

SECTION 01400

PROJECT SUSTAINABILITY REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

Section includes requirements for project compliance with the City of Livermore's Green Ordinance requirements for new construction. A copy of the checklist for the Project is attached. The Contractor shall be responsible to make sure the checklist requirements are fully complied with for the following activities:

- A. Site work including landscaping (Phase IA)
- B. Procurement and construction (Phase IB)
- C. Commissioning in accordance with the Commissioning specification section attached (Phase IB)
- D. Construction waste management in accordance with the Construction waste management specification section attached (Phase IB)
- E. Submittal of all documentation required by the City of Livermore Green Ordinance for items 1 through 4 above.
- F. Contractor shall review this section and include with the bid a list of exceptions to the requirements herein, if any.
- G. Contractor shall review this section and include with the bid a list of conflicts, if any, between the requirements herein and any other contract document, for Owner's resolution.

1.02 Related Sections:

- A. Comply with Section "Construction Waste Management".
- B. Comply with Section "Commissioning".

1.03 DEFINITIONS

- A. **Chain-of-Custody Certificates:** Certificates signed by manufacturers certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship." Certificates shall include evidence that manufacturer is certified for chain of custody by an FSC-FSC-accredited certification body.
- B. **LEED:** Leadership in Energy & Environmental Design.
- C. **Rapidly Renewable Materials:** Materials made from plants that are typically harvested within a 10-year or shorter cycle. Rapidly renewable materials include products made from bamboo, cotton, flax, jute, straw, sunflower seed hulls, vegetable oils, or wool.
- D. **Regional Materials:** Materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.

- E. **Regionally Manufactured Materials:** Materials that are manufactured within a radius of 500 miles from Project site. Manufacturing refers to the final assembly of components into the building product that is installed at Project site.
- F. **Regionally Extracted and Manufactured Materials:** Regionally manufactured materials made from raw materials that are extracted, harvested, or recovered within a radius of 500 miles from Project site.
- G. **Recycled Content:** The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.
- H. **"Post-consumer"** material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.
- I. **"Pre-consumer"** material is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.

1.04 SUBMITTALS

- A. General: submittals required to document Project Sustainability Requirements Checklist compliance may be in addition to submittals required by other specification sections. If submitted item is identical to that submitted to comply with other requirements, provide duplicate copies to verify compliance with indicated Project Sustainability Requirements Checklist requirements.
- B. Project Materials Cost Data: Provide statement indicating total cost for materials used for Project. Costs exclude labor, overhead, and profit. Include breakout of costs for the following categories of items:
 - a) Plumbing.
 - b) Mechanical.
 - c) Electrical.
 - d) Specialty items and equipment.
 - e) Wood-based construction materials.

1.05 Project Sustainability Action Plan: Provide a preliminary submittal within 14 days of date established for the Notice to Proceed indicating how the following requirements will be met:

- A. Waste management plan complying with Construction Waste Management for Project Sustainability Requirements Checklist compliance.
- B. Construction indoor-air-quality management plan.
- C. List of proposed salvaged and refurbished materials. Identify each material that will be salvaged or refurbished, including its source, cost, and replacement cost if the item was to be purchased new.

- D. List of proposed materials with recycled content. Indicate cost, post-consumer recycled content, and pre-consumer recycled content for each product having recycled content.
 - E. List of proposed regional materials. Identify each regional material, including its source, cost, and the fraction by weight that is considered regional.
 - F. List of proposed certified wood products. Indicate each product containing certified wood, including its source and cost of certified wood products.
- 1.06. Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with Project Sustainability Action Plan for the following:
- A. Waste reduction progress reports complying with "Construction Waste Management Compliance Checklist."
 - B. Receipts for salvaged and refurbished materials used for Project, indicating sources and costs for salvaged and refurbished materials.
 - D. Product data and certification letter indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.
 - E. Product data for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
 - F. Product data indicating location of material manufacturer for regionally manufactured materials. Include statement indicating cost for each regionally manufactured material and for each regionally manufactured material. Include statement indicating location of and distance from Project to point of extraction, harvest, or recovery for each raw material used in regionally extracted and manufactured materials.
 - G. Product data and chain-of-custody certificates for products containing certified wood. Include statement indicating cost for each certified wood product.
 - H. Product data for temporary filtration media.
 - I. Product data for filtration media used during occupancy.
- 1.07. Construction Documentation: Six photographs at three different times during the construction period, along with a brief description of the SMACNA approach employed, documenting implementation of the indoor-air-quality management measures, such as protection of ducts and on-site stored or installed absorptive materials.

Signed statement describing the building air flush-out procedures including the dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.

Product data for filtration media used during flush-out and during occupancy.

Product data for adhesives and sealants used inside the weatherproofing system indicating VOC content of each product used. Indicate VOC content in g/L calculated according to 40 CFR 59, Subpart D.

Product data for paints and coatings used inside the weatherproofing system indicating VOC content of each product used. Indicate VOC content in g/L calculated according to 40 CFR 59, Subpart D.

Product data for products containing composite wood or agrifiber products or wood glues indicating that they do not contain urea-formaldehyde resin.

PART 2 PRODUCTS

2.01 GENERAL

- A. Where products specified in any specification section do not support compliance with Project Sustainability Requirements Checklist, equivalent alternative products with equal or better performance shall be proposed with the bids.

2.02 SALVAGED AND REFURBISHED MATERIALS

- A. Provide salvaged or refurbished materials for a minimum of 1 percent of building materials (by cost).
- B. Provide salvaged or refurbished materials for a minimum of 5 percent of building materials (by cost).

2.03 RECYCLED CONTENT OF MATERIALS

- A. Provide building materials with recycled content such that post-consumer recycled content plus one-half of pre-consumer recycled content constitutes a minimum of 10 percent of cost of materials used for Project.
- B. Cost of post-consumer recycled content of an item shall be determined by dividing weight of post-consumer recycled content in the item by total weight of the item and multiplying by cost of the item.
- C. Cost of pre-consumer recycled content of an item shall be determined by dividing weight of pre-consumer recycled content in the item by total weight of the item and multiplying by cost of the item.

2.04 REGIONAL MATERIALS

- A. Provide a minimum of 10 percent of building materials (by cost) that are regional materials.

2.05 CERTIFIED WOOD

- A. Provide a minimum of 50 percent (by cost) of wood-based materials that are produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
- B. Wood-based materials include, but are not limited to, the following materials when made from wood, engineered wood products, or wood-based panel products:
 - 1. Rough carpentry.

2. Miscellaneous carpentry.
3. Heavy timber construction.
4. Metal-plate-connected wood trusses.
5. Structural glued-laminated timber.
6. Finish carpentry.
7. Architectural woodwork.
8. Wood cabinets.
9. Furniture.

2.06 LOW-EMITTING MATERIALS

A. For field applications that are inside the weatherproofing system, use adhesives and sealants that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D:

- Wood Glues: 30 g/L.
- Metal to Metal Adhesives: 30 g/L.
- Adhesives for Porous Materials (Except Wood): 50 g/L.
- Subfloor Adhesives: 50 g/L.
- Plastic Foam Adhesives: 50 g/L.
- Carpet Adhesives: 50 g/L.
- Carpet Pad Adhesives: 50 g/L.
- VCT and Asphalt Tile Adhesives: 50 g/L.
- Cove Base Adhesives: 50 g/L.
- Gypsum Board and Panel Adhesives: 50 g/L.
- Rubber Floor Adhesives: 60 g/L.
- Ceramic Tile Adhesives: 65 g/L.
- Multipurpose Construction Adhesives: 70 g/L.
- Fiberglass Adhesives: 80 g/L.
- Contact Adhesive: 80 g/L.
- Structural Glazing Adhesives: 100 g/L.
- Wood Flooring Adhesive: 100 g/L.
- Structural Wood Member Adhesive: 140 g/L.

2.07 Special Purpose Contact Adhesive (contact adhesive that is used to bond melamine covered board, metal, unsupported vinyl, Teflon, ultra-high molecular weight polyethylene, rubber or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.

- Top and Trim Adhesive: 250 g/L.
- Plastic Cement Welding Compounds: 250 g/L.
- ABS Welding Compounds: 325 g/L.
- CPVC Welding Compounds: 490 g/L.
- PVC Welding Compounds: 510 g/L.
- Adhesive Primer for Plastic: 550 g/L.
- Sheet Applied Rubber Lining Adhesive: 850 g/L.
- Aerosol Adhesive, General Purpose Mist Spray: 65 percent by weight.
- Aerosol Adhesive, General Purpose Web Spray: 55 percent by weight.

- 2.08 Special Purpose Aerosol Adhesive (All Types): 70 percent by weight.
- Other Adhesives: 250 g/L.
 - Architectural Sealants: 250 g/L.
 - Nonmembrane Roof Sealants: 300 g/L.
 - Single-Ply Roof Membrane Sealants: 450 g/L.
- 2.09 Other Sealants: 420 g/L.
Sealant Primers for Nonporous Substrates: 250 g/L.
Sealant Primers for Porous Substrates: 775 g/L.
Modified Bituminous Sealant Primers: 500 g/L.
- 2.10 Other Sealant Primers: 750 g/L.
- 2.11 For field applications that are inside the weatherproofing system, use paints and coatings that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D.
- Flat Paints, Coatings, and Primers: VOC not more than 50 g/L.
 - Nonflat Paints, Coatings, and Primers: VOC not more than 150 g/L.
 - Anticorrosive and Antirust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
 - Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
 - Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
- 2.12 Floor Coatings: VOC not more than 100 g/L.
- Shellacs, Clear: VOC not more than 730 g/L.
 - Shellacs, Pigmented: VOC not more than 550 g/L.
- 2.13 Stains: VOC not more than 250 g/L.
Do not use composite wood or agrifiber products or adhesives that contain urea-formaldehyde resin.

PART 3 EXECUTION

- 3.01 **GENERAL:** Where the methods of execution specified in any specification section do not support compliance with Project Sustainability Requirements Checklist, alternative methods with equal or better performance shall be proposed with the bids.
- 3.02 **CONSTRUCTION INDOOR-AIR-QUALITY MANAGEMENT:**
- A. Comply with SMACNA's "SMACNA IAQ Guideline for Occupied Buildings under Construction."
 - B. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Division 1 Section "Temporary Facilities and Controls," install filter media having a MERV 8 according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.
 - C. Replace all air filters immediately prior to occupancy.

- D. After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total volume of 14000 cu. ft. of outdoor air per sq. ft. of floor area while maintaining an internal temperature of at least 60 deg F and a relative humidity no higher than 60 percent.
- E. Project's mechanical engineer of record should verify that HVAC system design and equipment indicated are capable of delivering flush-out indicated, and provide HVAC system and equipment operating information necessary to achieve credit. If Project HVAC systems and equipment cannot suit requirement, consider requiring temporary systems and equipment.
- F. If occupancy is desired prior to flush-out completion, the space may be occupied following delivery of a minimum of 3500 cu. ft. of outdoor air per sq. ft. of floor area to the space. Once a space is occupied, it shall be ventilated at a minimum rate of 0.30 cfm per sq. ft. of outside air or the design minimum outside air rate required otherwise, whichever is greater. During each day of the flush-out period, ventilation shall begin a minimum of three hours prior to occupancy and continue during occupancy. These conditions shall be maintained until a total of 14000 cu. ft./sq. ft. of outside air has been delivered to the space.
- F. Mech. Engineer will provide operating procedure for each HVAC system and piece of equipment and the operating duration required for flush-out.
- G. Air-Quality Testing:
 - 1. Conduct baseline indoor-air-quality testing, after construction ends and prior to occupancy, using testing protocols consistent with the EPA's "Compendium of Methods for the Determination of Air Pollutants in Indoor Air," (EPA standard referenced in first subparagraph below is available from NTIS by calling (800) 553-6847 with PB90200288 ordering number).
 - 2. Demonstrate that the contaminant maximum concentrations listed below are not exceeded:
 - Formaldehyde: 50 ppb.
 - Particulates (PM10): 50 micrograms/cu. m.
 - Total Volatile Organic Compounds (TVOC): 500 micrograms/cu. m.
 - 4-Phenylcyclohexene (4-PH): 6.5 micrograms/cu. m.
 - Carbon Monoxide: 9 ppm and no greater than 2 ppm above outdoor levels.
 - 3. For each sampling point where the maximum concentration limits are exceeded, conduct additional flush-out with outside air and retest the specific parameter(s) exceeded to indicate the requirements are achieved. Repeat procedure until all requirements have been met. When retesting noncomplying building areas, take samples from same locations as in the first test.
 - 4. Air-sample testing shall be conducted as follows:

- a) All measurements shall be conducted prior to occupancy but during normal occupied hours, and with building ventilation system starting at the normal daily start time and operated at the minimum outside air flow rate for the occupied mode throughout the duration of the air testing.
- b) Building shall have all interior finishes installed including, but not limited to, millwork, doors, paint, carpet, and acoustic tiles. Nonfixed furnishings such as workstations and partitions are encouraged, but not required, to be in place for the testing.
- c) Number of sampling locations will vary depending on the size of building and number of ventilation systems. For each portion of building served by a separate ventilation system, the number of sampling points shall not be less than one per 25,000 sq. ft. or for each contiguous floor area, whichever is larger, and shall include areas with the least ventilation and greatest presumed source strength.
- d) Air samples shall be collected between 3 and 6 feet from the floor to represent the breathing zone of occupants, and over a minimum four-hour period.

END OF SECTION

SECTION 01515

CONSTRUCTION WASTE MANAGEMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Construction waste management, complying with City of Livermore Green Ordinance Requirements for New Construction.
- B. The Construction Waste Management shall include but not limited to the following:
 - a. Salvaging nonhazardous construction waste.
 - b. Recycling nonhazardous construction waste.
 - c. Disposing of nonhazardous construction waste.
 - d. Other construction waste item as required by the City of Livermore or USGBC or other prevailing industry practice

1.02 Related Sections:

- A. Comply with Section "Project Sustainability Requirements".
- B. Comply with Section "Commissioning".

1.03 DEFINITIONS

- A. **Construction Waste:** Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. **Disposal:** Removal off-site of construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
- C. **Recycle:** Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- D. **Salvage:** Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- E. **Salvage and Reuse:** Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.04 PERFORMANCE REQUIREMENTS

- A. General: Develop a waste management plan that results in end-of-Project rates for salvage/recycling of at least 75 percent by weight of total waste generated by the Work, including the following materials.
- B. Construction Waste:
 - Site-clearing waste.
 - Masonry and CMU.
 - Lumber.

- Wood sheet materials.
 - Wood trim.
 - Metals.
 - Roofing.
 - Insulation.
 - Carpet and pad.
 - Gypsum board.
 - Piping.
 - Electrical conduit.
- C. Packaging: Regardless of salvage/recycle goal indicated above, salvage or recycle 100 percent of the following uncontaminated packaging materials:
- Paper.
 - Cardboard.
 - Boxes.
 - Plastic sheet and film.
 - Polystyrene packaging.
 - Wood crates.
 - Plastic pails.
 - Other materials as required.

1.05 SUBMITTALS

- A. Waste Management Plan: Submit 3 copies of plan within 30 days of date established for the Notice to Proceed.
- B. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit three copies of report. Include the following information:
- Material category.
 - Generation point of waste.
 - Total quantity of waste in tons.
 - Quantity of waste salvaged, both estimated and actual in tons.
 - Quantity of waste recycled, both estimated and actual in tons.
 - Total quantity of waste recovered (salvaged plus recycled) in tons.
 - Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
- C. Waste Reduction Calculations: Before request for Substantial Completion, submit three copies of calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
- D. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
- E. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.
- F. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities

licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

- G. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- H. Waste management statement, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements of the City of Livermore for the credit have been met.
- I. Qualification Data: For Waste Management Coordinator.

1.06 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Waste Management Conference: Conduct conference at Project site and review methods and procedures related to waste management including, but not limited to, the following:
- C. Review and discuss waste management plan including responsibilities of Waste Management Coordinator.
- D. Review requirements for documenting quantities of each type of waste and its disposition.
- E. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
- F. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
- G. Review waste management requirements for each trade.

1.07 WASTE MANAGEMENT PLAN

- A. General: Develop plan consisting of waste identification, waste reduction work plan, and cost/revenue analysis. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
- B. Waste Identification: Indicate anticipated types and quantities of site-clearing and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.
- C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
- D. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
- E. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.

- F. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
- G. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
- H. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
- I. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location on Project site where materials separation will be located.
- J. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Include the following:
 - K. Total quantity of waste.
 - L. Estimated cost of disposal (cost per unit). Include hauling and tipping fees and cost of collection containers for each type of waste.
 - M. Total cost of disposal (with no waste management).
 - N. Revenue from salvaged materials.
 - O. Revenue from recycled materials.
 - P. Savings in hauling and tipping fees by donating materials.
 - Q. Savings in hauling and tipping fees that are avoided.
 - R. Handling and transportation costs. Include cost of collection containers for each type of waste.
 - S. Net additional cost or net savings from waste management plan.
 - T. Forms: Prepare waste management plan on forms acceptable to City of Livermore.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.01. PLAN IMPLEMENTATION

- A. General: Implement waste management plan as approved by Owner. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
- B. Comply with Specification Section "Temporary Facilities and Controls" for operation, termination, and removal requirements.
- C. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site full time for duration of Project.
- D. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project

site.

