance with NEC and local code requirements.
- B. At the first distribution point (i.e., panelboard, switchboard, etc.) of any separately derived electrical system, install a 3/4" diameter X 10'-0" long copper clad driven ground rod. If the first distribution point is not a ground level floor, connections shall be made to building steel and not to a ground rod. The ground rod or building steel connection point shall be a minimum

ELECTRICAL STANDARDS (cont'd)

- of 10'-0" from the ground points of the source. Bond the neutral to the enclosure. Using a separate wire, bond the neutral to the ground rod. Install a bonding jumper from the enclosure to the enclosure of the source. All grounding/bonding wires shall be sized per NEC and shall be the larger of table 250-66 or table 250-122. Connection at ground rod to be Cadweld.
- C. At each dry type transformer, bond the neutral to the enclosure. Using a separate wire, bond the neutral to the building steel at a point not less than 10'-0" from the ground rod. Install a 3/4" diameter X 10'-0" long copper clad driven ground rod as near transformer as possible. When transformer is not located on a ground floor, the ground rod shall be replaced by a second termination to building steel. The two building steel termination points shall be a minimum of 10'-0" separation and shall not be attached to the same piece of steel (i.e. use two separate columns, joists, or one of each). Using a separate wire, bond the neutral to the ground rod. Connections to the ground rod and to building steel shall be Cadweld.
 - D. Continuous metal raceway system shall **NOT** be used as equipment grounding conductors. All conduits/raceways (metallic and non-metallic) shall have a green insulated copper ground conductor installed. Conductor shall be sized per NEC Table 250-122.
 - E. All grounding conductors shall be solid or stranded copper. Connections to ground rods and building structural steel shall be Cadwelds.
 - F. Where connections are made to motors, luminaires, equipment, etc. with flexible conduit, grounding conductor shall be stranded copper conductor within the conduit, bonded to the equipment. Conductor shall be sized per NEC table 250-122.
 - G. Building shall be grounded where shown on the plans.
 - H. Any deviation from this grounding specification must have written approval from the Real Estate Services Electrical Engineer or the Real Estate Services Master Electrician. Written approval of deviation shall apply to the specific job only and shall not be applied to other location or jobs.

2.9. GROUNDING (SYSTEM WITH ISOLATED GROUND CIRCUITS)

- A. Safety grounding will be the same as specified in the section titled "Grounding (System with no isolated ground circuits)".
- B. The isolated ground circuits shall have a single point connection to the system ground. DO NOT connect isolated ground to any other point of system.
- C. The isolated ground conductor shall begin at the grounding source for the separately derived system and shall follow the system ground wire to the source. If the source is a SHIELDED ISOLATION TRANSFORMER, then connect the isolated ground conductor to the isolated terminal marked "**SHIELD**". The isolated ground wire shall then be run in the same conduit as the power wiring to all panelboards containing an isolated ground bar. Note: Isolated ground wires shall not be connected to any item that is not isolated from the system ground.

ELECTRICAL STANDARDS (cont'd)

- D. Each panelboard containing IG circuits shall have an isolated ground bar. Mark panel with a 2" X 5" yellow legend plate with black letters stating "IG CIRCUITS".
- E. ALL IG circuits shall have an insulated ground wire from the isolated ground bar to the isolated grounding receptacle and this wire shall be run in the same conduit with the power conductors.
- F. All IG circuits shall have their own IG wire and it shall not be shared with any other circuit.
- G. All circuits designated as IG shall have one neutral per phase and the conduit system containing the IG circuit shall have a bonding jumper from source to enclosure housing the IG receptacle. **DO NOT** connect bonding jumper and IG wire at any point of system.

SPECIAL NOTE:

In panels containing an IG ground bar, all ground wires/bonding jumpers other than IG wires shall be terminated on the neutral bar. Only IG ground wires shall be terminated on the IG ground bar. DO NOT terminate any IG ground wires on any neutral bar.

- H. Any deviation from this grounding specification must have written approval from the Real Estate Services Electrical Engineer or the Real Estate Services Master Electrician. Written approval of deviation shall apply to the specific job only and shall not be applied to other location or jobs.

2.10. CADWELD

A. GENERAL

- 1. This specification covers the exothermic welding system for use in making electrical connections of copper to copper and copper to steel.
- 2. This system shall include weld metal, molds, and accessories.
- 3. The welding system furnished under this specification shall meet the applicable requirements of IEEE-80, Chapter 9, Section of conductors and joints.

B. PRODUCTS

- 1. All exothermic welding system products shall be manufactured by Cadweld (no substitutions).
- 2. Products shall be Cadweld or Cadweld Exolon as follows:
 - (a) Cadweld Exolon is approved for all applications.
 - (b) Cadweld is permissible for all outdoor applications and for indoor applications when in unfinished areas of new construction.

C. EXECUTION

- 1. Personnel shall be thoroughly trained in the use of Cadweld welding system.

