

Humboldt State University
HSU Critical Electrical Generation

100% CD
December 23, 2020
Exhibit F1

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SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Pipe markers.

1.02 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2007.

1.03 SUBMITTALS

- A. See Division 1 for submittal requirements.
- B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Product Data: Provide manufacturers catalog literature for each product required.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A. Piping: Pipe markers.
- B. Valves: Tags.

2.02 TAGS

- A. Manufacturers:
 1. Advanced Graphic Engraving: www.advancedgraphicengraving.com/#sle.
 2. Brady Corporation: www.bradycorp.com/#sle.
 3. Brimar Industries, Inc: www.pipemarker.com/#sle.
 4. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 5. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 6. Seton Identification Products: www.seton.com/#sle.
- B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

2.03 PIPE MARKERS

- A. Manufacturers:
 1. Brady Corporation: www.bradycorp.com/#sle.
 2. Brimar Industries, Inc: www.pipemarker.com/#sle.
 3. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 4. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 5. Seton Identification Products: www.seton.com/#sle.
- B. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- C. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
- D. Color code as follows:
 1. Natural Gas and Other Flammable Fluids: Yellow with black letters.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

- A. Install tags with corrosion resistant chain.

- B. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- C. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

END OF SECTION

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SECTION 22 10 05
PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe, pipe fittings, specialties, and connections for piping systems.
 - 1. Gas.
 - 2. Valves.

1.02 REFERENCE STANDARDS

- A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2011.
- B. ASME B31.1 - Power Piping; 2014.
- C. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- D. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2015.
- E. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2015.
- F. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).
- G. ASTM D2513 - Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings; 2014.
- H. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2012.
- I. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing; 2014.
- J. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2011.
- K. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2010.
- L. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2009.
- M. California Code of Regulations, Title 24, Part 5: California Plumbing Code (CPC), latest edition.
- N. NFPA 58 - Liquefied Petroleum Gas Code; National Fire Protection Association; 2014, with 2015 interim Amendments.

1.03 SUBMITTALS

- A. See Division 1 for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- C. Pipe Test Reports: Submit pipe pressure test reports for all piping installed under this contract indicating that piping systems have been tested in accordance with the California Plumbing Code.

1.04 QUALITY ASSURANCE

- A. Perform work in accordance with applicable codes.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.06 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS**2.01 GENERAL REQUIREMENTS****2.02 NATURAL GAS PIPING, BURIED BEYOND 5 FEET OF BUILDING**

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASTM A234/A234M, wrought steel welding type, with AWWA C105/A21.5 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.
 - 2. Joints: ASME B31.1, welded.
- B. Polyethylene Pipe: ASTM D2513, SDR 11.
 - 1. Fittings: ASTM D2683 or ASTM D2513 socket type.
 - 2. Joints: Fusion welded.

2.03 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
 - 2. Joints: Threaded or welded to ASME B31.1.

2.04 PROPANE GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
 - 2. Joints: 1, threaded or welded to ASME B31.1.

2.05 BALL VALVES

- A. Manufacturers:
 - 1. Apollo: Series 80-100, for natural gas service through 3"
 - 2. Nibco, Inc: www.nibco.com.
- B. Valves for use with natural gas shall be in constructed per applicable ANSI, ASME and CSA standards for service and pressure required. Chrome plated brass ball acceptable for gas use.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

- A. Install and test all plumbing piping systems in strict accordance with the California Plumbing Code.
- B. Install in accordance with manufacturer's instructions.
- C. Inserts:
 - 1. Provide inserts for placement in concrete formwork.

END OF SECTION

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SECTION 23 21 13
HYDRONIC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hydronic system requirements.
- B. Heating water piping, buried.
- C. Unions, flanges, mechanical couplings, and dielectric connections.

1.02 REFERENCE STANDARDS

- A. ASME B31.9 - Building Services Piping; 2014.
- B. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- C. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2010.

