SECTION 16410 – LOW VOLTAGE DISTRIBUTION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. All of the Contract Documents, as listed on the Table of Contents and including General and Supplementary Conditions and Division 1, General Requirements, shall be included in, and made part of, this Section.

1.2 DESCRIPTION OF WORK

A. The Electrical Subcontractor shall furnish and install the low voltage distribution equipment as specified herein and as shown on the contract drawings.

B. The following low voltage distribution equipment shall be provided for the new building and, as a minimum, but not necessarily limited to the following:

1. Normal distribution system.
2. Life safety distribution system
3. Critical branch distribution system
4. Equipment branch distribution system
5. Grounding.
6. Hoisting, rigging, setting of all equipment.
7. Testing, cleaning and adjusting.
8. Power company related work and backcharges.
9. Shop drawings.
10. Power system studies and trip settings.
11. Phasing of construction and power interruptions.
12. Enclosed circuit breakers.
13. Fuses
14. Low voltage distribution switchboards, compartmented.
15. Mini power centers.
16. Motor control centers.
17. Motor controllers - magnetic starters.
18. Motor disconnect devices.
19. Panelboards - branch circuit and distribution. (100A-1200A)
20. Safety switches.
21. Transformers - dry type.

1.3 RELATED WORK

A. For work to be included as part of this Section, to be furnished and installed by the Electrical Subcontractor, refer to the Related Work section of Specification Section 16010.

B. Carefully examine all of the Contract Documents, criteria sheets and all other Sections of the specifications for requirements which affect work under this Section, whether or not such work is specifically mentioned in this Section.

1.4 REFERENCES

A. Low voltage distribution equipment and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of ANSI, NEMA and UL as follows:

B. Busway

1. NEMA BU.1.
2. ANSI/UL 857.
3. CSA

C. Molded Case Circuit Breakers

1. UL 489 - Molded Case Circuit Breakers
2. NEMA AB1 - Molded Case Circuit Breakers
3. NEMA 250 - Enclosures for Electrical Equipment
4. Fed. Spec. W-C-375a

D. Low Voltage Switchboards

1. UL 891
2. NEMA PB-2

E. Motor Control Centers

1. NEMA
2. ANSI
3. UL 845

F. Panelboards

1. UL 67 – Panelboards
2. UL 50 – Cabinets and boxes
3. NEMA PB-1
4. Fed. Spec. W-P115C
5. Fed. Spec. W-C-375a
6. Circuit Breaker – Type I, class I

7. Fusible Switch – Type II, class I

1.5 QUALITY ASSURANCE

A. The manufacturers listed within this specification have been preselected for use on this project. No submittal will be accepted from a manufacturer other than specified.

B. To ensure system compatibility, all low voltage distribution equipment shall be the products of one manufacturer.

1.6 WARRANTY

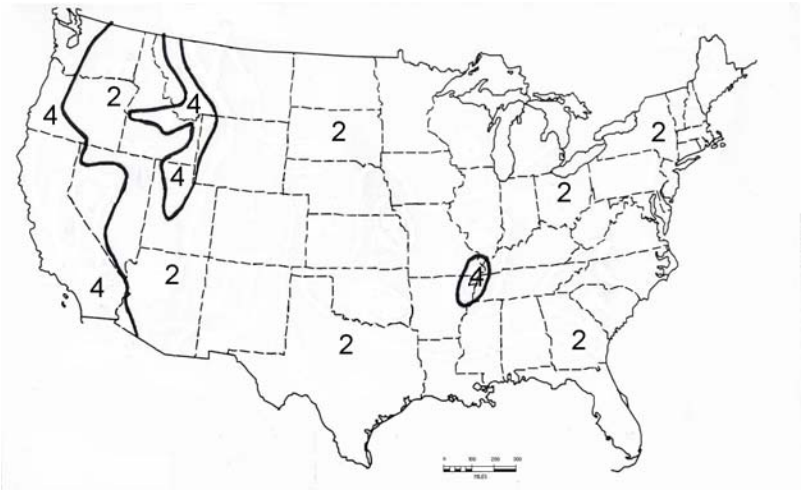
A. Attention is directed to provisions of the General Requirements, Supplementary General Requirements, Section 01784 - Warranties and Section 16010 – Electrical Special Conditions regarding guarantees and warranties for the work under this Contract.

1.7 QUALIFICATIONS

A. The manufacturer of the low voltage distribution equipment shall be the manufacturer of the major components within the equipment.

B. For the equipment specified herein, the manufacturer shall be ISO 9000, 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.



D. The low voltage distribution equipment shall be suitable for and certified to meet all applicable seismic requirements of the latest accepted edition of the International Building Code (IBC) for

seismic zone 2 application. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing of representative equipment. The test response spectrum shall be based upon a 5% minimum damping factor, with a peak acceleration and ZPA as required per the Code. The tests shall fully envelope the response spectrum for all equipment natural frequencies up to at least 35 Hz.

1.8 DELIVERY, STORAGE AND HANDLING

A. Manufacturer's directions shall be followed completely in the delivery, storage, protection and installation. Promptly notify the Architect in writing of any conflict between any requirements of the Contract Documents and the manufacturer's directions. Obtain the Architect's written instructions before proceeding with the work. Should Electrical Subcontractor perform any work that does not comply with the manufacturer's directions or written instructions from the Architect, he shall bear all costs arising in correcting any deficiencies that should arise.

B. Equipment and materials shall be delivered to the site and stored in original sealed containers, suitably sheltered from the elements, but readily accessible for inspection by the Architect until installed. All items subject to moisture damage such as controls shall be stored in dry, heated spaces. Equipment such as switchgear with heater elements installed shall have the heater elements energized after the equipment is received by the Electrical Subcontractor.

C. The Electrical Subcontractor shall be responsible to fully inspect all shipments for damage and report damage to the manufacturer and the Architect.

D. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical injury and theft. At the completion of the work, equipment and materials shall be cleaned and polished thoroughly and turned over to the Owner in a condition satisfactory to the Architect. Damage or defects that develop before acceptance of the work shall be made good at the Electrical Subcontractor's expense.

E. The Electrical Subcontractor shall make necessary field measurements to ascertain space requirements, for equipment and connections to be provided under his respective Trade and shall furnish and install such sizes and shapes of equipment to allow for the final installation to conform to the drawings and specifications.

F. The low voltage distribution equipment shall be split into shipping groups for handling as directed by the Electrical Subcontractor or as the manufacturer’s limitations dictate. Shipping groups shall be designed to be shipped by truck, rail or ship. Shipping groups shall be bolted to skids. Accessories shall be packaged and shipped separately. Each switchgear shipping group shall be equipped with lifting eyes for handling solely by crane.

G. The low voltage distribution equipment being stored prior to installation shall be stored so as to maintain the equipment in a clean and dry condition. If stored outdoors, indoor gear shall be covered and heated, and outdoor gear shall be heated.

1.9 ACCEPTABLE MANUFACTURERS

A. Cutler-Hammer
B. General Electric
C. Siemens

1.10 SUBMITTALS

A. Prepare and submit shop drawings in accordance with the requirements hereinbefore specified, and with the Shop Drawings, Product Data and Samples Section 01330 in the manner described therein, modified as noted hereinafter.

B. All shop drawings shall have clearly marked the appropriate specification number of drawing designation, for identification of the submittal.

