PUMP STATION ELECTRICAL SPECIFICATIONS

DRAWING SPECIFICATIONS – ELECTRICAL (DIVISION 16)

SECTION 16001 – SUMMARY OF THE WORK

1. WORK UNDER DIVISION 16 SHALL INCLUDE, BUT NOT BE LIMITED TO, THE FOLLOWING:

a. PROVIDE BREAKERS IN THE NORMAL AND EMERGENCY SWITCH GEAR TO FEED NEW ATS.
b. PROVIDE NEW ATS AND GENERATOR START CIRCUIT FOR PUMP STATION.
c. PROVIDE FEEDERS TO THE NEW ATS AND TO THE PUMP CONTROLLER FROM THE ATS.
d. PROVIDE TRENCHING FOR ANY WIRING BELOW GRADE ALONG WITH ANY REQUIRED PATCHING

SECTION 16010 – BASIC ELECTRICAL REQUIREMENTS

1. THE CONTRACTOR SHALL PROVIDE ALL LABOR, MATERIAL, EQUIPMENT AND SERVICES FOR THE PROPER INSTALLATION AND OPERATION OF THE ELECTRICAL WORK AS INDICATED ON THE DRAWINGS.
2. THE CONTRACTOR SHALL PROVIDE ALL LABOR, EQUIPMENT AND SERVICES NECESSARY FOR REMOVAL OR RELOCATION OF EXISTING ELECTRICAL EQUIPMENT AS REQUIRED BY THE PROJECT.
3. TEST AND OPERATE ALL SYSTEMS TO DEMONSTRATE TO THE OWNER, OR HIS DESIGNATED REPRESENTATIVE, THAT THE INSTALLATION OF THESE SYSTEMS CONFORM TO DESIGN INTENT.
4. THE CONTRACTOR SHALL COMPLY WITH ALL RULES AND REGULATIONS OF THE OWNER, LOCAL, STATE AND FEDERAL LAWS, ORDINANCES, RULES AND REGULATIONS APPLICABLE TO THE WORK SHOWN OR SPECIFIED, AND WITH THE RULES OF THE NATIONAL FIRE PROTECTION ASSOCIATION, THE OWNER'S UNDERWRITER, AND ALL PUBLIC UTILITIES HAVING CONNECTION WITH ANY OF THE VARIOUS SYSTEMS HEREIN SPECIFIED. WHERE APPLICABLE, ALL EQUIPMENT SHALL CARRY THE LABEL OF THE UNDERWRITERS LABORATORIES, INC.
5. THE CONTRACTOR SHALL GIVE ALL NECESSARY NOTICES, OBTAIN, PAY FOR AND DELIVER ALL PERMITS, CERTIFICATES OF INSPECTION, AND PAY ALL COSTS, REQUIRED BY THE AUTHORITIES HAVING JURISDICTION. DELIVER ALL PERMITS, CERTIFICATES AND APPROVALS TO THE OWNERS AGENT PRIOR TO FINAL ACCEPTANCE OF THE WORK. THE CONTRACTOR MUST FILE NECESSARY DRAWINGS, PREPARE DOCUMENTS AND MAKE APPLICATION FOR EACH REQUIRED PERMIT AND INSPECTION, PRIOR TO COMMENCING WORK TO AVOID DELAYS DURING CONSTRUCTION.
6. INDEPENDENT INSPECTION AGENCY CERTIFICATES SHALL BE FURNISHED FOR ALL ELECTRICAL WORK. ALL CERTIFICATES SHALL BE IN DUPLICATE AND SHALL BE DELIVERED TO THE OWNER'S AGENT AND SHALL BECOME THE PROPERTY OF THE OWNER.
7. BEFORE SUBMITTING HIS BID, THE CONTRACTOR SHALL VERIFY ALL EXISTING CONDITIONS IN THE FIELD. FAILURE TO DO SO WILL NOT RELIEVE THE CONTRACTOR OF HIS OBLIGATION TO PAY FOR ALL COSTS THAT MAY BE INCURRED DUE TO THE RELOCATION, REMOVAL OR MODIFICATION OF ANY PART OF THE EXISTING ELECTRICAL WORK THAT MAY BE REQUIRED, OR ANY CONDITION THAT MAY AFFECT THE COST OF INSTALLING THE NEW WORK.
8. IT IS THE INTENTION OF THE DRAWINGS AND SPECIFICATIONS TO CALL FOR CLEAR FINISHED WORK, TESTED AND READY FOR OPERATION. ANY INCIDENTAL ACCESSORIES NECESSARY TO MAKE THE WORK COMPLETE AND PERFECT IN ALL RESPECTS AND READY FOR OPERATION, EVEN IF NOT PARTICULARLY SPECIFIED OR SHOWN, SHALL BE PROVIDED WITHOUT ADDITIONAL EXPENSE. MINOR DETAILS NOT USUALLY SHOWN OR SPECIFIED, BUT MANIFESTLY NECESSARY FOR THE PROPER INSTALLATION AND OPERATION OF THE VARIOUS SYSTEMS, SHALL BE INCLUDED IN THE WORK, THE SAME AS IF SPECIFIED OR SHOWN ON THE DRAWINGS.
9. SUBMIT 7 COPIES OF SHOP DRAWINGS. SHOP DRAWINGS SHALL INCLUDE PLANS, ELEVATIONS, SECTIONS, MOUNTING DETAILS OF COMPONENT PARTS, POINT TO POINT INTERCONNECTION DIAGRAMS, ELEMENTARY DIAGRAMS, SINGLE LINE DIAGRAMS AND ANY OTHER DRAWINGS NECESSARY TO SHOW THE FABRICATION AND CONNECTION OF THE COMPLETE ITEM OR SYSTEM.
10. RECORD DRAWINGS SHALL BE KEPT IN THE CONTRACTOR'S JOB SITE OFFICE FROM THE BEGINNING OF THE WORK, SHALL BE MAINTAINED DAILY AND SHALL BE PRODUCED FOR INSPECTION BY THE OWNER OR HIS AGENTS UPON DEMAND. AT THE COMPLETION OF THE PROJECT, BIND THE PRINTS INTO A SET AND FORWARD THEM TO THE OWNER'S AGENT. THE RECORD DRAWINGS SHALL CONSIST OF A SEPARATE SET OF WHITE PRINTS OF THE CONTRACT DRAWINGS ON WHICH SHALL BE RECORDED IN INK OR COLORED PENCIL THE FOLLOWING:

   DIMENSIONED LOCATIONS OF CONDUITS BURIED BELOW, OR CAST INTO, CONCRETE FLOOR SLABS.

   A. DIMENSIONED LOCATIONS OF CONDUITS OUTSIDE THE BUILDING.
   B. LUMINAIRE ARRANGEMENTS, IF DIFFERENT FROM CONTRACT DRAWINGS.
   C. LOCATIONS OF ELECTRIC PANELS, MOTOR STARTERS, WALL MOUNTED EQUIPMENT AND THE LIKE, IF DIFFERENT FROM CONTRACT DRAWINGS.
   D. ALL WORK ADDED TO THE CONTRACT BY LAYOUT DRAWINGS, FIELD SKETCHES, ADDENDUM OR CHANGE ORDER.

11. BEFORE COMPLETION OF THE INSTALLATION, THE CONTRACTOR SHALL FURNISH THREE COPIES OF MANUALS COVERING IN DETAIL ALL REQUIRED INSTRUCTIONS FOR THE OPERATION OF THE SYSTEMS PROVIDED.
12. FURNISH ALL LABOR REQUIRED BY THE OWNER'S AGENT, AND OR INSPECTION AGENCIES IN MAKING EXAMINATION OF WORK, DURING THE COURSE OF CONSTRUCTION.
13. THE CONTRACTOR SHALL FURNISH A WRITTEN WARRANTY FOR THIS INSTALLATION, SUBSTANTIALLY STATING THAT ALL MATERIALS, EQUIPMENT, FIXTURES AND APPURTENANCES AND THE SYSTEMS WHICH THEY COMPRISE ARE FREE FROM INHERENT DEFECTS OR FLAWS IN WORKMANSHIP OR OPERATION, AND ARE FUNCTIONING PROPERLY AND CAPABLE OF PROVIDING SATISFACTORY OPERATION IN ACCORDANCE WITH DESIGN CONDITIONS. ANY DEFECTS IN WORKMANSHIP, DEFECTIVE MATERIALS, MALFUNCTION OF EQUIPMENT OR UNSATISFACTORY PERFORMANCE, AND ALL OTHER WORK DAMAGED THEREBY, SHALL BE REPAIRED, REPLACED OR OTHERWISE REMEDIED WITHOUT EXPENSE TO THE OWNER. SUCH REPAIRS OR REPLACEMENTS SHALL BE MADE WITHIN REASONABLE TIME AND AT THE CONVENIENCE OF THE OWNER. SUCH WARRANTY SHALL BE IN EFFECT FOR A PERIOD OF ONE YEAR FROM DATE OF ACCEPTANCE OF THE SYSTEMS AS A WHOLE.
14. MATERIAL OR EQUIPMENT SPECIFIED BY MANUFACTURER, BRAND NAME, TYPE OR CATALOG NUMBER, ARE DESIGNED TO ESTABLISH STANDARDS OF DESIRED QUALITY, STYLE, PERFORMANCE, ELECTRICAL, MECHANICAL AND PHYSICAL CHARACTERISTICS, AND DIMENSIONS. SUBSTITUTION OF ANY ITEMS SO SPECIFIED WILL NOT BE PERMITTED WITHOUT THE WRITTEN APPROVAL OF THE OWNER'S AGENT. WHERE THE SUBSTITUTION REQUIRES ANY redesign OR RELOCATION OF THE STRUCTURES, FOUNDATIONS, PARTITIONS, PIPING, RACEWAYS, WIRING OR ANY OTHER PART OF THE MECHANICAL, ELECTRICAL, STRUCTURAL OR ARCHITECTURAL WORK, ALL SUCH redesign AND ALL THE NEW DRAWINGS AND DETAILS REQUIRED SHALL BE PREPARED BY THE CONTRACTOR AT HIS OWN EXPENSE AND SUBMITTED FOR THE APPROVAL OF THE OWNER'S AGENT. ALL SUCH ADDITIONAL WORK AND ANY ADDITIONAL EQUIPMENT FOR THESE SYSTEMS SHALL BE PROVIDED AT THE EXPENSE OF THE CONTRACTOR.
15. THE CONTRACTOR SHALL PROVIDE, UPON REQUEST, COPIES OF MATERIAL SAFETY DATA SHEETS FOR ANY MATERIAL OR PRODUCT USED IN THE WORK AND NOT SUPPLIED BY THE OWNER. MSDS SHEETS SHALL BE PROVIDED PRIOR TO DELIVERY OF MATERIALS TO THE JOB SITE.
16. WORKMANSHIP SHALL BE FIRST CLASS IN EVERY RESPECT AND SHALL BE PERFORMED BY TRADESMAN SKILLED IN THE PARTICULAR AREA OF THE WORK AND IN STRICT ACCORDANCE WITH ALL APPLICABLE LOCAL, STATE OR PUBLIC UTILITY LAWS, ORDINANCES OR REGULATIONS.