ELECTRICAL STANDARDS (cont'd)

2. All connections shall be done in strict compliance with Cadweld written procedures.
3. Weld metal shall be correct type for system being used (Cadweld or Cadweld Exolon).
4. Weld metal shall be correct size for mold being used.
5. All welds shall be inspected per Installation and Inspection Guide (publication A-7D-01) for Cadweld Electrical Connections. Any connection failing this inspection shall be redone.

2.11. 480 VOLT DISTRIBUTION PANELBOARDS

- A. 480 volt distribution panelboards shall consist of a box, front, interior, and circuit protective devices and shall be manufactured in accordance with NEMA standards and when applicable shall bear Underwriters Laboratories service entrance labels.
- B. The box shall be fabricated of code gauge galvanized sheet steel, and shall have a turned edge around the front for rigidity and for clamping on front. Standard knockouts shall be provided. The front shall be fabricated from sheet steel and finished with baked-on gray enamel over a rust inhibitor.
 1. Each front shall be hinged to allow access to the energized portion of the box.
 2. Each front shall have a door mounted on semi-concealed hinges with a cylinder lock, index card and card holder.
 3. All panelboard locks shall be master-keyed and all index cards shall be properly completed on a typewriter.
- C. Each panelboard shall be identified by an engraved laminated plastic nameplate on the front of the cabinet, black background with 1/2" high white letters.
- D. The interior shall consist of a factory-assembled rigid frame supporting the rectangular bus, the mains, and the neutral bar. The bussing shall be arranged for sequenced phasing throughout. Bus bars shall be sized to limit the temperature rise in accordance with the latest NEMA standards and shall be **COPPER**. The insulated neutral bar shall be located at the opposite end of the structure from the mains and shall have numbered terminals. The mains shall have either solderless lugs or main circuit protective devices as scheduled. Panels shall be complete with ground bus with lugs for each protective device. The bus shall have a maximum ampacity as scheduled as well as bracing for short circuit currents up to 100,000 RMS symmetrical amperes.
- E. Circuit breaker type panelboards shall have molded case circuit breakers of the quick-make, quick-break, thermal magnetic type operated by a trip-free toggle mechanism. The number of poles, frame size, and trip rating of circuit breakers shall be as scheduled on the plans. The short circuit interrupting ratings shall be in accordance with UL standards for 480Y/277 volt circuit breakers. Minimum value of 18,000 RMS symmetrical amps. Furnish higher interrupting breakers if specified. All circuit breakers supplying HID

ELECTRICAL STANDARDS (cont'd)

lighting circuits shall be rated HID. All circuit breakers supplying fluorescent luminaire lighting circuits shall be either switching duty or HID rated. Refer to section titled "Circuit Breaker Testing" for specification concerning testing of all circuit breakers.

- F. Panelboard shall be equipped with manufacturers **POSITIVE LOCKOUT DEVICE** for each molded case circuit breaker in the panelboard.
- G. Panelboards shall be Square D I-LINE, General Electric SPECTRA SERIES, or Westinghouse type PRL-4.
- H. Grounding shall comply with the applicable section on **GROUNDING** as detailed in this specification.

2.12. 480 VOLT LIGHTING AND GENERAL PURPOSE PANELBOARDS

- A. 480 volt lighting and general purpose panelboards shall consist of a box, front, interior, and circuit protective devices and shall be manufactured in accordance with NEMA standards and when applicable shall bear Underwriters Laboratories service entrance labels.
- B. The box shall be fabricated of code gauge galvanized sheet steel, and shall have a turned edge around the front for rigidity and for clamping on front. Standard knockouts shall be provided. The front shall be fabricated from sheet steel and finished with baked-on gray enamel over a rust inhibitor.
 - 1. Each front shall be hinged to allow access to the energized portion of the box.
 - 2. Each front shall have a door mounted on semi-concealed hinges with a cylinder lock, index card and card holder.
 - 3. All panelboard locks shall be master-keyed and all index cards shall be properly completed on a typewriter.
- C. Each panelboard shall be identified by an engraved laminated plastic nameplate on the front of the cabinet, black background with 1/2" high white letters.
- D. The interior shall consist of a factory-assembled rigid frame supporting the rectangular bus, the mains, and the neutral bar. The bussing shall be arranged for sequenced phasing throughout. Bus bars shall be sized to limit the temperature rise in accordance with the latest NEMA standards and shall be **COPPER**. The insulated neutral bar shall be located at the opposite end of the structure from the mains and shall have numbered terminals. The mains shall have either solderless lugs or main circuit protective devices as scheduled. Panels shall be complete with ground bus with lugs for each protective device. The bus shall have a maximum ampacity as scheduled as well as bracing for short circuit currents up to 14,000 RMS symmetrical amperes.
- E. Circuit breaker type panelboards shall have molded case circuit breakers of the quick-make, quick-break, thermal magnetic type operated by a trip-free toggle mechanism. The number of poles, frame size, and trip rating of circuit breakers shall be as scheduled on the plans. The short circuit interrupting ratings shall be in accordance with UL standards for 480Y/277 volt circuit

ELECTRICAL STANDARDS (cont'd)

breakers. All circuit breakers shall be of the **BOLT-ON** type if available for the panel type being used. All circuit breakers supplying HID lighting circuits shall be rated HID. All circuit breakers supplying fluorescent luminaire lighting circuits shall be either switching duty or HID rated. Refer to section titled "Circuit Breaker Testing" for specification concerning testing of all circuit breakers.

