

**SAMUEL MAHELONA MEMORIAL HOSPITAL
ELECTRICAL UPGRADE PHASES 2
Kauai, Hawaii**

Prepared for:
Hawaii Health Systems Corporation (HHSC)
Kauai, Hawaii

TECHNICAL SPECIFICATIONS

BID SET

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DIVISION 2 – SITEWORK**SECTION 02200 - EARTHWORK FOR UTILITIES****PART 1 - GENERAL****1.01 SUMMARY**

- A. Furnish all materials, labor and equipment required to accomplish all excavation, filling and regrading as indicated on the drawings. The school shall be given the opportunity to remove any plants they wish to salvage prior to excavation. Provide toning prior to all excavation as specified in Section 00700 - GENERAL CONDITIONS.
- B. The existence and location of underground utilities and structures as shown on the plans are from available data, but are not guaranteed as to accuracy nor are there implied guarantees that other obstacles will not be encountered during the course of the work. The Contractor shall tone the area to be excavated to ascertain the location of uncharted utilities and structures and verify the locations of those improvements shown. The cost of toning shall be incidental to the cost of the contract.
- C. Any utilities that the Contractor encounters during the progress of the work, such as telephone ducts, electrical ducts, water lines, irrigation lines, sewer lines, electric lines and drainage pipes, whether shown or not on the contract plans, shall not be disturbed or damaged unless otherwise instructed by the Contracting Officer.
- D. Where irrigation lines or other utility lines are disturbed or temporarily removed, they shall be repaired or reinstalled to the Contracting Officer's satisfaction conforming to all codes and standards without additional cost to the State.

1.02 SUBMITTALS

- A. All submittals shall be in accordance with Section 01330 – SUBMITTAL PROCEDURES.

PART 2 - PRODUCTS**2.01 MATERIALS**

- A. Fill materials shall be non-expansive soil free from organics, rocks, or soil clods larger than 6 inches in diameter with a plasticity index of no more than 20.
- B. Structural fill materials and granular backfill shall be select imported non-expansive granular material, with not more than 15% of soil by weight passing the #200 sieve.

- C. Cushion fill under exterior and interior concrete slabs shall be crushed rock of No. 3B fine gravel, locally available, with a minimum of 4- inches compacted thickness.
- D. Top soils shall be imported, screened, natural, fertile, friable soils free from rocks, gravel, debris, noxious seeds, weeds, roots, and subsoil.
- E. Insufficient Earth Material: The Contractor shall import all necessary material to complete the grading work at no additional cost to the State. Such imported material shall be subject to the approval of the Contracting Officer and shall meet the requirements as specified for each category of materials.

PART 3 - EXECUTION

3.01 PROTECTIVE MEASURES

- A. All excavation shall be protected and guarded against danger to life, limb and property.
- B. Shoring, as required to safely preserve the trenches and earth banks free from damages resulting from the work, shall be provided and installed by the Contractor.
- C. All trenches shall be kept free from standing water. The Contractor shall do all pumping and draining that may be necessary to remove water to the extent required in carrying on work. Grading shall be controlled so that the ground surface is properly sloped to prevent water runoff from entering open trench excavations.
- D. The Contractor shall conduct operations with minimum interference to normal school operations, including summer school, streets, driveways, sidewalks, passageways, traffic, etc.
- E. The Contractor shall confine all work, equipment, materials and personnel as much as possible to the work area as indicated, so as not to interfere with the normal function of the school. The Contractor shall schedule all work that involves excessive noise, dust, dirt or any other detrimental aspect of this work in order that there will be a minimum disruption in normal school functions including summer school.
- F. When necessary, and when directed, the Contractor shall provide and erect barriers, etc. with special attention to protection of personnel.

3.02 LAYING OUT

- A. The laying out of the trenching shall be accomplished with ample time for the school to salvage any landscaping along the excavation path. Proposed path shall be marked with spray paint on the ground. The path shall be approved by the Contracting Officer prior to excavation. Small changes (within plus or minus 3 feet) may be made by the Contracting Officer to save landscape without additional cost to the State.

- B. Should any discrepancies be discovered in the dimensions given on the plans, the Contractor shall immediately notify the Contracting Officer before proceeding any further with the work; otherwise he will be held responsible for any costs incurred to correct construction in-place, due to such discrepancies.

3.03 SITE PREPARATION

- A. Prior to commencement of trenching operations, all vegetation and other deleterious materials interfering with the work shall be removed from the site.
- B. Soil or rock material determined by the Contracting Officer to be unsuitable for placement in compacted fills shall be removed and wasted from the site.
- C. Location of the existing utilities indicated is approximate. The Contractor shall physically verify the location and elevation of the existing utilities indicated prior to starting construction. The Contractor shall scan the construction site with electromagnetic and sonic equipment and mark the surface of the ground where existing underground utilities are discovered.
- D. The existing irrigation systems shall be tested before and after work. The School's custodian shall be contacted to operate the systems. Repair or replace components damaged by the Contractor's operations at no additional cost to the State.

3.04 UTILITY TRENCHING AND BACKFILL

- A. Trench excavation for exterior utilities shall be dug to depth shown on the drawings. If depths are not indicated, the trench shall be cut down to proper levels that will provide the minimum coverage as specified in the local design standard for Kauai County. Stockpile and save topsoil for regrading of trenches.
- B. Trench excavation and backfill shall be performed in accordance with Section 11, Standard Specifications for Public Works Construction, September 1986, Department of Public Works, City & County of Honolulu, Counties of Kauai, Maui, and Hawaii, State of Hawaii including all revisions, except for the subsection related Measurement and Payment, and as specified herein.
- C. Movement of construction machinery and equipment over pipes and utilities during construction shall be at the Contractor's risk. Excavation made with power-driven equipment is not permitted within 2 feet of utility of subsurface construction. For work immediately adjacent to or for excavations exposing a utility of other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated constructions and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work affected by the contract excavation until approval for backfill is granted by the Contracting Officer. Report damage to utility lines or subsurface construction immediately to the Contracting Officer.
- D. Grade bottom of trenches accurately to provide uniform bearing and support for each section of conduit on undisturbed soil, or bedding material as indicated or specified at every point along its entire length except for portions where it is necessary to excavate for bell holes and for making proper joints. Trench dimensions shall be as indicated.

- E. Buried Warning and Identification Tape: Install tape in accordance with manufacturer's recommendations except as modified herein. Bury tape at the depth indicated.
- F. Backfilling: Construct backfill in two operations (initial and final) as indicated and specified in this section. Place initial backfill in 6 inch maximum loose lifts to one foot above conduit unless otherwise specified. Bring up evenly on each side and along the full length of the conduit structure. Ensure that no damage is done to the utility or its protective coating. Place the remainder of the backfill (final backfill) in 9 inch maximum loose lifts unless otherwise specified. Compact each loose lift before placing the next lift. Do not backfill where the material in the trench is muddy, except as authorized. Provide a minimum cover from final grade, as indicated. Where settlements occur in trenches due to improper compaction, excavate to the depth necessary to rectify the problem, then backfill and compact the excavation as specified herein and restore the surface to the required evaluation. Coordinate backfilling with testing of utilities.
- G. Compaction: Use hand-operated, plate-type, vibratory, or other suitable hand tampers in areas not accessible to larger rollers or compactors. Avoid damaging pipes and protective pipe coatings. Compact material in accordance with the following unless otherwise specified. If necessary, alter, change, or modify selected equipment or compaction methods to meet specified compaction requirements. Place final backfill in 6 inch maximum loose lifts. If a vibratory roller is used for compaction of final backfill, the lift thickness can be increased to 9 inches. Compact all backfill surrounding conduits and other structures to 95 percent of ASTM D 1557 maximum density for work under pavements and 90 percent of ASTM D 1557 maximum density for landscaped areas. Backfill to permit the rolling and compacting of the completed excavation with the adjoining material, providing the specified density necessary to enable paving of the area immediately after backfilling has been completed.

3.05 FILL TESTING

- A. All fill shall be tested by an independent testing agency. All costs of testing shall be borne by the Contractor. Testing shall be made throughout the areas for each 6 inch compacted layer. All test results must be approved before the Contractor can proceed with placing of cushion fill or base course.

3.06 CUSHION FILL UNDER CONCRETE SLABS

- A. Under patched slabs, the subgrade shall have been compacted to at least 90% relative compaction. The compacted subgrade shall be overlain by 4-inches of slab cushion consisting of lightly compacted #3B Fine cushion fill.

3.07 FINISH GRADING

- A. Trenches shall be graded to finish grade and contours with allowance for 4 inch layer of topsoil.
 1. Topsoil shall be evenly spread and raked to a uniform plane at required contours and grade.

2. Rake to finish grade. Break up or remove all lumps larger than one inch. The finished surface shall blend continuously with the surrounding adjacent grade.

END OF SECTION

DIVISION 3 – CONCRETE**SECTION 03300 – CAST-IN-PLACE CONCRETE****PART 1 - GENERAL****1.01 SUMMARY**

- A. The work to be done under this section shall include performing all operations and furnishing all plant, labor, equipment, and materials for all concrete work indicated on the drawings and specified hereinafter.

1.02 SUBMITTALS

- A. All submittals shall be in accordance with Section 01330 – SUBMITTAL PROCEDURES.

1.03 STORAGE OF MATERIALS

- A. Store cement and aggregates so as to prevent their deterioration or the intrusion of foreign matter. Use no material which has deteriorated or which has been damaged; promptly remove same from the site.

PART 2 - PRODUCTS**2.01 MATERIALS**

- A. Asbestos Prohibition: No asbestos containing materials equipment shall be used under this section. The Contractor shall ensure that all materials and equipment incorporated in the project are asbestos-free.
- B. Portland Cement: Conform to the requirements of ASTM C150, Type I.
- C. Concrete Aggregates:
1. Fine Aggregates: Calcareous or basalt sands, or a combination thereof, meeting the grading requirements of ASTM C33. If manufactured sands are used, use a water-reducing and/or an air entraining admixture as specified hereinafter to provide satisfactory workability. The cement content of a mix in no way be reduced if an admixture is used.
 2. Coarse-Aggregates: Crushed close-grained, blue lava rock grading sizes 57 or 67 (ASTM D448) or both, with a maximum size not larger than one-fifty of the narrowest dimensions between sides of the forms not larger than 3/4 of the minimum clear spacing between reinforcing bars.
- D. Water: Fresh, clean and drinkable.
- E. Admixture: If used, shall conform to ASTM C 494 or ASTM C 260. Mix in proper amount in accordance with directions of the manufacturer.

- F. Curing Compound: Conform to ASTM C 309.

PART 3 - EXECUTION

3.01 DESIGN OF CONCRETE MIXES

- A. Ingredients: Portland cement, fine and coarse aggregates and water.
- B. Design concrete so that the materials will not segregate nor cause excessive bleeding. Slump shall be 4 inches or less.
- C. Concrete cement content and test results for 28 day compressive strength shall meet the following requirements:

28-Day Compressive Strength Test Results

<u>Class</u>	<u>Min. Cement Contents per Cubic Yard, Sacks</u>	<u>Min Average For 3 Cylinders, psi</u>	<u>Min Average for 2 Cylinders, psi</u>
3,000	5.50	3,000	2,750

Submit for approval by the Contracting Officer the mixes intended for use at least 14 days before the actual concrete placing operation.

- D. Use only approved mixes.
- E. Use Class 3,000 concrete for all concrete work.

3.02 TES

- A. As directed by the Contracting Officer. If required, slump tests shall conform to ASTM C143, and compressive strength test shall conform to ASTM C 39. Cost of testing and transportation will be borne by the Contractor. Compression cylinders to be made by Contractor under direction of the Contracting Officer and tested by independent laboratory, certified in the State of Hawaii.
- B. If the strength of any test specimens ordered by the Contracting Officer fall below the requirements stipulated above, the Contracting Officer shall have the right to require any and all defective concrete to be replaced, and all costs resulting therefrom shall be borne by the Contractor

3.03 MIXING CONCRETE

- A. All concrete throughout shall be either job or plant mixed in and approved type of power operated mixer that will ensure uniformity and homogeneity of the concrete produced. Provide a sufficient number of mixers to continuously carry on the work.
1. Mixing at jobsite shall be done in accordance with ACI 304 and as follows:
 - a. Ready Mixed and Mixed-in-Transit Concrete shall be mixed in accordance with ASTM C 94.

- b. Mix concrete only in such quantity as is required for immediate use. No retempering will be permitted; discard concrete that has started to harden and promptly reform the job.
- c. Admixtures conforming to Paragraph 2.01 may be used as recommended by the supplier and approved by the Contracting Officer.
- d. Hand mixing of concrete will not be permitted except to make up shortages for sidewalks, curbs, and gutters, and thrust blocks.