C. Disposition of shop drawings shall not relieve the Electrical Subcontractor from the responsibility for deviations from drawing or specifications, unless he has submitted in writing a letter itemizing or calling attention to such deviations at time of submission and secured written approval from the Engineer, nor shall such disposition of shop drawings relieve the Electrical Subcontractor from responsibility for errors in shop drawings or schedules.

D. Shop drawings shall include, but shall not be limited to, the following:

1. Enclosed circuit breakers.
2. Fuses
3. Low voltage distribution switchboards, compartmented.
4. Mini power centers.
5. Motor control centers.
6. Motor controllers - magnetic starters.
7. Motor disconnect devices.
8. Panelboards - branch circuit and distribution. (100A-1200A)
9. Power system studies and trip settings.
10. Safety switches.
11. Transformers - dry type.

E. The following equipment rooms, drawn at ¼”=1’-0” scale, with all the electrical equipment laid out including dimensions, Code clearances, etc., shall be submitted with the equipment shop drawings. Acceptance of these shop drawings shall be obtained prior to installation of feeder conduits:

1. Main electric room
2. Main emergency electric room
3. All satellite normal and emergency electrical rooms and closets.

Notes:

Equipment shop drawings will not be reviewed without the room/equipment layouts.

The Architect/Engineer reserve the right to rearrange equipment in electrical equipment rooms or spaces once final equipment dimensional information is known and prior to installation of the equipment. Install equipment in the final location selected by the Architect/Engineer at no additional cost to the Owner.

F. The switchgear manufacturer shall submit the following information with each submittal:

1. Master drawing index.
2. Front view elevation.
3. Floor plan.
4. Top view.
5. Single line.
6. Control schematics and wiring diagrams.
7. Nameplate schedule.
8. Component list/bill of material.
9. Conduit entry/exit locations.
10. Assembly ratings including:

    a. Short circuit rating.
    b. Information regarding series short circuit ratings.
    c. Voltage.
    d. Continuous current.
    e. Basic Impulse level for equipment over 600 volts.
    f. KVA.

11. Major component ratings including:

    a. Voltage.
    b. Continuous current.
    c. Interrupting ratings.

12. Cable terminal sizes.
13. Connection details between close-coupled assemblies.
14. Composite floor plan of close-coupled assemblies.
15. Impedance for transformers.
16. Manufacturer's catalog data sheets.
17. Test reports.
18. The following additional information shall be submitted to the Engineer:

    a. Busway connection.
    b. Key interlock scheme drawing and sequence of operations.

19. The following product information shall be submitted:

    a. Descriptive bulletins.
    b. Product sheets.

1.11 CLOSEOUT SUBMITTALS AND O & M MANUALS

A. The following information shall be submitted for record purposes, in a binder, prior to final payment:

1. Final as-built drawings and information for items listed above.
2. Operation and maintenance manuals with the following information:

    a. Instruction books and/or instruction leaflets
    b. Recommended renewal parts

3. Wiring diagrams.
4. Certified production test reports.
5. Installation information.
6. Seismic certification and equipment anchorage details.

PART 2 - PRODUCTS

2.1 ENCLOSED CIRCUIT BREAKERS

A. Molded Case Circuit Breakers

1. Molded case circuit breakers shall provide circuit overcurrent protection with inverse time and instantaneous tripping characteristics.
2. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy, and arc extinction shall be accomplished by means of arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.
3. All enclosed, individually mounted circuit breakers shall have short circuit ratings as follows:

    a. 240 Volt Class Breakers

        1) 10 kAIC where shown fed via 150 kVA transformer and less
        2) 22 kAIC where shown fed via 225 and 300 kVA transformer
        3) 42 kAIC where shown fed via 500 kVA transformer

b. 480 Volt Class Breakers

1) 14 kAIC where shown fed via 500 kVA transformers or less
2) 30 kAIC where shown fed via 750 or 1,000 kVA transformers
3) 42 kAIC where shown fed via 1,500 kVA transformers
4) 50 kAIC where shown fed via 2,000 kVA transformers
5) 65 kAIC where shown fed via 2,500 kVA transformers

4. All enclosed circuit breakers shall be UL listed and labeled. Enclosed circuit breakers shall have rating not less than the short circuit ratings available from the power sources.
5. Enclosed circuit breakers shall be fully rated for short circuit ratings indicated above. Series ratings of enclosed circuit breakers will not be acceptable.
6. Circuit breakers 600 ampere frame and below shall be of the thermal-magnetic type with inverse time-current characteristics or shall be of the solid state type.
7. Circuit breakers over 600 ampere frame shall be microprocessor-based with true RMS sensing trip units.

a. Each molded case circuit breaker microprocessor-based tripping system shall consist of three current sensors, a microprocessor, and a flux-transfer shunt trip. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached.
b. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
c. The microprocessor-based trip system shall have thermal memory capabilities to prevent the breaker from being reset following an overload condition until after a preset time delay.
d. Molded Case Circuit Breaker Trip Units

1) System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments:

a) Adjustable long time pick-up and delay
b) Adjustable short time pick-up and delay, with selective curve shaping
c) Adjustable instantaneous pick-up
d) Adjustable ground fault pick-up and delay, with selective curve shaping

2) The trip unit shall have an LCD or LED display.
3) Trip targets indicating the operation of a trip and the function causing it shall be provided via the display.

4) Trip units shall be able to perform the following metering with access to values via the trip unit display.

a) Amperes
b) Voltage
c) Watts
d) Volt-amperes
e) Watt-hours
f) Frequency

5) The trip unit shall have communications capabilities compatible with Cutler Hammer IMPAC power management system, General Electric PMCS 5.0 power management system, Siemens Access power management system.
6) The trip unit shall be capable of zone interlocking.

8. Provide circuit breakers UL listed for application at 100% of their continuous ampere rating in their intended enclosure.

B. Accessories

1. Provide shunt trips, bell alarms, and auxiliary switches as shown on the contract drawings.

C. Enclosures

1. All enclosed circuit breakers shall have NEMA 1 general purpose enclosures unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below.

a. NEMA 1 surface or flush-mounted general purpose enclosures primarily intended for indoor use.
b. NEMA 12 dust-tight enclosures intended for indoor use primarily to provide protection against circulating dust, falling dirt, and dripping non-corrosive liquids.
c. NEMA 3R raintight enclosures intended for outdoor use primarily to provide protection against rain, sleet, and damage from external ice formation.
d. NEMA 4 watertight stainless steel intended for indoor or outdoor use primarily to provide protection against windblown dust and rain, splashing rain, hose-directed water, and damage from external ice formation.
e. NEMA 7, Class I, Group D hazardous location cast aluminum intended for indoor use in locations classified as Class I, Group D as defined in the National Electrical Code.
f. NEMA 9, Class II, Groups E, F, G hazardous location cast aluminum intended for indoor use in locations classified as Class II, Groups E, F, and G as defined in the National Electrical Code.

2. All enclosed circuit breakers shall have metal nameplates, front cover mounted, that contain a permanent record of catalog number and maximum rating. Provide handle mechanisms that are padlockable in the "OFF" position.