- F. Panelboard shall be equipped with manufacturers **POSITIVE LOCKOUT DEVICE** for each molded case circuit breaker in the panelboard.
- G. Panelboards shall be Square D NF, General Electric type AE, or Westinghouse type PRL-2.
- H. Grounding shall comply with the applicable section on **GROUNDING** as detailed in this specification.

2.13. 240 VOLT LIGHTING AND GENERAL POWER PANELBOARDS

- A. Panelboards shall consist of a box, front, interior and circuit protective devices and shall be manufactured in accordance with NEMA standards and bear applicable UL labels.
- B. The box shall be fabricated of code gauge galvanized sheet steel in accordance with latest UL standards, shall have a minimum width of 20 inches and shall have turned edges around the front for rigidity and for clamping on front. Standard knockouts shall be provided. The front shall be fabricated from sheet steel and finished with baked on gray enamel over a rust inhibitor.
 - 1. Each front shall be hinged to allow access to the energized portion of the box.
 - 2. Each front shall have a door mounted on semi-concealed hinges with a cylinder lock, index card and card holder.
 - 3. All panelboard locks shall be master-keyed and all index cards shall be properly completed on a typewriter.
- C. Each panelboard shall be identified by an engraved laminated plastic nameplate on the front of the cabinet, black background with 1/2" high letters.
- D. The interior shall consist of a factory-assembled rigid frame supporting the rectangular bus, the mains and the neutral bar. The bussing shall be arranged for sequence phasing throughout. Bus bars shall be sized so as to limit the temperature rise in accordance with the latest NEMA standards and shall be **COPPER**. The insulated neutral bar shall be located at the opposite end of the structure from the mains and shall have numbered terminals. The mains shall have either solderless lugs or a main circuit protective device as scheduled. Each enclosure shall be provided with grounding lugs and uninsulated equipment-grounding terminals. The bus shall have a maximum ampacity as scheduled as well as bracing for short circuit currents up to 10,000 RMS symmetrical amperes.
- E. The circuit protective devices shall be molded case circuit breakers of the quick-make, quick-break, thermal magnetic type and shall be operated by means of toggle type mechanism with trip indication. The number of poles,

ELECTRICAL STANDARDS (cont'd)

ampere rating, and trip rating of the breakers shall be as scheduled. The short circuit rating shall be in accordance with UL standards and shall be 10,000 amperes RMS symmetrical for 240 and 208Y/120 volt circuit breakers. All circuit breakers shall be of the **BOLT-ON** type. All circuit breakers supplying HID lighting circuits shall be rated HID. All circuit breakers supplying fluorescent luminaire lighting circuits shall be either switching duty or HID rated. Refer to section titled "Circuit Breaker Testing" for specification concerning testing of all circuit breakers

- F. Panelboard shall be equipped with manufacturers **POSITIVE LOCKOUT DEVICE** for each molded case circuit breaker in the panelboard.
- G. Panelboards shall be Square D NQOD, General Electric type AQ, or Westinghouse type PRL-1.
- H. Grounding shall comply with the applicable section on **GROUNDING** as detailed in this specification.

2.14. BALANCING OF PANELS

- A. Each panelboards shall be checked for full load amperage on each phase under both normal and full load operating conditions.
- B. Single phase loads (single pole and two pole breakers) shall be arranged in the panelboard to provide balanced loading on each phase under both full load and normal load conditions.

2.15. DRY-TYPE TRANSFORMERS

- A. Transformers shall be air-cooled dry type with the size and electrical characteristics indicated, 220° C, class insulation rated at 150° C winding rise, with respect to a 40° C ambient. Insulation shall be high grade insulating varnish of the non-hygroscopic thermo-setting type. Windings shall be continuous without splicing. Units shall be fabricated in full accordance with NEMA standards and bear applicable UL labels.
- B. Transformers shall have non-aging silicon steel held together with channels or angles, with low magnetic flux density, and shall be vibration isolated from case and support channels.
- C. Each transformer shall be furnished with two (2) 2-1/2% taps above and four (4) 2-1/2% taps below normal rating on the high voltage coils.
- D. Where transformers are indicated to be mounted on the floor, they shall be set on raised concrete pads. Where transformers are to be wall mounted or suspended, these supports shall be furnished and installed by the Electrical Contractor. Furnish shop drawings of supports for approval before fabrication. Transformers shall be isolated from steel supports and concrete bases by setting on combination ribbed neoprene and cork pads. All transformers shall be isolated from their conduit system by at least 18" of flexible conduit.
- E. Each transformer shall be guaranteed to have sound ratings not to exceed those listed in the tables section.
- F. Approved manufacturers: Square D, GE, Westinghouse.

ELECTRICAL STANDARDS (cont'd)

- G. Grounding shall comply with the applicable section on **GROUNDING** as detailed in this specification.