- E. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- F. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- G. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
- H. Comply with Specification Section "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.02 RECYCLING CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.
- C. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical.
- D. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
- E. Inspect containers and bins for contamination and remove contaminated materials if found.
- F. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
- G. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
- H. Store components off the ground and protect from the weather.
- I. Remove recyclable waste off Owner's property and transport to recycling receiver or processor.

3.03 RECYCLING CONSTRUCTION WASTE

- A. Packaging:
 - 1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
 - 2. Polystyrene Packaging: Separate and bag materials.
 - 3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.

4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.
- B. Wood Materials:
1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
 2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.
 3. Gypsum Board: Stack large clean pieces on wood pallets and store in a dry location.
 4. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

3.04 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill acceptable to authorities having jurisdiction.
- B. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
- C. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- D. Burning: Do not burn waste materials.
- E. Disposal: Transport waste materials off Owner's property and legally dispose of them.

END OF SECTION

SECTION 01810

FUNDAMENTAL COMMISSIONING OF BUILDING ENERGY SYSTEMS

PART 1 - GENERAL

1.01 CONDITIONS AND REQUIREMENTS

- A. The General Conditions, Supplementary Conditions, and Division 1 - General Requirements of the Contract Documents are hereby made a part of this Section of the specifications as fully as if repeated herein.

1.02 DESCRIPTION OF WORK

- A. Fundamental commissioning of the following building energy systems complying with City of Livermore requirements for LEED for New Construction v2.2, Credit EA1.
1. Heating, ventilating and air conditioning (HVAC) systems and associated controls
 2. Lighting and daylighting controls.
 3. Domestic hot water systems.
 4. Site lighting and controls.
- B. Related Section:
1. Comply with Section 01400 - "Project Sustainability Requirements".
 2. Requirements of Division-15 & Division-16 drawings and specifications.
 3. Architectural, Civil & Landscape drawings and specifications.
 4. Title-24 compliance requirements.
 5. City of Livermore requirements for LEED for New Construction v2.2, Credit EA1 and checklist of targeted LEED points.

1.03 DEFINITIONS

- A. **Acceptable Performance:** That level of performance, by equipment and systems meets the standards s defined by the equipment/system's manufacturer, and the construction contract documents. "Acceptable Performance" is confirmed through Pre-functional and Functional testing.

- B. **BoD:** Basis of Design. A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.
- C. **Commissioning:** The process to demonstrate to the Owner that systems and equipment including mechanical, electrical, controls, and other special systems, function individually, and as a system, properly to meet performance requirements established in the Contract Documents.
- D. **Commissioning Process:** The process of demonstrating to the Owner that systems are installed, functionally tested and capable of being operated and maintained to perform in conformity with the construction documents and manufacturer's standards. The commissioning process encompasses and coordinates the traditionally separate functions of equipment start-up, control system calibration, testing and balancing acceptance, performance testing, system documentation and training.
- E. **Commissioning Plan:** A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- C. **CxA:** Commissioning Authority; the designated person on the Contractor's team who plans, schedules, and coordinates the commissioning team to implement the commissioning process.
- D. **OPR:** Owner's Project Requirements. A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.
- E. **Systems, Subsystems, Equipment, and Components:** Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.04 COMMISSIONING TEAM

- A. **Members Appointed by Contractor:** Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action, including the Commissioning Authority (CxA). The commissioning team shall consist of, but not be limited to, representatives of Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.
- B. **Members Appointed by Owner:**
- C. **Engineering design professionals.**

1.05 OWNER'S RESPONSIBILITIES

- A. **Provide the OPR documentation to the CxA and Contractor for information and use.**
- B. **Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.**

- C. Provide the BoD documentation, prepared by the Engineer and approved by Owner, to the CxA and Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

1.06 CONTRACTOR'S RESPONSIBILITIES

- A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
- B. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
- C. Cooperate with the CxA for resolution of issues recorded in the Issues Log.
- D. Attend commissioning team meetings held on a weekly basis.
- E. Integrate and coordinate commissioning process activities with construction schedule.
- F. Review and accept construction checklists provided by the CxA.
- G. Complete electronic construction checklists as Work is completed and provide to the Commissioning Authority on a weekly basis.
- H. Review and accept commissioning process test procedures provided by the Commissioning Authority.
- I. Complete commissioning process test procedures.

1.07 CxA'S RESPONSIBILITIES

- A. Organize and lead the commissioning team.
- B. Provide commissioning plan.
- C. Convene commissioning team meetings.
- D. Provide Project-specific construction checklists and commissioning process test procedures.
- E. Verify the execution of commissioning process activities using random sampling. The sampling rate may vary from 1 to 100 percent. Verification will include, but is not limited to, equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the OPR. When a random sample does not meet the requirement, the CxA will report the failure in the Issues Log.
- F. Prepare and maintain the Issues Log.
- G. Prepare and maintain completed construction checklist log.
- H. Witness systems, assemblies, equipment, and component startup.
- I. Compile test data, inspection reports, and certificates; include them in the systems manual and commissioning process report.

PART 2 - PRODUCTS

2.1 HVAC SYSTEMS TO BE COMMISSIONED

- A. HVAC systems installed under this contract are to be inspected, tested, signed off as complete and operational, and operated for commissioning agency verification as described in Part 3 of this Section. This includes, but is not necessarily limited to the work listed for each system. The foregoing includes all the following:
- a) AC-C-1 through AC-C-6: Including relief fans, automatic control dampers, temperature control, outside air economizer operation, outside air verification, carbon dioxide sensor activated demand control ventilation. Verifying the operation in heating and cooling modes, minimum & maximum heating and cooling operation, etc. Requires factory start-up and commissioning and documentation.
 - b) Exhaust fans EF-C-1 thru EF-C-3 operation.
 - c) Fire-Smoke Dampers (FSDs): Verify that the FSD is installed, controlled and operating properly per the manufacturer listing and per applicable Code.
 - d) Verify that the units are seismically anchored and all the utilities are installed (power, controls, gas, condensate drain, ductwork) supported and braced to the structure properly.
 - e) Domestic Hot Water system including the Water Heater (WH-1), tempering control valve operation and heat tracing or water recirculating systems.

2.2 PRE-FUNCTIONAL PERFORMANCE TEST

- A. Hot water – work includes installation inspections and checks; pressure tests and documentation; expansion tanks; confirmation of flow balancing completion; seismic restraints installation certification. Refer to Functional Performance Test checklist #X in 2.3.
- B. Duct and Air-Handling systems – work includes (AC units & Exhaust Fans) installation inspections and checks; confirmation of flow balancing completion; leak testing as applicable; seismic restraints installation certification. checkout and startup by manufacturer's representative; documented performance measurements including capacity, evaporator and condenser air flows, static pressures & temperatures, motor amperage, operation of all controls, and sound levels. Refer to Systems Verification checklist #X in 2.2. 10.
- C. Water Heaters: Work includes installation inspections and checks (including seismic restraints installation certification); checkout and startup by manufacturer's representative; documented performance measurements including combustion efficiency, capacity test, burner and

controls operation, verification of thermostatic mixing (tempering valve), water temperature maintenance system, thermal insulation, etc.. Refer to System Verification checklist #X in 2.2.

- D. Supply, Return, Relief and Exhaust Fans – Work includes checks on installation (including seismic restraints, dampers and other accessories), rotation, sound levels, motor current draw, and airflows and pressures. Refer to System Verification checklists #X through #Y in 2.2.

The contractor shall be responsible for carrying out all work required for commissioning these systems that is defined as a contractor responsibility in Part 3 of this Section.

2.3 SYSTEM VERIFICATION CHECKLISTS

This specification contains the system verification checklists as listed below:

1. Rooftop packaged air-handling unit, gas heat/DX cool units
2. Return fan
3. Exhaust fan
4. Domestic hot water system
5. Exterior & interior lighting

Refer to Attachment -A for the checklist

2.4 FUNCTIONAL PERFORMANCE TEST CHECKLISTS

This specification contains functional performance test checklists. Refer to paragraph 2.1 for the equipment and systems that require performance test.

2.5 MEMBERS OF THE COMMISSIONING TEAM

The commissioning team will consist of representatives of the following:

1. Owner's Representative or Construction Manager (O)
2. Architect & Engineers of Record (AE)
3. Commissioning agency (CA)
4. General Contractor (GC)
5. Mechanical (Div. 15) contractor, Includes Plumbing, Fire Protection (M).
6. Electrical (Div. 16) contractor (E)
7. Controls contractor (ATC)
8. Testing, Adjusting, and Balancing Agency (TAB)

During the commissioning process, participation of team members will generally be required as noted in the following table (with abbreviations as noted in brackets in the preceding list of team members). The mechanical contractor, indicated by "M", includes all mechanical subcontractors or suppliers whose participation is required for commissioning a particular system or piece of equipment.

EQUIPMENT/SYSTEM DESCRIPTION

Hot Water Heater - CA, GC, O, M
Rooftop AC units – CA, GC, O, A/E, M, E, TAB, ATC
Exhaust fan - CA, GC, O, M, E, TAB, ATC
Lighting - CA, GC, O, A/E, E

PART 3 – EXECUTION

3.1 COMMISSIONING RESPONSIBILITIES – NON-CONTRACTOR TEAM MEMBERS

- A. Introduction: As noted in 2.2, a multi-disciplinary team carries out commissioning. The commissioning responsibilities of some non-contractor team members during the construction and acceptance phases of the project are provided here for information, and to provide some context for the overall process.
- B. Commissioning Agency Responsibilities: The commissioning agency will:
- Plan, organize and implement the commissioning process as specified herein,
 - Prepare the commissioning plan, and ensure its distribution for review and comment,
 - Revise the commissioning plan as required during construction,
 - Chair commissioning meetings, and prepare and distribute minutes to all commissioning team members, whether or not they attended the meeting,
 - In conjunction with the General Contractor, coordinate commissioning activities among all contractors, sub-trades and suppliers,
 - Monitor system verification checks, and ensure the results are documented as the checks are done,
 - Monitor controls point-to-point checks done by the controls contractor, and ensure the results documented as the checks are done,
 - Observe all start-ups and initial system operations tests and checks,
 - Direct the contractors to operate equipment and systems as required to ensure that all required functional performance tests are carried out for verification purposes,
 - Witness all functional performance tests and document the results,
 - Prepare and submit a Commissioning Report which documents all checks and tests done throughout the Commissioning process, and the results obtained from each, and

- Ensure all required O&M manuals, instructions and demonstrations are provided to the Owner's designated operating staff.

C. Mechanical Engineer Responsibilities:

- The Mechanical Engineer will review the Commissioning Plan, and will participate, as appropriate, in on-site commissioning meetings.
- During the acceptance phase of the commissioning process, the Mechanical Engineer may be on site to review commissioning documentation, to witness functional performance tests, and to analyze the installation and its performance.

D. Owner's Responsibilities:

- The Owner will ensure the availability of operating staff for all scheduled instruction and demonstration sessions. This staff will possess sufficient skills and knowledge to operate and maintain the installation following attendance at these sessions.
- The Owner will also ensure the appropriate involvement of the

E. Electrical Engineer, Architect, and any other consultants as required, in the commissioning process.

3.2 COMMISSIONING RESPONSIBILITIES – GENERAL CONTRACTOR

The General Contractor has responsibility to ensure the overall completion of the Work. In this regard, he shall:

1. Participate as required in the HVAC commissioning process,
2. Ensure the Mechanical Contractor performs all assigned HVAC commissioning responsibilities as specified in 3.3,
3. Ensure the testing, adjusting and balancing agency performs HVAC commissioning responsibilities as listed in 3.4,
4. Ensure the Electrical Contractor performs all assigned HVAC commissioning responsibilities as specified in 3.6,
5. Ensure the cooperation and participation in the HVAC commissioning process of all other sub-contractors as applicable.

The General Contractor shall assign a representative to the commissioning team, and submit the person's name to the commissioning agency, within one (1) month of the award of the contract.

The representative shall have the authority to make decisions on behalf of the general contractor as they relate to the organization and scheduling of HVAC commissioning. The representative shall facilitate communications among all

contractors and suppliers and other commissioning team members, and shall foster the necessary cooperative action. One specific responsibility shall be to attend commissioning meetings, and ensure action items arising from them are attended to as required to allow the commissioning process to proceed on schedule.

In the event that any scheduled equipment or system start-ups or functional performance tests are terminated because the CA or the mechanical engineer discover deficient or incomplete work, or due to the non-attendance of required contractor or supplier personnel, the contractor or sub-contractor responsible for the termination shall also be responsible for paying reasonable costs of time and travel expenses of any or all of the following representatives who were physically present for the purpose of witnessing the start-up or the FPT: the CA, the mechanical engineer, the electrical engineer, and the owner. The owner may provide a statement to the General Contractor identifying the specific activity that was terminated, the scheduled date, and a list of those in attendance, along with their reasonable time and travel expense costs.

3.3 COMMISSIONING RESPONSIBILITIES – DIVISION 15 (MECHANICAL) CONTRACTOR

The mechanical contractor, and all the sub-contractors and suppliers within Division 15, shall cooperate with the commissioning agency (CA), and other commissioning team members, to facilitate the successful completion of the commissioning process.

The contractor shall assign a representative to the commissioning team, and submit the person's name to the commissioning agency, within one (1) month of the award of the contract. The representative shall have the authority to make decisions on behalf of the mechanical contractor as they relate to the organization and scheduling of HVAC commissioning. The representative shall ensure communications between Division 15 contractors and suppliers and all other commissioning team members, and shall foster the necessary cooperative action. One specific responsibility shall be to attend commissioning meetings, and ensure action items arising from them are attended to as required to allow the commissioning process to proceed on schedule.

The Mechanical Contractor, and all mechanical sub-contractors and suppliers, shall cooperate with the Commissioning Agency in carrying out the HVAC commissioning process. In this context, the Mechanical Contractor shall:

1. Each contractor and sub-contractor in this division shall include in their quotes the cost of participating in the commissioning process as specified herein.
2. Ensure the automatic temperature controls (ATC) contractor performs HVAC commissioning responsibilities as listed in 3.5.
3. Provide instruction and demonstrations for the Owner's designated operating staff, in conjunction with the commissioning agency and

- mechanical engineer, and with the participation of qualified technicians from major equipment suppliers and the controls contractor.
4. Include requirements for submittal data, O&M data, and training information in each purchase order or sub-contract written.
 5. Ensure cooperation and participation of specialty sub-contractors such as sheet metal, piping, refrigeration, and water treatment as applicable.
 6. Ensure participation of major equipment manufacturing in appropriate start-up, testing and training activities.
 7. Attend HVAC commissioning meetings scheduled by the CA.
 8. Notify the CA a minimum of two weeks in advance of scheduled equipment and system start-ups, so that the CA may witness system verifications, and equipment and system start-ups.
 9. Provide sufficient personnel to assist the CA as required during system verification and functional performance testing.
 10. Prior to start-up, inspect, check and confirm the correct and complete installation of all equipment and systems for which system verification checklists are included in the commissioning plan. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory and the system is ready for safe startup.
 11. Notify the CA a minimum of two weeks in advance, of the time for start of the TAB work. Attend the initial TAB meeting for review of the TAB procedures.
 12. Provide equipment and systems start-up resources as specified and required. If during an attempted equipment or system start-up, deficient or incomplete work is discovered that would preclude safe operation, the start-up shall be aborted until corrective action has been taken. Ensure such action is taken and verified before re-scheduling a new start-up. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.2 in this Section.
 13. Carry out performance checks to ensure that all equipment and systems fully functional and ready for the CA to witness formal functional performance tests (FPTs).
 14. Operate equipment and systems for FPTs in accordance with the commissioning plan and as directed by the commissioning agency. If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.2 in this Section. Ensure that all corrections necessary for full and complete system operation as specified are completed; then with the ATC contractor and other applicable sub-contractors, carry out functional performance checks to confirm correct operation before applying to the CA to reschedule the FPTs for the system in question.
 15. Prepare preliminary schedule for mechanical system orientation and inspections. O & M manual submission, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up TAB, and task

completion for use by the CA. Update schedule as appropriate throughout the construction period.

16. Attend initial O&M staff training session.
17. Conduct mechanical system orientation and inspection at the equipment placement completion stage.
18. Update drawings to as-built condition and review with the CA.
19. Gather O & M data on all equipment, and assemble in binders as required by the commissioning specification. Submit to CA prior to the completion of construction.
20. Participate in, and schedule vendors and contractors to participate in the O&M staff training sessions as set up by the CA.
21. Provide written notification to the general contractor [or construction manager] and CA that the following work has been completed in accordance with the contract documents and the equipment, systems and sub-systems are operating as required.
 - HVAC equipment including all fans, air handling units, dehumidification units, ductwork, dampers, terminals and all Division 15 equipment.
 - Refrigeration equipment, pumping systems and heat rejection equipment.
 - Fire stopping in the fire rated construction, including fire and smoke damper installation, caulking, gasketing and sealing of smoke barriers.
 - Seismic restraints installed to specification; a certification from the seismic restraint engineer meets this requirement.
 - Dedicated smoke control systems including stairway pressurization and atrium systems.
 - Non-dedicated systems using the air-handling units for smoke control.
 - Fire detection and smoke detection devices furnished under other divisions of this specification as they affect the operation of the smoke control systems.
 - That the building control system is functioning to control mechanical equipment and smoke control systems as specified.
22. Provide a complete set of as-built drawings and O & M manuals to the CA.