2.2 MINI-POWER CENTERS

A. Rating

1. KVA and voltage ratings shall be as shown on the drawings.
2. Units shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96.
3. Transformer sound levels shall not exceed the following ANSI and NEMA levels for self-cooled ratings:

    a. Up to 9 kVA: 40 dB
    b. 10 to 50 kVA: 45 dB

B. Construction

1. Each mini-power center shall include a main primary breaker, an encapsulated dry-type transformer, and a secondary panelboard with main breaker.
2. Main primary, secondary, and feeder breakers shall be enclosed with a padlockable hinged door.
3. Insulation Systems

    a. Transformers shall be insulated with a 185 degrees C insulation system.
    b. Required performance shall be obtained without exceeding the above indicated temperature rise in a 40 degrees C maximum ambient, with a 30 degrees C average over 24 hours.
    c. All insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM Standard Test Method D635.

4. Core and Coil Assemblies

    a. Transformer core shall be constructed with high grade, nonaging, grain oriented silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point. The transformer core volume shall allow efficient transformer operation at 10% above the highest tap voltage. The core laminations shall be tightly clamped and compressed. Coils shall be wound of electrical grade aluminum with continuous wound construction.
    b. The core and coil assembly shall be completely encapsulated in a proportioned mixture of resin and aggregate to provide a moistureproof, shock resistant seal. The core and coil encapsulation system shall minimize the sound level.
    c. The core of the transformer shall be grounded to the enclosure.

5. Transformer shall exceed the minimum efficiencies as required by TP-1, 1996.

C. Bus

1. Panelboard bus shall be copper sized to NEMA 65 degrees C rise.

D. Wiring/Terminations

1. All interconnecting wiring between the primary breaker and transformer, secondary main breaker and transformer, and distribution section shall be factory installed.
2. All transformers shall be equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring.

E. Main Devices

1. Each mini-power center shall include a main primary breaker with an interrupting rating of 25 kA at 480 volts; and a secondary panelboard with main breaker rated 10 kA interrupting rating at 240 volts.

F. Feeder Devices

1. The secondary distribution section shall accommodate one inch, plug-in breakers with 10 kA interrupting capacity.

G. Enclosure

1. The enclosure shall be made of heavy-gauge steel and the maximum temperature of the enclosure shall not exceed 90 degrees C.
2. The enclosure shall be totally enclosed, nonventilated, NEMA 3R, with lifting eyes.

2.3 MOTOR CONTROL CENTERS

A. Ratings

1. The Motor Control Center(s) shall be 600 volt class suitable for operation on a three phase, 60 Hertz system. The system operating voltage and number of wires shall be as indicated on the drawings.

B. Construction

1. Structures shall be totally enclosed deadfront, free-standing assemblies. They shall be 90 inches high and 20 inches deep (minimum) for front accessible units. Back-to-back type units will not be acceptable. Structures shall contain a horizontal wireway at the top, isolated from the horizontal bus and shall be readily accessible through a hinged cover. Adequate space for conduit and wiring to enter the top or bottom shall be provided without structural interference.
2. Compartments for mounting control units shall be incrementally arranged such that not more than six size 1 starters can be mounted within each vertical structure. Guide rails shall be provided.

3. A vertical wireway with minimum of 35 square inches of cross sectional area shall be adjacent to each vertical unit and shall be covered by a hinged door. Wireways shall contain steel rod cable supports.
4. All full voltage starter units through NEMA size 5 shall be of the draw-out type. Minimum size starter shall be NEMA 1. Draw-out provisions shall include a positive guide rail system and stab shrouds to absolutely ensure alignment of stabs with the vertical bus. Draw-out units shall have a tin-plated stab assembly for connection to the vertical bus. No wiring to these stabs shall extend into the bus compartment. Interior of all units shall be painted white for increased visibility. Units shall be equipped with side-mounted, positive latch pull-apart type control terminal blocks rated 600 volts. Knockouts shall be provided for the addition of future terminal blocks. All control wire to be 16 gauge minimum.
5. All draw-out units shall be secured by a spring-loaded quarter-turn indicating type fastening device located at the top front of the unit. Each unit compartment shall be provided with an individual front door.
6. An operating mechanism shall be mounted on the primary disconnect of each starter unit. It shall be mechanically interlocked with the unit door to prevent access unless the disconnect is in the OFF position. A defeater shall be provided to bypass this interlock. With the door open, an interlock shall be provided to prevent inadvertent closing of the disconnect. A second interlock shall be provided to prevent removal or re-insertion of the unit while in the ON position. Padlocking facilities shall be provided to positively lock the disconnect in the OFF position with from one to three padlocks with the door open or closed. In addition, means shall be provided to padlock the unit in a partially withdrawn position with the stabs free of the vertical bus.

C. Bus

1. Each structure shall contain a main horizontal copper bus, with ampacity as shown on the drawings, minimum 600 amperes. The horizontal bus shall be rated at 50 degrees C temperature rise over a 40 degree C ambient in compliance with UL standards. Vertical busses feeding unit compartments shall be copper and shall be securely bolted to the horizontal main bus. All joints shall be front accessible for ease of maintenance. The vertical bus shall be rated 50% of the main horizontal bus or 300 amperes, whichever is greater for front mounted units.
2. The vertical bus shall be completely isolated by means of a labyrinth design barrier. The labyrinth barrier shall effectively isolate the vertical busses to prevent any fault generated gases to pass from one phase to another. The vertical bus shall include a shutter, an automatic shutter mechanism to provide complete isolation of the vertical bus when a unit is removed.
3. Busses shall be braced for 65,000 amperes RMS symmetrical at 480 volts.
4. A bolted copper ground bus shall be included in all motor control centers.
5. Provide bus extensions, end plates, knockouts, etc. for bolting to future motor control center cubicles.

D. Wiring/Terminations

1. Wiring shall be NEMA Class I, Type B.

2. All control wiring internal to the assembly shall be done at the factory by the manufacturer. Field control wiring shall terminate at pull-apart terminal blocks in the wiring gutter.
3. The manufacturer shall submit wiring diagram(s) for each type of starter assembly. Prior to submission for approval by the Engineer, the Electrical Subcontractor shall submit these drawings to the HVAC/Automatic Temperature Control (ATC) Subcontractors to determine suitability in their system(s). Following this review, the Electrical Subcontractor may submit the drawings to the Engineer for review. The submittal shall clearly indicate that the HVAC/ATC Subcontractors have reviewed the wiring diagrams and have accepted them for use with their systems.

E. Motor Controllers

1. Combination starter units through NEMA size 3 shall be full voltage, non-reversing, unless shown otherwise. Combination starters NEMA size 4 and above shall be auto-transformer type reduced voltage, closed transition starters with starting taps at 65%, 80% and 90% of full voltage. All accessories for reduced voltage starters shall be the same as full voltage starters.
2. All 480 volt starters sizes shall be as follows:

a.	1/2 to 10 HP:	NEMA Size 1
b.	15 to 25 HP:	NEMA Size 2
c.	30 to 50 HP:	NEMA Size 3
d.	60 to 100 HP:	NEMA Size 4 - Reduced Voltage
e.	125 to 200 HP:	NEMA Size 5 - Reduced Voltage

3. All 208 volt starters sizes shall be as follows:

a.	1/2 to 7½ HP:	NEMA Size 1
b.	10 HP:	NEMA Size 2
c.	15 to 25 HP:	NEMA Size 3
d.	30 to 40 HP:	NEMA Size 4 - Reduced Voltage
e.	50 to 75 HP:	NEMA Size 5 - Reduced Voltage

4. All starters shall utilize magnetic only breakers/motor circuit protectors and shall be sized by the equipment manufacturer based on the motor horsepower size indicated on the accepted mechanical equipment shop drawings (also refer to nameplate rating of motors). Thermal magnetic devices with solid state overload may be provided to obtain specified short circuit rating. The manufacturer shall replace, at no cost to the Owner any breaker that is not coordinating with the motor starter.
5. Each combination unit shall be rated 65,000 AIC symmetrical at 480V. The magnetic only breaker shall provide adjustable magnetic protection up to, but not over 1,700% motor nameplate full load current to comply with NEC requirements. All magnetic only breaker/combination starter units shall have a "tripped" position on the unit disconnect and a push-to-test button on the magnetic only breaker.
6. For all normal power, 480 volt motor control centers, provide ground fault protection, with pick-up of approximately 20% of device rating for all starters.