2.16. SAFETY SWITCHES

- A. Safety switches shall be 600V single throw, fusible or non-fusible depending upon the service indicated. They shall be horsepower rated, heavy duty, designed for locking in "ON" or "OFF" position, in code gauge steel cabinets.
- B. Switches shall have number of poles required, dependent on phases serving equipment.
- C. Switches shall be UL approved for duty shown and NEMA 3R where exposed to weather. NEMA 3R switches shall have weatherproof threaded hubs for all conduit entries into switch.
- D. All switches shall be identified, as to equipment served, with engraved laminated plastic plates. White letters on black background shall be minimum of 3/8" high.
- E. Approved manufacturers: Square D, GE, Westinghouse.

2.17. FUSES

- A. All time delay fuses (class RK-5 and class RK-1) feeding transformers, motor control centers, motors, etc. shall be sized at 125% of the full load amperage. Where size falls between fuses, use the fuse closest to the calculated size but never below 120%.
- B. All fuses shall be sized in accordance with the rules and regulations of the National Electric Code.
- C. All fuses rated at 600 volt or less shall be manufactured by Bussmann. No substitutions shall be allowed.
- D. Fuses 601 amperes and larger shall be Class L time-delay Bussmann KRP-C.
- E. Fuses 600 amperes and smaller that feed transformers, motor control centers, motors, **or any such load that requires a high inrush or starting current** shall be Bussmann Class RK-5 dual-element time delay. Fuses shall be FRS-R (600V) or FRN-R (250V). NOTE: Bussmann Class RK-1 dual-element time delay fuses [LPS-RK (600V) or LPN-RK (250V)] may be used in this application.
- F. Fuses 600 amp and smaller that feed resistive heaters, panelboards, **or any such load that does not require high inrush or starting current** shall be Bussmann Class RK-1 dual-element time delay. Fuses shall be LPS-RK (600V) or LPN-RK (250V). NOTE: Bussmann Class RK-1 Limitron fast-acting fuses [KTS-R (600V) or KTN-R (250V)] may be used in this application.

ELECTRICAL STANDARDS (cont'd)

2.18. WIRING DEVICES

- A. The wiring devices as shown in symbol list on the drawings, and/or specified herein shall be furnished and properly installed in their respective outlets and shall be ivory or white color (following the predominate existing type for the location).
- B. Device plates shall be smooth plastic in office areas or formed galvanized steel in shop areas in proper units or gangs as required. Furnish carpet flanges as required for floor outlets.
- C. Switches shall be as specified. All switches shall be 120/277 volt and shall firmly terminate up to No. 10 AWG conductors. Refer to the tables section for a listing of approved switches.
- D. Receptacles shall be as specified. All general purpose duplex receptacles shall be 120V, 1-phase, 3-wire self grounding. All duplex receptacles shall have the ground terminal installed on the top. Refer to the tables section for a listing of approved receptacles.
- E. Ground fault receptacles shall be as specified. All GFCI receptacles shall be "Class A" or "Class B" as required by the code. All GFCI receptacles shall be 120V, 1-phase and shall provide visible indications of trip condition. Refer to the tables section for a listing of approved GFCI receptacles.
- F. Isolated ground receptacles shall be as specified. All isolated ground receptacles shall be 120 volt, 1-phase, 3-wire, duplex, and shall be orange in color. All isolated ground receptacles shall have the ground terminal installed on the top. Refer to the tables section for a listing of approved isolated ground receptacles.

2.19. LIGHTING

- A. Design
 - 1. Shall comply with the guidelines of the EPA's "**ENERGY STAR**" program requiring the most energy efficient light source available for the task to be performed.
 - 2. Lighting design shall be performed by a competent lighting designer, familiar with the standards of good lighting practice.
 - 3. Illuminance levels shall comply with the standards set forth in the "IES Lighting Handbook" and shall be designed with zero (0) weighting factor.
- B. General Guidelines
 - 1. HID light sources
 - (a) High Pressure Sodium luminaires shall be used for all HID applications unless the task is color critical.
 - (b) Metal Halide luminaires shall be used for all color critical tasks.
 - (c) Mercury luminaires shall not be used.
 - 2. Fluorescent light sources (including high bay applications)
 - (a) Use cool white FO-28 lamps (standard 48 inch length lamps).
 - (b) Use electronic ballasts.

ELECTRICAL STANDARDS (cont'd)