1.03 SUBMITTALS

- A. See Division 1 for submittal procedures.
- B. Product Data:
 - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
 - 2. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
 - 1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 - 2. Use non-conducting dielectric connections whenever jointing dissimilar metals.

2.02 HEATING WATER PIPING, BURIED

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, with AWWA C105/A21.5 polyethylene jacket, or double layer, half-lapped polyethylene tape.

2.03 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

- A. Flanges for Pipe 2 Inches and Greater:
 - 1. Ferrous Piping: 150 psig forged steel, slip-on.
 - 2. Gaskets: 1/16 inch thick, preformed neoprene.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment using jointing system specified.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

- E. After completion, fill, clean, and treat systems.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and to avoid interference with use of space.
- D. Group piping whenever practical at common elevations.

END OF SECTION

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SECTION 23 51 00

DIESEL PARTICULATE FILTER

PART-1 STANDBY DIESEL ENGINE/GENERATOR – ACTIVE PARTICULATE FILTER SYSTEM

1.01 SCOPE

- A. ACTIVE DIESEL PARTICULATE FILTER SYSTEM (A-DPF) – Provide an automatic, regenerating diesel particulate filter that meets CARB Level 3+ verification standards. The system will consist of a combination Passive DPF(P-DPF)/silencer and load bank that will provide automatic filter regeneration on an as required basis. The A-DPF housing design to include a minimum exhaust silencing insertion loss of 30-35dBA. No moving parts are permitted in the A-DPF. The DPF shall be the Johnson Matthey SDPF-H model or CRT(+)-H model and Simplex load bank, or an equivalent pre-approved by the specifying engineer.
- B. A UL listed, Data logger/filter monitor (F-M) shall be supplied. The F-M unit and associated mounting and sensing hardware will measure both inlet temperature and pressure of the P-DPF. It will record/store those measurements for a minimum of 5 years, based on 5 second sampling intervals. In addition to the storage of these temperature and pressure time stamps, the unit will be capable of multiple set point alarms and storing those alarms in the device. The data logger/filter monitor shall be a Johnson Matthey F-M Module or an equivalent pre-approved by the specifying engineer.
- C. The P-DPF data-logger/filter monitor (F-M) shall work in conjunction with the Active Load Bank Controller (ALBC). The ALBC shall include inputs for two dry signals from the F-M. The first input is a “Warning” of high exhaust back pressure and the second input is an “Alarm” of high back pressure. During generator start-up, the ALBC shall perform an Active Pressure Check of the P-DPF under various loads. The ALBC shall step up a user defined kW load. Each step will hold for a user defined amount of time prior to moving to the next step. Once the maximum programmed load is reached, the controller will begin stepping down in the same manner until the load reaches the programmed load level set point which will be maintained until the generator is turned off or a signal is received from the F-M to increase load. If at any point during the Active Pressure Check, or thereafter, a pressure Warning or Alarm signal is received from the F-M, the ALBC will begin increasing load to a user defined kW window by user defined time delays. The ALBC will maintain this load level until the Warning or Alarm signal drops out and a user defined time period has passed to prevent cycling. If the Alarm signal from the F-M is present for more than a user defined time, then the ALBC will step the load down to zero load and signal a fault condition dry contact output. This output will indicate a condition where high back pressure persistence could cause damage to the generator. If at any time the signal from the generator identifying a shutdown/cool-down mode is received, the load bank shall step down to zero load and hold there until the signal is removed, or the generator is no longer running.
- D. CONSTRUCTION
- E. The P-DPF section of the system will have a minimum external shell construction thickness of 3/16”, constructed with carbon or stainless steel metal, fully welded, leak tight and capable of continuously operating at pressures of 60” water column or greater. The P-DPF must be capable of self-support from supplied lifting lugs or mounting brackets, both of sufficient strength to provide both lift and anchoring of the unit in a safe and practical manner. Filter elements and catalyst elements must be individual, not combined into one element and each easily removed and replaced by removing and replacing one band-clamp and one locking nut. Access hatch(es) that enable access to these elements must weigh less than 40 lbs. so as a single operator can open and close the access hatch(es).
1. Inlet and Outlet connections will be ANSI 150# Class Flat-Face flanges.
 2. Multiple Inlet and Outlet sampling ports and at least one Inlet and one Outlet port capable of being tapped for installation of temperature and pressure sensors.
 3. An internal means of handling thermal stress/expansion must be provided. This can take the form of sliding mounting brackets or sliding mounting channel.
 4. Connections flanges are not to be used as a means of support or to handle weight or thermal stresses.