3.04 PLACING CONCRET

- A. Place no concrete in the absence of the Contracting Officer, who shall be given one day advance notice of starting time of concrete pour.
 - 1. Preparation:
 - a. All construction debris and extraneous matter shall be removed from interior of forms.
 - b. Place concrete upon clean, damp surfaces with no free water, or upon properly compacted fills but never upon soft mud or dry, porous earth. Before pouring footings or foundations, bottoms of excavations shall be leveled off and tamped.
 - 2. Depositing: Place concrete so as to avoid segregation of the materials and the displacement of the conduits. As nearly as practicable, the concrete shall be dropped into final position so as to avoid separation of coarse aggregates from concrete. After the initial set of concrete, the forms shall not be jarred and no strain shall be placed on the reinforcing.
 - 2. Compaction: Consolidate all concrete by vibration or other approved means so that the concrete is thoroughly worked around the reinforcement, around embedded items, and into corners of forms, eliminating all air or stone pockets which may cause honeycombing, pitting or planes of weakness. Where a vibrator cannot be used, provide compaction by spading, rodding or forking.

3.05 CURING AND PROTECTION

- A. Cure all concrete for a period of not less than 7 days by one of the methods listed below. During this curing period, maintain the concrete without drying at a relatively constant temperature. Protect fresh concrete from flowing water, mechanical injury, heavy rains, and injurious action of the sun.
 - 1. Curing shall immediately follow the finishing operation.
 - 2. Water Curing: If cured with water, keep concrete wet by any other method which will keep the surfaces continuously wet.
 - 3. Saturated Sand Curing: Cover surfaces to be cured with sand a minimum of 1-inch thickness of sand, kept uniformly distributed and continuously saturated during the entire curing period.
 - 4. Curing Compounds: Apply in accordance with the manufacturer's recommendations.
 - 5. Waterproof Paper: Waterproof paper or opaque polyethylene film conforming to ASTM C171 may be used, if anchored securely and all edges sealed or applied so as to prevent moisture escaping from

the concrete. Waterproof paper shall not be used on floors that will not be covered when finished.

3.06 CLEAN UP

- A. Contractor shall clean up all concrete and cement materials, equipment and debris upon completion of any portion of the concrete work and upon completion of the entire concrete and related work.

END OF SECTION

SECTION 16301 – UNDERGROUND ELECTRICAL WORK

PART 1 – GENERAL

1.01 SUMMARY

- A. Section 16010 - ELECTRICAL applies to this section with the additions and modifications specified herein.

1.02 APPLICABLE PUBLICATIONS

- A. The publications listed within this specification form a part of this specification to the extent referenced. Unless otherwise indicated, most recent edition of publication with current revisions and amendments will be enforced.

PART 2 – PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials and equipment shall conform to the respective specifications and standards and to the specifications herein. Electrical ratings shall be as indicated:
 - 1. Conduit:
 - a. Rigid Plastic Conduit: UL 651, Schedule 40 and 80 PVC.
 - 2. PVC Fittings: UL 651
 - 3. Pullstring: Pullstring shall be nylon pullstring having a minimum tensile strength of 200 lbs in each empty duct except those intended for telephone cabling.
 - 4. Grounding and Bonding Equipment: Shall conform to UL 467.
 - 5. Plastic Marking Tape: Plastic marking tape shall be acid and alkali-resistant polyethylene film, 6 inches wide with minimum thickness of 0.004 inch. Tape shall have a minimum strength of 1750 psi lengthwise and 1500 psi crosswise. The tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 3 feet deep. The tape shall be of a type specifically manufactured for marking and locating underground utilities. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion. Tape color shall be red for electric power system ductlines and orange for telephone/television/fire/communications systems ductlines.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Underground cable installation shall conform to NFPA 70 and ANSI C2.

1. Concrete: Concrete for electrical requirements shall be at least 3000 psi concrete with one-inch maximum aggregate conforming to the requirements of Division 3 of these specifications
2. Earthwork: Excavation, backfilling, and pavement for repairs for electrical requirements shall conform to the requirements of Division 2 of these specifications.
3. Underground Duct Direct Buried: Construct underground ductlines of individual conduits direct buried in trench. The conduit shall be of Schedule 80 PVC construction. The bank surrounding shall be rectangular in cross-section and shall provide at least 12 inches of earth between power duct and signal ducts.
 - a. Top of the conduit shall not be less than 24 inches below grade
 - b. Duct lines shall have a continuous slope downward toward handholes and away from buildings with a pitch of not less than 3 inches in 100 feet. Except at conduit risers, accomplish changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, by long sweep bends having a minimum radius of curvature of 25 feet. Sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 18 inches for use with conduits of less than 3 inches in diameter and a minimum radius of 36 inches for ducts of 3 inches in diameter or larger.
 - c. Terminate conduits in end-bells where duct lines enter handholes. Separators shall be of precast concrete, high impact polystyrene, steel, or any combination of these. Stagger the joints of the conduits by rows and layers so as to provide a duct line having the maximum strength. During construction, protect partially completed duct lines from the entrance of debris such as mud, sand and dirt by means of suitable conduit plugs. As each section of duct line is completed from handhole to handhole, draw a brush through having the diameter of the duct, and having stiff bristles until the conduit is clear of all particles of earth, sand, and gravel; then immediately install conduit plugs.
4. Cable Pulling: Pull cables down grade with the feed-in point at the handhole or buildings of the highest elevation. Use flexible cable feeds to convey cables through the handhole opening and into the duct runs. Cable slack shall be accumulated at each handhole or junction box where space permits by training the cable around the interior to form one complete loop. Minimum allowable bending radii shall be maintained in forming such loops.
 - a. Lubricants for assisting in the pulling of jacketed cables shall be those specifically recommended by the cable manufacturer. The lubricant shall not be deleterious to the cable sheath, jacket, or outer coverings.
 - b. Cable pulling tensions shall not exceed the maximum pulling tension recommended by the cable manufacturer.

5. Grounding: Non-current carrying metallic parts associated with electrical equipment shall have a maximum resistance to solid "earth" ground not exceeding the following values:
 - a. Grounds in handholes: 10 ohms
 - b. Grounded secondary distribution system neutral and non-current carrying metal parts associated with distribution systems and grounds not otherwise covered: 25 ohms
6. When work in addition to that indicated or specified is directed in order to obtain the specified ground resistance, the provisions of the contract covering "Changes" shall apply.
 - a. Grounding electrodes shall be cone pointed driven ground rods driven full depth less 6 inches, installed when indicated to provide an earth ground of the value before stated for the particular equipment being grounded.
 - b. Make grounding connections which are buried or otherwise normally inaccessible, and excepting specifically those connections for which access for periodic testing is required by exothermic type process. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which have "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. No mechanical connector is required at thermit weldments.
 - c. Grounding conductors shall be bare soft-drawn copper wire No. 6 AWG minimum unless otherwise indicated or specified.
7. Pullstring: Provide all empty conduits with a nylon rope or mule tape. Leave 48 inches of spare at each end of the pull.

3.02 UNDERGROUND CABLE IDENTIFICATION

- A. Cables shall be labeled at both ends.

3.01 FIELD TESTS

- A. Ground Rods: Test ground rods for ground resistance value before any wire is connected. Use a portable ground testing megger to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground electrode under test. Provide one copy of the megger manufacturer's directions for use of the ground megger indicating the method to be used.
- B. Test Report: Provide three copies of each test report to the Contracting Officer.
 1. Grounding Electrodes and Systems (identify electrodes and systems, each test).

END OF SECTION

DIVISION 7 - THERMAL AND MOISTURE PROTECTION

SECTION 07920 SEALANTS

PART 1 – GENERAL

1.01 GENERAL CONDITIONS

- A. Drawings and other provisions of contract, including General and Supplementary Conditions and other Division I specifications apply to this section.

1.02 SUMMARY

- A. Completely close with sealant all joints indicated or specified to be sealed to a watertight and airtight condition without staining substrates.

1.03 SUBMITTALS

- A. Manufacturer's Data: Submit copies of manufacturer's product data and specifications for type of sealant required, to the Engineer for acceptance.
- B. Material Safety Data Sheets (MSDS): Submit MSDS for each sealant product.
- C. Color Samples: Submit 4 sets of color finish samples of sealants.
- D. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- E. Warranty: Submit warranty as stipulated in item entitled "WARRANTY" hereinbelow.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized installer who is approved or licensed for installation of elastomeric sealants required for this Project.
- B. Source Limitations: Obtain each type of sealant through one source from a single manufacturer.
- C. Preconstruction Compatibility and Adhesion Testing: Submit to sealant manufacturers, for testing samples of materials that will contact or affect sealants. Use manufacturer's standard test method to determine whether priming and other specific joint preparation techniques are required to obtain optimum adhesion of sealants to joint substrates. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for

adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

- D. Stain-Test Response Characteristics: Where elastomeric sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver sealants to the jobsite in sealed containers labeled to show the designated name, formula, or specification number, lot number, color, date of manufacture, shelf life, curing time, manufacturer's directions, and name of manufacturer.
- B. Storage: Carefully handle and store all materials to prevent inclusion of foreign materials. Remove from project site all damaged and deteriorated materials and materials exceeding shelf life.
- C. Sealant materials shall be handled in accordance with the manufacturer's specifications and installed prior to expiration of shelf life.

1.06 WARRANTY

- A. Provide a 2-year written warranty from the project acceptance date against leaks, air infiltration, cracks, and other failures of the installation and materials. Where sealant is associated with a system with longer warranty period, sealant warranty shall match applicable system.
 - 1. Repair of sealants to seal leaks caused by faulty materials or workmanship;
 - 2. Repair or replace damage to the building or its finishes, equipment or furniture when occasioned by such leaks at no additional cost to the Owner.
- B. The Surety shall not be held liable beyond 2 years from the project acceptance date.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. General: Provide sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.
- B. Sealants At Vertical and Overhead Joints: One-part polyurethane-based sealant, conforming to ASTM C 920, Type S, Grade NS, Class 25, Use NT. Provide one of the following, or accepted equivalent:
 - 1. Vulkem 116; Tremco, Inc.
 - 2. Chem-Calk 900; Bostik Construction Products Div.
 - 3. Sikaflex Ia; Sika Corp.
 - 4. DynaTrol I-XL; Pecora Corp.
 - 5. NP-I; MasterSeal.

- C. Primer for Sealants: Non-staining, as recommended by the sealant manufacturer.
- D. Sealant Backer Rod: Compressible rod stock of polyethylene foam, polyethylenejacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable, nonabsorptive material conforming with ASTM C 1330 as recommended for compatibility with sealant by the sealant manufacturer to control the joint depth for sealant placement, to break bond of sealant at bottom of joint, to form optimum shape of sealant bead on back side, and to provide a highly compressible backer which will minimize the possibility of sealant extrusion when joint is compressed. Do not use oakum or other types of absorptive materials as backstops.
- E. Bond-Breaker Tape: Polyethylene tape or other plastic tape as recommended by sealant manufacturer. Provide self adhesive tape where required.
- F. Masking Tape: Non-staining, nonabsorbent type compatible with joint sealants and to surfaces adjacent to joints.

PART 3- EXECUTION

3.01 EXAMINATION

- A. Examine joint widths, surfaces, and backing, and their anchorage to the structure, and conditions under which joint sealer work is to be performed, and notify Contractor in writing of conditions detrimental to proper completion of the work and performance of sealers. Do not proceed with joint sealer work until unsatisfactory conditions have been corrected in a manner acceptable to installer.
- B. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealers to comply with recommendations of joint sealer manufacturers and the following requirements:
 1. Remove foreign material from joint substrates which could interfere with adhesion of joint sealer, including dust; paints, except for permanent, protective coatings tested and accepted for sealant adhesion and compatibility by sealant manufacturer; oil; grease; waterproofing; water repellants; water; and surface dirt.
 2. Clean concrete and masonry and similar porous joint substrate surfaces, by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealers. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
 3. Remove laitance and form release agents from concrete.

4. Steel Surfaces in Contact with Sealant: Scrape and wirebrush to remove loose mill scale. Remove dirt, oil, or grease by solvent cleaning, and wipe surfaces with clean cloths.
 5. Clean metal and other nonporous surfaces by chemical cleaners or other means which are not harmful to substrates or leave residues capable of interfering with adhesion of joint sealers.
 6. Do not permit solvents to air dry. Wipe surfaces free of solvent using clean, dry white cloth or white lintless paper.
- C. Joint Priming: Prime joint substrates where indicated or where recommended by joint sealer manufacturer based on preconstruction joint sealer-substrate tests or prior experience. Apply primer to comply with joint sealer manufacturers recommendations. Confine primers to areas of joint sealer bond, do not allow spillage or migration onto adjoining surfaces.
- D. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces which otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.
- E. Examine joint size and correct to achieve depth ratio of 1/2 of joint width with a minimum width and depth of 1/4-inch, maximum width of one-inch unless specifically allowed otherwise by the sealant manufacturer.