3.4 COMMISSIONING RESPONSIBILITIES – TAB AGENCY

With respect to HVAC commissioning, the TAB agency shall:

1. Include costs for HVAC commissioning requirements in the quoted price.
2. Attend commissioning meetings scheduled by the CA prior to, and during, on-site TAB work being done.
3. Submit proposed TAB procedures to the CA and mechanical engineer for review and acceptance.

4. Attend the TAB planning meeting scheduled by the CA. Be prepared to discuss the procedures that shall be followed in testing, adjusting and balancing the HVAC system.
5. At the completion of the TAB work, submit the final TAB report to the general contractor [or construction manager], with copies to the Owner, CA and mechanical engineer.
6. Participate in verification of the TAB report by the CA for verification or diagnostic purposes. This will consist of repeating a sample (normally 10% to 20%) of the measurements contained in the TAB report as directed by the CA.
7. Participate in O & M personnel training sessions as scheduled by the CA.

3.5 COMMISSIONING RESPONSIBILITIES – CONTROLS CONTRACTOR

With respect to HVAC commissioning, the controls contractor shall:

1. Include cost for commissioning requirements in the quoted price.
2. Review design for controllability with respect to equipment selected for the project;
 - Review and confirm in writing that a proper hardware specification exists to permit functional performance testing as required by specification and sequence of operation.
 - Review and confirm in writing that proper safeties and interlocks are included in design.
 - Ensure the proper sizing of control valves and actuators, based on design pressure drops. Ensure that control valve authority will result in capacity control as specified. Include valve sizing and authority information in submittal to mechanical engineer.
 - Ensure the proper sizing of control dampers. Ensure damper authority to control air flows as specified. Review and confirm in writing proper damper positioning for mixing to prevent stratification. Ensure correct actuator vs. damper movement for smooth operation. Include damper sizing, control authority and actuator selection data in submittal to mechanical engineer.
 - Ensure the proper selection of sensor ranges, and include data with submittal to mechanical engineer.
 - Clarify all questions concerning sequences of operation with the mechanical engineer.
3. Attend commissioning meetings scheduled by the CA.
4. Provide the following submittals to the CA for review;
 - Hardware and software submittals.
 - Control panel construction shop drawings.
 - Diagrams showing all control points, sensor locations, point names, actuators, controllers and where necessary, points of access, all superimposed on diagrams of the physical equipment.
 - Narrative description of all control sequences for each piece of equipment controlled.
 - Logic diagrams showing the logic flow of all control sequences.

- A list of all control points, including analog inputs, analog outputs, digital inputs and digital outputs. Include the values of all parameters for each system point. Provide a separate list for each stand-alone control unit.
 - A complete control language program listing including all software routines employed in operating the control system. Also provide a program write-up, organized in the same manner as the control software. This narrative shall describe the logic flow of the software and the functions of each routine and sub-routine. It should also explain individual math or logic operations that are not clear from reading the software listing.
 - Hardware operation and maintenance manuals.
 - Application software and project applications code manuals.
5. Inspect, check, and confirm the proper installation and performance of controls/BAS hardware and software provided by others.
 6. Integrate installation and programming scheduling with construction and commissioning schedules.
 7. Inspect, check and confirm the correct installation and operation of input and output field points and devices through documented and signed off point-to-point checkouts.
 8. Provide thorough training to operating personnel on hardware operations and programming, and the application program for the system, in accordance with the O&M staff training program in the commissioning plan.
 9. In conjunction with the mechanical contractor, demonstrate system performance to the CA including all modes of system operation (e.g. occupied, unoccupied, emergency) during the functional performance tests (FPTs). If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.2 in this Section.
 10. Provide control system technician to assist during system verification and functional performance testing.
 11. Provide support and coordination with TAB contractor on all interfaces between controls and TAB scopes of work. Provide, at no additional cost to the TAB and commissioning agencies, all devices, such as portable operator's terminals and all software for the TAB agency to use in completing TAB procedures.
- 3.6 COMMISSIONING RESPONSIBILITIES – ELECTRICAL (DIVISION 16)
CONTRACTOR

With respect to HVAC commissioning, the electrical contractor shall:

1. Include cost for HVAC commissioning requirements in the quoted price.
2. Review design with respect to providing power to the HVAC equipment;
 - Verify that proper hardware specifications exist for functional performance and sequence of operation required by specification.

- Verify that proper safeties and interlocks are included in the design of electrical connections for HVAC equipment.
- 3. Attend commissioning meetings scheduled by the CA.
- 4. Schedule work so that required electrical installations are completed, and systems verification checks and functional performance tests can be carried out on schedule.
- 5. Inspect, check and confirm in writing the proper installation and performance of all electrical services provided.
- 6. Provide electrical system technicians to assist during system verification and functional performance testing as required by the CA.

END OF SECTION

SECTION 16010 – ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.1 CONDITIONS AND REQUIREMENTS

- A. Refer to the General Conditions, Supplementary General Conditions and Division 1 – General Requirements. The Contractor, having read the same and being familiar with the contents, shall be responsible for and governed by all requirements thereunder. This SECTION applies to all SECTIONS of DIVISION 16000.

1.2 CORRELATION, INTERPRETATION AND INTENT OF CONTRACT DOCUMENTS

- A. It is the intent of the Specifications and Drawings to describe a completed project to be performed under the Contract.
- B. The Contract Documents are complementary, what is called for by one is as binding as if called for by all. If the Contractor finds a conflict, error or discrepancy in the Contract Documents, he shall call it to the Architect's attention in writing before proceeding with the work affected thereby. Any work that may reasonably be inferred from the Specifications or Drawings as being required to produce the intended result shall be supplied whether or not it is specifically called for. Work, materials or equipment described in words which so applied have a well-known technical or trade meaning shall be deemed to refer to such recognized standards. The Contractor assumes full responsibility for having familiarized himself with the nature and extent of the Contract Documents, work, locality and local conditions that may in any manner affect the work to be done.
- C. The Drawings are, in general, made to scale and the Contractor may obtain approximate distances and dimensions by scaling the Drawings. It is distinctly understood, however, that he does so entirely on his own responsibility. The accuracy of the Drawings is not guaranteed. Refer to Architect's Drawings, Specifications and Room Schedules for construction details which will affect this work and equipment. Examine the Plumbing, Heating and Ventilating Drawings and Specifications to ensure that this work does not conflict with the above trades. Mechanical and Electrical Drawings are largely schematic and, therefore, do not necessarily represent the exact installations; it shall remain the Contractor's responsibility to cover all conditions on his prepared Shop Drawings and by arrangement in the field.

1.3 REGULATIONS

- A. The Contractor shall give all notices and comply with all laws, ordinances, rules and regulations applicable to the work and safety. These authorities include, but are not limited to:
 - 1. The latest revision of the State of California Electrical Code
 - 2. The applicable Rules and Regulations of the National Fire Protection Association
 - 3. State Fire Marshal
 - 4. The National Electric Code
 - 5. Any other applicable Federal, State, County or City Codes or Regulations, including OSHA
- B. Nothing in these Drawings or Specifications shall be construed to permit work not conforming to the above Regulations and Codes.

1.4 PERMITS, LAWS AND TAXES

- A. The Contractor shall secure and pay for all permits, licenses, inspection fees and all governmental and public utility charges necessary for the completion of the work. See DIVISION 1.

1.5 EXAMINATION OF SITE

- A. The Contractor shall examine the site and familiarize himself with the existing conditions and make allowances therefore in preparing his proposal. He shall verify existing conditions, and in the event of discrepancies between existing conditions and the Drawings, the Contractor shall bid new conditions, wires and necessary equipment in order to complete the job and

provide a fully operable and acceptable system. Extras will not be allowed for work not indicated or noted on the Drawings and/or required in Specifications when such work is apparent from an inspection of the premises at that time.

1.6 DRAWINGS AND SPECIFICATIONS

- A. All Drawings and all DIVISIONS of these Specifications shall be considered as a whole and work of this DIVISION shown anywhere therein shall be furnished under this DIVISION.
- B. Drawings are diagrammatic and indicate the general arrangement of equipment and wiring. Exact requirements shall be governed architectural, structural and mechanical conditions of the job. Consult all other drawings in preparation of the bid. Extra lengths of wiring or addition of pull or junction boxes, etc., necessitated by such conditions shall be included in the bid. Check all information and report any apparent discrepancies before submitted bid.
- C. Right is reserved to make changes of up to ten feet in location of any outlet or equipment prior to roughing-in without increasing contract cost.

1.7 SAFETY AND INDEMNITY

- A. Safety: The Contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. See DIVISION 1 and General Conditions.
- B. No act, service, drawing review or construction review by the Owner, the Architect, the Engineers or their Consultants is intended to include review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.

1.8 RECORD DRAWINGS

- A. See DIVISION 1.

1.9 GUARANTEE

- A. See DIVISION 1.

PART 2 PRODUCTS

2.1 MATERIAL APPROVAL

- A. The design, manufacture and testing of electrical equipment and materials shall conform to or exceed latest applicable NEMA, IEEE and ANSI standards.
- B. All materials must be new and bear UL label. Materials that are not covered by UL testing standards shall be tested and approved by an independent testing laboratory or a governmental agency, which laboratory shall be acceptable to the Engineer, Owner and code enforcing authority.

2.2 SUBSTITUTIONS

- A. See DIVISION 1.
- B. A list of materials, methods and/or equipment proposed as substitutes for that specified shall be submitted as required for shop drawings in DIVISION 1. Where proposed substitutions are disapproved, the specified materials, methods and/or equipment shall be provided.
- C. All subsequent changes and substitutions shall be requested in letters from the Contractor to the Architect and shall be considered as authorized only upon written approval from the Architect.
- D. Any item which is proposed as a substitute shall be accompanied by Drawings and/or data giving sizes, capacities and all other necessary information for determining equality. When Drawings are submitted to the Architect for the purpose of showing the installation in greater detail, their approval shall not excuse the Contractor from the requirements of the Plans or Specifications.
- E. No work involving materials submitted for substitution shall proceed until written approval is received from the Architect.

2.3 SHOP DRAWINGS AND MATERIALS LIST

- A. Submit Shop Drawings for all equipment and material as required in DIVISION 1.
- B. Submittals shall be required for the following:

1. Material List: Identifying materials proposed for installation.
 2. Lighting Fixtures: Catalog cuts and ETL photometric data.
 3. Signal systems equipment and wiring diagrams.
 4. Panelboards and Switchboards: Shop fabrication details and components.
- 2.4 OPERATING AND MAINTENANCE MANUALS
- A. Submit three sets of Operating and Maintenance Manuals of equipment as specified in DIVISION 1.
- 2.5 PRODUCT DELIVERY, STORAGE AND HANDLING
- A. Deliver, store and handle materials in a manner to prevent damage. Any cost from damage shall be borne by the Contractor.
 - B. Protect equipment from weather and dampness.

PART 3 EXECUTION

3.1 WORKMANSHIP AND CONTRACTOR'S QUALIFICATIONS

- A. Only quality workmanship will be accepted. Haphazard or poor installation practice shall be cause for rejection of work.
- B. Provide foreman in charge of this work at all times.

3.2 COORDINATION

- A. Coordinate work with other trades to avoid conflict and to provide correct rough-in and connection for equipment furnished under trades that require electrical connections. Inform Contractors of other trades of the required access to and clearances around electrical equipment to maintain serviceability and code compliance.
- B. Follow manufacturer's instructions where they cover points not specifically indicated on drawings and specifications. If they are in conflict with the drawings and specifications, obtain clarification from the Architect before starting work.

3.3 QUALITY ASSURANCE

- A. Provide a meaningful Quality Assurance program. To assist the Contractor in this program, the specifications contained herein are set forth as the minimum acceptable requirements. This does not relieve the Contractor from executing other Quality Assurance measures to obtain a complete operating facility within the scope of this project.
- B. The Contractor shall insure that all workmanship, all materials employed, all required equipment and the manner and method of installation conforms to accepted construction and engineering practices, and that each piece of equipment is in satisfactory working condition to satisfactorily perform its functional operation.
- C. Quality Assurance Tests and Operational Check:
 1. Provide Quality Assurance Tests and Operational Check as specified in SECTION 16040.

3.4 CUTTING AND PATCHING

- A. The Contractor shall do all cutting and patching and shall provide all openings and supports which may be required for the installation of the work under this DIVISION of the Specifications. Patching shall be of the same workmanship, materials and finish as, and shall match accurately, all surrounding construction. No cutting of the structure shall be permitted without written permission of the Architect.

3.5 ACCEPTANCE DEMONSTRATION

- A. Upon completion of work, at a time to be designated by the Architect, the Contractor shall demonstrate for the Owner, the operation of the electrical installation, including any and all special items installed by him or installed under his supervision. A minimum of sixteen (16) hours of time must be allowed for this purpose.
- B. The demonstrations shall be held by this Contractor in the presence of the Owner's plant facilities manager or his designated representative and the manufacturer's representative.
- C. Demonstrate the function and location (in the structure) of each system and indicate its relationship to the single line diagrams and drawings.

- D. Demonstrate by “start-stop operation” how to work the controls, how to reset protective devices, how to replace fuses and what to do in case of emergency.
- E. Demonstrate how maintenance and spare parts manuals are related to the equipment and systems installed.

3.6 CLOSING IN UNINSPECTED WORK

- A. The Contractor shall not allow or cause any of his work to be covered up or enclosed until it has been inspected, tested and approved by the Architect. This inspection does not waive the inspections required by the Building Permit and performed by the local inspection authority.
- B. Should any of the work be enclosed or covered up prior to inspection and testing, the contractor shall uncover the work at his own expense, and after it has been tested, inspected and approved, make all repairs with such materials as may be necessary to restore all work disturbed by him to its original and proper condition.

3.7 PRELIMINARY OPERATION

- A. Should the Owner demand that any portion of the plant, apparatus or equipment be operated prior to final completion and acceptance of the work, the Contractor shall consent, and such operation shall be under the supervision and direction of the Contractor, but all expense thereof will be paid by the Owner, separate and distinct from money paid on account of the Contract. Such preliminary operation and payment thereof shall not be construed as an acceptance of any of the work of this Contract.

3.8 POWER INTERRUPTIONS

- A. The facility will be in operation during construction.
- B. Electrical circuits shall be interrupted only with prior written consent. Such interruptions shall be preceded by all possible preparations by the Contractor which are necessary to keep the electrical circuits off for a minimum period in an expeditious manner pursuant with good workmanship. If required, this work shall be done on weekends with no added expense to the Owner.
- C. Written requests for outages shall be submitted 7 calendar days in advance of the outage date. This request will delineate the particular circuits in question, the time of day the power should be removed, and an approximate number of hours the power shall be off.
- D. All work on service conductors and other such equipment shall be done only when such conductors and equipment are de-energized. The foreman of the work must disconnect the voltage from these circuits himself, install his own padlock and keep the key. In addition, a safety warning tag shall be affixed to the switch. This tag shall describe the work being done and the location of the job. The padlock shall be removed at the earliest possible moment after the line has been cleared of all personnel.

3.9 DEMOLITION

- A. Under this SECTION, the Contractor before submitting his bid, shall visit the site, review the existing drawings and allow for all demolition that is necessary for complete installation of new Electrical work. Demolition work is either partially shown or not shown on drawings. See architectural demolition drawings for extent of demolition.
- B. Remove all abandoned wiring, electrical equipment and fixtures. Such items will either be stored at a predetermined location or removed from the premises as directed by the Owner.
- C. Existing conduit, fittings, wire, etc., removed from the existing facility shall not be re-used unless specifically approved by the Architect.
- D. Wherever existing wiring or equipment is abandoned as a result of this Contract, it shall be removed insofar as possible. This includes, but is not limited to:
 1. Remove all wire and cable.
 2. Remove all devices and equipment.
 3. Remove all exposed conduit as far as possible.
 4. Cut of and cap all abandoned conduit. Stubs shall not be extended above floor.
 5. Provide closure plates for all abandoned flush outlets.

- E. Where removal of an existing outlet will result in loss of circuit continuity, the isolated portions of the circuit shall be reconnected to provide service to all outlets. If site conditions make a reconnection impossible, connection shall be made from an adjacent available outlet as noted and/or as directed.

3.10 SITE WORK AND PROTECTION

- A. The nature of the work requires disturbances of existing site surface installations by trenching. Contractor shall consult with Owner's representative a minimum of seven days prior to opening any trench or doing any excavation in order that Owner may take proper step to protect or temporarily remove existing plantings in the area to be disturbed.
- B. The routing of trenching is generally shown on the Drawings, which were prepared without indication of existing vegetation. Contractor, consulting with the Architect where necessary, shall route trenches to avoid trees, and where possible, shrubbery. The route of trenches shall be staked, and sufficient time allowed prior to excavation for Owner's forces to remove shrubs and sodding which are to be retained.
- C. Except for trees, which will not be disturbed, it shall be solely the responsibility of the Owner to remove, replant and/or protect site vegetation. Contractor shall, however, plan his operation to avoid damage to adjacent plantings. Do not disturb existing earth grades within the drip line of existing trees to remain.