7. Line starters shall be electrically operated, electrically held, three pole assemblies with arc extinguishing characteristics and shall have silver-to-silver renewable contacts. They shall have a minimum of five normally open or five normally closed auxiliary contacts wired to a terminal block with two normally open and two normally closed unused spare auxiliary contacts.
8. Each motor controller shall include an overload relay assembly with the following features:

    a. Ambient insensitive or ambient compensated
    b. Overload protection shall be based on the actual nameplate full load ampere rating and service factor of the motor. The Electrical Subcontractor shall obtain this information from the final accepted shop drawings for each motor to be served and shall provide this information to the motor control center manufacturer.
    c. Ground fault protection (for normal power motor control centers only)
    d. A built-in push-to-test button
    e. Electrically isolated normally open - normally closed contacts.
    f. Phase loss protection
    g. Adjustable phase unbalance protection
    h. The assembly shall allow automatic restart upon restoration of power following a shutdown/power interruption

9. Each starter shall be equipped with the following:

    a. A primary and secondary fused control power transformer sized 50 VA above the minimum rating.
    b. Two LED indicating lights, red for run; green for stop.
    c. A mechanical H-O-A selector switch. Electronic or touch pad type H-O-A switches will not be acceptable.
    d. Device panel with space to accommodate five (5) oil-tight, pilot-control devices or indicating ammeters, voltmeters, or elapsed time meters.

10. Two-speed, two-winding starters shall be provided for two-speed, two-winding motors. Starters shall be provided with overcurrent protection, sized for each speed. Two (2) motor circuit protectors per starter shall be provided. In addition, three (3) pilot lights ("High", "Low", "Off") and a 4 position selector switch (High/Low/Off/Automatic) shall be provided. Refer to HVAC schedule for quantities. Single short circuit protective device for both speeds will not be acceptable.
11. Two-speed, two-winding, reversing starters shall be provided for two-speed, two-winding motors. Starter shall be provided with overload protection in each speed. Two (2) motor circuit protectors per starter, one sized for each speed shall be provided. In addition, five (5) pilot light (Forward, Reverse, High, Low, Off) and three (3) selector switches ([1] 3 position [Local, Off, Auto]) ([1] 2 position [Forward, Reverse]), and ([1] 2 position [High, Low]) shall be provided. Two-speed and reversing contactors shall be mechanically and electrically interlocked. Each contactor (Forward, Reverse, High, Low) shall be provided with two (2) spare normally open contacts and two (2) spare normally closed contacts.
12. For all motors 3.0 HP and above, provide a combination current transformer and transducer with a 4-20 milliampere analog output mounted on Phase B of output of

starter. Wire current transformer/transducer to shorting time terminal board for remote use by HVAC Subcontractor.

13. No IEC control devices shall be used.
14. All pilot lights shall be LED type for long life.

F. Time delay relays shall be provided as follows:

1. All motors 15 HP and above to delay starting of motor upon energization of motor control center.
2. All two-speed motors for delay between "high" and "low" speeds to allow coast-down of motor.
3. All reversing starters between forward and reverse and between reverse and forward to allow motor to stop.
4. All timers shall be adjustable between 1 and 60 seconds continuous. Final adjustment shall be made by the Electrical Subcontractor to coordinate with system conditions. List of settings shall be provided to the Owner and Electrical Engineer for review.

G. Overcurrent Devices

1. Individual feeder breakers for "package" equipment or other equipment as indicated on the drawings shall have a minimum interrupting capacity of 65 KAIC at 480 volts.
2. Individual feeder breakers on normal power, 480 volt motor control centers shall have ground fault protection with time and current adjustments.

H. Incoming Feeder Terminations and Device

1. Incoming cable shall terminate within the control center on a main lug termination point. Main lug terminations shall have adequate dedicated space for the type and size of cable used and the lugs shall be compression type with antiturn feature. Main breakers, if required, shall be as scheduled on the drawings and be molded case, 80% rated.

I. Enclosures

1. The type of enclosure shall be in accordance with NEMA Standards for Type 1A with gasketed doors. All enclosing sheet steel, wireways and unit doors shall be gasketed.

J. Nameplates

1. Each motor control center shall have an engraved nameplate. Engraved nameplate shall include motor control center designation, voltage, phase, ampere rating of upstream feeder breaker or main circuit breaker, and upstream panel feeder as follows:

MCCP
800 AMPERE, 480/277 VOLT, 3 PHASE, 4 WIRE
FED FROM PANEL D4P

2. Each feeder cell of the motor control center shall have a nameplate.

3. Nameplates shall be laminated plastic, black characters on white background, and secured with screws. Characters shall be 3/16 inch high, minimum.

K. Finish

1. The control center shall be given a phosphatizing pretreatment. The paint finish shall be an anionic, thermoset acrylic. Manufacturer's standard color shall be used.
2. The control center finish shall pass 600 hours of corrosion resistance testing per ASTM B 117.

L. Vibration Isolation

1. Isolation/isolators shall comply with seismic restraint requirements.

2.4 MOTOR CONTROLLERS – MAGNETIC STARTERS

A. Wiring/Terminations

1. Wiring shall be NEMA Class I, Type B.
2. All control wiring internal to the assembly shall be done at the factory by the manufacturer. Field control wiring shall terminate at pull-apart terminal blocks in the wiring gutter.
3. The manufacturer shall submit wiring diagram(s) for each type of starter assembly. Prior to submission for approval by the Engineer, the Electrical Subcontractor shall submit these drawings to the HVAC/Automatic Temperature Control (ATC) Subcontractors to determine suitability in their system(s). Following this review, the Electrical Subcontractor may submit the drawings to the Engineer for review. The submittal shall clearly indicate that the HVAC/ATC Subcontractors have reviewed the wiring diagrams and have accepted them for use with their systems.