3.03 INSTALLATION OF JOINT SEALERS

- A. General: Comply with joint sealer manufacturers' printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.
- B. Weather Conditions: Do not proceed with installation of sealants under adverse weather conditions. Proceed with the work only when weather conditions are favorable for proper cure and development of high early bond strength.
- C. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- D. Installation of Sealant Backings: Install sealant backings to comply with the following requirements:
1. Install joint fillers of type indicated to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths which allow optimum sealant movement capability.
 - a. Do not leave gaps between ends of joint fillers.
 - b. Do not stretch, twist, puncture, or tear joint fillers.
 - c. Remove absorbent joint fillers which have become wet prior to sealant application and replace with dry material,

2. Install bond breaker tape between sealants and joint fillers, compression seals, or back of joints where adhesion of sealant to surfaces at back of joints would result in sealant failure.
 3. Install compressible seals serving as sealant backings to comply with requirements indicated above for joint fillers.
- E. Primer: Immediately prior to application of the sealant, clean out all loose particles from joints. Where recommended by sealant manufacturer, apply primer to joints in concrete, masonry units, wood, and other porous surfaces in accordance with compound manufacturer's instructions. Do not apply primer to exposed finish surfaces.
- F. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths which allow optimum sealant movement capability.
- G. Tooling of Nonsag Sealants: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents which discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
1. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
 2. Provide flush joint configuration per Figure 5B in ASTM C 1193, where indicated.

3.04 CLEAN-UP

- A. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.

3.05 PROTECTION

- A. Protect joint sealers during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of project acceptance. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original work.

END OF SECTION

DIVISION 9 - FINISHES

SECTION 09900 PAINTING

PART 1 – GENERAL

1.01 GENERAL CONDITIONS

- A. Drawings and other provisions of contract, including General and Supplementary Conditions and other Division I specifications apply to this section.

1.02 SUMMARY

- A. The work includes painting and finishing of exterior and interior items and surfaces throughout the project, whether scheduled or not, except as otherwise indicated. Painting shall include new work and existing new surfaces made bare or damaged during construction. Surface preparation, priming, and coats of paint specified are in addition to shop-priming and surface treatment specified under other sections of the work and is included in this Section.
- B. The work includes field painting of exposed bare and covered pipes and conduits (including color coding), and of hangers, exposed steel and iron work, and primed metal surfaces of equipment installed under the electrical work, such as junction boxes, raceways, and cabinets, except as otherwise indicated.
- C. "Paint" as used herein means all coating systems materials, including primers, enamels, sealers, stain, varnish, and fillers, and other applied materials whether used as prime, intermediate, or finish coats, except as specifically noted herein.
- D. Paint all exposed surfaces whether or not colors are designated in "schedules". Where items or surfaces are not specifically mentioned, paint these the same as adjacent similar materials or areas. If color or finish is not designated, the Engineer will select these from standard colors available for the materials systems specified.

1.03 PAINTING NOT INCLUDED

- A. The following categories of work are not included as part of the field-applied finish work, or are included in other sections of these specifications.
 1. Shop Priming: Unless otherwise specified, shop priming of ferrous metal items is included under the various sections for miscellaneous metal, hollow metal work, and similar items. Also, for fabricated components such as shop fabricate or factory-built electrical equipment or accessories.
 2. Electrical Work: The prime coat for electrical work is specified in DIVISION 16 - ELECTRICAL. Finish coats are as specified herein.

3. Concealed Surfaces (Present and Future): Unless otherwise indicated, painting is not required on surfaces such as walls or ceilings in concealed areas and generally inaccessible areas, furred areas, and pipe spaces.
4. Finished Metal Surfaces: Metal surfaces of anodized aluminum, stainless steel, chromium plate, and similar finished materials will not require finish painting, unless otherwise indicated.
5. Labels: Do not paint over any code-required labels, such as Underwriters' Laboratories, or any equipment identification, performance rating, name, or nomenclature plates.

1.04 SUBMITTALS

- A. Schedule of Finishes: Submit sets of the proposed painting finish schedule to the Engineer for acceptance. The schedule shall indicate the wet film thickness (mils) at which the proposed paints/coatings will be applied that are necessary to achieve the final dry film thickness indicated on the Schedule of Finishes under item entitled "SCHEDULE OF FINISHES" hereinbelow.
- B. Color Samples: All colors shall match existing. Color samples are not required. Contractor shall be responsible for tinting colors to match existing as found in the field.
- C. Schedule of Operations: Before work on the project is commenced, submit complete sets of a work schedule showing Contractor's sequence of operations and dates.
- D. Warranty: Submit warranty as stipulated in item entitled "WARRANTY" hereinbelow.
- E. Certifications: Submit copies of asbestos-free, lead-free, zinc-chromate-free, strontium-chromate-free, cadmium-free, and mercury free paint certificates.
- F. Manufacturer's Product Data Sheets: Submit copies of the manufacturer's product data sheets for the primers, paints, coatings, solvents, sealing and patching materials, sealants and caulking, and other materials being used. Data sheets shall indicate thinning and mixing instructions, required film thickness (mil) and application instructions.
- G. Manufacturer's Material Safety Data Sheets (MSDS): Submit copies of the manufacturer's material safety data sheets for coatings, solvents, and other hazardous materials.

1.05 ANALYZING AND TESTING

- A. All paints and their applied thickness shall be subject to testing whenever the Engineer deems necessary to determine conformation to the requirements of these specifications. Should testing by a laboratory be required, the laboratory shall be selected by the Engineer and the cost of testing shall be borne by the Contractor. However, should test results

show that the paint is in compliance with this specifications, the cost will be borne by the Owner.

- B. All rejected material shall be removed from the job site immediately. Surfaces painted with the rejected material shall be redone at no additional cost to the Owner.
- C. Where the required paint thickness is deficient, the affected surface(s) shall be recoated as necessary to provide the required paint thickness at no additional cost to the Owner.

1.06 QUALITY ASSURANCE

- A. Painting Terminology: Refer to ASTM D 16, "Standard Terminology for Paint, Related Coatings, Materials, and Applications".
- B. Gloss/Sheen Levels: ASTM D 523, "Specular Gloss", as follows:

Description	Units at 60 Degrees	Units at 85 Degrees
Matte or Flat	0 to 5	10 max
Velvet	0 to 10	10 to 35
Eggshell	10-25	10 to 35
Satin	20 to 35	35 min
Semi-Gloss	35 to 70	
Glss	70 to 85	
High Gloss	More than 85	

- C. Where the Contractor proposes to employ airless spraying, the applicator(s) shall have completed an accepted "Spray Applicator Certification Program" conducted by the Painting Industry of Hawaii.
- D. As a minimum, the certification shall include material and equipment selection, use and maintenance, hands-on application, and safety training.

1.07 WARRANTY

- A. The Contractor shall warrant that the work performed under this Section conforms to the contract requirements and is free of any defect in the materials used and workmanship performed by the Contractor. Such warranty shall continue for a period of one year from the project acceptance date and the Contractor shall remedy any such defect which is discovered during that period at no cost to the Owner.
- B. The Owner will notify the Contractor in writing within a reasonable time after discovery of any failure or defect.
- C. C, Should the Contractor fail to remedy any failure or defect described in Paragraph A above within 10 working days after receipt of notice thereof, the Owner shall have the right to repair or otherwise remedy such failure or defect and charge the Contractor for the cost of same.

1.08 SPECIAL REQUIREMENTS

- A. Codes: The Contractor shall comply with the State OSHL (Occupational Safety and Health Law) and all pollution control regulations of the State Department of Health.
- B. Safety methods used during coating application shall comply with SSPC-PA Guide 3.
- C. Protection:
1. Persons:
 - a. The Contractor shall take all necessary precautions to protect public pedestrians, including tenants from injury.
 - b. The Contractor shall provide, erect, and maintain safety barricades around scaffolds, hoists, and wherever Contractor's operation create hazardous conditions in order to properly protect the public and workmen.
 2. Completed Work: The Contractor shall provide all necessary protection for wet paint surfaces.
 3. Protective Covering: The Contractor shall provide and install protective covering over equipment, floor, and other areas that are not scheduled for treatment. Protective covering shall be clean, sanitary drop cloth or plastic sheets. Paint applied to surfaces not scheduled for treatment shall be completely removed and surfaces shall be returned to original condition.
 4. Safeguarding of Property: The Contractor shall take whatever steps may be necessary to safeguard his work and also the property of the Owner and other individuals in the vicinity of the work area during the execution of this Contract. Contractor shall be responsible for and make good on any and all damages and for losses to work or property caused by his or his employee's negligence. Where the damaged property cannot be cleaned and restored to its original condition (i.e. prior to being damaged) it shall be replaced with a new product of equal quality. No proration or use of Husedhi products will be permitted.
 5. Fire Safety: The Contractor shall direct his employees not to smoke in the vicinity and to exercise precautions against fire at all times. Waste rags, plastic (polyester sheets), empty cans, etc., shall be removed from the site at the end of each day.
- D. Right of Rejection: The Engineer will have the right to reject all work which is not in compliance with the plans and specifications. Rejected work will be redone at no additional cost to the Owner. In addition, the Engineer will have the right to require the immediate removal of any paint applicator who demonstrates negligence, lack of competence or repeated non-compliance with the contract requirements.
- E. Sequence of Operations: The sequence of operations shall divide the surfaces into work areas and present a schedule for:
1. Surface preparation and spot prime.
 2. Prime coat.
 3. First finish coat.

4. Second finish coat.

- F. Inspection and Acceptance: The Contractor shall obtain written acceptance from the Engineer upon completion of each phase of work (phases of work are surface preparation and spot prime, prime, first finish coat, and second finish coat) before proceeding into the next phase of work. The Contractor shall give the Engineer one day (24 hours minimum) advance notice of completion of any phase of work for a work area only when he deviates from the previously submitted work schedule. The Contractor shall provide necessary access to areas to be inspected. Failure to obtain acceptance of any phase of work for a work area may result in redoing the operation at no cost to the Owner.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Deliver paint materials to the job site in original unopened containers with original labels intact.
- B. No paint material, empty cans and paint brushes and rollers, drop cloths and rags, may be stored in buildings, but shall be stored in separate storage facilities away from the buildings. Receiving, opening, and mixing of painting materials shall be done in this area.
- C. The Contractor may furnish a job site storage facility. Such facility shall comply with requirements of the local Fire Department. The storage area shall be kept clean and facility shall be locked when not in use or when no visual supervision is possible.
- D. Ensure the safe storage and use of paint materials and the safe storage or disposal of waste at the end of each work day.
- E. Handle manufactured materials as recommended by the manufacturer.

PART 2- PRODUCTS

2.01 MATERIALS

- A. Asbestos Prohibition: All paint shall be asbestos-free.
- B. Lead Prohibition: All paint shall be lead-free.
- C. Mercury Prohibition: All paint shall be mercury-free.
- D. Chromate Prohibition: All paint shall be free of zinc-chromate and/or strontiumchromate.
- E. Cadmium Prohibition: All paint shall be cadmium-free.
- F. Material shall be equal in quality to that specified under the Schedule of Finishes and any given finish shall be as labeled by one manufacturer.

- G. All materials shall be delivered to the job site in undamaged original containers bearing the manufacturer's label and shall be stored in such a manner as to prevent damage. All rejected materials shall be removed from the job site immediately.
- H. Paints shall be as manufactured by Benjamin Moore, Carboline, Dupont, Devoe, Devoe Coatings, Glidden, Glidden Professional, PPG Protective & Marine Coatings, Pittsburg, Sherwin-Williams, Tnemec, or accepted equivalent.
- I. Thinning of paint shall be done using material recommended by the manufacturer. Mix proprietary products according to manufacturer's printed specifications. Compound thinner, mineral oil, kerosene, refined linseed oil, or gasoline shall not be used for thinning.
- J. Except for metal primers, all paint shall contain maximum amount of mildewcide per gallon of paint permitted by the mildewcide manufacturer without adversely affecting the quality of the paint.
- K. The supplier shall submit a signed certificate indicating the amounts of mildewcide added by both the paint manufacturer and the paint supplier. Mercurial fungicide shall not be used.

2.02 SCHEDULE OF FINISHES

- A. The Schedule of Finishes is made for the convenience of the Contractor and indicates the types and quality of finishes to be applied to the surfaces. Refer to Finish Schedule for symbols indicating location for various finishes. Provide additional systems for surfaces to be painted not listed hereinafter.
- B. All paints unless otherwise noted, are the products of Benjamin Moore and are so named to establish desired quality and standard of materials. Painting materials, equal to those mentioned by trade name under the various treatments may be used, provided they meet with the acceptance of the Engineer.
- C. Treatments shall be applied on exposed surfaces of designated materials, in conformity with instructions of the paint product used.
- D. Exterior Painting: Spread rates are approximate.
 - 1. Concrete:
 - Prime Coat: N068 Super Spec Masonry Interior/Exterior Acrylic High Build Masonry Primer
1.2 mils DFT @ 425 sf/gal
 - 2nd and 3rd Coats: N448 Ultra Spec Ext Satin Finish
1.5 mils DFT @ 403 sf/gal/coat
 - 2. Typical Coating System for Steel: Follow SSPC-SP-1 for solvent cleaning, for maximum protection follow SSPC-SP-10 near white metal blast.