3.11 TESTS

- A. Where the Contract Documents, laws, ordinances or any public authority requires any work to be tested specifically or reviewed by another authority, the Contractor shall give the Architect timely notice of readiness therefore. The Contractor shall furnish the Architect the required certificates of testing or review. If any such work required to be tested is covered up without written approval or consent of the Architect, it must, if directed by the Architect, be uncovered for examination at the Contractor's expense.
- B. The cost of all such tests shall be borne by the Contractor.
- C. Any work which fails to meet the requirements of any such test or review and any work which meets the requirements of any such test or review but does not meet the requirements of the Contract Documents shall be considered defective or may be rejected. Rejected work shall be removed promptly from the site by the Contractor unless the deficiencies are corrected promptly by him.

END OF SECTION

SECTION 16040 – FIELD TEST AND OPERATION CHECK

PART 1 GENERAL

1.1 CONDITIONS AND REQUIREMENTS

- A. Refer to the General Conditions, Supplementary General Conditions and Division 1 – General Requirements.

1.2 DESCRIPTION

- A. Work included in this SECTION, but not limited to:
 1. Ground resistance test.
 2. 600V cable insulation test.
 3. Operational check of selected equipment.

1.3 GENERAL SCOPE

- A. Where the Contract Documents, the Architect's instructions, laws, ordinances or any public authority requires any work to be tested specifically or approved by another authority, the Contractor shall give the Architect timely notice of readiness therefore. The Contractor shall furnish the Architect the required certificates of testing for approval. All such tests shall be in accordance with the methods prescribed by the American Society for Testing and this Specification. If any such work required to be tested is covered up without written approval or consent of the Architect, it must if directed by the Architect, be uncovered for examination at the Contractor's expense. The cost of all such tests shall be borne by the Contractor, provided that, if any such test is called for only by the Architect's instructions (and not required by the Contract Documents or otherwise) and if the test reveals that the work involved meets the requirements of the Contract Documents, the Contractor shall be allowed an increase in the Contract Price or an extension of the Contract time directly attributable to making the test if he makes claim therefore as provided under the General Conditions.
- B. All wiring and equipment including Owner-furnished equipment shall be tested for continuity and short circuits before the circuits are energized. The Contractor shall furnish all test equipment and materials and labor that are required to perform the tests. The Contractor shall advise the Architect of date of each test at least five (5) days prior to the performance of the test. The Architect reserves the right to witness all or any test.

1.4 FAILURE TO MEET TEST

- A. In the event that the results obtained in the tests are not satisfactory, the Contractor shall make such adjustments, replacements and changes as are necessary and shall then repeat the test or tests which disclosed the faulty or defective work or equipment and shall make such additional tests as the Owner's representatives deem necessary without additional charge to this Contract.

1.5 OWNER'S OPTIONAL TESTING

- A. If the Owner requires additional testing that is not part of this Contract, the Owner shall cover such testing costs.
- B. If additional tests disclose defective workmanship and equipment, it shall be replaced under this Contract at no extra cost to the Owner.

PART 2 EXECUTION

2.1 GROUND RESISTANCE TEST

- A. Building ground electrode resistance testing shall be accomplished with a ground resistance direct-reading single test meter utilizing the Fall-of-Potential Method and two reference electrodes. Perform test prior to interconnection to other grounding systems. Orient the ground electrode to be tested and the two reference electrodes to be tested and the two reference electrodes in a straight line spaced fifty (50) feet apart. Drive the two reference electrodes five (5) feet deep.

- B. Test results shall be in writing, and shall show temperature, humidity and condition of the soil at the time of the tests. In the case where the ground resistance exceeds 1 ohm, Owner will issue additional instructions.

2.2 600 VOLT CABLE INSULATION TEST

- A. All conductors shall receive an insulation resistance test and the values shall not be less than the following:

1. Lighting circuit with fixtures connected	1 Megohm
2. Lighting panels	1 megohm
3. Distribution panels, bus bars	5 Megohms
4. Motors (cold condition)	5 Megohms

- B. The insulation resistance per 1,000 feet for type THW wire, 600 volt, single conductor (not connected to devices), shall not be less than the following:

1. No. 14 through No. 10 AWG	700 Megohms
2. No. 8 through No. 2 AWG	500 Megohms
3. No. 1 through No. 4/0 AWG	300 Megohms
4. No. 250 MCM through No. 500 MCM AWG	200 Megohms
5. No. 501 MCM through No. 1,000 MCM AWG	150 Megohms

2.3 OPERATIONAL CHECK OF SELECTED EQUIPMENT

- A. The following tests and checks shall be performed before equipment is placed in operation.
 1. Check all equipment for mechanical adjustments, lubrication, and freedom of operation. Remove all shipping blocks.
 2. Operate all breakers in distribution panels.
 3. Operate all motor starters. Test all control circuits for correct connection and operation.
 4. Test all circuits for correct connection and operation.
 5. Perform rotation checks on all motors to make sure that rotation is as required for the driven equipment.
 6. Check the polarity of all receptacles.
 7. Check all branch circuits on lighting and distribution panels.

END OF SECTION

SECTION 16050 – BASIC CONSTRUCTION MATERIALS AND METHODS

PART 1 GENERAL

1.1 CONDITIONS AND REQUIREMENTS

- A. Refer to the General Conditions, Supplementary General Conditions and Division 1 – General Requirements.

1.2 DESCRIPTION

- A. Work included in this SECTION are conduits, wires and other miscellaneous materials not specifically mentioned in other SECTIONS of DIVISION 16000, but necessary or required for equipment or system operation or function and the labor to install them.
- B. Related work included in other SECTIONS: All other SECTIONS of DIVISION 16.

1.3 INCORPORATED DOCUMENTS

- A. SECTION 16010, Electrical Requirements, applies to this SECTION.

1.4 SUBMITTALS

- A. Materials list with manufacturer, style, series or model identified.
- B. Manufacturer's descriptive literature and/or sample if requested by the Architect.
- C. Dimensioned cable tray shop drawings and descriptive literature.

1.5 MATERIALS AND WORKMANSHIP

- A. Materials, workmanship and installation shall conform to all requirements of the legally constituted authorities having jurisdiction.
- B. Where larger sizes or better grade materials than required by the Regulations or Codes are specified herein, the Specifications shall have precedence.
- C. All electrical equipment and material shall be new, unless otherwise noted or indicated on the Drawings, and all new equipment and material shall be as recognized by the Underwriters' Laboratories, Inc., and/or be listed by the laboratories, wherever applicable, and shall be in perfect condition after installation.
- D. All material furnished under these Specifications shall be the standard products of manufacturers regularly engaged in the production of such equipment, and shall be that manufacturer's latest standard design. All similar items for similar uses shall be identical insofar as practical, and shall be the product of one manufacturer.
- E. Workmanship shall be of the best standard practice of the trade.

PART 2 PRODUCTS

2.1 BRANCH CIRCUIT RACEWAYS

- A. Conduits shall be rigid steel (not intermediate steel conduit), hot dipped galvanized or sherardized of approved type and manufacture. Rigid conduit shall be used in all cases where circuits are to be buried in earth, concrete, or installed in wet locations except as hereinafter indicated.
- B. Branch circuit raceways shall be sized based on THW wire insulation conduit fill. The minimum conduit size shall be ½".
- C. All metallic conduit when run in earth, or in sand or gravel fill (not concrete encased), shall be protected by 3M Scotchrap No. 50 applied to clean degreased pipe in a Helical wrap, half-lap. Individual joint wrap shall overlap conduit wrap by 3" minimum.
- D. Electrical Metallic Tubing (EMT) 2" maximum, shall be hot dipped galvanized or sherardized of approved type and manufacture. EMT may be used in stud walls, above drop ceiling and for exposed wiring in dry locations more than 7 feet above the floor.
- E. Couplings, connectors, and fittings shall be approved type specifically designed and manufactured for the purpose. They shall be installed expertly to provide a firm mechanical assembly and electrical conductivity. All conduit fittings shall be steel of the threaded type for rigid conduit, and EMT fittings shall be steel of the threadless type.

2.2 WIREWAY

- A. Code gauge steel, with knockouts and hinged cover. Corrosion resistant gray baked enamel finish.

2.3 BRANCH CIRCUIT CONDUCTORS

- A. All conductors in raceways for branch circuits shall be of the AWG sizes noted and insulated for 600 volts; shall be soft drawn copper; No. 10 and smaller shall be solid; No. 8 and larger stranded with THHN/THWN insulation. Where conductor size is not indicated on the Drawings, the wire shall be No. 12 minimum.
- B. Wire size, insulation type and the manufacturer's name shall be permanently marked on the conductor jacket at regular intervals.
- C. All wire shall be delivered to the job site in complete coils containing the manufacturer's name with an approval tag indicating wire size and type of insulation.
- D. Branch circuit wiring within lighting fixtures shall have Type RHH or THHN insulation.
- E. All branch circuit wires shall be identified by using factory colored wires, color-coded, with a separate color for each phase. The neutral insulation shall be white and the equipment ground shall be green.

CABLE COLOR CODE CHART

CONDUCTOR	120/208	277/480
Phase A	Black	Brown
Phase B	Red	Purple
Phase C	Blue	Yellow
Neutral	White	or Light Grey
Equipment Ground	Green	

2.4 PANEL BOARDS AND BRANCH PANELS

All panels shall have copper bus one each for the phases, neutral and ground with plug-in or bolt-on type breakers to match existing. The minimum AIC rating is 10kA. See drawings for additional information. Perform arc flash study and affix arc-flash labels per code.

2.5 OUTLET BOXES, JUNCTION AND PULL BOXES

- A. Outlet boxes shall be hot dipped galvanized or sherardized. Boxes for lighting fixtures shall be strongly secured using screws or equal type fasteners. Boxes shall have only the holes necessary to accommodate the conduits of point of installation. All boxes shall have lugs or ears to secure covers.
- B. Surface mounted receptacles and switches shall be installed in cast boxes (FS or FSD type).
- C. Ceiling outlet boxes where conduit is concealed shall not be less than 4" in diameter by 1-1/2" deep.
- D. Outlet boxes for wall fixtures where conduit is concealed shall be deep type, 4" in diameter, and have covers with center opening 3" in diameter.
- E. Outlet boxes for switches and receptacles in finished walls shall be of one piece standard galvanized steel, code gauge boxes, 4"x4"x1-1/2" minimum. They shall have covers with rectangular openings of proper size and shape. Outlet boxes for telephone system shall be 4-11/16"x4-11/16"x2-1/8" deep minimum with single gang ring. All boxes shall be flush with finished wall or ceiling line, not more than 1/4" back of same. All boxes shall be rigidly secured in position using screws or equal type fasteners. Bracket outlets shall be set as directed by Architect. When located on beams, columns or over doors, they shall be set symmetrical with beam, column or door. Receptacles and junction boxes shall be 18", switches 48" above finish floor, unless otherwise noted, and set flush in walls. Receptacle outlets for electric water coolers (EWC) shall be installed so they are concealed behind the water cooler or as inconspicuous as possible. Single gang rings to have long axis vertical wherever possible.
- F. Junction and pull boxes shall be installed as noted on the Drawings and at other locations where necessary or convenient for installing wires. Junction and pull boxes shall be of the sizes indicated on the Drawings and/or sizes proportionate to the sizes of conduit and conductors served, but in no case shall junction boxes be less than 4" square by 1-1/2" deep.

- G. No outlets shall be mounted back-to-back on any common wall unless otherwise noted.

2.6 WIRING DEVICES

- A. Device plates shall be satin finish, stainless steel, type 302/304, alloy 18-8 for all interior flush type outlets, unless otherwise noted. Where two or more devices occur together, gang plates shall be used. Plates shall be Hubbell "S" series, Bryant or Arrow-Hart.
- B. Weatherproof covers shall be cast aluminum and hinged. Device plates for walls having wood paneling shall match the paneling finish. Submit samples for approval by Architect.
- C. Provide blank stainless steel covers on all flush junction boxes and future outlet boxes.
- D. Switches and receptacles shall be Hospital Specification grade as noted on the Drawings. Color of devices shall be coordinated with wall finish and Architect; ivory for light walls, brown for dark and paneled walls.
- E. Install receptacles with grounding pole on bottom or right hand side.
- F. All floor outlets shall have tapping as required (3/4" minimum) and must be perfectly flush with finish floor.
- G. Provide carpet flange for all floor outlets located in areas to be provided with carpet.
- H. Provide Brother P-System nameplates on all switches and receptacles indicating panel and circuit number to which the device is connected.
- I. Provide engraved device plate reading "Exhaust Fan" for all switches controlling exhaust fans.
- J. Attachment plug caps shall be provided with all receptacle outlets other than 15 and 20 amps – 120 volt, unless otherwise noted.
- K. All grouped switches (2 or more) shall be labeled with engraved device plate. Coordinate with Architect and/or Owner for proper identification prior to ordering.
- L. Provide Lew #530-R rubber bell nozzle for all telephone floor outlets.
- M. Cover plates for telephone system wall outlets shall be coordinated with the telephone company. Contractor shall provide suitable stainless steel cover plate.

2.7 SUPPORTS AND FASTENING

- A. Conduit and equipment shall be supported from structural elements (not suspended ceilings, etc.); hangers, brackets, beam clamps, etc., shall be manufactured products designed for purpose used (Kindorf, Unistrut, Superstrut, etc.) Wire, wire cinch clamps and perforated strap iron shall not be used.
- B. Fasteners shall be of a type approved by the Engineer (having a safety factor of 4).
 1. Concrete: Rawl "6000 series" self-drill or equal.
 2. Steel: Beam clamps (drill and tap or punch holes only if approved by Structural Engineer). Beam clamps shall have seismic retaining clips.
 3. Wood: Wood screws (use nails only in shear). Power driven anchors, nail straps, "nailin" anchors, plastic or fiber plugs shall not be used.
- C. Hangers shall be provided with the necessary diagonal bracings, retaining clips, etc., in order to meet the requirements of the guidelines of "SMACNA" (Sheet Metal and Air Conditioning Contractors National Association Inc.) manual.

2.8 MISCELLANEOUS EQUIPMENT

- A. Where disconnect devices are required at the Heating and Ventilating units, etc., furnish a manual motor starter. Manual starters shall be Square D, Class 2510, Allan-Bradley, Cutler-Hammer, or G.E., mounted in the appropriate enclosures. Provide a manual starter with overload protection for all motors provided without built-in overload protection.
- B. Where motor sizes exceed manual motor starter switch ratings, a safety switch shall be provided. Safety switches shall be Square D, Type HD, Cutler-Hammer, or G.E., sized in accordance with individual load to be served, mounted in appropriate enclosures. All switches shall have a short circuit rating of 35,000 rms amperes with Class J spacing feature installed in the fuse holders.
- C. Where individual magnetic starters are required, provide Square D, Class 8536 or 8539, Allan-Bradley, Cutler-Hammer, or G.E., mounted in the appropriate enclosures. Minimum

size 1. All starters shall have three (3) overloads, H-O-A and transformer style push-to-test pilot light (unless otherwise noted), 120 volt control transformer with secondary fuse and disconnect for control circuit. The Contractor shall be responsible for reviewing the circuit diagrams and the associated schedules on the Mechanical and Plumbing Drawings to insure that additional auxiliary contacts are provided as required.

- D. At all packaged mechanical equipment provide a disconnect switch or switches, fused with time delay current limiting fuses. Fuses shall be sized per unit label. A main disconnect shall be provided for each unit and subdisconnect switches shall be provided where required by the manufacturer. Package equipment shall be considered on any equipment with integral starters and controls.
- E. Provide a Zerust vapor capsule Model VC2-1 in each disconnect switch and in each starter compartment.

2.9 EQUIPMENT FINISH

- A. Coordinate the final finish on all equipment and devices with Architect. Actual finish for electrical equipment and devices shall match other equipment in the room as directed by Architect.

PART 3 EXECUTION

3.1 GENERAL

- A. The electrical systems indicated on the drawings are generally diagrammatic, and shall be followed as closely as actual construction and work of other trades will permit. Govern the exact routing of wiring and the locations of outlets by the structure and the equipment served. Take all dimensions from architectural drawings.
- B. Consult all other Contract Drawings. Verify all scales and report any dimensional discrepancies or other conflicts to Architect before submitting bid.
- C. All homeruns to panelboards are indicated as starting from the outlet nearest the panel and continuing in the general direction of that panel. Continue such circuits to the panel as though the routes were completely indicated. Terminate homeruns of signal, alarm and communication systems in a similar manner.
- D. Avoid cutting and boring holes through structure or structural members wherever possible. Obtain prior approved of Architect and conform to all structural requirements when cutting or boring the structure is necessary and permitted.
- E. Furnish and install all necessary hardware, hangers, blocking, brackets, bracing, runners, etc., required for equipment specified under this SECTION and DIVISION.
- F. Provide necessary backing required to insure rigid mounting of outlet boxes.