- (c) Use compact fluorescent luminaires in lieu of incandescent products.
 - (d) Use dimmable compact fluorescent lamps in areas where dimmable incandescent lamps would normally be used.
 - 3. Incandescent light sources
 - (a) Standard "A" lamps shall not be used unless they are required by the Special Areas section.
 - 4. LED light sources
 - (a) Use LED MR-16 lamps in place of Halogen MR-16 lamps.
 - (b) Use LED lighting source for sign backlighting in exit signs and exterior signage.
 - (c) LED street lights and wall packs shall be used where efficiency and life cycle performance exceed HPS (with current technology LED outdoor lighting outperforms HPS lighting sources at 400W and below)
 - 5. Special Areas
 - (a) Where good lighting design requires the use of non-energy efficient light sources to perform a specific task, use the light source required by the special task.
- C. Luminaires
 - 1. This Contractor shall furnish and install a luminaire as hereinafter specified and as scheduled on the drawings on each and every outlet in accordance with the type designation shown on the drawings. If a type designation is omitted, the luminaire shall be of the same type as is shown for rooms of similar usage.
 - 2. It shall be the Contractor's responsibility to check the architectural finishes, and regardless of specified or scheduled catalog number, prefixes and suffixes, furnish luminaires with the proper trim, frames, support, hangers and other miscellaneous appurtenances required to properly coordinate with said finishes. Where ceiling construction requires reinforcing to support the weight of the luminaires, reinforcing shall be furnished by this Contractor. Clip (Do not screw) lay-in luminaires to ceiling grids using acoustical Tee Bar clips as manufactured by Caddy (Cat. No. 515) or equal.
 - 3. Contractor shall connect fluorescent ballasts to supply using Thomas and Betts Sta-Kon Disconnects (or equal) catalog numbers LD2 (2 wire) or LD3 (3 wire) as appropriate.
 - (a) Where existing fixtures are relocated during remodels, Sta-Kon Disconnects shall be installed
 - (b) When ballasts are replaced due to failure, Sta-Kon disconnects shall be installed.
 - 4. Immediately before final inspection, this Contractor shall thoroughly clean all luminaires, inside and out, including plastics and glassware, shall adjust all trim to proper fit adjacent surfaces, replace broken or

ELECTRICAL STANDARDS (cont'd)

- damaged parts, and lamp and test all luminaires for electrical as well as mechanical operation.
5. All lamps shall be new and delivered to the job in the original packing cases and sleeves. Use lamps as scheduled on the drawings. Approved manufacturers: Sylvania, GE.
 6. Ballasts for fluorescent lamps shall be:
 - (a) electronic
 - (b) high power factor (.97 or greater)
 - (c) voltage (120/277 as required)
 - (d) one, two, three, or four lamps to match luminaire
 - (e) low harmonic distortion (less than 15% THD)
 - (f) lamp current crest factor less than 1.7
 - (g) UL listed, Class P, Type 1
 - (h) Sound rated 'A' or better.
 - (i) Meet IEEE 587A (ANSI C62.41) and FCC Part 18C, Class A.
 7. Lenses in fluorescent luminaires to be 100% virgin acrylic prismatic. Overall lens thickness shall not be less than 0.125 inches. Each lens shall be pre-stressed to span 48" x 24" without sagging.
 8. HID ballasts shall be of the proper type for scheduled lamp and manufactured by Advance.
 9. Exact locations of all lighting luminaires shall be per Architect's reflected ceiling plan.
- D. Emergency Lighting
1. Luminaires indicated on the electrical plans as un-switched shall have emergency power for egress / regress supplied by either:
 - (a) Designated emergency power system.
 - (b) Battery backup such as Bodine 90 minute back-up battery ballast.

2.20. LIGHTING CONTROLS

- A. Lighting Controls
1. Use lighting time control products manufactured by Hubbell Building Automation, Inc. such as the "LX Networked Controls" and "LX touch tablet" that operate on a LONTalk data sharing platform.
 2. Lighting controls shall be integrated with HVAC building automation system (Trane Tracer Summit) which also uses the LONTalk data sharing platform where applicable.
- B. Occupancy Sensors
1. Use occupancy sensor products manufactured by Hubbell Building Automation, Inc.
 2. Refer to installation considerations and coverage diagrams for all products available at www.hubbell-automation.com and or call technical support at (888) 698-3242.

ELECTRICAL STANDARDS (cont'd)

3. For individual offices and conference rooms up to 1000 Square Feet use wall mounted multi-technology occupancy sensors with an override "off" button.
 - (a) Use "LightHawk™ Multi-Technology Sensor" model LHMTS1 (120/277 Volt) automatic and manual control.
 - (b) Sensor adjustments are automatic and daylight sensing will turn off lights when a room has enough natural light.
4. For rest rooms use a ceiling or wall mount ultra sonic sensors.
 - (a) Up to 250 square feet use "Omni Ultrasonic Sensor" model OMNIUS500 (120/277 Volt) automatic control only (add "RP" to the part number to include the Relay Pak).
 - (b) Up to 500 square feet use "Omni Ultrasonic Sensor" model OMNIUS1000 (120/277 Volt) automatic control only (add "RP" to the part number to include the Relay Pak).
 - (c) Up to 1000 square feet use "Omni Ultrasonic Sensor" model OMNIUS2000 (120/277 Volt) automatic control only (add "RP" to the part number to include the Relay Pak).
 - (d) Sensor adjustments are automatic and daylight sensing will turn off lights when a room has enough natural light.
5. For highbay areas with fluorescent lighting use "HBA WASP™ – Fluorescent High Bay Occupancy Sensor" (120-347VAC)
 - (a) FHB141NPUNV – HBA Wasp Fluorescent High Bay Sensor with 1.4 area lens, 1-SPST Output, 120-347VAC, White
 - (b) FHB142NPUNV – HBA Wasp Fluorescent High Bay Sensor with 1.4 area lens, 2-SPST Output, 120-347VAC, White
 - (c) FHB141PSUNV – HBA Wasp Fluorescent High Bay Sensor with 1.4 area lens, 2-SPST Output, Photosensor, 120-347VAC, White
 - (d) FHB142PSUNV – HBA Wasp Fluorescent High Bay Sensor with 1.4 area lens, 2-SPST Output, Photosensor, 120-347VAC, White
6. For larger rooms, hallways and or technical support call Hubbell Building Automation at (888) 698-3242 or (512) 450-1100 or visit the website www.hubbell-automation.com