5. Gaskets and bolting that are supplied by others must be capable of 950 F continuous service, as is the construction of the P-DPF itself.
 6. No frangible sound absorbing materials to be used upstream of catalyst and filter sections.
 7. This exhaust system, including any and all interconnecting duct/pipe shall be designed and installed to be gas tight and thus prevent leakage of combustion exhaust.
 8. The exhaust system that connects the P-DPF from the engine and past the P-DPF to the final discharge point shall be designed to compensate for all flue gas induced thermal expansion.
 9. The exhaust system supports and roof penetrations shall be suitable for the specified roof construction and shall comply with the manufacturer's installation instructions.
- F. The manufacturer shall provide "to scale" drawings depicting the actual unit, including "center of gravity" call out, the total weight of the unit and connection details.

1.02 EXTERNAL INSULATION BLANKET

- A. Thermal Blanketing
1. The thermal blanket shall be composed of woven Treo fiber insulation that is lightweight, water-repellent and sound absorbent. The outer surface of the insulation blanket shall be of silicone impregnated fiberglass material and be installed using stainless steel spring and hook latching.
 2. The fiber insulation shall be noncombustible, asbestos free and contain no resinous or inorganic binders and conform to Mil-I-24244, USCG subpart 164.009.
 3. The maximum material operating temperature shall meet or exceed the operating temperature range of the genset exhaust.
 4. Materials must pass requirements for fire testing according to ASTM E84, NFPA 701 and UL 1709.
 5. Kevlar thread to be used to stitch sections of blanketing together, when needed.
 6. The thermal insulation blanket shall be manufactured by InsulTech LLC, or an equivalent pre-approved by the specifying engineer.

1.03 PART-2 PERFORMANCE

1.04 EMISSIONS

- A. PM2.5 removal to be in excess of 85%,
- B. CO removal to be in excess of 80%,
- C. HC removal to be in excess of 70%.
- D. Discharge of NO2 from NO to NO2 conversion not to exceed 20% of inlet NO value.

1.05 REGENERATION

- A. Unit shall be capable of rapid regeneration at engine loads of 50% or greater, and the total duration of regeneration after reaching the maximum engine allowable back pressure must be less than 6 hours - while at optimal regeneration temperature.
- B. Inorganic oil ash does not regenerate, so unit must be able to hold ash at least 1000 hours of operation without exceeding maximum allowable engine back pressure due to engine oil ash build-up.

1.06 PART-3 EXPERIENCE

1.07 MINIMUM QUALIFICATIONS

- A. The P-DPF manufacturer must have 10+ years of successful experience in providing CARB verified diesel particulate filters.
- B. The P-DPF manufacturer must have 100+ CARB verified units successfully installed in California
- C. The load bank manufacturer must have 25+ years of successful experience in providing load bank for generator set applications.

1.08 PART-4 WARRANTY**1.09 4.1 WARRANTY**

- A. The P-DPF shall be factory warranted for a period of 5 years from shipment. This includes repair and/or replacement of factory defects and other faults or failures that are not due to normal wear and tear or mistreatment, abuse or abnormal conditions.
- B. The F-M shall be factory warranted for a period of 2 year from shipment. This also includes repair and/or replacement of factory defects and other faults or failures that are not due to normal wear and tear or mistreatment, abuse or abnormal conditions.
- C. The load bank shall be factory warranted for a period of 2 years from shipment. This includes repair and/or replacement of factory defects and other faults or failures that are not due to normal wear and tear or mistreatment, abuse or abnormal conditions.