3.2 WIRING METHOD

- A. Install all wiring in raceway, unless specifically shown otherwise.
- B. Minimum conduit size shall be ½" for interior lighting circuits or where shown otherwise on drawings.
- C. Size all 120 volt branch circuit conductors as follows to limit voltage drop:
 - 1. Use #12 AWG for circuits up to 80 feet long.
 - 2. Use #10 AWG for circuits up to 120 feet long.
 - 3. Use #8 AWG for circuits up to 200 feet long.
 - 4. Length will be measured from the branch panelboard branch breaker to the center of the load.
- D. Conduit shall be rigid steel, EMT or PVC as follows:
 - 1. Above Ground: Use rigid steel (not intermediate steel), hot dipped galvanized or EMT.
 - a) Wet Locations: Rigid steel.
 - b) Hazardous Locations: Rigid steel conforming to NEC requirements.
 - c) Locations Subject to Mechanical Injury: Rigid steel.
 - d) In Concrete Floors, Ceilings, Walls or Block Walls: Rigid steel.

e) Dry Locations and Those Not Subject to Mechanical Injury: EMT, above 7'-0", 2" maximum size, or rigid steel conduit. EMT shall be used for branch circuits only, all feeders shall be rigid steel.

2. Make all risers to grade with rigid steel conduit, including elbows and fittings. All stubs shall have couplings.

E. Use flexible conduits in the following applications:

1. Recessed lighting fixtures in T-bar ceilings.
2. Motor connections.
3. Connection between fan plenum and structure.
4. At expansion joints or seismic joints, Sealtite only.
5. At transformers and other equipment which produces vibration.

At wet locations and motor connections, flexible conduit shall be liquid tight type. In all cases, the flexible conduit shall be standard or reduced wall (RW) steel galvanized.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Rigid conduit and Electrical Metallic Tubing conduit shall be installed in a workmanlike manner and shall conform to the best modern practice. All raceways shall be installed with long radius bends and where more than four 90 degree radius bends are required, pullboxes shall be installed. Raceways shall be tightly corked and shall be otherwise well protected during construction and shall be blown out and swabbed prior to wires being pulled. After cutting conduit and EMT, all ends shall be properly reamed to prevent damage to conductor insulation.

B. Running threads shall not be used for connecting conduits. If required, approved conduit unions shall be used.

C. All conduit, unless otherwise noted on Drawings or Specifications shall be 1/2" with 2#12 AWG.

D. Conduit with number of conductors indicated shall be sized in accordance with codes, except in all cases for conduit in or under floor slabs, the minimum size shall be 3/4", or underground conduit for outside lighting the minimum size shall be 1", unless otherwise noted.

E. All conduit shall be concealed except where specifically noted on the Drawings.

F. All conduit risers out of concrete floor shall be provided with a threaded coupling at floor line. This also applies at all interior walls and partitions. See detail on the Drawings.

G. All exposed raceway runs indicated on the Drawings shall be routed at right angles to or parallel with the structure. Conduits shall be secured at 8'-0" maximum intervals and within 3'-0" of every outlet or termination.

H. Flashing and sleeves for roof penetrations shall comply with the architectural requirement. Refer to architectural specifications.

I. All conduit risers inside concrete columns or walls shall be verified with Architect prior to installation.

J. Structure shall not be cut without authorization from Architect. Sleeves through concrete floor shall be acceptable to the Architect. All holes in block walls or concrete floors shall be core drilled. Chipping of block or concrete is not permitted.

K. All electrical equipment in mechanical rooms shall be installed so that Code required clearances are maintained.

L. Conduits shall be run parallel to walls, either below slab or overhead, and as near as possible to the indicated location.

M. A No. 12 AWG Type TW copper pull wire or a 3/16" diameter nylon pull rope shall be left in each empty conduit run installed under this Contract. This includes all telephone conduits.

N. Switches shall not be grouped or ganged in outlet boxes unless they can be arranged so that the voltage between exposed live metal parts does not exceed 300 volts. Use separate outlet boxes and covers for switches on different phases of a 277/480 volt system.

O. All necessary sleeves and chases required where conduits pass through floors, footings, walls or ceiling beams, shall be coordinated by and the responsibility of this SECTION. Any

other openings or spaces found necessary shall be arranged for in time to prevent any unnecessary cutting. All cutting shall be done by the craft involved and paid for by this SECTION.

- P. All metallic conduit when run in earth, or in sand or gravel fill (not concrete encased), shall be protected by 3M Scotchrap No. 50 applied to clean degreased pipe in Helical wrap, half-lap. Individual joint wrap shall overlap conduit wrap by 3" minimum.
- Q. Provide Seal-Tite flex connections and/or expansion fittings for all conduits between building separations, at expansion joints or seismic joints to conform with the Codes.
- R. Not more than three (3) lighting or convenience outlet branch circuits in one (1) conduit unless otherwise indicated on the drawings or approved by the Architect.
- S. The following details shall be required of each PVC conduit installation:
 - 1. No PVC conduit shall extend above finish grade. The final fittings on raceways which extend above finish floor level shall consist of rigid steel conduit extending into the concrete duct bank for at least a minimum of 1 ft. (12"). Rigid steel 90 degree elbows or long sweep bends shall be used for extending conduits above finish grade.
 - 2. All changes in direction under the concrete slab shall be accomplished by recognized and UL labeled fittings, or by large sweep bends of the conduit lengths.
 - 3. Each panelboard which has branch circuits which are routed through PVC raceways shall be provided with a separate bond conductor bus which is secured directly to the interior of the panelboard cabinet. This bond shall be constructed in the same manner as the standard neutral bus, yet it shall be securely bonded to the enclosure.
 - 4. PVC conduit, when routed through interior footings in the project shall be properly sleeved to provide an opening, which is two (2) times the outside diameter of the PVC conduit, in order to prevent any damage to conduit during differential settling on the project.
 - 5. Each PVC raceway shall be provided with a bonding conductor No. 12 AWG minimum, which is continuous from the bond bus previously required in the panelboard, to the end of the branch circuit raceway. This bonding conductor shall be secured to each of the branch circuit outlets or boxes by a separate terminal device specifically recognized for this application. This especially prohibits the use of mounting screws or other components in the boxes as methods of terminating the bonding conductor. Bonding conductor shall be bare copper.

3.4 INSTALLATION OF WIRES

- A. All wire shall be continuous from outlet to outlet and/or terminal to terminal, and shall be identified by suitable tags indicating circuit connections.
- B. Wire shall not be pulled into any portion of the raceway system until all construction work which might cause damage to the conductors has been completed. Mechanical means shall not be used to pull wires unless approved by the Architect. Provide Kellems cable grips in each feeder riser for support of feeder cables.
- C. Splices in wires and cables, except as herein before mentioned, shall be spliced by approved solderless connectors of proper size. All splices shall be provided with insulation equal to or greater than the insulation of the wire. Splices in outlet boxes for fixture or receptacles shall be completed by the use of the proper size "Scotch-Lok" insulated electrical spring connector as manufactured by the 3M Company. A minimum of 12" free length shall be provided for each conductor to be spliced in an outlet box.
- D. All cables and wires passing through manholes and handholes shall be full looped inside the manhole and handhole and supported by galvanized steel racks.
- E. Make all ground, neutral and line connections to receptacle and wiring device terminals as recommended by manufacturer. Provide ground jumper from outlet box to ground terminal of devices when the device is not approved for grounding through the mounting screws.
- F. All cable shall be installed per manufacturer's recommendations. Methods of gripping cables, tension limitations shall be coordinated prior to pulling all cables. To limit sidewall pressure at

bends in ducts and conduit runs, the pulling force in pounds shall not exceed values set forth by the cable manufacturer.

3.5 CONNECTIONS TO EQUIPMENT

A. General

1. Furnish and install required power supply conduit and wiring to all equipment. See below for other wiring required.
2. Mount all motor starters and provide all power wiring to them, including those furnished under other Sections of Specifications.
3. Install all rough-in work for equipment from approved shop drawings to suit the specific requirements of the equipment.
4. Furnish and install all magnetic motor starters that are shown on the electrical drawings or specified under other Divisions to be furnished under this DIVISION of work. Verify equipment nameplate ratings prior to installation and furnish adequately rated starters for the loads.
5. Furnish 120 volt power to each control panel and time clock requiring a source of power to operate.

B. Heating, Ventilating and Air Conditioning Equipment

1. Connection of all heating, ventilating and air conditioning equipment, provision and installation of all motor controllers, all disconnects and all associated line voltage wiring and conduit shall be completed by this SECTION.
2. The furnishings of all motors, thermostats, temperature controllers, control wiring and control panels is included as a part of other SECTIONS of this Specification.
3. The temperature control system outlines several associated interlocks for the heating and ventilating equipment. The Contractor shall be responsible for reviewing the circuit diagrams and the associated schedules on the Mechanical Drawings to insure the necessary auxiliary contacts are provided on the line voltage starters to complete the interlocks as indicated.
4. Provide a 120 volt receptacle within 25 ft. of mechanical equipment for service and maintenance purposes, whether shown on Drawings or not.

3.6 ANCHORING

- #### A.
- Anchor all floor standing electrical equipment to floor or concrete housekeeping pads with anchor bolts. Bolts and washers shall be galvanized. Strength of materials used to secure the equipment shall be sufficient to resist shear and uplift produced by force equal to the equipment mass applied horizontally at center of gravity. Submit shop drawings of seismic requirement anchoring methods for approval by the structural engineer.

3.7 IDENTIFICATION

- #### A.
- Provide engraved lamicoide nameplates for switchgear, panels, motor starters, disconnect switches, relay cabinets, signal cabinets, telephone cabinets, time switches and all associated devices.
- #### B.
- Provide Brother P-Touch System or equal self-adhesive labels of clear tape with 1/8" black letters on all switches, convenience outlets and special purpose receptacles indicating panel and circuit number to which the device is connected.
- #### C.
- Provide label on all motors: "Caution. Automatic equipment. May start at any time."
- #### D.
- Covers for precast boxes and vaults shall have hold-down bolts and engraved system name such as: Site Lighting, Fire Alarm, Electrical, Telephone, TV, Security or Grounding.
- #### E.
- Identify manhole covers for Electrical System such as: High Voltage, Telephone or Electrical.

END OF SECTION

SECTION 16060 – GROUNDING

PART 1 GENERAL

1.1 CONDITIONS AND REQUIREMENTS

- A. Refer to the General Conditions, Supplementary General Conditions and Division 1 – General Requirements.

1.2 DESCRIPTION

- A. Work included in this SECTION: Conduits, wires, ground rods and other miscellaneous materials for the electrical grounding system.
- B. Related work included in other SECTIONS;
 - 1. SECTION 16040, Field Test and Operation Check
 - 2. SECTION 16050, Basic Construction Materials and Methods

1.3 INCORPORATED DOCUMENTS

- A. SECTION 16010, Electrical Requirements, applies to this SECTION.

1.4 SUBMITTALS

- A. Material List: Shall be included in SECTION 16050, Submittals.

PART 2 EXECUTION

2.1 GROUNDING AND BONDING

- A. Grounding and bonding shall be as required by codes and local authorities.
- B. All electrical equipment shall be grounded and shall specifically include the main switchboard, panelboards, cabinets, outlet boxes, transformers and motor cases of refrigeration, heating and ventilating equipment.
- C. Grounding of the service and each of the distribution panels shall be completed as indicated on the Plans. The continuous grounding electrode conductor used to ground system neutral shall be connected to the grounding electrode as directed by the local authorities, verify prior to installation. Where the cold water pipe is used for neutral ground connection shall be 1” or larger and shall meet code requirements.
- D. Water pipe connections shall be made with a T&B ground fitting which bonds both conduit and conductor to water pipe. Ground connections shall be accessible to inspection (extension of a water line, inclusion of an access panel or ground rod well), at all times, shall be unobtrusive as possible, and shall be verified with the Architect prior to installation.
- E. Internal ground bonding jumpers shall be provided for all lengths of flexible metallic conduit, unless it is U.L. listed for grounding. All equipment provided with two conductor cords shall be rewired to provide three (3) conductor Type “S” cord and grounding attachment plug caps.
- F. A bare copper ground conductor shall be provided in all non-metallic raceways sized in accordance with the codes. This conductor may not be shown on the Plans.
- G. All branch circuits and feeders shall include a ground conductor. Feeder and motor circuit grounds shall be sized in accordance with code requirements. This conductor may not be shown on the Plans.
- H. All metal parts of pull boxes or manholes shall be grounded as per code requirements.
- I. The ground system shall be tested for resistance before the ground loop is connected. Maximum ground system resistance shall be 5 ohms.
- J. All ground conductors shall be copper, and shall be bare for non-metallic raceways, and green insulated for metallic raceways.
- K. Connect wiring device grounding terminal to branch circuit equipment grounding conductor, when provided with circuit conductors.

END OF SECTION

SECTION 16322

POWER TRANSFORMER

PART 1 GENERAL

1.1 SUMMARY OF WORK

- A. This section covers the design, manufacturing, shop testing, shipment, delivery of and Special Services for two substation class, oil-immersed power transformers to be manufactured and tested in accordance with the latest applicable NEMA, ANSI, and IEEE Standards for power transformers. Furnish transformers built in accordance with ANSI C57.12.00, ANSI C57.12.10, and ANSI Appendix C57.92, except where specific requirements of this Section take precedence
- B. The VENDOR shall furnish the transformers (also referred to as power transformers) complete with tank-mounted surge arresters, features, and accessories as specified.
- C. The transformer will be utilized in a low resistance ground application with the XO bushing grounded through a 6 ohm grounding resistor furnished by others. The H0 and tertiary will not be brought out.

1.2 SPECIFIC CODES AND STANDARDS

- A. The equipment shall meet the performance requirements of, and be designed, manufactured, and tested (including all auxiliary equipment) in accordance with the latest applicable standards of:
 - 1. NESC: National Electrical Safety Code
 - 2. ANSI: American National Standards Institute
 - 3. IEEE: Institute of Electrical and Electronics Engineers
 - 4. NEMA: National Electrical Manufacturing Association
 - 5. ASME: American Society of Mechanical Engineers
 - 6. AISC: American Institute of Steel Construction
 - 7. ASTM: American Society of Testing and Materials
- B. The above listed codes and standards are referenced to establish minimum requirements, and wherever these specifications require higher grades of materials or workmanship than required by the codes and standards, these specifications shall apply. In the event a conflict occurs between the above listed codes and standards and these specifications, the more stringent requirements shall govern.

- C. The transformers, including bushings and all accessories, shall be capable of operating with all loadings and temperature rise limitations of the IEEE C57.92 - Guide for Loading Mineral Oil - Immersed Power Transformers (65°C Winding Rise). As specified in 2.2 A.10., this power transformer shall have an average winding temperature rise of 55°C rise under the specified conditions.
- D. The transformers minimum clearance from live parts shall be in accordance with ANSI C2, National Electrical Safety Code (Latest Edition).

1.3 SUBMITTALS

- A. Submittals shall provide complete information required to complete the design of facilities or work to be provided by others, including interconnection wiring. The submittals shall provide information and drawings necessary for field erection and installation and operation and maintenance for the life of the equipment.
- B. Production and Delivery Schedule
 - 1. Prepare, update and submit a production and delivery schedule monthly. Identify status and completion dates. Schedule to include:
 - a) Design and shop drawing review and approval.
 - b) Material ordering and delivery dates.
 - c) Fabrication.
 - d) Drying.
 - e) Testing.
 - f) Delivery.
 - 2. Submit copies of suppliers' and sub-suppliers' requisitions, purchase orders, and packing slips, or other documentation confirming ordering and delivery of material.
- C. Shop Drawings
 - 1. VENDOR shall submit six sets (one reproducible and five copies) of Shop Drawings in standard "A", "B", or "D" size drawings. The final set of approved drawings shall be submitted with electronic copy of the all equipment outline drawings, one line drawings, schematic drawings, connection wiring diagrams, and three line diagrams in AutoCAD 14.0 format on 3 1/2 inch PC diskettes. Final "Approved" Shop Drawings shall be submitted with electronic copy of drawing as well as hard copies of the drawing specified. Schematic and wiring diagrams shall be arranged to allow for addition of the interconnecting devices and wiring. Interconnecting terminal blocks shall allow space for all external interconnecting wiring on one side of the column of terminal blocks.
 - 2. VENDOR shall submit to AMAT the VENDOR's accepted schedule of shop drawings. Shop drawings will have been checked by and bear a specific notation or indication of approval of VENDOR and shall be identified as AMAT may require. The data shown on the Shop Drawings will be complete

with respect to dimensions, design criteria, and materials and like information to enable AMAT to review the information as needed. In addition to VENDOR's standard drawings the shop drawings shall include the following:

- a) Transformer outline showing physical dimensions and center of gravity (shipping and installed), both horizontal and vertical, and the location of accessories. Indicate phase-to-phase and phase-to-ground dimensions.
- b) Dimension plan and section views (each face).
- c) Nameplate and connection diagram.
- d) Bushing and surge arrester outlines (not catalog sheets).
- e) Current transformer ratio correction factor and secondary excitation curves, polarity, nameplate, and connection diagrams.
- f) Itemized list of connected load KW of all accessories.
- g) Bill of material, keyed to plan and section drawings.
- h) Schematic and connection diagrams of all terminal boards, panels, control circuits, and others.