17. THE CONTRACTOR SHALL EFFECTIVELY PROTECT THE EXISTING BUILDING, ITS CONTENTS AND ALL HIS NEW WORK AGAINST DAMAGE FROM ANY SOURCE RELATED TO THIS CONTRACT UNTIL FINAL COMPLETION AND ACCEPTANCE BY THE OWNER. THE CONTRACTOR SHALL REPAIR OR REPLACE ANY DAMAGED WORK AT HIS EXPENSE AND TO THE SATISFACTION OF THE OWNER'S AGENT.
18. AT ALL TIMES, KEEP THE PREMISES FREE FROM ACCUMULATION OF WASTE MATERIAL AND RUBBISH CAUSED BY AGENTS AND EMPLOYEES OF THE CONTRACTOR.
19. THE CONTRACTOR SHALL NOT PERFORM ANY FUNCTIONS WHICH WILL INTERRUPT MECHANICAL OR ELECTRICAL SERVICES WITHOUT PRIOR APPROVAL OF THE OWNER. NECESSARY INTERRUPTIONS SHALL BE REVIEWED, SCHEDULED AND APPROVED BY THE OWNER. DURING PARTIAL OR FULL OCCUPANCY OF THE FACILITY, ALL WORK SHALL BE SCHEDULED AND COORDINATED WITH THE OWNER SO THAT DISRUPTION TO THE AREAS INVOLVED IS KEPT TO A MINIMUM. THE CONTRACTOR SHALL GIVE THE OWNER A MINIMUM OF FIVE WORKING DAYS NOTICE OF ANY WORK THAT WILL INTERFERE WITH THE OWNER'S OPERATION SO A SCHEDULE SUITABLE TO THE OWNER CAN BE ARRANGED. ANY ACCIDENTAL INTERRUPTIONS TO SERVICES SHALL BE REPAIRED IMMEDIATELY BY THE CONTRACTOR WITHOUT ADDITIONAL COST TO THE OWNER.
20. PROVIDE SCAFFOLDING, LADDERS, RIGGING, HOISTING AND ALL OTHER EQUIPMENT REQUIRED FOR THE INSTALLATION OF THE WORK.
21. ESTABLISH PASSAGE CLEARANCES REQUIRED TO DELIVER, INSTALL AND ERECT ALL REQUIRED EQUIPMENT. IF STRUCTURES, EQUIPMENT AND SYSTEMS MUST BE ALTERED TO PROVIDE PASSAGE OF EQUIPMENT, THE CONTRACTOR SHALL RESTORE STRUCTURES, EQUIPMENT AND SYSTEMS TO THEIR ORIGINAL CONDITION, AT THE CONTRACTOR'S EXPENSE.
22. AT THE COMPLETION OF THE PROJECT, THE CONTRACTOR SHALL MAKE A THOROUGH INSPECTION OF ALL THE ELECTRICAL WORK. AT THE FINAL INSPECTION, ALL SYSTEMS MUST BE 100 PERCENT COMPLETE AND TESTS SHALL BE PERFORMED IN STRICT COMPLIANCE WITH EACH EQUIPMENT MANUFACTURER'S STANDARD TEST PROCEDURES AND THE ACCEPTANCE TEST STANDARDS OF THE INTERNATIONAL ELECTRICAL TESTING ASSOCIATION. ALL INSTRUMENTS, METERS, WIRING, PERSONNEL, ETC., REQUIRED FOR TESTING SHALL BE INCLUDED UNDER THIS CONTRACT.
23. AFTER ALL ADJUSTMENTS AND TESTS HAVE BEEN COMPLETED, CLEAN, DUST, WASH AND VACUUM, ETC., ALL PARTS OF INSTALLATION, INCLUDING INTERIORS OF BOXES, CABINETS AND EQUIPMENT ENCLOSURES. CLEAN LIGHTING FIXTURE LENS AND REFLECTORS WITH ANTI-STATIC DETERGENT TO ENSURE RATED OUTPUT.
24. PROVIDE SERVICES OF MANUFACTURER'S FACTORY ENGINEERS TO SUPERVISE INSTALLATION, FINAL CONNECTIONS AND TESTING. PROVIDE SERVICES OF FACTORY ENGINEERS OR REPRESENTATIVES WHO WILL GIVE FULL INSTRUCTIONS AND DEMONSTRATIONS IN THE OPERATION AND MAINTENANCE OF ALL THE ELECTRICAL SYSTEMS AND EQUIPMENT INSTALLED TO THE DESIGNATED REPRESENTATIVE OF THE OWNER.