B. Combination Motor Controllers

1. Combination starter units through NEMA size 3 shall be full voltage, non-reversing. Combination starters NEMA size 4 and above shall be auto-transformer type reduced voltage, closed transition starters with starting taps at 65%, 80% and 90% of full voltage. All accessories for reduced voltage starters shall be the same as full voltage starters. All starters shall utilize magnetic only breakers.
2. All 480 volt starters sizes shall be as follows:

a.	1/2 to 10 HP:	NEMA Size 1
b.	15 to 25 HP:	NEMA Size 2
c.	30 to 50 HP:	NEMA Size 3
d.	60 to 100 HP:	NEMA Size 4 - Reduced Voltage
e.	125 to 200 HP:	NEMA Size 5 - Reduced Voltage

3. All 208 volt starters sizes shall be as follows:

a.	1/2 to 7½ HP:	NEMA Size 1
b.	10 HP:	NEMA Size 2
c.	15 to 25 HP:	NEMA Size 3
d.	30 to 40 HP:	NEMA Size 4 - Reduced Voltage
e.	50 to 75 HP:	NEMA Size 5 - Reduced Voltage

4. All combination starters shall utilize magnetic only breakers/motor circuit protectors and shall be sized by the equipment manufacturer based on the motor horsepower size indicated on the accepted mechanical equipment shop drawings (also refer to nameplate rating of motors). Thermal magnetic devices with solid state overload may be provided to obtain specified short circuit rating. The manufacturer shall replace, at no cost to the Owner any breaker that is not coordinating with the motor starter.
5. Each combination unit shall be rated 65,000 AIC symmetrical at 480V. The magnetic only breaker shall provide adjustable magnetic protection up to, but not over 1,700% motor nameplate full load current to comply with NEC requirements. All magnetic only breaker/combination starter units shall have a "tripped" position on the unit disconnect and a push-to-test button on the magnetic only breaker.
6. For all 480 volt normal power motors, provide ground fault protection, with pick-up of approximately 20% of device rating for all starters.
7. Line starters shall be electrically operated, electrically held, three pole assemblies with arc extinguishing characteristics and shall have silver-to-silver renewable contacts. They shall have provisions for a total of five normally open or five normally closed auxiliary contacts wired to a terminal block with two normally open and two normally closed unused spare auxiliary contacts.
8. The overload relay assembly shall be of the thermal bimetallic ambient compensated type. Overload relays shall be reset from outside the enclosure by means of an insulated button. Overload heaters for each motor shall be determined by the actual nameplate ampere rating of the motor. The Electrical Subcontractor shall obtain this information from the final accepted shop drawings for each motor to be served and shall provide this information to the motor control center manufacturer. The overload relay shall have a built-in push-to-test button, electrically isolated normally open - normally closed contacts and single phase protection.
9. Each starter shall be equipped with the following:

    a. A primary and secondary fused control power transformer sized 50 VA above the minimum rating.
    b. Two LED indicating lights, red for run; green for stop.
    c. A mechanical H-O-A selector switch. Electronic or touch pad type H-O-A switches will not be acceptable.
    d. Device panel with space to accommodate five (5) oil-tight, pilot-control devices or indicating ammeters, voltmeters, or elapsed time meters.

10. Two-speed, two-winding starters shall be provided for two-speed, two-winding motors. Starters shall be provided with overcurrent protection, sized for each speed. Two (2) motor circuit protectors per starter shall be provided. In addition, three (3) pilot lights ("High", "Low", "Off") and a 4-position selector switch (High/Low/Off/Automatic) shall

be provided. Refer to HVAC schedule for quantities. Single short circuit protective device for both speeds will not be acceptable.

11. Two-speed, two-winding, reversing starters shall be provided for two-speed, two-winding motors. Starter shall be provided with overload protection in each speed. Two (2) motor circuit protectors per starter, one sized for each speed shall be provided. In addition, five (5) pilot light (Forward, Reverse, High, Low, Off) and three (3) selector switches ([1] 3 position [Local, Off, Auto]) ([1] 2 position [Forward, Reverse]), and ([1] 2-position [High, Low]) shall be provided. Two-speed and reversing contactors shall be mechanically and electrically interlocked. Each contactor (Forward, Reverse, High, Low) shall be provided with two (2) spare normally open contacts and two (2) spare normally closed contacts.
12. For all motors 3.0 HP and above, provide a combination current transformer and transducer with a 4-20 milliampere analog output mounted on Phase B of output of starter. Wire current transformer/transducer to shorting time terminal board for remote use by HVAC Subcontractor.
13. No IEC control devices shall be used.
14. Time delay relays shall be provided as follows:

    a. All motors 15 HP and above to delay starting of motor upon energization.
    b. All two-speed motors for delay between "high" and "low" speeds to allow coastdown of motor.
    c. All reversing starters between forward and reverse and between reverse and forward to allow motor to stop.
    d. All timers shall be adjustable between 1 and 60 seconds continuous. Final adjustment shall be made by the Electrical Subcontractor to coordinate with system conditions. List of settings shall be provided to the Owner and Electrical Engineer for review.

C. Manual Starters

1. Manual starters shall be provided with thermal overload protection in each phase, quick-break operating mechanism, silver contacts, pressure type terminal contacts, bimetallic type overload device, H/O/A selector switch, etc.

2.5 PANELBOARDS - BRANCH CIRCUIT AND DISTRIBUTION (100A – 1,200A)

A. Ratings

1. 240 Volt Class Panels:

    a. 10 kAIC where shown fed via 150 kVA transformer and less
    b. 22 kAIC where shown fed via 225 and 300 kVA transformer
    c. 42 kAIC where shown fed via 500 kVA transformer

2. 480 Volt Class Panels:

    a. 14 kAIC where shown fed via 500 kVA transformers or less

b. 30 kAIC where shown fed via 750 or 1,000 kVA transformers
c. 42 kAIC where shown fed via 1,500 kVA transformers
d. 50 kAIC where shown fed via 2,000 kVA transformers
e. 65 kAIC where shown fed via 2,500 kVA transformers

3. All panelboards shall be UL listed and labeled. Panelboards shall have rating not less than the short circuit ratings available from the power sources.
4. Panelboards shall be fully rated for short circuit ratings indicated above. Series ratings of Panelboards will not be acceptable.

B. Construction

1. Interiors shall be completely factory assembled with bolt-on devices. They shall be designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
2. Trims for distribution, lighting and appliance panelboards shall be supplied with a door-in-door trim. The inner door shall be a hinged door over all circuit breaker handles. The outer door shall be the entire trim with a piano hinge to expose wiring gutters. Inner door in panelboard trim shall not uncover any live parts. Inner doors shall have a semiflush cylinder lock and catch assembly. Doors over 48 inches in height shall have auxiliary fasteners. Switching device handles in distribution panelboards shall be accessible.
3. Surface trims shall be same height and width as box. Flush trims shall overlap the box by 3/4 of an inch on all sides.
4. Where double tub panels are indicated on the drawings, each tub shall contain the same number of breakers and spaces. Box and trim sizes shall be identical.
5. Where auxiliary gutters are indicated for feed through lugs, a separate gutter shall be attached to the panelboard, sized as required based on conductor size. The auxiliary gutter shall contain a separate cover and the panel shall contain a door-in-door trim.
6. A directory card with a clear plastic cover shall be supplied and mounted on the inside of each door.
7. All locks shall be keyed alike.

C. Bus

1. Main bus bars shall be copper sized in accordance with UL standards to limit temperature rise on any current carrying part to a maximum of 65 degrees C above an ambient of 40 degrees C maximum.
2. A bolted copper ground bus shall be included in all panels.
3. In addition to the bolted ground bus, an isolated copper ground bus shall be included in panels as indicated on the drawings.
4. Bus bar taps for panels with single pole branches shall be arranged for sequence phasing of the branch circuit devices.
5. Neutral Bus

    a. Full-size insulated copper neutral bars shall be included for panelboards shown with neutral.
    b. Neutral busing shall have a suitable lug for each outgoing feeder requiring a neutral connection.

c. For panels 600 amperes and below, fed directly via "K" factor transformers, neutral bus shall be 200% of phase busses.
d. For panels over 600 amperes, fed directly by "K" factor transformers, switchboards shall be provided with 200% neutral bus. Refer to Switchboard section of these specifications.