3. Drawing Format

- a) Shop drawings shall, as a minimum, show the following:
 - 1) Clearly identify elements by device number for this project.
 - 2) Identify terminal numbers for external contacts both in the schematic and for spare device contacts.
 - 3) Identify all the relay contacts, both used and spares.
 - 4) Provide control switch and limit switch developments.
 - 5) Title block shall define specific element by project element, device or function name.
 - 6) Identify all SCADA and indication.
 - 7) Identify dc source breaker number.
- b) Wiring diagrams shall, as a minimum, show the following:
 - 1) Clearly identify elements by device number for this project.
 - 2) Elements shall be located in physical representation.
 - 3) Terminate and identify all spare contacts on terminal blocks.
 - 4) All outgoing Applied Materials (AMAT) interconnections to be terminated on terminal in one area and on one side of the terminal blocks. Clearly identify customer interconnections. Identify device name and contact on manufacturer's side of terminal block.
 - 5) At customer interconnection terminal blocks, allow space for customer to add interconnection cables, wire numbers, cable numbers and termination designation.

D. Certified Test Reports

1. Submit copies of certified test reports for all other tests required in this Section. Test reports shall be dated and signed by a responsible person at the test location.

E. Operations and Maintenance Manuals

1. Include with the four sets of the final copies of the Operations and Maintenance Manuals, one set of eight-inch by ten-inch glossy photographs showing the following:
 - a) Core and coil assembly just prior to placing the complete core and coil assembly into the tank H.V. and L.V. sides. Top view showing core ground strap.
 - b) H.V. and L.V. sides - transformer completely assembled.
 - c) Each end view - transformer completely assembled.

1.4 SHIPMENT, DELIVERY, HANDLING AND STORAGE

A. Ship and deliver transformers in accordance with the terms and conditions below:

1. All Goods will be delivered f.o.b. point of delivery. VENDOR shall select the means and methods of transportation. All transportation charges, including but not limited to switching, trucking, lighter-age and special handling will be paid by VENDOR.
2. VENDOR shall give AMAT at least fifteen days' prior written notice of the date when the Goods will be ready for shipment and the manner of shipment. Such notice will include instructions concerning any special equipment or services required at the point of delivery to unload and care for the Goods. VENDOR also shall require the carrier to give AMAT not less than 24 hours notice by telephone of the anticipated hour of delivery.
3. AMAT shall provide facilities for receipt and unloading of the Goods. If the point of delivery is a construction site, AMAT shall provide the carrier reasonable access within the site to the point of delivery.
4. VENDOR shall deliver the Goods to the point of delivery within a period of fifteen days (the "delivery period") prior to expiration of the Contract Time for delivery specified in the Procurement Agreement.
 - a) AMAT will not be obligated to accept any delivery of goods not made within the delivery period. Additional costs arising from delivery prior to or after the delivery period will be the responsibility of VENDOR.
 - b) AMAT may by Change Order direct VENDOR to ship to another point of delivery or to accelerate or postpone the delivery period. AMAT shall be responsible for all additional expenses incurred by VENDOR as a result of any such direction, including but not limited to charges for storage, reconditioning, handling, overtime and insurance. If VENDOR believes that any such direction justifies an increase in the Contract Price or Contract Time, VENDOR may make a claim therefor as provided in Article 11 or Article 12.
5. AMAT shall inspect the Goods upon delivery for the sole purpose of identifying the Goods and general verification of quantities in order to provide a basis for a progress payment. Such inspection will not be construed as final or as acceptance of any Goods not in conformance with the Procurement Documents. If, when delivered, there are apparent defects in the

Goods (through damage or otherwise), ENGINEER will give prompt written notice thereof to VENDOR. VENDOR shall without cost to AMAT correct the defect or replace the Goods with non-defective Goods. If VENDOR does not do so promptly and to the satisfaction of AMAT, AMAT may accept delivery of the defective Goods and remedy the defect as appropriate with an appropriate reduction in the Contract Price instead of requiring removal or replacement. AMAT may refuse to accept delivery of any Goods that are apparently defective. If there are no apparent defects, AMAT shall accept delivery.

6. Notice of AMAT's acceptance of delivery will be provided to VENDOR by a receipted copy of the shipping documents or as otherwise provided.

PART 2 PRODUCTS

2.1 OPERATING CONDITIONS

- A. Furnish transformers suitable for outdoor service at the ratings specified herein and operating under the special condition that the transformer will be located in a seismic zone 4 area.

2.2 RATINGS AND CHARACTERISTICS

- A. The power transformers shall have the following ratings and features:
 1. Type: Three phase, 60Hz, outdoor
 2. Class: OA/FA/FA
 3. Rated Output:
 - a) High Voltage: 30/40/50 mVA
 - b) Low Voltage: 30/40/50 mVA
 - c) Tertiary Voltage: 10.5/14/17.5 mVA
 4. Rated voltage and BIL Levels: Rated voltage and basic impulse insulation levels, all in kilovolts, of windings and bushings:

Winding or Bushing	Rated Voltage (Kilovolts L-L)	Winding BIL (Kilovolts)	*Bushing BIL (Kilovolts)
High Voltage	60 grounded wye	350	350
Secondary Voltage	12 grounded wye	110	110
Tertiary Voltage	4.16 delta	60	N/A (Note 1)
Neutral Low Voltage	15	110	110
Note 1. The H0, Y1, Y2, and Y3 tertiary windings will not be brought out.			
*Bushings shall be suitable for operation at an elevation of 3,300 feet.			

5. Externally Operating Fixed Taps: Externally operated, full kilovolt-ampere capacity, fixed taps, equivalent to the following:
 - a) High voltage 2-1/2% taps; 2 above and 2 below 60-kilovolts

- 6. Load-tap-changer Equipment: Automatic load-tap-changer equipment which shall regulate the voltage of the nominally 12-kV output (plus and minus 10% range). Load Tap changer equipment located in the neutral end of the winding is not acceptable.
- 7. Impedances: Design impedances (positive sequence) on a 30-megavolt-ampere base:
 - a) High voltage to low voltage: 6.9%

- 8. Loading Conditions: Loading conditions for full cooling operation:

Winding	Design Loading Condition
High Voltage 60-kilovolt	50 mVA input at 0.85 power factor lagging
Secondary Voltage 12-kilovolt	50 mVA output at 0.85 power factor lagging

- 9. Short-Circuit Withstand Capability: The power transformer shall be capable of withstanding the short-circuit requirements and tests of ANSI C57.12.00, Section 7. The VENDOR shall supply a certified test report of a similar unit with his bid to demonstrate capability.

- a) In addition, when the impedance and connections of the transformer and the impedance of the connected systems listed below can result in fault current greater than 25 times the base current in any winding, the transformers shall be capable of withstanding, thermally and mechanically, the maximum short-circuit currents that can flow, due to a fault in any location.
- b) The duration of time which the transformer shall be capable of withstanding fault current in excess of 25 times the base current of any winding, are as follows:

RMS Symmetrical Current in winding	Time in Seconds
25 times base current	2.00
35 times base current	1.00
40 times base current	0.75
50 times base current	0.05

- c) The positive sequence impedances (on a 100-megavolt-ampere base) of the systems to which the transformer is to be connected are as follows:
 - 1) 60-kilovolt terminals -
 - 2) 12-kilovolt terminals - no source
- d) The zero sequence impedance at the fault current sources may be assumed equal to the positive sequence impedance.
- e) The transformer shall be designed to be self-protecting.

10. Operating Temperatures

- a) The transformer shall be capable of operating at the specified loading and temperature rises and under no-load conditions when installed in the following ambient temperatures:
 - 1) Minimum ambient temperatures -10°C
 - 2) Average ambient temperatures for 24 hours 30°C
 - 3) Maximum ambient temperature 40°C
- b) The transformer shall be designed for operation at the specified ratings and under the specified conditions with an average winding temperature rise of 55°C.
- c) Other associated temperature rises shall be in accordance with ANSI C57.12.00.

2.3 SURGE ARRESTERS

- A. The metal-oxide surge arresters shall meet all applicable requirements of ANSI C62.11 and the following specifications. The primary arresters shall be mounted on the transformer cover and the secondary arresters shall be mounted in the throat of the tank. Each station-type arrester unit shall be provided with a pressure-relief diaphragm which will rupture, in the event of excessive current, causing high internal pressure, to prevent explosive shattering of the porcelain housing. Color of the porcelain shall be gray. Each surge arrester shall be provided with a discharge counter equipped with a leakage current ammeter.
- B. The surge arresters shall have sufficient mechanical strength to withstand, without damage, repeated earthquake accelerations of 0.5G in any direction.
- C. The VENDOR shall furnish the following listed metal-oxide station-class surge arresters or arresters having equivalent or better protective characteristics for each system listed below:

Arrester Ratings (kV)

System kV (L-L)	MCOV Rating (kV)	Duty-Cycle Rating (kV)	Maximum Discharge Voltage (kV) at 20 kA Discharge Current
60	42.0	54	138
12	10.0	15	43.9

- D. The maximum discharge voltage shown in the above table is based on a 20,000 ampere discharge current for an 8 X 20 microsecond impulse wave.
- E. Each arrester shall be capable of withstanding 1.4 times the MCOV rating for one second at 60°C ambient temperature.
- F. Each 60-kV and 12-kV arrester shall be furnished complete with insulated base, hardware, line and ground terminals (350Kcmil minimum size).

- G. One lightning discharge counter with leakage current indicator shall be provided for each 60-kV and 12-kV arrester. The counter shall be Bowthorpe EMP Cat #24-51-21 or equal. The 60-kV counter shall be mounted at a height not to exceed eight (8) feet above the base of the transformer. 5-kV insulated cable or copper-bar with proper supports shall be furnished for all arrester ground connections. The insulated ground system shall be extended to the base of the transformer for connection to the station ground bus.

2.4 TERMINAL CONNECTORS

- A. All bushings and surge arresters on top of the transformer tank shall be furnished with removable NEMA standard 4-hole pads and tinned plated on both sides for aluminum or copper connection.
- B. The terminals shall be corona free and of sufficient size to continuously carry the rated current.

2.5 AUDIBLE SOUND LEVEL

- A. The audible sound level shall not exceed the value given in NEMA Standard Table 0-2 TR1, Section 05, when measured in accordance with the procedure established in ANSI/IEEE C57.12.190-93, Section 13.

2.6 IN-SERVICE OIL DIELECTRIC

- A. Refiltering of the transformer oil in service will not be performed until it reaches a dielectric test level of 25-kilovolts when tested by ASTM Method D877. Therefore, the transformer will be designed to operate satisfactorily with oil of this dielectric strength.

2.7 CURRENT TRANSFORMERS

- A. All current transformers shall be in accordance with ANSI C57.13.
- B. All secondary leads shall be brought to short-circuiting-type terminal blocks.
- C. All current transformers specified are in addition to those which may be required for operation of temperature relays, or its internal use.
- D. On bushing type current transformers, the turns between any two taps on the secondary winding shall be uniformly distributed along the entire core.

- E. The transformer shall be furnished with multi-ratio bushing current transformers as follows:

Quantity	Maximum Ratio	Accuracy	Location
3	600 to 5	C800	1 per high voltage bushing (upper)
3	1,200 to 5	C800	1 per high voltage bushing (lower)
6	3,000 to 5	C800	12 per low voltage line bushing
1	600 to 5	C800	1 per tertiary bushing (lower)

- F. Each bushing current transformer shall have a continuous thermal current rating factor of one.
- G. Each current transformer shall have the ratios pertaining to its ampere class as listed in ANSI C57.13, Table 10.
- H. In addition to the above, the transformer shall be equipped with multi-ratio wound or bushing-type current transformers as follows:
1. Each current transformer shall have a minimum continuous thermal current rating factor of one.

2.8 INTERNAL IONIZATION

- A. Internal Ionization within the transformer shall not cause ratio influence voltages that exceed the values given in subparagraph 2.1.17 when measured in accordance with the procedures established in the paragraph.

2.9 DE-ENERGIZED TAP CHANGER

- A. An externally operated, manual tap changer shall be furnished with the power transformer to be operated only when the transformer is de-energized.
- B. The tap changer shall be designed for convenient operation by a person standing on the same level as the transformer base.
- C. It shall include an operating level or handwheel, tap position indicator, and a means for locking the tap changer in any tap position.
- D. The locking device shall be arranged to prevent locking the tap changer in an off-tap position.

2.10 LOAD-TAP-CHANGER

- A. The transformer shall have a load-tap-changer (LTC) capable of operating in parallel with other transformer.

- B. LTC Controls: The LTC controls shall include the following equipment (no substitutions) installed in a NEMA 4X weatherproof control cabinet.
 - 1. Beckwith Electric Company, Model M-0067 tap changer control unit.
 - 2. Beckwith, Model M-0115A parallel balancing module. Transformer shall be provided with necessary equipment for parallel operation by the circulating current method utilizing the Beckwith M-0115 module.
 - 3. Beckwith Model M-0127 circulating current relay.
- C. The tap-changer equipment shall provide regulation of the nominal 12-kV output over a range of plus or minus 10% automatic adjustment in steps of approximately 5/8% each with 16 steps above and 16 steps below rated low voltage.
- D. The LTC shall have local and future remote electrical, manually actuated and automatic control.
- E. The transformer shall be capable of delivering rated kilovolt-amperes at the rated low-voltage position and on all positions above rated low voltage.
- F. Provisions shall be made on the transformer for manually moving the tap-changer for adjustment and test.
- G. Facilities shall also be furnished for remote and local tap position indication of the transformer.
- H. The design of the tap-changer mechanism shall be such that the mechanism will not stop in an intermediate position. However, if the mechanism through mis-operation does stop in an intermediate position, the design shall be such that full load can be carried by the transformer continuously without injury to any component.
- I. The moving contact assembly shall be self-aligning and when in closed position, heavy contact pressure shall be applied.
- J. All current-carrying parts shall be of sufficient areas and cross section to ensure a temperature rise under full-load conditions not to exceed 10°C.
- K. The tap-changing device shall be designed to withstand the applied potential test of the winding to which it is connected.
- L. The load tap-changing equipment shall consist of a liquid-immersed tap selector with a vacuum interrupting device and motor-driven mechanism.
- M. Each tap-changer mechanism shall be motor driven and shall be mechanically capable of performing 400,000 operations at full load without the necessity of replacing or rebuilding any of the parts.

- N. Each completely assembled tap-changer shall be capable of withstanding, without damage, the maximum short-circuit stresses which would be imposed upon it when the transformer itself is subjected to short-circuit current in accordance with the requirements of subparagraph 2.2 A.9 above.
- O. Those elements of the tap-changing under load mechanism which may cause arcing during operation shall not be placed in the transformer main tank but must be located in a separate compartment to exclude the possibility of contamination of the oil in the main tank.
- P. Connections from the main tank to the tap-changer compartment shall be made by means of entrance bushing with compressions flanges or other equally effective method of preventing interchange of oil between the transformer main tank and the tap-changer compartment.
- Q. Vacuum interrupter shall be used in lieu of arcing contacts.
- R. Positive control of the tap-changer shall be provided such that a tap-changer operation, once initiated, will be automatically completed, and then stopped, until the control switch is again operated to continue or reverse the operation.
- S. An operation counter shall be furnished to record the number of tap changes.
- T. Control switches associated with the tap-changer shall be in accordance with subparagraph 2.19D below (Control Equipment for Oil Pumps and Fans).

2.11 BUSHINGS

- A. All transformer bushings rated above 110-kV BIL shall be oil-filled and shall be in accordance with ANSI C76.2/IEEE 24.
- B. The oil-filled bushings shall be equipped with a sight gauge to indicate oil level and a capacitance or power factor test tap.
- C. All bushings shall be constructed using porcelain materials and the color of the bushings shall be ANSI 70 gray. Porcelain parts of each bushing shall be one piece.
- D. The bushing nameplate shall state that the bushing contains no PCBs.
- E. Bushing stud diameter, length, and threading shall be stated on the drawings.
- F. All winding leads shall be brought out through bushings.
- G. Phase bushings of like voltage shall be interchangeable.

- H. All bushings shall be so designed that there will be no undue stresses on any parts due to temperature changes. Adequate means shall be provided to accommodate conductor expansion.
- I. High voltage bushings shall be cover mounted with 4-hole NEMA pads included.
- J. Low voltage bushings shall be in a throat conveniently mounted for underground cable access and provided with 4-hole spades to accommodate three 1000 kcmil cables per phase.
- K. Current Ratings: Bushing current ratings shall be based on the continuous line current rating at maximum MVA. Provide bushings with sufficient excess capacity as tabulated in ANSI Appendix C57.92, without exceeding temperature rise requirements as defined by ANSI C76.1.
- L. All bushings supplied with the transformer shall be used for all tests performed by the manufacturer. Transformer to be shipped with low voltage bushings installed.