SECTION 16110 – CONDUIT SYSTEMS

1. INSTALL ALL WIRE AND CABLES IN ELECTRICAL METALLIC TUBING UNLESS OTHERWISE SPECIFIED OR INDICATED BY THE DRAWINGS. ELECTRICAL METALLIC TUBING (EMT) SHALL BE GALVANIZED STEEL IN ACCORDANCE WITH FS WMC 563, ANSI C80.3 AND UL 797. FITTINGS 1-1/4-INCH AND SMALLER SHALL BE COMPRESSION TYPE AND 1-1/2-INCH AND LARGER SHALL BE SET SCREW TYPE. ALL FITTINGS SHALL BE OF WROUGHT STEEL CONSTRUCTION.
2. RIGID ALUMINUM CONDUIT WITH THREADED FITTINGS SHALL BE USED FOR ALL CONDUIT INSTALLATIONS EXPOSED TO THE WEATHER. RIGID ALUMINUM CONDUIT SHALL BE 6063 ALLOY, T41 TEMPER, CONFORMING TO FS WMC 540, ANSI C80.5 AND UL 6. FITTINGS SHALL BE THREADED TYPE OF ALUMINUM CONSTRUCTION.
3. LIQUID-TIGHT FLEXIBLE METALLIC CONDUIT SHALL BE USED FOR CONNECTION TO MOTORS AND OTHER EQUIPMENT WHICH PRODUCES OR TRANSMITS VIBRATION OR NOISE, UNLESS THE MOTORS OR EQUIPMENT ARE MOUNTED RIGIDLY SUSPENDED CEILING. PROVIDE SUITABLE BONDING JUMPER FOR ALL CONNECTIONS. LIQUID-TIGHT FLEXIBLE METAL CONDUIT SHALL BE CONSTRUCTED OF SINGLE STRIP, FLEXIBLE, CONTINUOUS, INTERLOCKED AND DOUBLE-WRAPPED STEEL, GALVANIZED INSIDE AND OUTSIDE AND COATED WITH LIQUID-TIGHT JACKET OF FLEXIBLE POLYVINYL CHLORIDE (PVC). FITTINGS SHALL BE LIQUID-TIGHT COMPRESSION TYPE.
4. FLEXIBLE METALLIC CONDUIT (MIN. 1/2-INCH TRADE SIZE) SHALL BE USED FOR CONNECTION FROM A JUNCTION BOX TO LIGHTING FIXTURES, MOTORS AND SIMILAR EQUIPMENT MOUNTED IN A SUSPENDED CEILING, AS WELL AS FOR CONNECTION TO TRANSFORMERS. FLEXIBLE METAL CONDUIT SHALL BE FORMED FROM CONTINUOUS LENGTH OF SPIRALLY WOUND, INTERLOCKED ZINC-COATED STRIP STEEL CONFORMING TO FS WMC 566 AND UL 1. FITTINGS SHALL BE OF THE THREADLESS, HINGED CLAMP TYPE.
5. RIGID STEEL CONDUIT SHALL BE USED WHERE CONDUIT IS ENCASED IN THE BUILDING'S POURED CONCRETE CONSTRUCTION. RIGID STEEL CONDUIT SHALL BE HOT DIP GALVANIZED CONFORMING TO FS WMC 581, ANSI C80.1 AND UL 6. FITTINGS SHALL BE THREADED TYPE OF GALVANIZED MALLEABLE IRON CONSTRUCTION.
6. HEAVY WALL PVC CONDUIT SHALL BE USED FOR ALL GROUNDING CONDUCTORS AND OTHER SPECIFIC USES AS INDICATED BY THE DRAWINGS. HEAVY WALL CONDUIT SHALL BE SCHEDULE 40, 90 DEGREES C, UL RATED, CONSTRUCTED OF POLYVINYL CHLORIDE AND CONFORMING TO NEMA TC-2 FOR DIRECT BURIAL OR NORMAL ABOVE GROUND USE. FITTING SHALL BE OF THE SOLVENT WELD TYPE. CONDUITS SHALL BE SUPPORTED WITH NON-METALLIC DEVICES.
7. MINIMUM SIZE CONDUIT UNLESS OTHERWISE INDICATED SHALL BE 3/4-INCH TRADE SIZE. ALL CONDUITS WHICH ARE TO REMAIN EMPTY SHALL BE PROVIDED WITH A NYLON PULL LINE. CONDUITS SHALL BE INDEPENDENTLY SUPPORTED FROM THE BUILDING STRUCTURE AND SHALL NOT BE ATTACHED TO THE SUPPORT SYSTEMS PROVIDED BY OTHER TRADES UNLESS SPECIFICALLY INDICATED.
8. PROVIDE SLEEVES FOR ALL CONDUITS PASSING THROUGH FLOOR SLABS AND WALLS. THE ANNULAR SPACE BETWEEN THE WALL AND THE SLEEVE SHALL BE KEPT TO A MINIMUM AND FILLED WITH FIRE STOP MATERIALS. SLEEVES SHALL BE NOMINALLY 1-INCH TRADE SIZE LARGER AND CONSTRUCTED OF THE SAME MATERIAL AS THE CONDUIT BEING INSTALLED.