2.21. EXIT SIGNS

- A. Exit signs shall comply with NFPA, NEC, OSHA, and all local codes. Sign shall be UL listed.
- B. This contractor shall furnish and install an exit sign as hereinafter specified and as scheduled on the drawings.
- C. Standard AC exit signs shall be Dual-Lite, Liteforms LX series, single face (cat. no. LXSRW) or dual face (cat. no. LXURW).
- D. Emergency stand alone AC exit signs shall be Dual-Lite, Liteforms LX series, single face (cat. no. LXSRWE) or dual face (cat. no. LXURWE).

ELECTRICAL STANDARDS (cont'd)

- E. Emergency AC exit signs located in buildings where emergency lighting is supplied by specified emergency power system shall be standard AC units with the DC option.
- F. LED's shall have rated life of 20+ years.
- G. Signs shall have concealed chevrons, knockouts, and mounting hardware.
- H. Standard signs shall be 120 / 277 dual voltage. DC option signs shall match the voltage of the DC power source.
- I. Exit signs shall have solid state charger, integral test switch, AC-on LED charge indicator, and sealed maintenance free 10 year battery.

2.22. ELECTRICAL CONNECTIONS TO SPECIAL EQUIPMENT:

- A. The Electrical Contractor shall make all electrical connections for power to equipment furnished under this contract and furnish wiring, conduit, and outlet boxes, disconnect switches, etc. He shall check the General Construction, Plumbing, Heating and Air Conditioning plans and specs and inform himself as to the amount of such wiring that may be required and include same in his bid. Locations, horsepower, voltages, etc. of all such equipment, shall be verified as the job progresses. If an apparent conflict arises in any part of power wiring, the electrical contractor shall advise the Owner immediately for clarification. Note: refer to the section covering 600 volt conductors for proper termination procedures for all conductors and motor terminations.
- B. The Electrical Contractor shall furnish all starters for any equipment that pertains to power wiring, unless specifically noted otherwise. The Electrical Contractor will mount all such equipment for the purpose of making electrical power connections, in accordance with diagrams furnished by the supplier of the equipment.
- C. The Electrical Contractor shall furnish and install all of the disconnect switches as shown and where required by **NEC OR LOCAL CODES**. In general, all such wiring shall be in conduit, with short section flexible conduit at each motor, and shall be securely attached at the point of adapting to flexible conduit. If the motor is an integral part of a piece of equipment, the entire piece of equipment shall be isolated with a short section of flexible conduit to prevent vibration and/or noise amplification to be transferred to the building structure. If the motor is adjustable, an additional length of flexible conduit shall be installed at the motor. A bonding jumper shall be installed in the conduit.
- D. Major equipment furnished under the mechanical and other sections of the specifications may require different rough-in requirements than indicated on the plans due to the "or equal" equipment clause. The Electrical Contractor shall secure detailed drawings from the contractor furnishing the equipment, to determine actual rough-in locations and conduit and conductor requirements to assure a proper and workmanlike installation.
- E. Connections to all electrically operated equipment are included in this contract; whether or not specifically mentioned herein. (This includes

ELECTRICAL STANDARDS (cont'd)

owner-furnished equipment). The Electrical Contractor shall check on the job from time to time for further details on plumbing, heating and air conditioning equipment. Grounding of all such equipment shall be done in an approved manner by the Electrical Contractor per NEC.

2.23. VARIABLE SPEED DRIVES

- A. Yaskawa
 - 1. model E7 (3 contactor design only) for HVAC fan motors
 - 2. IQPump Controller for HVAC pumps