D. Power Distribution Panelboards, Circuit Breaker Type

1. Molded case circuit breakers shall provide circuit overcurrent protection with inverse time and instantaneous tripping characteristics.
2. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy, and arc extinction shall be accomplished by means of arc chutes.
3. Circuit breakers 250 ampere frame and below may be of the thermal-magnetic type with inverse time-current characteristics or shall be microprocessor based, as specified below.
4. Circuit breakers over 250 ampere frame shall be microprocessor-based with true RMS sensing trip units.

a. Each molded case circuit breaker microprocessor-based tripping system shall consist of three current sensors, a microprocessor, and a flux-transfer shunt trip. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached.
b. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
c. The microprocessor-based trip system shall have thermal memory capabilities to prevent the breaker from being reset following an overload condition until after a preset time delay.
d. Molded Case Circuit Breaker Trip Units

1) System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments:

a) Adjustable long time pick-up and delay
b) Adjustable short time pick-up and delay, with selective curve shaping
c) Adjustable instantaneous pick-up

E. Branch Circuit Panelboards

1. Bolt-in type, heavy-duty, quick-make, quick-break, single- and multi-pole circuit breakers of the types specified herein, shall be provided for each circuit with toggle handles that indicate when unit has tripped.
2. Circuit breakers shall be thermal magnetic type with common type handle for all multiple pole circuit breakers. Circuit breakers shall be minimum 100 ampere frame and through

100 ampere trip sizes shall take up the same pole spacing. 20 ampere, single pole circuit breakers shall be UL listed as type SWD for lighting circuits.

3. Circuit breaker handle locks shall be provided for all circuits that supply exit signs, emergency lights, energy management and control system (EMCS) panels and fire alarm panels.

F. Enclosure

1. Enclosures shall be at least 20 inches wide and 5 3/4 inches deep made from galvanized steel. Provide minimum gutter space in accordance with the National Electric Code. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, an auxiliary gutter shall be provided, sized to include the additional required wiring space. At least four interior mounting studs with adjustable nuts shall be provided.
2. Enclosures shall be provided with removable blank ends.
3. All panelboards shall have NEMA 1 general purpose enclosures unless otherwise noted.

G. Nameplates

1. Each panel shall have an engraved nameplate for each section. Engraved nameplate shall include panel designation, voltage, phase, ampere rating of upstream feeder breaker or main circuit breaker, and designation of upstream panel or other device similar to:

PANEL L42
100 AMPERE, 480/277 VOLT, 3 PHASE, 4 WIRE
FED FROM PANEL D42

2. Where panel is fed directly from an upstream transformer, nameplate shall be similar to:

PANEL D22
800 AMPERE, 208/120 VOLT, 3 PHASE, 4 WIRE,
FED FROM PANEL D42 VIA 225 kVA TRANSFORMER

3. Nameplates shall be laminated plastic, black characters on white background, and secured with screws. Characters shall be 3/16 inch high, minimum.
4. Panelboards shall be provided with typewritten directories with plastic protector indicating circuit numbers, equipment served and room number of the area served. All room numbers used for directory cards shall be the room numbers assigned by the Owner and not necessarily room numbers indicated on the drawings. Coordinate all room numbers with Architect prior to final printing of directory cards. Directory cards shall be edited and maintained during the course of construction to keep an accurate, up to date record of each feeder or branch circuit.

H. Finish

1. Surfaces of the trim assembly shall be properly cleaned, primed, and a finish coat of gray ANSI 49 or 61 paint applied.

2.6 SAFETY SWITCHES

A. All safety switches shall be heavy duty type.

B. Ratings

1. Safety Switches 60 amperes and below

a. 30 to 60 Amperes.
b. 250 Volts AC, DC; 600 Volts AC.
c. 2, 3 or 6 Poles.
d. Fusible or Non-Fusible
e. Copper-Aluminum Terminals.
f. 10,000 Amp Withstand

2. Safety Switches over 60 amperes

a. 100 to 1,200 Amperes.
b. 600 Volts AC.
c. 3 or 6 Poles.
d. Fusible
e. Copper-Aluminum Terminals.
f. 200,000 Amp Withstand

C. Enclosures

1. Types

a. NEMA 1 General Purpose.
b. NEMA 3R Raintight.
c. NEMA 4 Watertight Stainless Steel.
d. NEMA 12 Dust-tight and Oil-tight Special Industry.

2. All interior safety switches shall have NEMA 1 general purpose enclosures. All exterior safety switches shall have NEMA 3R raintight enclosures unless otherwise noted.

D. All switches shall have metal nameplates, front cover mounted, that contain a permanent record of switch type, catalog number and Hp ratings (with both standard and time delay fuses); handle whose position is easily recognizable and is padlockable in the “OFF” position; visible blades; reinforced fuse clips; nonteasible, positive, quick-make quick-break mechanisms; and switch assembly plus operating handle as an integral part of the enclosure base.

E. All switches shall be Underwriters Laboratories, Inc. listed, HP rated, meet Federal Specification WS-865c, and NEMA Specifications KSI-1975.

F. All switches shall have defeatable door interlocks that prevent the door from opening when the operating handle is in the "ON" position.

G. Switches shall have line terminal shields.

H. All fused switches shall have Class J time delay fuses.

2.7 TRANSFORMERS - DRY TYPE DISTRIBUTION

A. Ratings

1. kVA and voltage ratings shall be as shown on the drawings.
2. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96.
3. Transformer sound levels shall not exceed the following ANSI and NEMA levels for self-cooled ratings:

a.	Up to 9 kVA:	40 dB
b.	10 to 50 kVA:	45 dB
c.	51 to 150 kVA:	50 dB
d.	151 to 300 kVA:	55 dB
e.	301 to 500 kVA:	60 dB
f.	501 to 700 kVA:	62 dB
g.	701 to 1,000 kVA:	64 dB

4. Transformer shall exceed the minimum efficiencies as required by TP-1, latest edition.

B. Insulation Systems

1. Transformers shall be insulated as follows:

   a. 2 kVA and below: 150 degrees C insulation system based upon 80 degree C rise.
   b. 3 to 15 kVA: 185 degrees C insulation system based upon 115 degree C rise.
   c. 15 kVA and above: 220 degrees C insulation system based upon 150 degree C rise.

2. Required performance shall be obtained without exceeding the above indicated temperature rise in a 40 degrees C maximum ambient with a 30 degrees C average ambient over 24 hours.
3. All insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM Standard Test Method D635.

C. Core and Coil Assemblies

1. Transformer core shall be constructed with high-grade, nonaging, grain-oriented silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point. The transformer core volume shall allow efficient transformer operation at 10% above the highest tap voltage. The core laminations shall be tightly clamped and compressed.
2. Coils shall be wound of electrical grade copper with continuous wound construction.