SECTION 16120 – WIRE AND CABLES (600 VOLT AND BELOW)

1. WIRE AND CABLES FOR FEEDER AND BRANCH CIRCUITS SHALL BE SINGLE ANNEALED STRANDED COPPER CONDUCTORS WITH CONDUCTIVITY OF NOT LESS THAN 98 PERCENT AT 20 DEGREES C. WIRE AND CABLE SHALL BEAR THE UL LABEL AND SHALL MEET OR EXCEED THE REQUIREMENTS OF IPCEA-NEMA STANDARDS S-19-81 AND ASTM D-1352.
2. WIRE SIZES SHALL GENERALLY BE AS FOLLOWS:

   A. CONTROL AND INTERLOCK WIRING NO. 14 AWG.
   B. BRANCH CIRCUIT AND FEEDER WIRING NO. 12 AWG AND LARGER.

3. WIRE AND CABLE INSULATION SHALL BE AS FOLLOWS:

   A. CONDUCTORS SIZE NO. 14 AWG THROUGH NO. 4/0 AWG SHALL BE 600 VOLT TYPE THWN FOR DRY AND WET LOCATIONS WITH A MAXIMUM OPERATING TEMPERATURE OF 75 DEGREES C.
   B. CONDUCTORS SIZE 250 KCMIL AND LARGER SHALL BE 600 VOLT TYPE THHN/THWN OR XHHW FOR DRY AND WET LOCATIONS WITH A MAXIMUM OPERATING TEMPERATURE OF 90 AND 75 DEGREES C, RESPECTIVELY.

4. FOR CONVENIENCE IN TESTING AND MAINTENANCE ALL SECONDARY CONDUCTORS SHALL BE COLOR-CODED IN ACCORDANCE WITH THE ESTABLISHED BUILDING STANDARD. CONTROL CIRCUIT WIRING SHALL HAVE SEPARATED IDENTIFYING COLORS OR NUMBERS.
5. ARMORED CABLE (TYPE AC) SHALL BE PERMISSIBLE FOR INSTALLATION OF INDOOR BRANCH CIRCUITS ABOVE ACCESSIBLE CEILING AND IN HOLLOW DRYWALL PARTITIONS IN HEALTH CARE FACILITIES, WITHOUT being INSTALLED IN RACEWAYS, IF PERMISSIBLE BY CODE. TYPE AC CABLES SHALL NOT BE USED FOR ESSENTIAL CIRCUITS OR IN HAZARDOUS LOCATIONS. TYPE AC CABLES SHALL NOT BE INSTALLED EXPOSED, INCLUDING IN ELECTRICAL CLOSETS. TYPE AC CABLE SHALL BE SUPPORTED AND SECURED NOT EXCEEDING EVERY 4-1/2-FEET, AND SHALL BE SECURED WITHIN 12-INCHES OF EVERY BOX, CABINET, OR FITTING FOR CABLES. TYPE AC CABLES SHALL BE COPPER, MULTI-CONDUCTOR TYPE WITH GROUND, WITH NO MORE THAN THREE CONDUCTORS. THE INTERLOCKING ARMOR SHALL BE OF EITHER GALVANIZED STEEL OR ALUMINUM. CONDUCTORS SHALL BE SOFT-ANNEALED COPPER, MEETING ASTM B3. TYPE AC CABLE SHALL BE UL LABELED. THE GROUNDING CONDUCTOR SHALL BE INSULATED AND SHALL BE ROUTED WITH THE CIRCUIT CONDUCTORS. THE INSULATION SHALL BE GREEN IN COLOR. ALUMINUM BOND WIRE SHALL BE IN CONTACT WITH THE ARMOR. TYPE AC CABLE SHALL BE AFC TYPE HCF, BICC TYPE HCF, OR APPROVED EQUAL.
6. PROVIDE UL LABELED CONNECTORS OF AMPACITY RATINGS AND TYPES FOR APPLICATIONS INDICATED.