Producer	Coat	Products	DFT (mils)	Min. Time to Recoat	Max. Time to Recoat
Corotech	1st	V175*	1.5-2.1	2 hours	2 weeks exterior 3 months interior
Corotech	2nd	V150	2.2-2.8	8 hours	4 weeks
Corotech	3rd	V500	2.3-3.3	8 hours	3 days

*for galvanized surfaces

- E. Interior Paints: Use low VOC/low odor paint to maximum extent possible. Spread rates are approximate.
1. Gypsum Wallboard and Concrete:
 - Prime Coat: N372 Eco Spec WB Interior Latex Primer
1.2 mils DFT @ 577 sf/gal
 - 2nd and
3rd Coats: N374 Eco Spec WB Interior Latex Eggshell Finish
1.4 mils DFT @412 sf/gal/coat
or
N376 Eco Spec WB Interior Latex Semi-Gloss
Finish
1.5 mils DFT @ 428 sf/gal/coat

2.03 COMPATIBILITY OF PAINTING SYSTEMS AND SUBSTRATES

- A. The Contractor shall ensure that painting systems specified are compatible with existing painted surfaces. Alkyd paints shall not be applied over existing latex coating. Alkyd paints shall not be used over cementitious surfaces. Latex paints shall not be applied directly over alkyd paints without proper conditioner and accepted by the Engineer.
- B. Field Tests for Alkyd or Latex Paints: The Contractor shall perform the following field tests for compatibility of substrates to new paint systems prior to ordering paint:
1. Latex films will dissolve when wiped with rubbing alcohol; alkyd films will not.
 2. When sanded, latex films will TTclog sandpaper; alkyd films will sand clean.
 3. Alkyds will soften after applying a 10 percent solution of Drano in water; latex films will not soften.
 4. Alkyds will burn when exposed to a flame; latex film will not burn.
 5. Paints which do not respond to 2 or more of these tests are probably epoxy, urethane, or other type of coating.
 6. Provide a packaged swab test in accordance with the package directions.
 7. Existing paint identified or suspect of having lead-containing paint shall be tested in a manner that does not produce airborne or uncontrolled lead debris.
- C. Should there be any discrepancies between the specified Schedule of Finishes and the existing paint systems, the Contractor shall notify the

Engineer in writing of any incompatible systems specified and submit a revised Schedule of Finishes for acceptance when necessary. With the acceptance of the revised Schedule of Finishes, the Contractor shall make any corrections and/or revisions necessary to resolve the discrepancies and/or inconsistencies. The Contractor shall not proceed with any painting systems that are incompatible, although specified otherwise, until all incompatible conditions detrimental for the proper application and performance of the painting systems have been corrected. The failures due to the application of the incompatible paint systems shall be corrected at no additional cost to the Owner. Proceeding with the work shall imply acceptance of the specified Schedule of Finishes and the compatibility with the existing painted surfaces by the Contractor.

PART 3- EXECUTION

3.01 SURFACE PREPARATION

- A. General:
1. Surface preparation shall be in accordance with the Painting and Decorating Contractors of America, "Architectural Specification Manual", methods are applicable to all substrates.
 2. Scrub surfaces with stiff nylon bristle brush and Trisodium Phosphate (TSP) solution at rate of 3/4 cup TSP per gallon of warm water to remove accumulated film of wax, oil, grease, smoke, dust, dirt, chalky, or other foreign matter which would impair bond or bleeding through new finish. Thoroughly sponge wipe surfaces with clean water. Allow surfaces to thoroughly dry before priming, painting, caulking, or sealing. Following sponge wiping, the surfaces shall be allowed to dry for a minimum of 24 hours.
 3. Cracks and openings found at joints and where different materials abut each other shall be sealed with a caulking compound compatible with the substrate and primer/paint. The caulking shall be applied and allowed to set in accordance with the manufacturer's recommendations and instructions.
- B. The Painting Contractor shall be wholly responsible for the finish of his work and shall not commence any part of it until surfaces are in proper condition. If Painting Contractor considers any surfaces unsuitable for proper finish of his work, he shall notify the Engineer of this fact in writing and he shall not apply any material until the unsuitable surfaces have been made satisfactory, or until the Engineer has instructed him to proceed. Major defects shall be restored by the proper trades. In general, follow paint manufacturer's directions for surface preparation for the paint to be applied.
- C. Remove all hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items in place and not to be finish-painted, or provide surface-applied protection prior to surface preparation and painting operations. Remove, if necessary, for the complete painting of the items and adjacent surfaces. Following completion of painting of each

space or area, reinstall the removed items by workmen skilled in the trades involved.

- D. Puttying of nail holes, cracks, and blemishes shall be done after priming coat has become hard and dry and before second coat is applied.
- E. Concrete surfaces shall be wire brushed and cleaned to remove all dust and loose mortar.
- F. Surfaces adjacent to areas being finished shall be protected and left clean of paints, stains, etc. Clean drop cloths shall be used until completion of job.
- G. Unprimed galvanized metal shall be washed with a solution of chemical phosphoric metal etch and allowed to dry.
- H. Metal surfaces shall be made clean and free of any defects or condition that may produce unsatisfactory finish. Touch-up any chipped or abraded places on surfaces that have been shop coated with the proper primer.
- I. Gypsum Board Surfaces:
 - 1. Surface Cleaning: Surfaces shall be dry. Remove loose dirt and dust by brushing with a soft brush or rubbing with a dry cloth prior to application of the first coat material.
 - 2. Repair of Minor Defects: Prior to painting, repair joints, cracks, holes, surface irregularities, and other minor defects with patching plaster or spackling compound and sand smooth.

3.02 PAINT APPLICATION

- A. General:
 - 1. Apply coating materials in accordance with SSPC-PA 1. SSPC-PA I methods are applicable to all substrates, except as modified herein. Thoroughly work coating materials into joints, crevices, and open spaces, Touch-up damaged coatings before applying subsequent coats.
 - 2. Work shall be done in a workmanlike manner by skilled and experienced mechanics and shall conform to the best painting practices.
 - 3. Materials shall be applied in accordance with the manufacturer's specifications and the finished surfaces shall be free from runs, sags, drips, ridges, waves, laps, streaks, brush marks, and variations in color, texture, and finish (glossy or dull). The coverage shall be complete and each coat shall be so applied as to produce a film of uniform thickness. No paint, varnish or enamel shall be applied until the preceding coat is thoroughly dry and acceptance.
 - 4. No exterior painting of unprotected surfaces shall be done in rainy, damp weather. Coats shall be applied only to surfaces that are thoroughly dry.

5. Interior areas shall be broom clean and dust free before and during the application of coating material.
 6. Mixing shall be done outside the building.
- B. Application:
1. Paint application shall be by brush or roller or combination thereof or as required by manufacturer.
 2. Drying Time: Allow time between coats, as recommended by the coating manufacturer, to permit thorough drying. Provide each coat in specified condition to receive the next coat.
 3. Primers and Intermediate Coats: Do not allow primers or intermediate coats to dry more than 30 days, or longer than recommended by the manufacturer, before applying subsequent coats. Follow manufacturer's recommendations for surface preparation if primers or intermediate coats are allowed to dry longer than recommended by manufacturers of subsequent coatings. Each coat shall cover the surface of the preceding coat or surface completely, and there shall be a visually perceptible difference in shades of successive coats.
 4. Finished Surfaces: Provide finished surfaces free from runs, drops, ridges, waves, laps, brush marks, and variations in selected colors.
- C. Colors: Colors shall match existing or as selected by the Engineer.
- D. Finish Film Thickness: Apply primer, intermediate, and finish coats to not less than 1.5 mils dry film thickness, 4 mils wet unless recommended otherwise in writing by the manufacturer, for each coat and in accordance with the manufacturer's recommendations. Verify mil thickness by use of a suitable wet film gauge. Use a Tooke or other dry film gauge to test for total dry film thickness.

3.03 MISCELLANEOUS

- A. Installation of Removed Items: After completion of final paint coat, removed items shall be reinstalled.
- B. At the completion of other trades, touch-up damaged surfaces.

3.04 CLEAN-UP

- A. During the progress of the work, all debris, empty crates, waste, drippings, etc., shall be removed by the Contractor and the grounds about the areas to be painted shall be left clean and orderly at the end of each work day.
- B. Upon completion of the work, staging, scaffolding, containers, and all other debris shall be removed from the site. All paint, shellac, oil or stains splashed or spilled upon adjacent surfaces not requiring treatment (hardware, fixture, floor) shall be removed and the entire job left clean and acceptable.

END OF SECTION

DIVISION 16 - ELECTRICAL

SECTION 16011 - GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. This section specifies the general electrical requirements for all labor, materials, equipment, and services provided under DIVISION 16 - ELECTRICAL.

1.02 WORK INCLUDED

- A. The Contractor under this Division shall provide all labor, materials, equipment, supervision and services required for the construction of the electrical systems. The finished installations shall be complete, operable and shall include all work specified herein and shown on the Drawings.
- B. The work shall include complete testing of all equipment and wiring at the completion of the work and making any minor connection changes or adjustments necessary for the proper functioning of the system and equipment. All systems shall be properly adjusted and in working order at the time of final acceptance.
- C. It is the intent of these Specifications and other Contract Documents to require an installation complete in every detail. Consequently, the Contractor will be responsible for minor details or for any special construction which may be found necessary to properly furnish, install, adjust, test, and place in successful and continuous operation, the entire electrical system and the cost of same shall be included in the contract price.

1.03 DESCRIPTION OF WORK

- A. Work specified in this Division shall include, but not be limited to the following:
 - 1. Distribution system modifications, including panelboards, and feeders.
 - 2. Electrical system modifications including branch circuits, switches, and control devices.
 - 3. Power wiring for electrically-operated equipment.
 - 4. Include in the bid and pay for the permits, plan review fees, inspection fees and deliver the certificate of final inspection to Engineer.
 - 5. Testing.
 - 6. Record drawings.

- B. Electrical wiring system shall have sufficient capacity to accommodate all equipment and other electrical loads as specified herein and shown on the drawings and as required per National Electrical Code and other applicable codes, standards and requirements plus spare capacity to accommodate any planned future facilities and additions and minimum 25 percent spare capacity for future growth.

1.04 REFERENCES

- A. The publications listed herein form a part of this specification to the extent referenced. The publications may be referred to in the text by the basic designation only. Unless otherwise indicated, the most recent edition of the publication with current revisions and amendments will be enforced.
- B. Comply with the ordinances of the County having jurisdiction over this project.
- C. In the event of conflict between pertinent codes and regulations, and the requirements of the referenced standards, or those indicated in Specifications and on drawings, the provisions of the more stringent shall govern.

1.05 RELATED WORK

- A. DIVISION 1 - GENERAL REQUIREMENTS.
- B. SECTION 09901 - PAINTING.

1.06 DEFINITIONS

- A. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.
- B. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.
- C. The technical paragraphs referred to herein are those paragraphs in PART 2 - PRODUCTS and PART 3 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

1.07 SUBMITTALS

- A. Submit in accordance with SECTION 01330 - SUBMITTAL PROCEDURES.
- B. Certificates:

1. Submit written certification that electrical systems are complete and operational as stipulated in item entitled "DEMONSTRATION OF COMPLETE ELECTRICAL SYSTEMS" hereinbelow.
 2. Submit certificate of final inspection and acceptance as stipulated in item entitled "INSPECTION" hereinbelow.
- C. Warranty: Submit warranty as stipulated in item entitled "WARRANTY" hereinbelow.
- D. Record Drawings: After the work is complete, Contractor shall provide record drawings showing the as-built conditions in accordance with SECTION 01770 – CLOSE-OUT PROCEDURES.
- E. Submittals required in the sections which refer to this section shall conform to the following additional requirements. Submittals shall include the manufacturer's name, trade name, place of manufacture, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification and technical paragraph reference. Submittals shall also include applicable industry and technical society publication references, and years of satisfactory service, and other information necessary to establish contract compliance of each item to be provided. Photographs of existing installations are unacceptable and will be returned without approval. Transmittal letter shall include a listing of all items by manufacturer and catalog number which are included in the submittal package and shall clearly identify the submittal with this project.
- F. Submittals for each manufactured item shall be current manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog cuts. Handwritten and typed modifications and other notations not part of the manufacturer's preprinted data may result in the rejection of the submittal. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified for certificates of compliance.
- G. Submittal drawings shall be a minimum of 11 inches by 17 inches in size using a minimum scale of 1/8 inch per foot, except as specified otherwise. Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.
- H. Where installation procedures or part of the installation procedures are required to be in accordance with manufacturer's instructions, submit printed copies of those instructions prior to installation. Installation of the item shall not proceed until manufacturer's instructions are received.