3. On units rated 15 kVA and below the core and coil assembly shall be completely encapsulated in a proportioned mixture of resin and aggregate to provide a moistureproof, shock-resistant seal. The core and coil encapsulation system shall minimize the sound level. Taps shall be two steps below nominal voltage in 5% increments.
4. On units rated 30 kVA and above the core and coil assembly shall be impregnated with non-hydroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture. The assembly shall be installed on vibration-absorbing pads and securely bolted to the base to minimize sound transmission. Taps shall be two steps above and 4 steps below nominal voltage in 2.5% increments.
5. Transformers 112.5 kVA and above shall have impedance levels of 5% or higher. If the transformer impedance levels are below 5%, it shall be the Electrical Subcontractor's responsibility to adjust the short circuit ratings of all panelboards downstream of the transformer to a rating higher than the maximum theoretical let-thru current of the proposed transformer.

D. Wiring/Terminations

1. Recommended external cable shall be rated 90 degrees C for encapsulated and 75 degrees C for ventilated designs. Connectors should be selected on the basis of the type and cable size used to wire the specific transformer.

E. Enclosure

1. The enclosure shall be made of heavy-gauge steel. All transformers shall be equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring. The maximum temperature of the enclosure shall not exceed 90 degrees C. The core of the transformer shall be grounded to the enclosure.
2. On units rated 15 kVA and below the enclosure construction shall be totally enclosed, non-ventilated, NEMA 3R, with lifting eyes.
3. On units rated 30 kVA and above the enclosure construction shall be ventilated, NEMA 2, drip-proof, with lifting holes. All ventilation openings shall be protected against falling dirt.

F. Finish

1. Enclosures shall be finished with ANSI 61 color weather-resistant enamel.

PART 3 - EXECUTION

3.1 COOPERATION AND WORK PROGRESS

A. The Electrical work shall be carried on under the usual construction conditions, in conjunction with all other work at the site. The Electrical Subcontractor shall cooperate with the Architect, General Contractor, all other Subcontractors and equipment suppliers working at the site. The Electrical Subcontractor shall coordinate the work and proceed in a manner so as not to delay the progress of the project.

B. The Electrical Subcontractor shall coordinate his work with the progress of the building and other Trades so that he will complete his work as soon as conditions permit and such that interruptions of the building functions will be at a minimum. Any overtime hours worked or additional costs incurred due to lack of or improper coordination with other Trades or the Owner by the Electrical Subcontractor, shall be assumed by him without any additional cost to the Owner.

C. The Electrical Subcontractor shall furnish information on all equipment that is furnished under this Section but installed under another Section to the installing Subcontractor as specified herein.

D. The Electrical Subcontractor shall provide all materials, equipment and workmanship to provide for adequate protection of all electrical equipment during the course of construction of the project. This shall also include protection from moisture and all foreign matter. The Electrical Subcontractor shall also be responsible for damage which he causes to the work of other Trades, and he shall remedy such injury at his own expense.

E. Waste materials shall be removed promptly from the premises. All material and equipment stored on the premises shall be kept in a neat and orderly fashion. Material or equipment shall not be stored where exposed to the weather. The Electrical Subcontractor shall be responsible for the security, safekeeping and damages, including acts of vandalism, of all material and equipment stored at the job site.

F. The Electrical Subcontractor shall be responsible for unloading all electrical equipment and materials delivered to the site. This shall also include all large and heavy items or equipment which require hoisting. Consult with the General Contractor for hoisting/crane requirements. During construction of the building, the Electrical Subcontractor shall provide additional protection against moisture, dust accumulation and physical damage of the main service and distribution equipment. This shall include furnishing and installing temporary heaters within these units, as approved, to evaporate excessive moisture and ventilate it from the room, as may be required.

G. It shall be the responsibility of the Electrical Subcontractor to coordinate the delivery of the electrical equipment to the project prior to the time installation of equipment will be required; but he shall also make sure such equipment is not delivered too far in advance of such required installation, to ensure that possible damage and deterioration of such equipment will not occur. Such equipment stored for an excessively long period of time (as determined in the opinion of the Architect) on the project site prior to installation may be subject to rejection by the Architect.

H. The Electrical Subcontractor shall erect and maintain, at all times, necessary safeguards for the protection of life and property of the Owner, Workmen, Staff and the Public.

I. Prior to installation, the Electrical Subcontractor has the responsibility to coordinate the exact mounting arrangement and location of electrical equipment to allow proper space requirements as indicated in the NEC. Particular attention shall be given in the field to group installations. If it is questionable that sufficient space, conflict with the work of other Subcontractors, architectural or structural obstructions will result in an arrangement which will prevent proper

access, operation or maintenance of the indicated equipment, the Electrical Subcontractor shall immediately notify the Contractor and not proceed with this part of the Contract work until definite instructions have been given to him by the Architect.

J. The Electrical Subcontractor shall not allow any equipment or piping foreign to the electrical installation to be installed or pass through any room in which electrical systems or equipment are located, such as electric rooms, electric closets, telephone or data closets. The Electrical Subcontractor shall notify the Contractor of such violations and request immediate removal.

3.2 INSTALLATION

A. General

1. Unless specifically noted or indicated otherwise, all equipment and material specified in Part 2 of this specification or indicated on the drawings shall be installed under this Contract whether or not specifically itemized herein. This Section covers particular installation methods and requirements peculiar to certain items and classes or material and equipment.
2. The Electrical Subcontractor shall obtain detailed information from manufacturers of equipment provided under Part 2 of this specification as to proper methods of installation.
3. The Electrical Subcontractor shall obtain final roughing dimensions and other information as needed for complete installation of items furnished under other Sections or furnished by the Owner.
4. The Electrical Subcontractor shall keep fully informed of size, shape and position of openings required for material and equipment provided under this and other Sections. Ensure that openings required for work of this Section are coordinated with work of other Sections. Provide cutting and patching as necessary.
5. The Electrical Subcontractor shall coordinate the electric service installation with Central Maine Power Company.
6. All miscellaneous hardware and support accessories, including support rods, nuts, bolts, screws and other such items, shall be of a galvanized or cadmium plated finish or of another approved rust-inhibiting coating.
7. Throughout this Section where reference is made to steel channel supports, it shall be understood to mean that the minimum size shall be 1 5/8" mild strip steel with minimum wall thickness of 0.105", similar to Unistrut P1000 or equal products manufactured by Kindorf or Husky Products Co. Where reference to channel supports is made under "Lighting Fixtures" paragraph of this Section, the maximum length of span shall be 10'-0". If longer spans are required, the size and wall thickness of the steel channel support shall be as specifically approved by the Engineer.

B. Concrete Housekeeping Pads

1. Concrete pads shall be installed for all freestanding low voltage distribution equipment.
2. The General Contractor shall provide the concrete work. Electrical Subcontractor shall supervise and coordinate concrete work to ensure that proper grounding cable, rods, conduit, etc., are located as detailed and as required. The electrical Subcontractor shall also ensure that the concrete is level to within manufacturers published tolerances.

3. All concrete housekeeping pads shall extend a minimum of 6" on each side from the equipment mounted on it. Mounting height of each overcurrent/disconnect device in the above equipment shall not exceed 6'-6" above finished floor. If overcurrent devices exceed 6'-6" above finished floor as a result of the housekeeping pad, the pad shall extend in front of the gear a minimum of 4'-0".