1.10 PART-5 PRODUCTS**1.11 5.1 MANUFACTURERS**

- A. Product specification requirements shall be met by using Johnson Matthey P-DPF, Johnson Matthey F-M, InsulTech LLC blanketing, Simplex load bank or an equivalent pre-approved by the specifying engineer. Equivalent submittals shall specify manufacturer's model number, and other pertinent identification, and attest that the alternate material is in compliance with all specification requirements and be submitted to the specifying engineer 14 days ahead of bid.

1.12 PART-6 EXECUTION**1.13 5.1 INSTALLATION & TRAINING**

- A. Provide factory trained technician for on-site testing.
- B. Testing to be completed as part of facility training.
- C. Training to include load bank and filter operation as well as data recording operation.
- D. Provide factory recommended maintenance scheduling and tests for University in excel format.

END OF SECTION

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SECTION 26 05 01
MINOR ELECTRICAL DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical demolition.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify field measurements and circuiting arrangements are as shown on Drawings.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition drawings are based on casual field observation and existing record documents.
- D. Report discrepancies to University before disturbing existing installation.
- E. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with utility company.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations. Fire Alarm work to be performed by C-10 licensed contractor.
- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Provide fire watch and security watch for all areas affected by outages. To be approved by SFM.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:
 - 1. PCB-containing electrical equipment, including transformers, capacitors, and switches.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned wiring to source of supply.
- D. Disconnect and remove abandoned panelboards and distribution equipment.
- E. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- F. Repair adjacent construction and finishes damaged during demolition and extension work per listed rated assembly.
- G. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- H. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.04 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment that remain or that are to be reused.

- B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

END OF SECTION

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SECTION 26 05 10
ELECTRICAL GENERAL PROVISIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, apparatus, tools, equipment, transportation, temporary construction and special or occasional services as required to make a complete working electrical installation, as shown on the drawings or described in these specifications.

1.02 REFERENCES

- A. Reference to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies shall mean the latest edition of such publications adopted and published prior to submittal of the bid proposed. Such codes or standards shall be considered a part of this specification as though fully repeated herein.
- B. When codes, standards, regulations, etc., allow work of lesser quality or extent than is specified under this Division, nothing in said codes shall be construed or inferred as reducing the quality, requirements or extent of the drawings and specifications.
- C. California Code of Regulations (CCR) Title 24, Part 3, California Electrical Code.
- D. National Fire Protection Association (NFPA).
- E. Equipment and materials specified under this Division shall conform to the following standards where applicable:
 - 1. UL Underwriters' Laboratories
 - 2. ASTM American Society for Testing Materials
 - 3. CMB Certified Ballast Manufacturers
 - 4. IPCEA Insulated Power Cable Engineer Assoc.
 - 5. NEMA National Electrical Manufacturer's Assn.
 - 6. ANSI American National Standards Institute
 - 7. ETL Electrical Testing Laboratories
- F. All base material shall be ASTM and/or ANSI standards.
- G. All electrical apparatus furnished under this Section shall conform to National Electrical Manufacturers Association (NEMA) standards and the NEC and bear the Underwriters' Laboratories (UL) label where such label is applicable.

1.03 SUBMITTALS

- A. See Division 1 for submittal procedures.
- B. Where items are noted as "or equal" a product of equal design, construction and performance will be considered. Contractor must submit all pertinent test data, catalog cuts and product information required to substantiate that the product is in fact equal. Refer to Division 1, General Requirement for additional requirements. Only one substitution will be considered for each product specified.
- C. Submittals shall consist of detailed shop drawings, specifications, "catalog cuts" and data sheets containing physical and dimensioned information, performance data, electrical characteristics, material used in fabrication, material finish and shall clearly indicate those optional accessories which are included and those which are excluded. Furnish one reproducible and 4 prints of each shop drawing.

1.04 CUTTING, PAINTING AND PATCHING

- A. Structural members shall in no case be drilled, bored or notched in such a manner that will impair their structural value. Cutting of holes, if required, shall be done with core drill and only with the approval of the Architect.
- B. Cutting and digging shall be under the direct supervision of the General Contractor. Include as necessary for the work in this section.