2.24. MOTOR STARTERS AND CONTACTORS

- A. Manual Motor Starters
 - 1. Manual switches, used to control single phase motor loads up to one horsepower, shall be manual motor starters. Starters shall have one or two poles as required by the device served. Starters shall have overloads sized for actual full load amperage. Manual motor starters shall be toggle operated and shall have padlock attachment to lock unit in either "on" or "off" position.
 - 2. Manual motor starters shall be either Square D class 2510 type F or G.E. type CR101. No substitutions.
- B. Electro-Mechanical Type, Nema size 00 only.
 - 1. Contactors and starters shall have the proper number of poles required to supply the device being served.
 - 2. Contactors and Starters shall be full voltage rated and have coil voltage as specified on the plans.
 - 3. Thermal overloads for starters shall be sized for actual full load amperage of device being served.
 - 4. Enclosures shall be provided and shall be Nema 1 for indoor and Nema 3R for outdoor applications.
 - 5. Provide control switches or pushbuttons as detailed on the plans.
 - 6. Contactors and Starters shall be Square D, Westinghouse, or G.E.
- C. Electro-Mechanical Type, Nema Size 0 and larger.
 - 1. Contactors and starters shall have the proper number of poles required to supply the device being served.
 - 2. Contactors and Starters shall be full voltage rated.
 - 3. Enclosures shall be provided and shall be Nema 1 for indoor and Nema 3R for outdoor applications.
 - 4. Starters and Contactors shall be Westinghouse Advantage, no substitution.
 - 5. Provide accessories as indicated on the plans.
 - 6. At time of installation, consult Real Estate Services Engineering for settings of dip switches on Advantage unit.
 - 7. All Westinghouse Advantage Starters require a 120V control circuit that is unswitched. Coil is rated for control input voltage from 24 VAC

ELECTRICAL STANDARDS (cont'd)

to 120 VAC. Provide 120V unswitched power source for each Advantage unit.

2.25. MEDIUM VOLTAGE (ABOVE 600V AND LESS THAN 36KV)

- A. Pad mounted transformers
 - 1. Non-Hazardous/ Environmentally Friendly Dielectric Fluid (Cooper Power Systems Envirotrans oil filled transformers are preferred)
 - 2. Dead front construction
 - 3. Loop feed
 - 4. Parking well for each cable
 - 5. Oil immersed Bay-O-Net fusing if available. Use oil immersed internal fusing above 25,000 Volts
 - 6. Oil sampling valve in a lockable enclosure on the exterior of the transformer
 - 7. IR sight glasses for IR camera inspection on the primary side
 - 8. Liquid level gauge
 - 9. Vacuum gauge
 - 10. KVA and primary/secondary voltages as specified
 - 11. On-off selector switch for each set of feeders
- B. Medium voltage cable
 - 1. Cable shall be single conductor shielded stranded copper.
 - 2. Cable shall have EPR insulation with PVC jacket.
 - 3. Cable shall be Type MV-105.
 - 4. Cable shall be rated for 133% insulation for 5 and 15 KV systems and 100% insulation for 35 KV systems.
 - 5. Cable shall be rated for the voltage being used.
- C. Transformer terminations
 - 1. Dead front transformers
 - (a) Load break elbows
 - (1) Shall be 200 amp rated.
 - (2) Manufactured by Elastimold or Cooper Power Systems
 - (3) Sized for the wire and voltage being installed.
 - (4) Lugs crimped a minimum of two times.
 - (b) Provide insulated parking bushings for number of cables.
 - (c) Provide inserts for transformer load break elbows.
 - 2. Live front transformers.
 - (a) 3M Cold Shrink QT-111 Outdoor Terminations.
 - (b) Sized for wiring and voltage being used.
 - (c) Use 7690-S series terminations for all voltages 28KV and less. Use class 7680-S series terminations for 35KV.
- D. Utility Pole terminations.
 - 1. 3M Cold Shrink QT-111 Outdoor Terminations.
 - 2. Sized for wiring and voltage being used.
 - 3. Use 7680-S series terminations for all voltages 35KV and less
- E. Lightning Arrestors

ELECTRICAL STANDARDS (cont'd)

1. Contractor shall furnish and install lightning arrestors on all drops from overhead utility distribution wiring.
2. Properly sized for voltage supplied.

2.26. TESTING REQUIREMENTS FOR NEW CIRCUIT BREAKERS

- A. All molded case circuit breakers (MCCB's) and all switchgear type drawout circuit breakers that have field adjustable settings shall be delivered to Real Estate Services prior to installation so that they may be tested by an independent testing firm in accordance with NETA specifications.
- B. Owner will pay the cost of all such testing.
- C. This contractor shall promptly replace any breaker that does not pass the NETA test.

2.27. CLEANUP

- A. Remove all trash and debris from work area at the end of each day.
- B. Dispose of trash in containers designated for that purpose.

Tables

| HALLIBURTON STANDARD WIRING COLOR CODE | | |
|---|---|-------------------|
| WIRE | 208Y/120 V | 480Y/277 V |
| Phase A | Black | Brown |
| Phase B | Red | Orange |
| Phase C | Blue | Yellow |
| Neutral | White | Gray |
| Ground | Green | Green |
| Isolated Ground Wires | Green with yellow stripe (use for all voltages) | |

The white or gray conductor shall be the neutral at each outlet. All switches shall be installed in "hot" leg. On all lighting circuits the switch leg shall be purple from switch to luminaire. All travelers from switch to switch on 3 and 4 way switches shall be pink. This color code shall be followed by contractor for all luminaire whips except for factory manufactured whips. When factory manufactured whips are used, color code shall apply to all wiring except the factory whip.

| TRANSFORMER SOUND LEVELS | |
|---------------------------------|---------------------------------------|
| KVA RATING | SOUND LEVEL IN DECIBELS - ANSI |
| 0 - 9 | 40 |
| 10 - 50 | 45 |
| 51 - 150 | 50 |