   A. CONNECTIONS FOR WIRE SIZES NO. 14 AWG THROUGH NO. 10 AWG SHALL BE MADE WITH 3-M "SCOTCHLOK" SPRING CONNECTORS.
   B. CONDUCTORS NO. 8 AWG AND LARGER SHALL BE SPLICED AND TAPPED WITH COLOR-KEYED WROUGHT COPPER COMPRESSION CONNECTORS AS MANUFACTURED BY THOMAS & BETTS. THE MANUFACTURER'S RECOMMENDED TOOLING SHALL BE USED FOR INSTALLATION. LONG BARREL SLEEVES, TWO HOLE LUGS AND "C" TYPE CONNECTORS SHALL BE USED. SPLICE AND TAP CONNECTORS SHALL BE COMPATIBLE WITH CONDUCTOR MATERIAL.

7. UNLESS SPECIFICALLY INDICATED OTHERWISE, EACH SINGLE PHASE BRANCH CIRCUIT SHALL CONSIST OF RESPECTIVE PHASE CONDUCTOR AND A DEDICATED NEUTRAL CONDUCTOR.
8. PROVIDE A SEPARATE "GREEN" INSULATED GROUND WIRE IN EACH FEEDER, BRANCH CIRCUIT AND OTHER CONDUITS CONTAINING CURRENT CARRYING CONDUCTORS.

SECTION 16135 – ELECTRICAL BOXES AND FITTINGS

1. OUTLET BOXES SHALL BE CONSTRUCTED OF GALVANIZED FLAT ROLLED SHEET-STEEL OF SHAPES AND SIZES SUITABLE FOR INSTALLATION OF WIRING DEVICES. PROVIDE BOXES WITH THREADED SCREW HOLES, WITH CORROSION-RESISTANT COVER AND GROUNDING SCREWS FOR FASTENING SURFACE AND DEVICE TYPE BOX COVERS AND FOR EQUIPMENT TYPE GROUNDING. OUTLET BOX ACCESSORIES SHALL BE PROVIDED AS REQUIRED FOR EACH INSTALLATION.
2. JUNCTION AND PULL BOXES SHALL BE CONSTRUCTED OF GALVANIZED CODE-GAUGE SHEET STEEL WITH SCREW-ON COVERS OF TYPES, SHAPES AND SIZES TO SUIT EACH RESPECTIVE LOCATION AND INSTALLATION. BODIES SHALL BE OF WELDED OR WELDED CONSTRUCTION AND SHALL HAVE PLAIN MACHINE SCREW ATTACHED COVERS.

SECTION 16170 – DISCONNECT SWITCHES

1. PROVIDE SURFACE-MOUNTED, HEAVY-DUTY TYPE, SHEET-STEEL ENCLOSED SAFETY SWITCHES, OF TYPES, SIZES AND ELECTRICAL CHARACTERISTICS INDICATED. SWITCHES SHALL BE QUICK-MAKE, QUICK-BREAK TYPE CONSTRUCTED SO THAT SWITCH BLADES ARE VISIBLE IN OFF POSITION WITH DOOR OPEN. EQUIP WITH OPERATING HANDLE WHICH IS INTEGRAL PART OF ENCLOSURE BASE AND WHOSE OPERATING POSITION IS EASILY RECOGNIZABLE, AND IS PADLOCKABLE IN THE ON OR OFF POSITION. CONSTRUCT CURRENT CARRYING PARTS OF HIGH-CONDUCTIVITY COPPER, WITH SILVER-TUNGSTEN TYPE SWITCH CONTACTS AND POSITIVE PRESSURE TYPE REINFORCED FUSE CLIPS. SWITCH ENCLOSURES GENERALLY SHALL BE NEMA TYPE 1 AND 3R FOR RAIN-TIGHT CONSTRUCTION.
2. PROVIDE FUSES FOR SAFETY SWITCHES, AS RECOMMENDED BY SWITCH MANUFACTURER, OF CLASSES, TYPES AND RATINGS NEEDED TO FULFILL ELECTRICAL REQUIREMENTS FOR SERVICE INDICATED.
3. FOR EACH SAFETY SWITCH ON THE LOAD SIDE OF A VARIABLE FREQUENCY DRIVE, PROVIDE A SINGLE POLE, DOUBLE THROW AUXILIARY CONTACT TO STOP THE VARIABLE FREQUENCY DRIVE WHEN THE SAFETY SWITCH IS IN THE OFF POSITION. INTERLOCK WIRING BETWEEN DISCONNECT SWITCH AND VARIABLE FREQUENCY DRIVE SHALL BE IN SEPARATE RACEWAY FROM THE MOTOR FEEDER WIRING FROM THE DRIVE.