- C. The contractor shall be responsible for returning any surface from which he has removed equipment or devices to the condition and finish of the adjacent surfaces.

1.05 SUPERVISION

- A. Contractor shall personally or through an authorized and competent representative constantly supervise the work from beginning to completion and, within reason, keep the same workmen and foreman on the project throughout the project duration.

1.06 PROTECTION

- A. Keep conduits, junction boxes, and outlet boxes, and other openings closed to prevent entry of foreign matter: cover fixtures, equipment, and apparatus and protect against dirt, paint, water, chemical, or mechanical damage, before and during construction period. Restore to original condition any fixture, apparatus, or equipment damaged prior to final acceptance, including restoration of damaged shop coats of paint, before final acceptance. Protect bright finished surfaces and similar items until in service. No rust or damage will be permitted.

1.07 EXAMINATION OF SITE

- A. The Contractor shall visit the site and determine the locale, working conditions, conflicting utilities, and the conditions in which the electrical work will take place. No allowances will be made subsequently for any costs which may be incurred because of any error or omission due to failure to examine the site and to notify the Engineer of any discrepancies between drawings and specifications and actual site conditions. Schedule visits at least 1 week in advance with University's Maintenance staff.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. After other work such as sanding, painting etc. has been completed, clean lighting fixtures, panelboards, switchboards, and other electrical equipment to remove dust, dirt, and grease, or other marks, and leave work in clean condition.

1.09 VOLTAGE CHECK

- A. At completion of job, check voltage at several points of utilization on the system which has been installed under this contract. During test, energize all loads installed. Measure 3-Phase voltages and note percentage differences. Submit report to Engineer. Include copy in O&M Manual.

1.10 WARRANTY

- A. See Division 1 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.

1.11 TESTS

- A. Perform tests as specified to prove installation is in accordance with contract requirements. Perform tests in the presence of the Engineer and furnish test equipment, facilities, and technical personnel required to perform tests. Tests shall be conducted during the construction period and at completion to determine conformity with applicable codes and with these Specifications. Tests, in addition to specific system test described elsewhere, shall include:
 1. Insulation Resistance: All 600 volt insulation shall be tested at 1,000 volts D.C for one minute on all feeder and branch circuit conductors including the neutral, and make a typed record of all readings to be included in the maintenance instructions. The direct current amperes shall be recorded at start and at one minute. The value shall be declining and not more than one microampere.
 2. Circuit Continuity: Test all feeder and branch circuits for continuity. Test all neutrals for improper ground.
- B. Equipment Operations: Test motors for correct operation and rotation.
- C. Product Failure: Any products which fail during the tests or are ruled unsatisfactory by the Engineer shall be replaced, repaired, or corrected as prescribed by the Engineer at the expense of the Contractor. Tests shall be performed after repairs, replacements, or corrections until satisfactory performance is demonstrated.

- D. Miscellaneous: Include all test results in the maintenance manual. Cost, if any, for all tests shall be paid by the Contractor.

1.12 DRAWINGS

- A. Layout: General layout shown on the drawing shall be followed except where other work may conflict with the drawings.
- B. Accuracy:
 1. Drawings for the work under this section are diagrammatic.
 2. Contractor shall verify lines, levels, and dimensions shown on the drawings and shall be responsible for the accuracy of the setting out of work and for its strict conformance with existing conditions at the site.
 3. Contractor shall insure reconnection of existing equipment and circuits affected by contract demolition whether or not reconnection is specifically shown on the contract documents.

1.13 PROJECT RECORD DRAWINGS

- A. Refer to General Conditions for contractual requirements. Provide project record drawings as required by the General Provisions of the specifications and as required herein. Such drawings shall fully represent installed conditions including actual locations of outlets, true panelboard connections following phase balancing routines, correct conduit and wire sizing as well as routing, revised fixture schedule listing the manufacturer and products actually installed and revised panel schedule. All changes to drawings shall be made by qualified draftspersons to match existing linework and lettering as close as possible. When all the changes have been made to the trade drawings, contractor shall produce one (1) full size (E-Size) updated set of trade drawing(s) utilizing AutoCad 2008 or newer and supply one (1) set of Compact Discs (CD's) reflecting same.
- B. Provide laminated single line diagram at each switchgear.