C. Electrical Distribution Equipment

1. The Electrical Subcontractor shall install the low voltage distribution equipment per the manufacturers recommendations and the Contract Drawings.
2. The installation of all equipment, including working space requirements, shall conform to all NEC and local codes.
3. All necessary hardware to secure the assembly in place shall be provided by the Electrical Subcontractor.
4. The Electrical Subcontractor shall ensure that no piping, ductwork or other equipment foreign to the electrical trade passes through the area extending from the floor to the structural ceiling with the width and depth equal to that of the electrical distribution equipment plus 6" on either side of panel.
5. Floor mounted assemblies shall be installed on concrete housekeeping pads and shall be provided with adequate lifting means. Floor mounted assemblies shall be capable of being moved into installation position and bolted directly to the floor without the use of floor sills. The Electrical Subcontractor shall ensure the floor is level to 1/8 inch per 3-foot distance in any direction.
6. All electrical equipment shall be installed such that the handle of the highest circuit breaker does not exceed 6'-6" above finished floor.
7. The location of all electrical distribution equipment installed in mechanical or plumbing equipment rooms shall be coordinated with the respective Subcontractor.
8. Electrical distribution equipment that is part of the emergency distribution system shall be located in spaces fully protected by an approved automatic fire suppression system or in spaces with a one (1) hour fire resistance rating.
9. The equipment shall be installed and checked in accordance with the manufacturer's recommendations prior to first energization. This shall include but not limited to:

    a. Checking to ensure that the pad location is level to within .125 inches.
    b. Checking to ensure that all bus bars are torqued to the manufacturer's recommendations.
    c. Assemble all shipping sections, remove all shipping braces and connect all shipping split mechanical and electrical connections.
    d. Secure assemblies to foundation or floor channels.
    e. Measure and record megger readings phase-to-phase, phase-to-ground, and neutral-to-ground (four-wire systems only).
    f. Inspect and install all circuit breakers, components, etc. in their proper compartments.

10. Identification shall be provided for all electrical distribution equipment. The electrical system identification shall clearly describe the equipment connected. Method of identification shall be by laminated nameplate made of bakelite or similar material with engraved letters at least 1/4" high and securely attached to the equipment with galvanized

screws. Adhesives or cements shall not be used. A list of nameplates shall be submitted to the Architect for approval prior to fabrication.

11. Control wiring shall be provided as required. Interface all local and remote control wiring and operational systems for each load.
12. Recessed and surface mounted equipment shall be mounted on walls with studs and cross-bracing, as required to assure sufficient strength so as to restrict any movement of the equipment.
13. Dry Type Transformers

    a. Floor mounted transformers shall be mounted a minimum of 6" from walls with proper clearance in front. Floor mounted transformers shall be installed on non-metallic, vibration isolating pads meeting seismic requirements and selected for at least 0.2” deflection. Panelboards shall not be mounted on wall above transformers.
    b. Trapeze mounted transformers shall be supported with threaded rods and channel and shall be isolated with hanger isolators meeting seismic requirements and suitable for the weight and size of the transformer.

3.3 MATERIALS AND WORKMANSHIP

A. All materials and equipment shall be new and unused and shall meet requirements of the latest Standards of NEMA, UL, IPCEA, ANSI and IEEE. Equipment shall have components required or recommended by OSHA, applicable NFPA documents and shall be UL listed and labeled.

B. Despite references in the specifications or on the drawings to materials or pieces of equipment by name, make or catalog number, such references shall be interpreted as establishing standards of quality for materials and performance.

C. Finish of materials, components and equipment shall not be less than Industry good practice. When material or equipment is visible or subject to corrosive or atmospheric conditions, the finish shall be as approved by the Architect.

D. Provide proper access to material or equipment that requires inspection, replacement, repair or service. If proper access cannot be provided, confer with the Architect as to the best method of approach to minimize effects of reduced access.

E. All work shall be installed in a neat and workmanlike manner and shall be done in accordance with all Local and State Codes.

F. The Owner will not be responsible for material, equipment or the installation of same before testing and acceptance.

3.4 FACTORY TESTING

A. Standard factory tests shall be performed on the low voltage distribution equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

B. Switchboards

1. Switchboards shall be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete switchboard will be tested for operation under simulated service conditions to assure the accuracy of the wiring and the functioning of all equipment.
2. The bus system shall be given a dielectric test of 2200 Volts for one minute between live parts and ground, and between opposite polarities.
3. The wiring and control circuits shall be given a dielectric test of 1500 Volts for one minute or 1800 Volts for one second between live parts and ground in accordance with ANSI C37.20.1.

C. Mini Power Centers

1. Ratio tests at the rated voltage connection and at all tap connections.
2. Polarity and phase-relation tests on the rated voltage connection.
3. Applied potential tests.
4. Induced potential test.
5. No-load and excitation current at rated voltage on the rated voltage connection.

D. Motor Control Centers

1. The motor control centers shall have been tested in a high power laboratory to prove adequate mechanical and electrical capabilities.
2. All factory tests required by the latest ANSI, NEMA and UL standards shall be performed.

E. Dry type Transformers

1. Ratio tests at the rated voltage connection and at all tap connections.
2. Polarity and phase relation tests on the rated voltage connection.
3. Applied potential tests.
4. Induced potential test.
5. No-load and excitation current at rated voltage on the rated voltage connection.
6. Resistance measurements on all windings at the rated voltage connection of each unit and at the tap extremes of the first unit made of a new design.

3.5 FIELD SETTINGS

A. The Electrical Subcontractor shall perform field adjustments of the circuit breakers as required to place the equipment in final operating condition. The settings shall be in accordance with the approved protective device coordination study or as directed by the Engineer.

B. For transformers, adjust taps to deliver appropriate voltage and measure primary and secondary voltage to confirm proper setting.

C. Field Adjustments for Motor Control Centers/Starters

1. Follow the manufacturer's instructions and the contract documents concerning any short circuit device settings, heater selection, timing relays, or startup of components.
2. Heater installation and overload relay adjustment shall be the responsibility of the Electrical Subcontractor after field installation of the motor control center and verification of all motor full load amperes.

3.6 FIELD QUALITY CONTROL

A. Provide the services of a qualified factory-trained manufacturer's representative to assist the Electrical Subcontractor in installation and start-up of the equipment specified under this section for a period of **[ ]** working days. The manufacturer's representative shall provide technical direction and assistance to the Electrical Subcontractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

B. The Electrical Subcontractor shall provide three (3) copies of the manufacturer's field start-up report before final payment is made.

3.7 MANUFACTURER'S CERTIFICATION

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted, and tested in accordance with the manufacturer's recommendations.

B. The Electrical Subcontractor shall provide three (3) copies of the manufacturer's representative's certification before final payment is made.

3.8 TRAINING

A. The Electrical Subcontractor shall provide a training session for up to 4 Owner's representative for 2 normal workdays at a jobsite location determined by the owner.

B. The training session shall be conducted by a manufacturer's qualified representative. The training program shall consist of the instruction on the operation of the assembly, circuit breakers, and major components within the assembly.

C. The training program shall include the following:

1. Review of the project one-line drawings and schedules.
2. Review of the factory record shop drawings.
3. Review of all equipment in the electrical distribution system.
4. Discuss the maintenance timetable and procedures to be followed in an ongoing maintenance program.
5. Provide three ring binders to participants complete with copies of drawings and other course material covered.

END OF SECTION