Failure to submit manufacturer's instructions shall be cause for rejection of the equipment or material.

- I. Submit manufacturer's certifications as required for products, materials, finishes, and equipment as specified in the technical sections. Certificates from material suppliers are not acceptable. Preprinted certifications and copies of previously submitted documents will not be acceptable. The manufacturer's certifications shall name the appropriate products, equipment, or materials and the publication specified as controlling the quality of that item. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; "achieve the same end use and results as materials formulated in accordance with the referenced publications"; or "equal or exceed the service and performance of the specified material." Certifications shall simply state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance.
- J. Where equipment or materials are specified to conform to industry and technical society reference standards of organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), and Underwriters Laboratories Inc. (UL), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.
- K. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.
- L. Submit text of posted operating instructions for each system and principal item of equipment as specified in the technical sections.
- M. Each submittal shall be prepared with a summary sheet attached to each copy identifying all items included in the submittal. Incomplete submittals and those without summary sheets will be returned without review.

1.08 QUALITY ASSURANCE

- A. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Engineer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

- B. Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where 2 or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.
- C. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.
- D. Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.
- E. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70.

1.09 PERMITS AND INSPECTION

- A. All permits required by local ordinances shall be obtained and paid for by the Contractor.

1.10 COORDINATION

- A. Refer to all project Drawings and to all Sections of the project Specifications. Coordinate and fit all work accordingly so that all electrical outlets and equipment will be properly located and readily accessible. The Drawings indicate the relation of wiring and connections and must not be scaled for exact locations. Verify all construction dimensions at the project and make changes necessary to conform to the building as constructed. Work improperly installed due to lack of construction verification shall be corrected at the Contractor's expense.
- B. Work shall be scheduled to avoid delays, interferences, and unnecessary work. If any conflicts occur, necessitating departures from the Drawings and Specifications, details of departures and reasons therefore shall be submitted immediately for consideration by the Engineer.

1.11 DELIVERY, HANDLING AND STORAGE

- A. Deliver all materials of this Division in manufacturer's original unopened packages or containers with label intact and legible.

- B. Use means necessary to protect the materials of this section before, during and after installation; to protect the installed work and materials of all other trades; and to protect the original structure, work and materials of the Owner.
- C. In the event of damage, immediately make all repairs and replacements necessary to the acceptance of the Engineer and at no additional cost to the Owner.

1.12 DRAWINGS AND SPECIFICATIONS

- A. Electrical system drawings are diagrammatic and symbolic. Locations of outlets, devices, raceways, apparatus, etc., shown are approximate and shall be installed with the required maintenance and code clearances and to avoid conflict with other systems and trades. Visit site and verify lineal footages required and check scales and dimensions shown on architectural drawings prior to bidding to verify locations, routing and lineal footages of electrical work required for inclusion into bid. Study the project drawings and specifications and make installation in most logical manner for eye appeal and coordination with other systems and trades. Unless dimensioned or noted otherwise, orderly configuration and visual composition are fully intended.
- B. Include additional components and wiring which are not shown or specified herein but are required for proper control and operation to provide for a complete and operable system within intent indicated on the drawings and specifications.
- C. Study the project drawings and specifications prior to bidding and provide additional wiring including apparatus and devices for equipment furnished by others without additional cost.
- D. Relocate devices, apparatus and associated wiring including raceways, from locations shown, without additional cost, for code compliance and to avoid conflict with other systems or trades, structures, utilities and when directed before installation.
- E. Equipment ratings or wire sizes that are missing or shown in error shall have adequate capacity to serve the required and future loads plus minimum 25 percent spare capacity, and be in compliance with NEC.
- F. Verify voltages and other ratings of energy conversion, transformation and electrical utilization equipment prior to placing order with factory. Input voltages of equipment shall match serving utility or system voltage available.

1.13 POSTED OPERATING INSTRUCTIONS

- A. Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:
 - 1. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
 - 2. Start up, proper adjustment, operating, lubrication, and shutdown procedures.
 - 3. Safety precautions.
 - 4. The procedure in the event of equipment failure.
 - 5. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

- B. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.14 MANUFACTURER'S NAMEPLATE

- A. Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.15 FIELD FABRICATED NAMEPLATES

- A. ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified in the technical sections or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white, with red center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one inch by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

1.16 ELECTRICAL REQUIREMENTS

- A. Electrical installation shall conform to IEEE C2, NFPA 70, and requirements specified herein.

1.17 INSTRUCTION TO GOVERNMENT PERSONNEL

- A. Where specified in the technical sections, furnish the services of competent instructors to give full instruction to designated Government personnel in the adjustment, operation, and maintenance of the specified

systems and equipment, including pertinent safety requirements as required. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section.

1.18 WARRANTY

- A. Installation shall be complete in every detail as specified and ready for use. Unless otherwise indicated, any items supplied by Contractor developing defects of design, construction, or quality within One year of final acceptance by Engineer shall be replaced by such new materials, apparatus or parts to make such defective portion of the complete system conform to the true intent and meaning of the Drawings and Specifications at no additional cost to the Owner. Lamps shall be warranted for fifty percent of rated lamp life.
- B. The warranty shall be countersigned by the General Contractor.

PART 2 - PRODUCTS

2.01 FACTORY APPLIED FINISH

- A. Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install all electrical materials and equipment in accordance with manufacturer's recommendations and as accepted by the Engineer for the seismic zone classification at the project site in accordance with the applicable Building Code.
- B. Cut, break, drill and patch as required, to install electrical system. Repair any surface damaged or marred by notching, drilling or any other process necessary for installation of electrical work. Patch any damaged surfaces to match the existing surface.
- C. All wiring and overcurrent devices for equipment furnished by other trades are sized for a contemplated equipment size. If equipment other than contemplated and indicated on the plan is provided, the Contractor shall be responsible for providing the required wiring, switches, and overcurrent devices at no cost to the Owner. The Contractor shall submit

the proposed revisions to the electrical design to the Engineer for acceptance.

- D. The Electrical Contractor shall coordinate his work with other trades to avoid conflicts with civil, mechanical, structural, and architectural elements of this project.

3.02 JOBSITE CONDITIONS

- A. These specifications are accompanied by construction drawings including building and site plans of all trades showing locations of all feeder runs, outlets, switches, devices, and other electrical equipment. The locations are approximate and before installing, study adjacent architectural details and make installation in most logical manner. Any device may be relocated within 10 feet before installation at the direction of the Engineer without additional cost to the Owner.
- B. Before installing, verify all dimensions and sizes of equipment.
- C. Verify that electrical system may be installed in strict accordance with the original design, the Drawings and Specifications and the manufacturer's recommendations.
- D. In the event of discrepancy, immediately notify the Engineer. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.03 CONNECTIONS TO EQUIPMENT PROVIDED BY OTHER TRADES

- A. Electrical Contractor shall provide conduit, wiring and all electrical connections from building wiring to motors for ventilation, air conditioning, and other equipment, including all switches, motor protection devices, and controllers/starters as specified by other trades.
- B. Electrical Contractor shall ascertain from other trades furnishing electrically-operated equipment, the exact size and type of all motors and other loads, the exact locations of such equipment and the proper point where electrical connections should be brought through the floors, ceiling or walls, as the case may be. Locations shown are diagrammatic only; coordination of the correct locations shall be the full responsibility of the Electrical Contractor.
- C. Examine Mechanical, Architectural, and other Drawings and Specifications for information concerning electrically-operated equipment and control apparatus and diagrams.
- D. Install individually mounted controllers/starters furnished for motors under other Divisions. Provide and install safety switches as necessary for each such motor in accordance with the NEC.

- E. All control devices and control wiring shall be provided as described in the installation manuals of equipment and/or the Drawings and Specifications of other trades and disciplines.

3.04 FIELD APPLIED PAINTING

- A. Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09901 - PAINTING.

3.05 FIELD FABRICATED NAMEPLATE MOUNTING

- A. Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of 2 sheet-metal screws or 2 rivets.

3.06 DEMONSTRATION OF COMPLETE ELECTRICAL SYSTEMS

- A. Submit written certification that electrical systems are complete and operational. Submit certification with Contractor's request for final review.
- B. At the time of final review of electrical work, demonstrate the operation of electrical systems. Provide labor, apparatus and equipment for systems' demonstration. The various tests shall be under the direction and supervision of the Engineer.
- C. The Contractor shall provide all test equipment, materials, labor, and temporary power hook-ups to perform start-up and all tests as required, to obtain final field acceptance from the Owner. All tests shall be conducted in the presence of the Engineer or his representative. All test procedures shall conform to this specification and applicable standards. (ANSI, IEEE, NEMA, OSHA, NFPA, NETA, etc.)
- D. The Contractor shall be responsible for all tests and test record. Testing shall be performed by and under the immediate supervision of the Contractor. Test record shall be kept for each piece of equipment. Copies shall be furnished to the Engineer for his review and/or acceptance.
- E. A visual inspection of all electrical equipment, to check for foreign material, tightness or wiring and connection, proper grounding, matching nameplate charts with specification, etc., shall be made prior to actual testing.
- F. After demonstration of systems, submit to the Engineer 6 sets of keys for electrical equipment locks.

3.07 INSPECTION

- A. Arrange for periodic inspection by the local authorities and deliver the certificate of final inspection to the Engineer.

END OF SECTION

SECTION 16100 – ELECTRICAL WORK

PART 1 - GENERAL

1.01 SUMMARY

- A. This section specifies the general electrical requirements for all labor, materials, equipment, and services provided under DIVISION 16 - ELECTRICAL.

1.02 RELATED WORK

- A. SECTION 16011 - GENERAL ELECTRICAL REQUIREMENTS applies to this section with additions and modifications specified herein.

1.03 APPLICABLE PUBLICATIONS

- A. The publications listed herein form a part of this specification to the extent referenced. The publications may be referred to in the text by the basic designation only. Unless otherwise indicated, the most recent edition of the publication with current revisions and amendments will be enforced.

1.04 SUBMITTALS

- A. Submit in accordance with SECTION 01330 - SUBMITTAL PROCEDURES.
- B. Submit shop drawings and catalog cuts of the following equipment for approval. Each submittal shall be prepared with a summary sheet attached to each copy identifying all items included in the submittal. Incomplete submittals and those without summary sheets will be returned without review.
- C. Manufacturer's Catalog Data:
 - 1. Panelboards.
 - 2. Safety switches.
 - 3. Dry transformers.
 - 4. Wiring Devices.
 - 5. Overcurrent protection devices.
 - 6.
- D. Reports: Submit test results for approval in report form:
 - 1. 600 volt wiring test.
 - 2. Grounding system test.

1.05 QUALITY ASSURANCE

- A. Regulatory Requirements: In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word,

“shall” or “must” had been substituted for “should” wherever it appears. Interpret references in these publications to the “authority having jurisdiction,” or words of similar meaning, to mean the Engineer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

- B. Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers’ catalogs, or brochures during the 2-year period. Where 2 or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.
- C. Alternative Qualifications: Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6,000 hours, exclusive of the manufacturers’ factory or laboratory tests, is furnished.
- D. Material and Equipment Manufacturing Date: Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Materials shall be new and those items listed by the Underwriters’ Laboratories shall bear “UL” label of approval.
- B. Brand names, manufacturer’s names and catalog numbers indicate the standard of design and quality required. Acceptable manufacturers for electrical apparatus include General Electric, Square D, Siemens-ITE, and Cutler-Hammer. All apparatus supplied shall bear the name of the approved manufacturer on its nameplates. Substitute materials may be used if pre-qualified prior to bidding by the Engineer.
- C. Electrical equipment and luminaires shall be supplied through the manufacturer’s designated representative by a local distributor.
- D. Proof of compliance shall be furnished when shop drawings are submitted.

- E. Where 2 or more similar type items are furnished, all shall be of the same manufacture, e.g., safety switches shall be of the same manufacturer unless otherwise noted.
- F. Where electrical apparatus is to be installed outdoors, NEMA 4X stainless steel housings shall be provided, unless noted otherwise.