1.14 MAINTENANCE AND OPERATING INSTRUCTIONS

- A. Furnish to the Engineer four (4) hard back 3-ring binders containing all bulletins, operating and maintenance instructions and part lists and other pertinent information for each and every piece of equipment furnished under this specification. Include service telephone numbers. Each binder shall be indexed into sections and labeled for easy reference. Bulletins containing more information than the equipment concerned shall be properly stripped and assembled.
- B. At the time of completion, a period of not less than eight hours shall be allotted by the Contractor for instruction of building operating and maintenance personnel in the use of all systems. All personnel shall be instructed at one time, the Contractor making all necessary arrangements with manufacturer's representative. The equipment manufacturer shall be requested to provide product literature and application guides for the user's reference. Costs, if any for the above services shall be paid by the Contractor.

1.15 WARRANTIES

- A. Furnish to the Engineer four (4) hard back 3-ring binders containing all warranties of every piece of equipment furnished under this specification. Include terms and limitations of warranties, contact names, addresses, and telephone numbers of manufacturer. Each binder shall be indexed into sections and labeled for easy reference for each equipment warranty.

1.16 EXTRA MATERIALS

- A. See Division 1 - Product Requirements, for additional provisions.
- B. All special tools for proper operation and maintenance of the equipment provided under this Section shall be delivered to the University's representative

PART 2 PRODUCTS - NOT USED**PART 3 EXECUTION****3.01 WORKMANSHIP**

- A. Preparation, handling, and installation shall be in accordance with manufacturer's written instructions and technical data particular to the product specified and/or accepted equal except as otherwise specified. Coordinate work and cooperate with others in furnishing and placing this work. Work to reviewed shop drawings for work done by others and to field measurements as necessary to properly fit the work.
- B. Conform to the National Electrical Contractor's Association "Standard of Installation" for general installation practice.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

END OF SECTION

Humboldt State University
HSU Critical Electrical Generation

SECTION 26 05 12
BASIC MATERIAL AND METHODS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Conduit, raceways and fittings.
- B. Wires and Cables for 600 Volts and less.
- C. Wire connections.
- D. Wire devices.
- E. Outlet boxes.
- F. Pull and junction boxes.
- G. Disconnect Switches.
- H. Fuses.
- I. Supporting Devices.
- J. Identifying Devices.
- K. Grounding and Bonding

1.02 SUBMITTALS

- A. Submit in accordance with the requirements of Division 1 the following items:
- B. A list of conduit types indicating where each type of conduit will be used. Indicate conduit manufacturers and fittings to be used.
- C. Wires and Cables.
- D. Wiring Devices and Plates
- E. Nameplates, including engraving schedules where engraved plates are specified.
- F. Fused disconnect switches.

1.03 QUALITY ASSURANCE

- A. Conform to requirements of 2016 California Electrical Code.
- B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.04 REFERENCES

- A. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated - latest edition.
- B. ANSI C80.3 - Electrical Metallic Tubing, Zinc Coated - latest edition.
- C. ANSI C80.5 - Rigid Aluminum Conduit - latest edition.
- D. NECA (INST) - Standard of Installation; National Electrical Contractors Association - latest edition.
- E. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies; latest edition.
- F. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit - latest edition.
- G. NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80) - latest edition.
- H. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing - latest edition.
- I. NFPA 70 - National Electrical Code - latest edition.