2.12 WINDINGS

- A. Winding conductors shall be free from scale, burrs, and splinters, and shall be insulated with paper, except that the insulation on the tertiary-voltage winding of 60-kilovolt BIL and below may be polyvinyl acetal or formal film.
- B. Permanent current-carrying joints or splices shall be welded or brazed, properly formed, finished and insulated, except that compression-type fittings may be used outside of the core winding.
- C. Transformer shall utilize conductor and lead insulation of specially treated paper to increase the thermal stability of the insulation; to maintain the required tensile, bending, and bursting strengths; and to insure normal life expectancy.
- D. If transposed conductor is utilized for the transformer windings, polyvinyl acetal or formal film insulation may be used to insulate the strands of the transposed conductor provided the specially treated paper is used as the main conductor insulation.
- E. The specially treated paper will not apply to low voltage windings which are insulated with polyvinyl acetal or formal film as permitted above. In addition, any other insulation shall be specially treated in order to insure normal life of the insulation where it is necessary to expose the insulation to high temperatures.
- F. The completed winding assembly shall be securely held in place so that there will be no disarrangement or deformation by stresses incident to shipment.

2.13 CORE

- A. Nuts, bolts, and clamps of the core assembly shall be provided with positive locking devices to prevent loosening by vibration or change of shape or position during transportation or operation.
- B. The core shall be securely grounded to the tank at one point. The grounding location shall be accessible from hand hole on tank cover.

2.14 OIL PRESERVATION EQUIPMENT

- A. The oil preservation system provided shall operate under the pressure limitations outlined under subparagraph 2.15 TANK without loss of inert nitrogen gas or dry air over the entire range specified. The use of auxiliary apparatus to compress or chill the gas will not be permitted.
- B. Sufficient nitrogen gas, shall be furnished for the initial flushing, filling, and operation of the transformer.
- C. The transformer shall be equipped with one of the following systems of oil preservation as defined in ANSI C57.12.80.
 - 1. Sealed Tank System: Paragraph 6.5.1
 - 2. Gas-Oil Sealed System: Paragraph 6.5.2
 - 3. Constant Pressure System:
 - a) If a constant pressure system is furnished, separation of oil from the atmosphere shall be accomplished by means of inflatable and deflatable cells or diaphragms.
 - b) The cells or diaphragms shall be confined to auxiliary tanks.
 - c) The cells or diaphragms shall vent air to the atmosphere by means of a weather-tight breather.
 - d) If a cell or diaphragm is damaged, the unit shall be fail-safe, by acting as a conservator.
 - e) A sinking cell or broken diaphragm shall activate an alarm.
 - f) The transformer shall have means of isolating the auxiliary tanks during installation and inspections.
 - g) The auxiliary tanks shall be equipped with a sump chamber and drain valve.
 - h) A pressure-vacuum bleeder shall protect the system in the event of incorrect overfilling or under-filling during installation.
 - i) The **VENDOR** shall furnish evidence showing that the material used in the cells or diaphragms has a demonstrated useful life of 5 years or more for this application.

2.15 TANK

- A. The shell, cover, and bottom of each tank, including auxiliary tanks, shall be of welded steel plate construction with all seams welded so as to remain oil-tight and gas-tight.
- B. During welding of the transformer cover, an inorganic gasket shall be permanently located between the cover and the tank flange to prevent weld spatter from entering the tank.
- C. Flanged horizontal joints that must be broken to untank the core and coil shall be designed for breaking and remaking in the field.
- D. The tanks, except auxiliary tanks vented to the atmosphere, shall be capable of withstanding, without leakage or permanent distortion, an internal pressure of 14.7-pounds-per-square-inch gauge and of withstanding a vacuum which produces a differential pressure of 15 pounds per square inch across the tank wall.
- E. Auxiliary tanks shall be capable of withstanding a differential pressure of 5 pounds per square inch.
- F. All flanged joints shall be provided with gaskets set in grooves or held in position by stops to prevent over-compression of the gaskets. The gaskets shall be of resilient material that will not deteriorate under the action of hot oil and will remain oil-tight.
- G. Stiffeners required for the tank shall be selected and arranged in order to minimize the collection of dirt particles, rain, or snow.
- H. Lug or jacking pads shall be provided for moving and lifting the transformer either by crane or jacks. Jacking pads shall be suitable for jacking the completed transformer filled with oil. Jacking pad dimensions shall be shown on the transformer outline drawing.
- I. VENDOR shall furnish hold-down clamping lugs for securing the transformers to foundation skids. Required number and dimensions shall be established by the manufacturer and provided in the bid packages.
- J. A manhole of sufficient size to permit the removal of the bushing current transformers shall be furnished in the tank cover.

- K. The construction of the main tank, auxiliary tanks, and the oil-preservation apparatus shall be such as to insure an adequate cushion of gas in applicable parts of the apparatus for the following conditions:
1. Internal Gas Pressure: For any of the systems of oil preservation, except the sealed tank system, the internal gas pressure shall be not less than 0 pounds per square inch with transformer temperature changes attained between de-energized condition and up to 110% maximum rated load condition with an ambient air temperature range as given in paragraph 2.1 J. For the sealed tank system, the internal gas pressure limits may be increased to those given in ANSI C57.12.10, paragraph 5.7.1.
 2. Loss of Gas or Oil: If a gas-oil seal system or a constant pressure system is furnished, either system shall operate without loss of gas or oil and without loss of the seal between the transformer interiors and atmosphere over the entire temperature range and operating conditions specified in subparagraph a. above.

2.16 BASE

- A. The transformer tank shall be provided with a fabricated or structural steel base.
- B. The base shall be provided with pulling eyes to permit pulling the transformer.
- C. The base shall be designed and built so as to allow skidding or moving on rollers in either direction.
- D. Flat plate bases without internal or external reinforcing structural members are not acceptable.

2.17 GROUND CONNECTION

- A. The transformer shall have the following grounding pad provisions:
 1. Provide two ground pads on opposite sides of the transformer near the base on the HV side of the tank.
 2. Provide ground pads in transformer throat near X1 and X3 phase arresters for secondary.
 3. Provide necessary ground cable support brackets on transformer case for grounding of XO bushing through a 6 ohm grounding resistor.
 4. Manufacturer shall furnish all necessary copper bus and connectors to connect the XO bushing and facilitate connection to the substation copper ground system, 250 kcmil through 500 kcmil. All connectors and pads shall be NEMA standard drilling pattern.
 5. Refer to Section 2.3, Surge Arresters, paragraphs F and G for 60-kV and 12-kV arrester grounding requirements in conjunction with discharge counters.

2.18 EARTHQUAKE AND WIND DESIGN LOADS

- A. Equipment shall be located in a seismic zone 4. Unless otherwise specified the equipment shall be designed in accordance with IEEE 693 using the characteristics of the Loma Prieta 1989 earthquake as recorded at the Corralitos station. Equipment shall be designed to withstand seismic forces equivalent to 0.63g horizontally and 0.50 vertically, applied individually or simultaneously at the base of the mounting surface without damage. In addition wind loads of 20 pounds per square foot on the projected area (non-simultaneous with earthquakes), without damage to component parts and without impairment of operation.

2.19 COOLING

A. Cooling Units or Radiators

1. The transformer shall be designed with radiators for cooling to provide for operation at ratings and temperature rises indicated in this solicitation. Particular attention shall be addressed to paragraph 2.18 EARTHQUAKE AND WIND DESIGN LOADS in the cooling unit design.
2. The cooling units shall be connected to the tank by bolted, machined steel flanges, with the flanges welded to the cooling units and to the tank.
3. Flanges shall be provided with gaskets and valves shall be installed on each cooling unit connection, so that any individual cooling unit may be removed without taking the transformer out of service.
4. An oil-tight, blank flange shall be provided for each connection, for use when cooling units are detached.
5. Each cooling unit shall have a lifting eye, an oil drain, and a vent.

B. Fans

1. Fan motors shall be of the totally enclosed design.
2. Fan motors shall operate from a 208-volt, single-phase, 60 Hz power supply.

- C. The leads for the fan motors shall be enclosed in liquid tight, flexible conduit. As an alternate, the connections to the supply circuits may be made by means of watertight plugs and receptacles, provided the interconnecting cables are mechanically protected by use of ducts or flexible conduits.

D. Control Equipment for Fans

1. The control equipment shall include a circuit breaker for each group of fan contactors with overload protection in each phase, selector test switches for TEST-AUTOMATIC-OFF, and any other necessary devices.
2. The VENDOR shall furnish all control transformers, fuses, circuit breakers, indicating lamps, terminal blocks, magnetic-type starters, and unfused disconnect switches, test push buttons or switches, and auxiliary and timing relays for the control, protection, annunciation and remote indication of the fans.

3. AMAT will furnish 208-volt, 60-Hz and 125-volt D.C. power supplies for the transformer.
4. The control switches shall be equal to General Electric Type SB1, or Electro-switch Series 24, switches. Control switches shall have at least one spare contact in each switch position, provided the spare contacts do not require an additional gang of switches. The switch identification shall be engraved on the escutcheon plate, or if necessary, on a separate adjacent nameplate furnished by the VENDOR.
5. Fuse cartridges and their clips shall be mounted inside the cover of the fuse enclosure, and shall be disconnected from the circuit when the cover is removed for fuse replacement.

2.20 ACCESSORIES

A. Standard Accessories

1. Furnish all standard accessories located in accordance with ANSI Standard C57.12.10.
2. None of these items shall protrude beyond the floor space determined by the radiating surfaces.
3. Wells for thermometer bulbs and liquid-level gauge floats shall be outside the main tank so as not to require untying for removal.
4. All gauges shall have drag-hands to show peak readings. Gauge resetting shall be accomplished by an external push rod.
5. General requirements for all accessories are as follows:
 - a) Service life of accessories shall be comparable to that of the transformer.
 - b) All gauges, meters, relays, recorders, thermal breakers, other instruments, and cabinets constituting or associated with the control fans, inert gas equipment, and all other temperature and pressure alarm systems shall be either "shock-mounted" to protect them from damage or wear that could be caused by normal transformer vibration, or they shall be sufficiently rugged and durable in construction to be functionally unaffected by transformer shock and vibration.
 - c) Contacts on all devices shall be ungrounded, rated for 250 volt DC.
 - d) All wire for alarm and auxiliary circuits shall be stranded, not less than No. 12 AWG copper, of high quality, and suitable for the specific purpose for which used.
 - e) All valves shall hold hot oil without leaking and shall withstand, when submerged, an air test of 125 pound per square inch gauge pressure.
6. Magnetic Liquid Level Gauge - A main tank liquid level gauge with high and low level alarm contacts shall be installed on the main tank or on the conservator or ancillary tank. A second identical gauge shall be installed on the LTC compartment.

7. Top Oil, Hot Spot, and Other Gauges - The top oil and hot spot maximum-minimum temperature gauges shall be mounted a maximum of six feet above the base of the transformer and shall have manual reset. The operating temperatures shall be included on the gauge nameplate and shall be readily visible without dismantling the gauge. A separate nameplate listing actuating and alarm settings is also acceptable.
 8. Pressure Relief Devices - Each transformer shall be equipped with fault pressure-relief devices in main transformer tank. Device shall be complete with visual indicator and alarm contacts and shall be of self-resealing type. Locate devices as close to the HV bushings as practical for maximum protection to tank in the event of bushing failure. Relief devices shall be mounted on tank cover; standpipes are not acceptable. The alarm shall be manual reset capability while the transformer is energized.
- B. The transformer shall be equipped with the following additional accessories.
1. Winding Temperature Relays
 - a) A winding temperature relay plus a current transformer and a heater well shall be installed in each winding of at least one phase of the three-phase power transformer and shall be responsive to the loading in such winding.
 - b) Each relay shall be equipped with four electrically separate, adjustable sequence contacts set to represent hotspot winding temperatures of 85°, 105°, 115°, and 125°C.
 - c) Each relay shall be furnished with a dial-type thermometer on the tank for hotspot indication.
 - d) Accessory equipment shall also be furnished for automatic control of the cooling equipment from the winding temperature relays.
 2. Sudden Pressure Relay
 - a) A separate sudden pressure relay Qualitrol model 910-101-03 shall be provided for the transformer.
 - b) The relay shall be actuated by sudden pressure rise inside the main tank and shall not operate on gradual pressure change within the normal operating range of the transformer.
 - c) The sudden pressure relays, auxiliary relays, and the control switches shall be mounted in such a way that mechanical vibration, such as that due to a close-in fault, will not cause false operation of the relay scheme.
 - d) The relaying scheme shall provide a Qualitrol model 909-010-03 seal-in relay with two normally open, electrically separate contacts, one for tripping and one for the alarm.
 - e) A control switch shall be mounted in the terminal cabinet on the transformer and shall be wired in series with the tripping contact to cut out the tripping function of the sudden pressure relay during maintenance. This switch shall be a miniature-type switch for 125-volt, direct-current operation with maintaining type contacts, with two-position

"OFF-ON" with at least two electrically separate contacts close in the "ON" position, and with contact capable of interrupting at least a 1.0-ampere inductive load.

- f) The tripping of circuit will operate a hand-reset auxiliary tripping relay located in the service building.
 - g) The relaying scheme shall contain time delay or seal-in features as required to insure proper tripping and to prevent false tripping.
 - h) An operations indicator or target shall be furnished with the auxiliary relay to provide positive indication of the operation of the sudden pressure relay.
 - i) If possible flashover of the sudden pressure relay contacts due to voltage transients is inherent in the scheme, a normally closed contact from the sudden pressure relay shall shunt the coil of the trip or seal-in relay.
 - j) Surge protectors shall be provided across the external tripping contact in order to prevent false operation of the auxiliary tripping relay in the service building.
 - k) The scheme shall be self-resetting at the transformer for all operations of the sudden pressure relay.
3. Winding Hotspot Temperature Detector
- a) On each winding of at least one phase of the three-phase transformer, a detector of the resistance-type shall be furnished with the necessary accessories, arranged for remote indication for use with temperature indicators and AMAT furnished data logging equipment.
 - b) Each detector shall be a standard 10-ohm copper unit (10-ohm at 25°C), 3 or 4 wire sensor having an accuracy of plus or minus 0.3°C and a sensitivity of 0.04 ohms/°C.

2.21 TERMINAL BLOCKS

- A. Terminal blocks for power wiring shall be of the heavy-duty type for insulated copper cable.
- B. The size of this cable will be determined by AMAT after actual power requirements of the transformer are known.
- C. Terminal blocks for control wiring shall be rated at least 600 volts and 25 amperes and shall be suitable for use with No. 10 AWG wire. Blocks shall be molded-block type to accommodate ring lugs 1/2 inch wide (outer diameter) at the terminal screws and shall be furnished with binding-head or washer-head screws having serrated or grooved contact surfaces or having lockwashers. Blocks shall be furnished with molded insulating barriers between terminals.
- D. Each terminal block shall have a removable marking strip.

- E. Examples of terminal blocks meeting the above requirements are:
 - 1. Buchanan Catalog No. B112
 - 2. General Electric Company Type EB-25A12W
- F. The arrangement and location of the blocks shall be such that incoming or outgoing cables can be supported.
- G. Adjacent rows of terminal blocks shall be separated at least 6 inches, edge-to-edge and shall be at least 6 inches from sides, top, or bottom of cabinet for all wiring that will be made in the field.
- H. Wiring that will be done at the factory may be made in a space which is not less than 3-inches instead of the preceding 6-inch space requirement provided that the factory wiring will not share common space with the field wiring.
- I. Approximately 25% spare terminals shall be provided for terminating spare conductors in each control cable and for possible future use.
- J. Preliminary terminal block layouts shall be provided with approval drawings.

2.22 CONTROL WIRING

- A. Control wiring shall be performed with switchboard type, No. 12 AWG, Class K stranded, copper conductor, rated for 600-volt service, with insulation equal to General Electric Co. Vulkene (SIS). Wiring for annunciator and temperature recorder wiring, shall be switchboard type, No. 14 AWG, Class K stranded.
- B. Provide approximately 20% spare terminals.
- C. The current transformer secondary leads shall not be less than No. 10 AWG.
- D. All terminations of wire shall be made with pre-insulated, pressure-crimp-type terminal connectors with ring tongues equal to AMP "Plastic-Grip" terminals manufactured by Aircraft-Marine Products, Harrisburg, Pennsylvania.
- E. Exposed wiring shall be kept to a minimum, and where used, shall be formed into compact groups bound together and firmly supported and shall be run straight, horizontally, or vertically with short radius right-angle bends.
- F. Hinge wiring shall be twisted around the longitudinal axis of the wire, whenever possible, instead of being bent laterally.
- G. Each wire shall be protected from abrasion where it leaves a channel or duct.

- H. There shall be no splices in the wiring and all connections shall be made at device studs or terminal blocks.
- I. There shall be no more than two wires terminated at each terminal point.
- J. No. 8 AWG wiring, or smaller, shall be connected directly to terminal studs.
- K. Wiring shall be trained neatly in insulated type wiring ducts with covers. The sum of the cross-sectional area the conductors shall not exceed thirty percent (30%) of the interior cross-sectional area of the wiring duct.
- L. All conductors shall be labeled at all terminations with terminal numbers corresponding to the connection diagrams. Labels that shall show destination, not origin, shall be machine imprinted and permanently held in place so as to be readable when the wire is secured to the terminal point.