Tables

SWITCHES

| Use with Solid Wire Only | | | | | |
|----------------------------------|----------|----------|-----------|-----------|-----------|
| AMP. | HUBBELL | BRYANT | P&S | LEVITON | GE |
| Single Pole | 1101 - I | 1101 - I | 501 - I | 1101 - 2I | 5901 - 2 |
| Double Pole | 1102 - I | 1102- I | 503 - I | 1102 - 2I | 5902 - 2 |
| 3-Way | 1103 - I | 1103 - I | 503 - I | 1103 - 2I | 5903 - 2 |
| 4-Way | 1104- I | 1104- I | 504 - I | 1104 - 2I | 5904- 2 |
| Use with Solid or Stranded Wire* | | | | | |
| AMP. | HUBBELL | BRYANT | P&S | LEVITON | GE |
| Single Pole | 1201 - I | 4901 - I | 15AC1 - I | 1201 - 2I | 5931 - 2G |
| Double Pole | 1202 - I | 4902- I | 15AC2 - I | 1202 - 2I | 5932 - 2G |
| 3-Way | 1203 - I | 4903 - I | 15AC3 - I | 1203 - 2I | 5933 - 2G |
| 4-Way | 1204- I | 4904- I | 15AC4 - I | 1204 - 2I | 5934- 2G |

***Note:** When using stranded wire, twist strands together and insert in back wire terminal.

RECEPTACLES

| Use with Solid Wire ONLY | | | | | |
|----------------------------------|----------|----------|----------|----------|----------|
| TYPE | HUBBELL | BRYANT | P&S | GE | LEVITON |
| 15 AMP. | 5242 - I | 5242 - I | 5242 - I | 5242 - I | 5242 - I |
| 20 AMP. | 5342 - I | 5342 - I | 5342 - I | 5342 - I | 5342 - I |
| Use with Solid or Stranded Wire* | | | | | |
| TYPE | HUBBELL | BRYANT | P&S | GE | LEVITON |
| 15 AMP. | 5252 - I | 5252 - I | 5252 - I | 5252 - I | 5252 - I |
| 20 AMP. | 5352 - I | 5352 - I | 5352 - I | 5352 - I | 5352 - I |

***Note:** When using stranded wire, twist strands together and insert in back wire terminal.

Tables

GROUND FAULT RECEPTACLES “CLASS A”

| Use with Solid or Stranded Wire** | | | | |
|-----------------------------------|----------|-----------|---------|---------|
| TYPE | HUBBELL | BRYANT | P&S | LEVITON |
| 15 amp. | GF5252IA | GFR52FT-I | 1591-FI | 6599-I |
| 20 amp. | GF5352IA | GFR53FT-I | 2091-FI | 6899-I |

****Note:** When using stranded wire, contractor shall terminate stranded wire to a solid wire pigtail. The solid wire pigtail shall be connected to the terminals on the ground fault device. Contractor shall use a deep box for this installation.



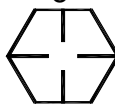

ISOLATED GROUND RECEPTACLES

| Isolated Ground Receptacles for Use with Solid or Stranded Wire* | | | | | |
|--|---------|---------|---------|--------|-----------|
| TYPE | HUBBELL | BRYANT | LEVITON | P&S | GE |
| 15 AMP. | IG5262 | 5262-IG | 8200-IG | IG6200 | GE5262-IG |
| 20 AMP. | IG5362 | 5362-IG | 8300-IG | IG6300 | GE5362-IG |

***Note:** When using stranded wire, twist strands together and insert in back wire terminal.

Tables

U. S. STANDARD BOLT TORQUES FOR BOLTED CONNECTIONS HEAT TREATED STEEL

| | | | | |
|--------------------------|---|---|--|---|
| Grade | SAE 1 & 2 | SAE 5 | SAE 6 | SAE 8 |
| |  |  |  |  |
| Minimum Tensile (P.S.I.) | 64K | 105K | 133K | 150K |

| BOLT DIAMETER | TORQUE (FOOT POUNDS) | | | |
|---------------|------------------------|-----|-----|------|
| 1/4 | 5 | 7 | 10 | 10.5 |
| 5/16 | 9 | 14 | 19 | 22 |
| 3/8 | 15 | 25 | 34 | 37 |
| 7/16 | 24 | 40 | 55 | 60 |
| 1/2 | 37 | 60 | 85 | 92 |
| 9/16 | 53 | 88 | 120 | 132 |
| 5/8 | 74 | 120 | 167 | 180 |
| 3/4 | 120 | 200 | 280 | 296 |
| 7/8 | 190 | 302 | 440 | 473 |
| 1 | 282 | 466 | 660 | 714 |

NOTE: Reduce bolt torque by 20% when cadmium plated bolts are used. Cadmium plated bolts can be recognized by a mirror like plated finish that may have a slight gold tint.

END OF: "HALLIBURTON ENERGY SERVICES, REAL ESTATE SERVICES ENGINEERING DEPARTMENT, ELECTRICAL STANDARDS"

Document name: **“Electrical Master Spec.doc”**