SECTION 16190 – SUPPORTING DEVICES

1. PROVIDE SUPPORTING DEVICES OF TYPES, SIZES AND MATERIALS INDICATED, HAVING THE FOLLOWING CONSTRUCTION FEATURES:

   A. CLEVIS HANGERS SHALL BE USED FOR SUPPORTING 2-INCH AND LARGER CONDUIT AND SHALL BE CONSTRUCTED OF GALVANIZED STEEL WITH 1/2-INCH DIAMETER HOLE FOR ROUND STEEL ROD.
   B. ONE-HOLE CONDUIT STRAPS SHALL BE USED FOR SUPPORTING 3/4-INCH TO 1-1/2-INCH CONDUIT AND SHALL BE CONSTRUCTED OF GALVANIZED STEEL.
   C. TWO-HOLE CONDUIT STRAPS SHALL BE USED FOR SUPPORTING CONDUIT ON STEEL RACKS.

2. PROVIDE STEEL ANCHORS OF TYPES, SIZES AND MATERIALS REQUIRED FOR THE EQUIPMENT BEING SUPPORTED.
3. PROVIDE CABLE SUPPORTS WITH INSULATING WEDGING PLUG FOR NON-ARMORED TYPE ELECTRICAL CABLES IN RISERS.
4. PROVIDE U-CHANNEL STRUT SYSTEM FOR SUPPORTING ELECTRICAL EQUIPMENT, 12-GAUGE HOT-DIP GALVANIZED STEEL, OF TYPES AND SIZES INDICATED AND WITH THE CONDUIT CLAMPS, CONDUIT HANGERS AND OTHER FITTINGS WHICH MATE AND MATCH WITH U-CHANNEL.
5. INSTALL HANGERS, SUPPORTS, CLAMPS AND ATTACHMENTS TO SUPPORT PIPING PROPERLY FROM BUILDING STRUCTURE, ARRANGE FOR GROUPING OF PARALLEL RUNS OF HORIZONTAL CONDUITS TO BE SUPPORTED TOGETHER ON TRAPEZE TYPE HANGERS WHERE POSSIBLE. INSTALL SUPPORTS WITH SPACINGS INDICATED AND IN COMPLIANCE WITH NEC REQUIREMENTS.
6. NO MINERALLAC "JIFFY" TYPE CONDUIT SUPPORTS SHALL BE INSTALLED EXPOSED BELOW 8'-0" A.F.F. USE ONE-HOLE STRAPS INSTEAD.
7. [PROVIDE SEISMIC RESTRAINTS IN ACCORDANCE WITH THE GEOGRAPHIC LOCATION AND THE APPLICABLE CODES. ALL RACEWAY, BUSWAY AND LIGHTING FIXTURES SHALL BE PROVIDED WITH SEISMIC RESTRAINTS IN ACCORDANCE WITH THE FOLLOWING SEISMIC HAZARD LEVEL (SHL) OF THE SEISMIC RESTRAINT MANUAL: GUIDELINES FOR MECHANICAL SYSTEMS, AS PUBLISHED BY THE SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION, INC., AND IN ACCORDANCE WITH BOCA.

   A. RACEWAY: SHL [A] OR [B] (CHOOSE B IF AV IS LESS THAN 0.10, INCLUDING PHILADELPHIA AND SOUTH JERSEY. CHOOSE A IF OTHERWISE.)
   B. BUSWAY: SHL [A] OR [B] (CHOOSE B IF AV IS LESS THAN 0.10, INCLUDING PHILADELPHIA AND SOUTH JERSEY. CHOOSE A IF OTHERWISE.)
   C. LIGHTING FIXTURES: SHL C

8. ELECTRICAL CONDUIT SEISMIC RESTRAINTS ARE NOT REQUIRED FOR ANY ONE OF THE FOLLOWING CONDITIONS:

   A. CONDUIT SUSPENDED BY INDIVIDUAL HANGERS 12-INCHES OR LESS IN LENGTH FROM THE TOP OF THE CONDUIT TO THE SUPPORTING STRUCTURE.
   B. CONDUIT WHICH HAS LESS THAN 2-1/2-INCHES INSIDE DIAMETER.

9. ELECTRICAL EQUIPMENT AND COMPONENTS, SUCH AS GENERATOR, SWITCHBOARD, MOTOR CONTROL CENTER, AND PANELBOARD SHALL BE MOUNTED FOR SEISMIC FORCES DETERMINED IN ACCORDANCE WITH BOCA, INCLUDE NECESSARY INFORMATION, SUCH AS EQUIPMENT WEIGHT, CENTER OF MASS LOCATION, MOUNTING DETAILS, AND BOLT STRENGTH DATA SHEETS IN THE SUBMITTAL.]