2.02 RACEWAYS

- A. Rigid Steel Conduit: Rigid steel, zinc-coated inside and outside, for use with threaded fittings. ANSI C80.1.
- B. Intermediate Metal Conduit (IMC): Rigid steel, zinc- and chromate-coated inside and outside, for use with threaded fittings. UL 1242.
- C. Plastic-Coated Rigid Steel and IMC Conduit: NEMA RN1, Type 40 (40 mils thick).
- D. Electrical Metal Tubing (EMT): Thin walled steel tubing, zinc-coated. ANSI C80.3.
- E. Flexible Metal Conduit: Flexible steel conduit; zinc-coated inside and outside, smooth inside walls, liquid-tight with factory fittings for liquid-tight installation. Provide bushings with bonding jumper lugs for flexible conduit in excess of 6 feet in length. UL 360.
- F. Rigid Nonmetallic Conduit: Polyvinyl chloride, Schedule 40.
- G. Metal Surface Raceways: UL 5, two-piece painted steel, totally enclosed, snap-cover type.
- H. Fittings for Metal Conduit, EMT, and Flexible Metal Conduit: UL 514B. Ferrous fittings shall be cadmium- or zinc-coated in accordance with UL 514B.
- I. Fittings for Rigid Metal Conduit and IMC: Threaded-type. Split couplings unacceptable.
- J. Fittings for EMT: Steel compression type.
- K. Fittings for Rigid Nonmetallic Conduit: NEMA TC 3 for PVC and UL 514B.
- L. Liquid-Tight Flexible Nonmetallic Conduit: UL 1660.

2.03 OUTLET BOXES AND COVERS

- A. Outlet and Small Junction Boxes: UL 514A, galvanized, if ferrous metal. UL 514C, if nonmetallic.

1. Nominal 4 inches square, 2-1/8 inches deep exclusive of plaster ring, pressed steel.
2. Boxes for Telecommunications outlets shall be a nominal 4-11/16 inches square, 2-1/8 inches deep exclusive of plaster ring.
3. Mount outlet boxes flush in finished walls/furred chases wherever possible.
4. Surface mounted boxes and boxes exposed to the weather shall be cast steel, type FD, prime painted and enamel finished with neoprene gasketed covers, threaded hubs for conduit connections and stainless steel screws.

2.04 CABINETS, JUNCTION BOXES, AND PULL BOXES

- A. Volume greater than 100 cubic inches, UL 50, hot-dip, zinc-coated, if sheet steel.

2.05 WIRES AND CABLES

- A. Wires and cables shall meet applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Wires and cables manufactured more than 12 months prior to date of delivery to site shall not be used.
- B. Conductors:
 1. Conductors No. 8 AWG and larger diameter shall be stranded.
 2. Conductors No. 10 AWG and smaller diameter shall be solid.
 3. Conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise.
 4. Conductor sizes and capacities shown are based on copper, unless indicated otherwise. All conductors shall be copper.
 5. Equipment Manufacturer Requirements: When manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to satisfy manufacturer's requirements.
 6. Minimum Conductor Sizes:
 - a. Minimum size for branch circuits shall be No. 12 AWG.
 - b. Class 1 remote-control and signal circuits: No. 14 AWG.
 - c. Class 2 low-energy, remote-control and signal circuits: No. 16 AWG.
 - d. Class 3 low-energy, remote-control, alarm and signal circuits: No. 22 AWG.
- C. Color Coding: Provide for feeder, branch, control, and signaling circuit conductors.
 1. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in same raceway or box, other neutrals shall be white with a different colored (not green) stripe for each.

2. Color of ungrounded conductors in different voltage systems shall be as follows:
 - a. 208/120 volt, 3-phase:
 - 1) Phase A - black.
 - 2) Phase B - red.
 - 3) Phase C - blue.
 - b. 480/277 volt, 3-phase:
 - 1) Phase A - brown.
 - 2) Phase B - orange.
 - 3) Phase C - yellow.

- D. Insulation: Unless specified or indicated otherwise or required by NFPA 70, power and lighting wires shall be 600-volt, Type THWN/THHN conforming to UL 83 or Type XHHW or RHW conforming to UL 44, except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits shall be Type TW or TF, conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

- E. Bonding Conductors: ASTM B1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

- F. Metal-Clad Cable: UL 1569; NFPA 70, Type MC cable, Hospital Grade only.

2.06 SPLICES AND TERMINATION COMPONENTS

- A. UL 486A-486B for wire connectors and UL 510 for insulating tapes. Connectors for No. 10 AWG and smaller diameter wires shall be insulated, pressure-type in accordance with UL 486A-486B or UL 486C (twist-on splicing connector). Provide solderless terminal lugs on stranded conductors.

2.07 DEVICE PLATES

- A. Provide UL listed, one-piece device plates for outlets to suit the devices installed.
 1. For metal outlet boxes, plates on unfinished walls shall be of zinc-coated sheet steel or cast metal having round or beveled edges.
 2. For nonmetallic boxes and fittings, other suitable plates may be provided.
 3. Plates on finished walls shall be nylon or lexan, minimum 0.03 inch wall thickness. Plates shall be same color as receptacle or toggle switch with which they are mounted.
 4. Screws shall be machine-type with countersunk heads in color to match finish of plate.
 5. Sectional type device plates will not be permitted.
 6. Plates installed in wet locations shall be gasketed and UL listed for "wet locations."

2.08 SWITCHES

- A. Toggle Switches: NEMA WD 1, UL 20, single pole, totally enclosed with bodies of thermoplastic or thermoset plastic and mounting strap with grounding screw.
 - 1. Handles shall be white thermoplastic.
 - 2. Wiring terminals shall be screw-type, side-wired or of the solderless pressure type having suitable conductor-release arrangement.
 - 3. Contacts shall be silver-cadmium and contact arm shall be one-piece copper alloy.
 - 4. Switches shall be rated quiet-type ac only, 120/277 volts, with current rating and number of poles indicated.
- B. Breakers Used as Switches For 120- and 277-Volt fluorescent fixtures, mark breakers "SWD" in accordance with UL 489.
- C. Disconnect (Safety) Switches: NEMA KS 1. Provide heavy duty-type switches where indicated, where switches are rated higher than 240 volts, and for double-throw switches. Fused switches shall utilize Class R fuseholders and fuses, unless indicated otherwise. Provide fuses as indicated. Switches serving as motor-disconnect means shall be horsepower rated. Provide switches in NEMA 1 enclosure per NEMA ICS 6, unless otherwise indicated.

2.9 RECEPTACLES

- A. General: UL 498, hospital grade, grounding-type.
 - 1. Ratings and configurations shall be as indicated.
 - 2. Bodies shall be of white as per NEMA WD 1.
 - 3. Face and body shall be thermoplastic supported on a metal mounting strap.
 - 4. Dimensional requirements shall be per NEMA WD 6.
 - 5. Provide screw-type, side-wired wiring terminals or of the solderless pressure type having suitable conductor-release arrangement.
 - 6. Connect grounding pole to mounting strap.
 - 7. The receptacle shall contain triple-wipe power contacts and double or triple-wipe ground contacts.
- B. Ground-Fault Circuit Interrupter Receptacles: UL 943, hospital grade, duplex type for mounting in standard outlet box. Device shall be capable of detecting current leak of 6 milliamperes or greater and tripping per requirements of UL 943 for Class A GFCI devices. Provide screw-type, side-wired wiring terminals or pre-wired (pigtail) leads.

2.10 PANELBOARDS

- A. Provide panelboards in accordance with the following:

1. UL 67 and UL 50 having a short-circuit current rating as indicated.
 2. Panelboards: circuit breaker-equipped.
 3. Designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL.
 4. "Specific breaker placement" is required in panelboards to match the breaker placement indicated in the panelboard schedule on the drawings.
 5. Where "space only" is indicated, make provisions for future installation of breakers.
 6. Directories: indicate load served by each circuit in panelboard.
 7. Directories: indicate source of service to panelboard (e.g., Panel PA served from Panel MDP).
 8. Provide new directories for existing panels modified by this project as indicated.
 9. Type directories and mount in holder behind transparent protective covering.
 10. Panelboards: listed and labeled for their intended use.
 11. Panelboard nameplates: provided in accordance with paragraph FIELD FABRICATED NAMEPLATES hereinbelow.
- B. Enclosure: Provide panelboard enclosure in accordance with the following:
1. UL 50.
 2. Cabinets mounted outdoors or flush-mounted: hot-dipped galvanized after fabrication.
 3. Cabinets: painted in accordance with paragraph PAINTING.
 4. Front edges of cabinets: form-flanged or fitted with structural shapes welded or riveted to the sheet steel, for supporting the panelboard front.
 5. All cabinets: fabricated such that no part of any surface on the finished cabinet deviates from a true plane by more than 1/8 inch.
 6. Holes: provided in the back of indoor surface-mounted cabinets, with outside spacers and inside stiffeners, for mounting the cabinets with a 1/2 inch clear space between the back of the cabinet and the wall surface.
 7. Flush doors: mounted on hinges that expose only the hinge roll to view when the door is closed.
 8. Each door: fitted with a combined catch and lock, except that doors over 24 inches long provided with a three-point latch having a knob with a T-handle, and a cylinder lock.
 9. Keys: two provided with each lock, with all locks keyed alike.
 10. Finished-head cap screws: provided for mounting the panelboard fronts on the cabinets.
- C. Panelboard Buses: Support bus bars on bases independent of circuit breakers. Main buses and back pans shall be designed so that breakers may be changed without machining, drilling, or tapping. Provide isolated neutral bus in each panel for connection of circuit neutral conductors.

Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet.

- D. Circuit Breakers: UL 489, thermal magnetic-type having a minimum short-circuit current rating equal to the short-circuit current rating of the panelboard in which the circuit breaker shall be mounted. Breaker terminals shall be UL listed as suitable for type of conductor provided.
 - 1. Multipole Breakers: Provide common trip-type with single operating handle. Breaker design shall be such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any 3 adjacent breaker poles are connected to Phases A, B, and C, respectively.
 - 2. Circuit Breakers for HVAC Equipment: Circuit breakers for HVAC equipment having motors (group or individual) shall be marked for use with HACR type and UL listed as HACR type.

2.11 ENCLOSED CIRCUIT BREAKERS

- A. UL 489. Individual molded case circuit breakers with voltage and continuous current ratings, number of poles, overload trip setting, and short circuit current interrupting rating as indicated. Enclosure type as indicated. Provide solid neutral.

2.12 TRANSFORMERS

- A. Provide transformers in accordance with the following:
 - 1. NEMA ST 20, general purpose, dry-type, self-cooled, ventilated.
 - 2. Provide transformers in NEMA 1 enclosure.
 - 3. Transformer insulation system:
 - a. 220 degrees C insulation system for transformers 15 kVA and greater, with temperature rise not exceeding 115 degrees C under full-rated load in maximum ambient of 40 degrees C.
 - 4. Transformer of 115 degrees C temperature rise shall be capable of carrying continuously 115 percent of nameplate kVA without exceeding insulation rating.
 - 5. Transformers shall be quiet type with maximum sound level at least 3 decibels less than NEMA standard level for transformer ratings indicated.

2.13 WIREWAYS

- A. UL 870. Material shall be steel galvanized 16 gauge for heights and depths up to 6 by 6 inches, and 14 gauge for heights and depths up to 12 by 12 inches. Provide in length required for the application with screw-cover NEMA 1 enclosure per NEMA ICS 6.

2.14 MANUFACTURER'S NAMEPLATE

- A. Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number

securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.15 FIELD FABRICATED NAMEPLATES

- A. Provide field fabricated nameplates in accordance with the following:
 - 1. ASTM D709.
 - 2. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings.
 - 3. Each nameplate inscription shall identify the function and, when applicable, the position.
 - 4. Nameplates shall be melamine plastic, 0.125 inch thick, white with red center core.
 - 5. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core.
 - 6. Minimum size of nameplates shall be one inch by 2.5 inches.
 - 7. Lettering shall be a minimum of 0.25 inch high normal block style.

2.16 WARNING SIGNS

- A. Provide warning signs for flash protection in accordance with NFPA 70E and NEMA Z535.4 for panelboards and industrial control panels in other than dwelling occupancies and are likely to require examination, adjustment, servicing, or maintenance while energized. Provide field installed signs to warn qualified persons of potential electric arc flash hazards when warning signs are not provided by the manufacturer. The marking shall be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

2.17 FIRESTOPPING MATERIALS

- A. Provide firestopping around electrical penetrations. Utilize UL-listed firestopping systems or assemblies suitable for the penetration being sealed.

2.18 FACTORY APPLIED FINISH

- A. Provide factory-applied finish on electrical equipment in accordance with the following:
 - 1. NEMA 250 corrosion-resistance test and the additional requirements as specified herein.
 - 2. Interior and exterior steel surfaces of equipment enclosures shall be thoroughly cleaned and then receive a rust-inhibitive phosphatizing or equivalent treatment prior to painting.
 - 3. Exterior surfaces shall be free from holes, seams, dents, weld marks, loose scale or other imperfections.
 - 4. Interior surfaces shall receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice.

5. Exterior surfaces shall be primed, filled where necessary, and given not less than 2 coats baked enamel with semi-gloss finish.
6. Equipment located indoors shall be ANSI Light Gray.
7. Provide manufacturer's coatings for touch-up work and as specified in item entitled "FIELD APPLIED PAINTING" hereinbelow.