2.23 INSULATING OIL

A. General

- 1. All electrical equipment shall be designed to operate with oil which conforms to the requirements of the latest revision on ANSI/ASTM D 3487 (or per ANSI C57.12.00), "Mineral Insulating Oil Used in Electrical Apparatus," except that for oil-filled bushings the manufacturer's standard insulating oil is acceptable.
- 2. Furnish Shell Oil Company, type Dialax mineral insulating oil with antioxidantizing and anti-foaming additives.
- 3. Electrical equipment with insulating liquids containing polychlorinated biphenyl (PCB) shall not be accepted.
- 4. Equipment requiring insulating oil shall be permanently marked and certification furnished to AMAT to certify that there are no more than one (1) part per million PCB present when the equipment is manufactured.
- 5. If the oil is shipped separately, the VENDOR shall also furnish certification that the oil meets the EPA requirements or the State requirement (whichever is more stringent) for non-PCB when the oil is delivered to AMAT.
- 6. The oil truck driver shall have in his possession and furnish this certification to AMAT upon arrival at the delivery site.

B. Sampling and Testing

- 1. Certified results of tests which demonstrate compliance with ANSI/ASTM D 3487 and this solicitation shall be furnished.
- 2. Copies of a certified report of the tests shall be furnished.
- 3. AMAT shall be furnished testing documentation of a sample of the oil directly from the shipping container at its receiving facility to demonstrate that the following requirement is met:

Type of Test	ASTM Method	Test Limit
Dielectric Strength	D877	30-kV minimum

- C. Delivery
 - 1. The oil shall be delivered in accordance with Section 1.4 (Shipment, Delivery, Handling and Storage).
- D. Oil Filling Procedure
 - 1. The VENDOR shall be responsible for filling the transformer with oil at the substation in accordance with his recommended procedures.
 - 2. It is expected that the dielectric strength will be approximately 30-kilovolts when tested in accordance with ASTM D 1816 (0.040 in gap).
 - 3. The VENDOR shall provide a complete description of the transformer oil-filling procedure with his bid.

2.24 FACTORY ASSEMBLY, INSPECTION, AND TESTS

- A. General: The transformers shall be completely assembled and adjusted at the factory and given the manufacturer's standard shop tests and other tests as specified below. All parts shall be marked for ease of field assembly. AMAT reserves the right to observe the core and coils prior to drying and to witness all transformer testing. Written notice shall be received by AMAT at least 30 calendar days prior to drying and prior to testing. Notice of testing shall include a schedule of daily tests to be performed. Certified test reports are required whether witnessed by AMAT or not.
- B. Tests: The transformers shall receive manufacturer's standard commercial tests in accordance with ANSI C57.12.90.
 - 1. Dielectric Tests
 - a) Impulse Test: Each transformer shall receive a complete impulse test to demonstrate its impulse insulation level. The test shall consist of one reduced full wave, two chopped waves, and one full wave applied to each terminal, one at a time without 60Hz excitation.
 - b) Applied Potential Tests: These tests shall be applied to demonstrate the insulation strength from the windings to the core and the tank, and the ability to withstand normal frequency over-voltages. In addition, the neutral (XO) bushing shall be tested.
 - c) Induced Voltage Tests: These tests shall be made as specified in the above standard, sufficient voltage being applied to the low-voltage terminals to induce the specified test voltage for 7,200 Hertz at the high-voltage terminals.
 - d) Insulation Resistance: The insulation resistance shall be determined for each winding on the rated voltage connection and at the tap extremes.
 - e) Insulation Power Factor: The insulation power factor shall be determined for each winding at room temperature and shall not exceed 0.5%.

2. Noise Level: The noise level shall be measured in accordance with NEMA TR-1, latest revision at OA and maximum FA ratings. Also measure and report noise level without the FA coolers running at 12 equally spaced points around the transformer, their distance from transformer being determined by TR-1, above. These measurements shall be made at no-load with 100% rated voltage, then 110% of rated voltage.
3. Loss Tests, Regulation, and Efficiency
 - a) Exciting Current and Excitation Loss: These values shall be measured at 100 and 110% of rated voltage.
 - b) Impedance: The impedance shall be determined at rated current with the taps set for nominal voltage ratings.
 - c) Regulation: The regulation shall be determined in accordance with the ANSI standards, for unity power factor and .9 power factor and .8 power factor.
 - d) Efficiency and Losses: The efficiency and losses shall be determined in accordance with ANSI Standards at 25%, 50%, 75%, and 100% of rated load.
4. Resistance: The resistance of the windings shall be measured hot and cold.
5. Winding and Polarity Ratios: The winding ratios, polarity, and phase relation shall be determined.
6. Temperature Rise Tests: The temperature tests shall be made in accordance with the ANSI Standards.
7. Pressure and Vacuum Tests: Pressure and vacuum tests of the tank shall be made to demonstrate freedom from oil and air leaks.
8. Bushing Power Factor Test: 60-kV and 12-kV bushings shall be power factor tested in accordance with the applicable sections of ANSI C76.1, "General Requirements and Test Procedure for Outdoor Apparatus Bushings."
9. Bushing Current Transformer Tests: Bushing current transformers shall be tested in accordance with applicable sections of ANSI C57.13 and shall be checked for proper nameplate and polarity markings. To ensure correct installation, they shall be given a polarity check and ammeter ratio check after mounting in the transformers. Bushing current transformers shall be capable of continuous loading of 150% of full load. The following performance data shall be furnished:
 - a) Typical excitation curves.
 - b) Typical ratio correction factor curves.
 - c) The resistance of the secondary winding at 75°C., including the approximate resistance of the secondary leads internal to the transformer.
 - d) The thermal and mechanical short-time current ratings.
10. Short-Circuit Strength: Transformer shall be designed and constructed to be completely self-protected by its ability to withstand a through fault, without failure and in accordance with Section 2.2 A.9. of this specification. There will be sufficient time between faults to permit cooling of the windings. Four of the above external short circuits are to be considered completely offset as defined in ANSI C57.12.00, Paragraph 7.1.

11. Short-Circuit Certified Test: The factory location furnishing the proposed transformers shall prove construction capability by certified test data showing that a transformer with a core and coil identical in design and construction, and identical or similar with respect to kVA capacity, kV ratings, BIL, impedance, and voltage taps, has been tested without failure for short-circuit strength. A description of the test code under which the transformer was tested for short circuit shall be provided by the manufacturer as a submittal prior to fabrication.
12. Certified Test Reports: All tests required in this part shall be submitted to AMAT in triplicate. All test reports shall be dated and signed by a responsible person at the test location. All other tests of components, assemblies, floor checks, or other tests required by this Specification, shall be submitted to AMAT in triplicate.

2.25 FIELD ACCEPTANCE TESTS

- A. The VENDOR shall complete the following tests after delivery of the power transformer to the substation site, and other tests that are recommended by the VENDOR, to ensure the integrity of the power transformer, its load tap changer (LTC) and its associated equipment.
 1. Insulation resistance
 2. Insulation power factor - bushings and transformer and its LTC
 3. Winding resistance
 4. Insulating oil dielectric strength and water content
 5. Winding turns ratio - all positions

2.26 TOOLS AND APPLIANCES

- A. The VENDOR shall furnish and include in the price offered, all special tools and appliances that are required for satisfactory installation, operation, and maintenance of the transformer, including any special wrenches or appliances that are necessary for assembling and disassembling the transformer. When shipping the transformer, the VENDOR shall ship and submit a complete list of the tools and appliances that he is furnishing.

2.27 PAINTING

- A. Metal Surfaces: Bare metal surfaces shall be painted one prime coat, one body coat and one finish coat unless otherwise required to obtain proper hiding and specified film thickness. Paint color shall be ANSI 70 light grey.
- B. Preparation of Surface for Painting
 1. Prior to painting, all surfaces shall be dry and free of dirt, dust, sand, grit, mud, oil, grease, rust, loose mill scale, or other objectionable substances.

2. Cleaning and painting shall be done in a manner that will prevent dust or other airborne particles from contaminating freshly painted surfaces.
3. Oil or grease shall be removed with solvents before mechanical cleaning is started.
4. Clean cloths and clean fluids shall be used to avoid leaving a film of greasy residue on the surface being cleaned.
5. Surfaces not intended to be painted, shall be adequately protected from contamination, discoloration, or other damage resulting from cleaning or painting operations.
6. Surfaces shall be free of cracks, pits, projections, or other imperfections that would prevent the formation of a smooth unbroken paint film.

C. Paint Application

1. Surface to be painted shall be at a temperature not less than the minimum surface temperature recommended by the paint manufacturer. In no case shall paint be applied under any of the following conditions:
 - a) When the surface temperature or air temperature is below 45°F.
 - b) When atmospheric conditions are causing condensation on the surface.
 - c) When exterior surfaces are wet or damp.
2. The manufacturer and his personnel shall be constantly aware that they are applying the complete protective coating system to the equipment. Their skill is required to secure the highest quality protection and appearance for each surface.
 - a) All painting materials shall be applied in accordance with the manufacturer's recommendations by competent and experienced painters.

D. Mixing

1. Paint shall be thoroughly mixed each time any is withdrawn from the container.
2. Paint containers shall be kept tightly closed at all times, except while paint is being withdrawn.

E. Thinning

1. Paint shall not be thinned except as recommended by the manufacturer of the paint.

F. Applying

1. Paint shall be flow coated or spray applied except as otherwise specified or as otherwise approved in writing by the AMAT.
2. Application of paint shall continue without interruption to all surfaces between corners, seams, or other surface breaks.
3. No laps will be permitted except at such surface breaks.
4. Air spray equipment shall be provided with pressure gauges, pressure regulators, and moisture traps or separators.

5. Nozzles shall be of proper size and type for the paint being applied in each case.
6. Air delivered to the spray nozzle shall be dry and of sufficient and suitable pressure for the proper application of the paint used.
7. Spray application of paint shall be followed immediately with a paint brush applied along vertical and lower horizontal edges of steel members, abutting surfaces, edges of connections, and between and beneath bolt heads and nuts, to remove all surplus paint and to smooth out all runs.
8. All sags in paint films shall be brushed out immediately.
9. Each coat of paint shall be of a visibly different color or shade from the preceding coat. Paints shall be factory tinted.
10. Paint systems applied under these specifications, whether flow coat or spray applied, shall have a dry film thickness of not less than five mils nor more than ten mils.
11. Each coat shall be applied to yield from 1.5 to two mils in dry film thickness, and the total dry film thickness of three coats shall be a minimum of five mils.

G. Curing

1. All paint in any one-paint coat shall be hard and dry through the entire paint film before the next coat is applied.
2. In no case shall the elapsed time between application of successive coats of paint to any surface be less than that recommended by the paint manufacturer.
3. In order to ensure that all parts of the paint are dry when repainted, all paint shall be applied in a film of uniform thickness at all points.
4. In no case shall paint be applied at a rate of coverage per gallon which is greater than the maximum rate recommended for that paint by its manufacturer.

2.28 SPARE PARTS

A. The VENDOR shall furnish the following spare parts:

1. One bushing of each voltage class, including neutral bushing.
2. One complete set of gaskets for one transformer.
3. One complete extra relay and contactor, of each relay type and of each contactor type and size.
4. One complete set of motor assemblies (including contactors) for one transformer.
5. Six cooling fans, complete with blades, guard, and motor assembly.
6. Three complete sets (one per phase) of tap changer contacts and associated contact assemblies.

B. In addition to the above required spare parts, the VENDOR shall include a list of any additional recommended spare parts in the transformer instruction book.

- C. The VENDOR shall include unit prices for the list of spare parts listed in above paragraph 2.28 A and for the VENDOR's recommended spare parts in the bid.

PART 3 EXECUTION

3.1 SPECIAL SERVICES

A. General

- 1. VENDOR shall furnish a field service representative during transformer oil filling, assembly, testing and training. Field service representative shall:
 - a) Provide technical advice
 - b) Inspect and test the equipment
 - c) Direct changes and/or adjustments required for proper operation
 - d) Provide technical direction
 - e) Direct changes for design or manufacturing corrections
 - f) Provide services necessary as a condition to furnish specified warranties
 - g) Provide training in operation and maintenance
 - h) Furnish written documentation and certification for field inspections, tests performed, modifications made, adjustments and settings, and certify equipment ready for operation prior to initial operation

B. Fill Transformer with oil

- 1. VENDOR shall furnish services to fill the transformer, once delivered on placed on the transformer foundation, with transformer oil. VENDOR shall provide all oil filling and testing equipment including the oil filter press. AMAT will provide for labor support through the Construction VENDOR.

C. Direct and Coordinate Transformer Assembly

- 1. VENDOR shall furnish direction and coordination to the Construction Contractor to assemble power transformer.

D. Direct and Coordinate Transformer Testing

- 1. VENDOR shall furnish direction and coordination to the Construction Contractor and the Test Firm to perform Acceptance tests and energization. The following Acceptance tests shall be performed and certified test reports submitted to AMAT:
 - a) Insulation resistance on each winding to ground and between windings
 - b) Power factor test on the high-voltage bushings
 - c) Winding ratio test on each tap
 - d) Hotspot and oil temperature indicating and control devices calibration tests
 - e) Oil dielectric and power factor tests

E. Furnish Training

1. VENDOR shall furnish power transformer operations and maintenance training to CUSTOMER operation and maintenance staff. Trainer shall be knowledgeable of the transformer operations and maintenance and shall have training experience and training material in a classroom and "hands on" training services.

END OF SECTION

SECTION 16500 – LIGHTING

PART 1 GENERAL

1.1 CONDITIONS AND REQUIREMENTS

- A. Refer to the General Conditions, Supplementary General Conditions and Division 1 – General Requirements.

1.2 DESCRIPTION

- A. Work included in this SECTION;
 - 1. Lighting fixtures and installation.
- B. Related work included in other SECTION;
 - 1. SECTION 16050, Basic Construction Materials and Methods
 - 2. SECTION 16060, Grounding

1.3 INCORPORATED DOCUMENTS

- A. SECTION 16010, Electrical Requirements, applies to all work in this SECTION.

1.4 SUBMITTALS

- A. Shop drawings and/or manufacturer's literature describing product.
- B. Photometric test data by an independent testing laboratory when requested.

PART 2 PRODUCTS

2.1 GENERAL

- A. All fixtures shall be complete, including lamps and ready for service and shall bear the label of Underwriters' Laboratories, Inc. All fixtures shall be wired in accordance with the manufacturer's recommendations and shall be hung earthquake-resistant in accordance with the State of California Title 24, Basic Electrical Regulations.
- B. Substitution of fixtures from those specified will be judged on the basis of equal or better efficiency, appearance, construction, and photometric data. The only photometric data acceptable will be that certified by the Electrical Testing Laboratories. All decisions relative to substitution on fixtures will be made by the Architect.
- C. Incandescent lamps shall be rated at 125 volts as manufactured by General Electric, Sylvania or Philips.
- D. Electronic fluorescent ballasts must be fully electronic and have a minimum life of 50,000 hours, a power factor >0.85 and must be UL and ETL/CBM listed. Electronic ballasts must have a total harmonic distortion <20% and a ballast efficacy factor, ballast factor divided by input power, >0.6 to meet PG&E rebate program requirements, as manufactured by Advance, Magnetic-Triad, or Motorola. Verify connection voltage prior to ordering.
- E. All fluorescent lamps shall be energy saving type, T8 Octron or approved equal (F036/835).
- F. Fluorescent fixtures shall be designed for 40 degrees C ambient.
- G. Recessed fixtures in suspended ceilings shall be supported from roof structure by wires at diagonal corners and on four ft. centers along row of fixtures, and two diagonal wires at 45 degrees on four ft. centers for lateral bracing. Wire shall be same as ceiling support, #12 gauge minimum.
- H. Exact location of all fixtures shall be coordinated with the Architect during construction.
- I. All lighting fixtures shall comply with California Electrical Code.
- J. Recessed fixtures shall be equipped with plaster rings and gaskets as required. Check room finish schedule on Architectural Drawings.
- K. Fixtures which are exposed to weather shall be weatherproof.
- L. All flex connections between J-boxes and recessed fluorescent fixtures in T-bar ceiling areas shall be six ft. long with #12 THHN conductors.
- M. Locate lighting fixtures in mechanical rooms to clear all ductwork, piping, etc.
- N. Each lighting fixture shall be grounded with a green insulated copper ground wire which extends from the panel ground bus to fixture body via branch circuit raceways and fixture

channels. Ground wire shall be sized in accordance with Code, minimum size #12. This ground wire may not be shown on the Plans.

- O. Recessed fixtures shall be complete with appropriate mounting devices and trim. Check room finish schedule on Architectural Drawings for exact details prior to ordering fixtures.
- P. In all areas which require fire rated ceilings or walls, the Contractor shall be responsible to provide continuous fire rating construction behind all recessed fixtures.
- Q. Fluorescent fixtures shall be aligned and bolted together with two (2) ¼" bolts.
- R. Where a fixture containing a ballast is to be installed on combustible low-density cellulose fiberboard, it shall where surface mounted:
 - 1. Be approved for this condition, OR
 - 2. Be installed as detailed on the Drawings, or with sheetrock backing, or spacers as directed.
- S. All open tube fluorescent lighting fixtures shall be provided with lamp retaining clips to secure lamps in place.
- T. The exact location, height, and/or stem length of fixtures shall be determined finally by the Structural and Mechanical limitations of the building. The Contractor shall work with the Architect to avoid any obstructions and to insure the proper illumination results.

END OF SECTION