SECTION 16195 – ELECTRICAL IDENTIFICATION

1. PANELBOARDS MOTOR STARTERS AND SIMILAR ELECTRICAL ENCLOSURES SHALL BE IDENTIFIED BY NAMEPLATES SHOWING THE EQUIPMENT IDENTIFICATION NUMBER, VOLTAGE AND FEEDER OR BRANCH CIRCUIT NUMBERS (E.G. PANEL LP-1 – 208/120 VOLTS – FDR 1-5). NAMEPLATES GENERALLY SHALL BE EUSTOM TWO-TONE LAMINATED PLASTIC WITH BEVELED EDGES. NAMEPLATES, UNLESS OTHERWISE INDICATED, SHALL BE WHITE LETTERS ON BLACK BACKGROUND.
2. CONDUITS SHALL BE IDENTIFIED IN EACH ROOM AND SO FOOT ON CENTERS IN OPEN AREAS BY VOLTAGE AND FEEDER NUMBER (E.G. FDR 1-5 – 208/120 VOLTS). CONDUIT MARKERS SHALL BE STANDARD PRE-PRINTED FLEXIBLE PLASTIC SHEET MATERIAL OR SELF-ADHERING VINYL LABELS.
3. FEEDER CONDUCTORS IN EACH PULL BOX AND IDENTIFIED WITH A PAPER TAG AS TO NUMBER, VOLTAGE AND CABLE SIZE (E.G. FDR 1-5 – 208/120 VOLTS – 4 NO. 250 MCM). BRANCH CIRCUITS SHALL BE IDENTIFIED WITH A PAPER TAG IN EACH JUNCTION AND OUTLET BOX BY PANEL AND CIRCUIT NUMBER (E.G. PNL. LP-5 – CIRC. 3).

SECTION 16480 – MOTOR STARTERS

1. PROVIDE COMBINATION CIRCUIT BREAKER/MAGNETIC MOTOR STARTER FOR EQUIPMENT REQUIRING MANUAL AND AUTOMATIC CONTROL. STARTERS GENERALLY SHALL BE FULL VOLTAGE NON-REVERSING UNITS CONSISTING OF A [MOTOR CIRCUIT PROTECTOR, HORSEPOWER RATED CONTACTOR AND THERMAL OVERLOAD RELAY MOUNTED IN A NEMA TYPE 1 COMMON ENCLOSURE. STARTER UNITS SHALL BE FURNISHED WITH EXTERNAL OPERATING HANDLE, CONTROL CIRCUIT TRANSFORMER (120V. SECONDARY), PILOT LIGHT, THERMAL OVERLOADS AND, UNLESS OTHERWISE INDICATED, A HAND-OFF-AUTOMATIC SELECTOR SWITCH. AUXILIARY CONTACTS SHALL BE PROVIDED AS REQUIRED. COMBINATION STARTERS SHALL BE ALLEN BRADLEY BULLETIN 513, OR APPROVED EQUAL. SUITABLE FOR THE VOLTAGE AND HORSEPOWER INDICATED ON THE DRAWINGS. STARTER UNITS SHALL BE MINIMUM NEMA SIZE "0".
2. MANUAL MOTOR STARTERS SHALL BE PROVIDED FOR EQUIPMENT REQUIRING MANUAL CONTROL ONLY. MANUAL STARTING SWITCHES GENERALLY SHALL BE FULL VOLTAGE NON-REVERSING UNITS CONSISTING OF A MOTOR RATED TOGGLE SWITCH AND THERMAL OVERLOAD RELAY MOUNTED IN A COMMON ENCLOSURE. STARTER UNITS SHALL BE FURNISHED WITH A NEON PILOT LIGHT. UNITS IN MECHANICAL AREAS OR OTHERWISE UNFINISHED AREAS SHALL HAVE A NEMA TYPE 1 SURFACE MOUNTED ENCLOSURE. UNITS IN FINISHED AREAS SHALL BE MOUNTED IN A RECESSED BOX WITH FLUSH COVER PLATE. MANUAL MOTOR STARTERS SHALLBE ALLEN BRADLEY BULLETIN 600 OR APPROVED EQUAL. SUITABLE FOR FRACTIONAL HORSEPOWER MOTORS AT 120 VOLTS, 60 HERTZ.
3. PROVIDE VARIABLE FREQUENCY DRIVES (VFD) FOR ALL MOTORS SHOWN ON THE DRAWINGS AS "VARIABLE SPEED.

   A. THE VARIABLE FREQUENCY DRIVE SHALL CONVERT THREE-PHASE, 60 HZ UTILITY POWER TO ADJUSTABLE VOLTAGE AND FREQUENCY, THREE-PHASE, AC POWER FOR STEPLESS MOTOR SPEED CONTROL FROM 10% TO 100% OF THE MOTOR'S RAT HZ SPEED.
   B. THE VFD SHALL INCLUDE A CONVERTER AND AN INVERTER SECTION. THE CONVERTER SECTION SHALL CONVERT FIXED FREQUENCY AND VOLTAGE AC UTILITY POWER TO A VARIABLE DC VOLTAGE. VFDs THAT USE SILICON CONTROLLED RECTIFIERS IN THE CONVERTER BRIDGE SHALL ALSO INCLUDE INPUT LINE REACTORS.
   C. THE INVERTER SECTION OF THE VFD SHALL INVERT THE VARIABLE DC VOLTAGE INTO A PULSE WIDTH MODULATED WAVE FORM, ADJUSTABLE VOLTAGE AND FREQUENCY OUTPUT FOR STEPLESS MOTOR SPEED CONTROL.
   D.