2.19 HARDWARE, SUPPORTS, BACKING, ETC.

- A. Provide all hardware, supports, backing and other accessories necessary to install electrical equipment. Wood materials shall be treated against termites, iron or steel materials shall be galvanized for corrosion protection, and non-ferrous materials shall be brass or bronze. Provide other specialty materials where indicated.
- B. Bolts, nuts, washers, and screws used for exterior use shall be high quality stainless steel or brass.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Electrical installations, including weatherproof and hazardous locations and ducts, plenums and other air-handling spaces, shall conform to requirements of NFPA 70 and IEEE C2 and to requirements specified herein.
- B. Hazardous Locations: Work in hazardous locations, as defined by NFPA 70, shall be performed in strict accordance with NFPA 70 for particular "Class," "Division," and "Group" of hazardous locations involved. Provide conduit and cable seals where required by NFPA 70. Conduit shall have tapered threads.
- C. Wiring Methods: Provide insulated conductors installed in rigid steel conduit, IMC, rigid nonmetallic conduit, or EMT, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Utilize non-wax type lubricants for pulling, chemically neutral to insulation and sheath. Mechanical means for pulling to be tongue-limiting type and not be used for #2 AWG wires and smaller. Grounding conductor shall be separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s) installed in conduit and raceways. Minimum conduit size shall be 3/4 inch in diameter for low voltage lighting and power circuits. Conduit which penetrates fire-rated walls, fire-rated partitions, or fire-rated floors shall be firestopped.
 1. Pull Wire: Install pull wires in empty conduits. Pull wire shall be plastic having minimum 200-pound force tensile strength. Leave minimum 36 inches of slack at each end of pull wire.
 2. Metal Clad Cable: Install in accordance with NFPA 70, Type MC cable.

- D. Conduit Installation: Unless indicated otherwise, conceal conduit under floor slabs and within finished walls, ceilings, and floors. Keep conduit minimum 6 inches away from parallel runs of flues and steam or hot water pipes. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project.
1. Restrictions Applicable to EMT:
 - a. Do not install underground.
 - b. Do not encase in concrete, mortar, grout, or other cementitious materials.
 - c. Do not use in areas subject to severe physical damage including but not limited to equipment rooms where moving or replacing equipment could physically damage the EMT.
 - d. Do not use in hazardous areas.
 - e. Do not use outdoors, including under open-sided covered lanais, patios, walkways or other similar locations.
 - f. Do not use exposed below +8 feet above the finished floor, except in dedicated Electrical Rooms.
 2. Restrictions Applicable to Nonmetallic Conduit:
 - a. PVC Schedule 40:
 - 1) Do not use in areas where subject to severe physical damage, including but not limited to, mechanical equipment rooms, electrical equipment rooms, and other such areas.
 - 2) Do not use in hazardous (classified) areas.
 - 3) Do not use in penetrating fire-rated walls or partitions, or fire-rated floors.
 - 4) Do not use above grade, except where conduit is concealed and located within walls up to the first outlet box or conduit coupling above the finished floor unless indicated otherwise.
 3. Restrictions Applicable to Flexible Conduit: Use only as specified in subparagraph entitled "Flexible Connections" hereinbelow.
 4. Conduit through Floor Slabs: Where conduits rise through floor slabs, curved portion of bends shall not be visible above finished slab.
 5. Stub-Ups: Provide conduits stubbed up through concrete floor for connection to free-standing equipment with adjustable top or coupling threaded inside for plugs, set flush with finished floor. Extend conductors to equipment in rigid steel conduit, except that flexible metal conduit may be used 6 inches above floor. Where no equipment connections are made, install screwdriver-operated threaded flush plugs in conduit end.
 6. Conduit Support: Support conduit by pipe straps, wall brackets, hangers, or ceiling trapeze. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, welded threaded studs, or spring-tension clamps on steel work.

- Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Load applied to fasteners shall not exceed 1/4 proof test load. Fasteners attached to concrete ceiling shall be vibration resistant and shock-resistant. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete joints shall not cut main reinforcing bars. Fill unused holes. In partitions of light steel construction, use sheet metal screws. In suspended-ceiling construction, run conduit above ceiling. Do not support conduit by ceiling support system. Conduit and box systems shall be supported independently of both (a) tie wires supporting ceiling grid system, and (b) ceiling grid system into which ceiling panels are placed. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts. Installation shall be coordinated with above-ceiling mechanical systems to assure maximum accessibility to all systems. Spring-steel fasteners may be used for lighting branch circuit conduit supports in suspended ceilings in dry locations. Where conduit crosses building expansion joints, provide suitable expansion fitting that maintains conduit electrical continuity by bonding jumpers or other means. For conduits greater than 2-1/2 inches inside diameter, provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.
7. Directional Changes in Conduit Runs: Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits. Avoid trapped conduits. Prevent plaster, dirt, or trash from lodging in conduits, boxes, fittings, and equipment during construction. Free clogged conduits of obstructions.
 8. Locknuts and Bushings: Fasten conduits to sheet metal boxes and cabinets with 2 locknuts where required by NFPA 70, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use at least minimum single locknut and bushing. Locknuts shall have sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by NFPA 70.
 9. Flexible Connections: Provide flexible steel conduit between 3 feet and 6 feet in length for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for motors. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size shall be 1/2 inch diameter. Provide liquid-tight flexible conduit in wet and damp locations for equipment subject to vibration, noise transmission, movement or motors. Provide separate ground conductor across flexible connections.
- E. Boxes, Outlets, and Supports: Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and

mounting of devices or fixtures. Boxes for metallic raceways shall be cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces, when surface mounted on interior walls exposed up to 8 feet above floors and walkways, or when installed in hazardous areas and when specifically indicated. Boxes in other locations shall be sheet steel, except that nonmetallic boxes may be used with nonmetallic conduit system. Each box shall have volume required by NFPA 70 for number of conductors enclosed in box. Boxes for mounting lighting fixtures shall be minimum 4 inches square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved. Provide gaskets for cast-metal boxes installed in wet locations and boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature; fixtures shall be readily removable for access to boxes unless ceiling access panels are provided. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports. Fasten boxes and supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel. Threaded studs driven in by powder charge and provided with lockwashers and nuts [or nail-type nylon anchors] may be used in lieu of wood screws, expansion shields, or machine screws. In open overhead spaces, cast boxes threaded to raceways need not be separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers. Where bar hangers are used, attach bar to raceways on opposite sides of box, and support raceway with approved-type fastener maximum 24 inches from box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.

1. Pull Boxes: Construct of at least minimum size required by NFPA 70 of code-gauge galvanized sheet steel or stainless steel where indicated, except where cast-metal boxes are required in locations specified herein. Provide boxes with screw-fastened covers. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.
 2. Extension Rings: Extension rings are not permitted for new construction. Use only on existing boxes in concealed conduit systems where wall is furred out for new finish.
- F. Mounting Heights: Mount panelboards, circuit breakers, motor controllers and disconnecting switches so height of operating handle at its highest position is maximum 78 inches above floor. Mount lighting switches 48 inches above finished floor. Mount receptacles and telecommunications outlets 18 inches above finished floor, unless otherwise indicated. Mount other devices as indicated. Measure mounting heights of wiring devices and outlets to center of device or outlet, unless otherwise indicated.
- G. Conductor Identification: Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No.

6 AWG and smaller diameter, color coding shall be by factory-applied, color-impregnated insulation. For conductors No. 4 AWG and larger diameter, color coding shall be by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves. Identify control circuit terminations in accordance with manufacturer's recommendations.

- H. Splices: Make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make splices in conductors No. 8 AWG and larger diameter with solderless connector, and cover with insulation material equivalent to conductor insulation.
- I. Covers and Device Plates: Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Install plates with alignment tolerance of 1/16 inch. Use of sectional-type device plates are not permitted. Provide gasket for plates installed in wet locations.
- J. Electrical Penetrations: Openings around electrical penetrations (such as conduit penetrations or flush mounted equipment enclosures or junction boxes) through fire resistance-rated walls, partitions, floors, or ceilings shall be sealed to maintain fire resistive integrity. Use 3M CP25, Type MPP moldable putty or equivalent material or assemblies to maintain fire resistive integrity for conduit penetration and flush mounted outlet boxes. Use other approved construction methods for larger enclosures.
- K. Grounding and Bonding: Provide in accordance with NFPA 70. Ground exposed, non-current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, telecommunications system grounds, and neutral conductor of wiring systems.
 - 1. Grounding Connections: Make grounding connections which are buried or otherwise normally inaccessible, by exothermic weld or compression connector.
 - a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.
 - b. Make compression connections using a hydraulic compression tool to provide the correct circumferential pressure. Tools and dies shall be as recommended by the manufacturer. An embossing die code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground wire.
 - 2. Resistance: Maximum resistance-to-ground of grounding system shall not exceed 25 ohms under dry conditions. Where resistance obtained exceeds 25 ohms, contact Engineer for further instructions.

- L. Equipment Connections: Provide power wiring for the connection of motors and control equipment under this section of the specification. Except as otherwise specifically noted or specified, automatic control wiring, control devices, and protective devices within the control circuitry are not included in this section of the specifications but shall be provided under the section specifying the associated equipment.
- M. Seismic Bracing: Contractor shall provide seismic bracing for all electrical equipment, apparatus, and raceways. Bracing shall, as a minimum, comply with the County Building Code.
- N. Repair of Existing Work: Repair of existing work, demolition, and modification of existing electrical distribution systems shall be performed as follows:
 1. Workmanship: Lay out work in advance. Exercise care where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces is necessary for proper installation, support, or anchorage of conduit, raceways, or other electrical work. Repair damage to buildings, piping, and equipment using skilled craftsmen of trades involved.
 2. Existing Concealed Wiring to be Removed: Existing concealed wiring to be removed shall be disconnected from its source. Remove conductors; cut conduit flush with floor, underside of floor, and through walls; and seal openings.
 3. Removal of Existing Electrical Distribution System: Removal of existing electrical distribution system equipment shall include equipment's associated wiring, including conductors, cables, exposed conduit, surface metal raceways, boxes, and fittings, back to equipment's power source as indicated.
 4. Continuation of Service: Maintain continuity of existing circuits of equipment to remain. Existing circuits of equipment shall remain energized. Circuits which are to remain but were disturbed during demolition shall have circuits wiring and power restored back to original condition.

3.02 FIELD FABRICATED NAMEPLATE MOUNTING

- A. Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of 2 sheet-metal screws or 2 rivets.

3.03 WARNING SIGN MOUNTING

- A. Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with NFPA 70E.

3.04 FIELD APPLIED PAINTING

- A. Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Where field painting

of enclosures for panelboards, load centers or the like is specified to match adjacent surfaces, to correct damage to the manufacturer's factory applied coatings, or to meet the indicated or specified safety criteria, provide manufacturer's recommended coatings and apply in accordance to manufacturer's instructions. Painting shall be as specified in SECTION 09901 - PAINTING.

3.05 FIELD QUALITY CONTROL

- A. Furnish test equipment and personnel and submit written copies of test results. Give Engineer 10 working days' notice prior to each.
1. Devices Subject to Manual Operation: Each device subject to manual operation shall be operated at least 5 times, demonstrating satisfactory operation each time.
 2. 600-Volt Wiring Test: Test wiring rated 600 volt and less to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of approximately 500 volts to provide direct reading of resistance. Minimum resistance shall be 250,000 ohms. Submit results to the Engineer.
 3. Transformer Tests: Measure primary and secondary voltages for proper tap settings.
 4. Ground-Fault Receptacle Test: Test ground-fault receptacles with a "load" (such as a plug in light) to verify that the "line" and "load" leads are not reversed.
 5. Grounding System Test: Test grounding system to ensure continuity and that resistance to ground is not excessive.

END OF SECTION

SECTION 16195 –ELECTRICAL IDENTIFICATION

PART 1 – GENERAL

1.01 GENERAL CONDITIONS

- A. Drawings and other general provisions of contract, including General and Supplementary Conditions and other Division 1 specification sections, apply to this section.

1.02 SUMMARY

- A. Electrical Equipment Nameplates.
- B. Panelboard Directories.
- C. Wire and Cable Identification.
- D. Buried Electrical Line Warnings
- E. Junction Box Identification.
- F. Warning and Caution Signs.
- G. Device Coverplates.

1.03 SUBMITTALS

- A. Submittals shall be provided in accordance with Section 01300 - Submittals.
- B. Comply with provisions of Division 1.
- C. Provide manufacturer's literature describing products.
- D. Nameplate schedule.
- E. Provide Samples of each color, lettering style and other graphics for identification materials.

1.04 QUALITY ASSURANCE

- A. Provide new material supplied by a manufacturer producing identification systems.
- B. Comply to OSHA, NFPA 70 or local jurisdiction identification requirements for electrical systems.

PART 2 – PRODUCTS

2.01 NAMEPLATES

- A. Type NP, Engraved, plastic laminated labels, signs and instruction plates:
Engrave stock melamine plastic laminate 1/16 inch minimum thickness for signs

up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger sizes.
Furnish nameplates with pre-punched mechanical fastener mounting holes.

- B. Color and letter height as specified in part 3, Execution.

2.02 LEGEND PLATES

- A. Type LP: Die stamped metal legend plate with mounting hole and positioning key for motor control pilot devices, etc.
- B. Fill stamped characters using brass paint.

2.03 BRASS TAGS

- A. Type BT: Metal tags with die stamped legend, punched for fastener. Dimensions: 2 inch diameter, 19 gauge.

2.04 PANELBOARD DIRECTORIES (400 AMPERE OR LESS)

- A. Directories: Provide a 6 by 8 inch minimum size circuit directory frame and card with clear plastic covering inside the panel door.
- B. Circuit Numbering: Starting at the top, odd numbered circuits in sequence down the left hand side and even numbered circuits down the right hand side. For multi-section panelboards use continuous consecutive circuit numbers, for example Section 1 (circuit numbers 1-42), Section 2 (circuit numbers 43-84), Section 3 (circuit numbers 85-126).

2.05 WIRE AND TERMINAL MARKERS

- A. Provide self-adhering, pre-printed, machine printable or write-on, self laminating vinyl wrap around strips. Inscribe blank markers using the printer or pen recommended by manufacturer for this purpose. Thomas & Betts WSL, Brady B191 series, or equivalent.

2.06 CONDUCTOR PHASE MARKERS

- A. Colored vinyl plastic electrical tape, 3/4 inch wide, for identification of phase conductors. Scotch 35 Brand Tape or equivalent.

2.07 INSCRIBED DEVICE COVERPLATES

- A. Methods of Inscription: (Unless otherwise noted)
 1. Type-on tape:
 - a. Provide imprinted thermal transfer character onto tape labeling system.
 - b. Tape option – Use UV stable tape rated for indoor/outdoor applications. Use black image on clear tape cartridge. (Kroy industrial cartridge, or equivalent.)
- B. Embossed metallic or plastic tape is not acceptable for any application.

PART 3 – EXECUTION

3.01 GENERAL

- A. Degrease and clean surfaces to receive nameplates.

- B. Install nameplates parallel to equipment lines.
- C. Secure nameplates to equipment fronts using No.4 machine screws.

3.02 NAMEPLATES

A. Provide type NP color coded nameplates as applicable, with the following information:

- 1. Equipment or device designation.
- 2. Amperage, KVA or horsepower rating, where applicable.
- 3. Voltage or signal system name.
- 4. "Served from" identification with "Room Number".
- 5. Miscellaneous information as shown in "Examples".
- 6. Examples:

- a. Panels:
 - 2EH1
 - 225A
 - 277/480V, 3PH, 4W
 - Served From: 2EHD1 in Room 2045

- b. Motor Control Centers:

Main Nameplate:	Each Compartment
MCC-NH1	EF-1
600A Main Bus	20HP
480V, 3PH, 3W	Switch Size: 100A
Served From: HDD1A-2 in Room 2045	Starter Size: 1

- c. Disconnects or Individual Motor Starters.
 - EF-1
 - 20PH
 - 480V, 3PH, 3W
 - Served From: MCCNH-1 in Room 2045

B. Nameplates for power system distribution equipment and devices are to be colored as follows: (Unless otherwise noted)

- 1. 277/480 VAC Normal – Yellow with black letters
- 2. 120/208 VAC Normal – Blue with white letters

C. Provide minimum letter height as follows:

- 1. For Panelboards Motor Control Center: 1/2 inch letters to identify equipment designation. Use 1/4 inch letters to identify voltage, phase, wires.
- 2. For Individual Circuit Breakers, Switches and Motor Starters in Motor Control Centers use 3/8 inch letters to identify equipment designation. Use 1/8 inch letters to identify all other.
- 3. For Individual mounted, Disconnect switches, and motor starters use 3/8 inch letters to identify all equipment designation. Use 1/8 inch to identify all others.
- 4. For equipment cabinets, terminal cabinets, control panels, and other cabinet enclosed apparatus use 3/8 inch letters to identify equipment designation.

3.03 METAL LEGEND PLATES

- A. Provide panel mounted operators devices such as pilot lights, reset buttons, hand-off-auto switches, and other control devices.

3.04 BRASS TAGS

- A. Provide Type BT tags for individual ground conductors to exposed ground bus indicating connection. For example: "Ufer", "Cold water bond".

3.05 PANELBOARD DIRECTORIES (400 AMPERE OR LESS)

- A. Provide typewritten directories arranged in numerical order denoting loads served by room number or area for each circuit.
- B. Verify final room numbers or area designation with project manager.
- C. Mount panelboard directories in a minimum 6 by 8 inch metal frame under clear plastic inside every panelboard.

3.06 WIRE AND CABLE IDENTIFICATION

- A. Provide wire markers on each conductor in panelboard and motor control center gutters, pull boxes, outlet and junction boxes and at load connection. Identify with branch circuit or feeder number for power circuits and with control wire number as indicated on equipment manufacturer's shop drawings for control wiring.
- B. Provide colored phase markers for color coding noted in Section 16120 – Wires and Cables (600 Volts and Below). Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 3 inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Do not cover cable identification markers by taping.

3.07 JUNCTION BOX IDENTIFICATION

- A. Paint junction, pull and connection box covers, located below ceilings in non-public areas, using the color coding listed below.
- B. Use finish paint suitable for use on metal surfaces. Provide spray paint that complies with local VOC (Volatile Organic Compound) regulations. Acceptable paint manufacturers; One-Shot, Sem or equivalent.
- C. Legibly mark the painted covers using black permanent ink felt pen; identify circuit(s) contained I the box by circuit number(s) and panel designation.
- D. Color Coding:
 1. Normal 277/480 volt systems: Fluorescent yellow.
 2. Normal 120/208 volt systems: Fluorescent blue.

3.08 WARNING, CAUTION AND INSTRUCTION SIGNS

- A. Provide warning, caution, or instruction signs where required by OSHA, where indicated, or where reasonably required to assure safe operation and maintenance of electrical system and of the items to which they connect.

1. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation.
2. Provide polyester film (PPS) self-adhesive signs for indoor/outdoor equipment and door warning. Use rigid polyethylene (PRS) non-adhesive signs where adhesives will not work; for example, installing on a fence. Provide sign color and marking that meets OSHA regulations. For example, DANGER (red with white letters), HIGH VOLTAGE (white with black letters).
 - a. Use 2 by 4 inch signs for small equipment or enclosure doors.
 - b. Use 7 by 10 inch or 10 by 14 inch signs for large equipment or enclosure doors.

3.09 INSCRIBED DEVICE COVERPLATE

- A. General:
 1. Provide inscribed coverplates for all receptacles with panel circuit number (for example "HA1-16").
- B. Method of Inscription: Use imprinted thermal type-on-tape labels as follows:
 1. Use Kroy Duratype 240-SE labeling system.
 2. Lettering Type: Helvetica, 12 point or 1/8 inch high.
 3. Color of characters shall be black.
 4. Locate the top of the inscription ½ inch below the top edge of the coverplate.
 5. Install so the inscription is centered and square with coverplate.
 6. Labeling cartridge shall be exterior grade for industrial labeling environments. Other cartridge types are not acceptable.

3.10 RECEPTACLES

- A. Write the circuit number on the front side of the device body. Locate so that cover plate conceals number. Use a fine point black permanent marking pen. Identify by noting panelboard and circuit number; for example, "HA1-16".

3.11 NAMEPLATES

- A. Provide Owner with labeling equipment and accessories as follows:
 1. One Kroy Dura Type 240 SE labeling machine, or equivalent, complete with accessories such as battery charger and case.
 2. Four full tape cartridges, black image on clear tape, rated for exterior industrial use.

END OF SECTION

SECTION 16301 – UNDERGROUND ELECTRICAL WORK

PART 1 – GENERAL

1.01 SUMMARY

- A. Section 16010 - ELECTRICAL applies to this section with the additions and modifications specified herein.

1.02 APPLICABLE PUBLICATIONS

- A. The publications listed within this specification form a part of this specification to the extent referenced. Unless otherwise indicated, most recent edition of publication with current revisions and amendments will be enforced.

PART 2 – PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials and equipment shall conform to the respective specifications and standards and to the specifications herein. Electrical ratings shall be as indicated:
 - 1. Conduit:
 - a. Rigid Plastic Conduit: UL 651, Schedule 40 and 80 PVC.
 - 2. PVC Fittings: UL 651
 - 3. Pullstring: Pullstring shall be nylon pullstring having a minimum tensile strength of 200 lbs in each empty duct except those intended for telephone cabling.
 - 4. Grounding and Bonding Equipment: Shall conform to UL 467.
 - 5. Plastic Marking Tape: Plastic marking tape shall be acid and alkali-resistant polyethylene film, 6 inches wide with minimum thickness of 0.004 inch. Tape shall have a minimum strength of 1750 psi lengthwise and 1500 psi crosswise. The tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 3 feet deep. The tape shall be of a type specifically manufactured for marking and locating underground utilities. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion. Tape color shall be red for electric power system ductlines and orange for telephone/television/fire/communications systems ductlines.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Underground cable installation shall conform to NFPA 70 and ANSI C2.

1. Concrete: Concrete for electrical requirements shall be at least 3000 psi concrete with one-inch maximum aggregate conforming to the requirements of Division 3 of these specifications
2. Earthwork: Excavation, backfilling, and pavement for repairs for electrical requirements shall conform to the requirements of Division 2 of these specifications.
3. Underground Duct Direct Buried: Construct underground ductlines of individual conduits direct buried in trench. The conduit shall be of Schedule 80 PVC construction. The bank surrounding shall be rectangular in cross-section and shall provide at least 12 inches of earth between power duct and signal ducts.
 - a. Top of the conduit shall not be less than 24 inches below grade
 - b. Duct lines shall have a continuous slope downward toward handholes and away from buildings with a pitch of not less than 3 inches in 100 feet. Except at conduit risers, accomplish changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, by long sweep bends having a minimum radius of curvature of 25 feet. Sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 18 inches for use with conduits of less than 3 inches in diameter and a minimum radius of 36 inches for ducts of 3 inches in diameter or larger.
 - c. Terminate conduits in end-bells where duct lines enter handholes. Separators shall be of precast concrete, high impact polystyrene, steel, or any combination of these. Stagger the joints of the conduits by rows and layers so as to provide a duct line having the maximum strength. During construction, protect partially completed duct lines from the entrance of debris such as mud, sand and dirt by means of suitable conduit plugs. As each section of duct line is completed from handhole to handhole, draw a brush through having the diameter of the duct, and having stiff bristles until the conduit is clear of all particles of earth, sand, and gravel; then immediately install conduit plugs.
4. Cable Pulling: Pull cables down grade with the feed-in point at the handhole or buildings of the highest elevation. Use flexible cable feeds to convey cables through the handhole opening and into the duct runs. Cable slack shall be accumulated at each handhole or junction box where space permits by training the cable around the interior to form one complete loop. Minimum allowable bending radii shall be maintained in forming such loops.
 - a. Lubricants for assisting in the pulling of jacketed cables shall be those specifically recommended by the cable manufacturer. The lubricant shall not be deleterious to the cable sheath, jacket, or outer coverings.
 - b. Cable pulling tensions shall not exceed the maximum pulling tension recommended by the cable manufacturer.

5. Grounding: Non-current carrying metallic parts associated with electrical equipment shall have a maximum resistance to solid "earth" ground not exceeding the following values:
 - a. Grounds in handholes: 10 ohms
 - b. Grounded secondary distribution system neutral and non-current carrying metal parts associated with distribution systems and grounds not otherwise covered: 25 ohms
6. When work in addition to that indicated or specified is directed in order to obtain the specified ground resistance, the provisions of the contract covering "Changes" shall apply.
 - a. Grounding electrodes shall be cone pointed driven ground rods driven full depth less 6 inches, installed when indicated to provide an earth ground of the value before stated for the particular equipment being grounded.
 - b. Make grounding connections which are buried or otherwise normally inaccessible, and excepting specifically those connections for which access for periodic testing is required by exothermic type process. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which have "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. No mechanical connector is required at thermit weldments.
 - c. Grounding conductors shall be bare soft-drawn copper wire No. 6 AWG minimum unless otherwise indicated or specified.
7. Pullstring: Provide all empty conduits with a nylon rope or mule tape. Leave 48 inches of spare at each end of the pull.

3.02 UNDERGROUND CABLE IDENTIFICATION

- A. Cables shall be labeled at both ends.

3.01 FIELD TESTS

- A. Ground Rods: Test ground rods for ground resistance value before any wire is connected. Use a portable ground testing megger to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground electrode under test. Provide one copy of the megger manufacturer's directions for use of the ground megger indicating the method to be used.
- B. Test Report: Provide three copies of each test report to the Contracting Officer.
 1. Grounding Electrodes and Systems (identify electrodes and systems, each test).

END OF SECTION