PART 2 PRODUCTS

2.01 CONDUIT, RACEWAYS AND FITTINGS

- A. Rigid Steel Conduit

1. Rigid steel conduit shall be full weight, pipe size, finished inside and out by hot-dip galvanizing after fabrication, and shall conform with ANSI C80.1 and UL.
 2. Couplings shall be electroplated steel.
 3. Insulating Bushings: Threaded polypropylene or thermo-setting phenolic rated 150°C minimum.
 4. Insulated grounding Bushings: Threaded cast malleable iron body with insulated throat and steel "lay-in" ground lug with compression screw.
 5. Insulated Metallic Bushings: Threaded cast malleable iron body with plastic insulated throat rated 150°C.
 6. Running threads are not acceptable.
- B. Electrical Metallic Tubing (EMT):
1. Conduit: Conduit shall be formed of cold rolled strip steel, and shall comply with ANSI C80.3 and UL requirements.
 2. Couplings: Electroplated steel, UL listed rain and concrete tight through 1-1/4" trade size. All EMT fittings shall be compression type.
 3. Connectors: Steel, gland compression type with insulated plastic throat, 150°C temperature rated. All EMT fittings shall be compression type.
- C. Liquid Tight Flexible Metal Conduit:
1. Conduit: Conduit shall be fabricated in continuous lengths from galvanized steel strip, spirally wound. Flexible conduit, except where installed in concealed dry locations, shall be liquid tight with plastic jacket extruded over the outer zinc coating. No aluminum substitute will be accepted.
 2. Fittings: Connectors shall be the screw clamp on screw-in (Jake) variety with cast malleable iron bodies and threaded male hubs with insulated throat or insulated bushings. Set screw type connectors are not acceptable. Liquid tight fittings shall be of cadmium plated cast malleable iron, with insulated throat.
- D. Rigid Non-Metallic Conduit:
1. Conduit and fittings shall be homogeneous plastic material free from visible cracks, holes or foreign inclusions. The conduit bore shall be smooth and free of blisters, nicks or other imperfections which could damage conductors or cables.
 2. Materials: Polyvinyl Chloride (PVC) schedule 40. Material shall comply with NEMA TC-2 for conduit and NEMA TC-3 for fittings.

2.02 WIRING AND CABLES

- A. Acceptable manufacturers: Southwire, or approved equal.
- B. Conductor material: All wire and cable shall be insulated, stranded copper conductors. Soft drawn annealed copper wire 98% conductivity, bearing the UL label.
- C. Minimum conductor size: AWG No. 12 for all power and lighting branch circuits. AWG No. 14 for all signal and control circuits.
- D. Color Coding: System conductors shall be identified as to voltage and phase connections by means of color impregnated insulation or approved colored marking tape as follows:
- E. For 120/240 volt, single phase, 3 wire system.
1. Phase A - Black
 2. Phase B - Red
 3. Phase C - Orange for High Leg (208v to neutral)
 4. Neutral - White
 5. Ground - Green
- F. For 120/208 volt, 3 phase, 4 wire systems.
1. Phase A - Black
 2. Phase B - Red
 3. Phase C - Blue
 4. Neutral - White
 5. Ground - Green

- G. for 277/480 Volt, 3 phase, 4 wire system
 - 1. Phase A - Brown
 - 2. Phase B - Orange
 - 3. Phase C - Yellow
 - 4. Neutral - Grey
 - 5. Ground - Green
- H. Secondary Wire and Cable, 0 to 600 Volts;
 - 1. NEC Type THWN, or Type XHHW for feeders and branch circuits in wet or dry locations.
NEC type THHN for branch circuits in dry locations.

2.03 WIRE CONNECTION

- A. Wire Joints: Wires in sizes from #18 to #8 AWG, stranded conductor, with insulation rated 105 degrees C. or less shall be joined with electrical spring connectors of three part construction incorporating a non-restricted, zinc coated steel spring enclosed in a steel shell with an outer jacket of vinyl plastic with a flexible insulating skirt.
- B. Mechanical Compression Connectors and Taps: Stranded conductors from #6 AWG to 750 Kcmil shall be joined or tapped using bolted pressure connectors having cast bronze compression bolts. Fittings shall be wide range-taking and designed to facilitate the making of parallel taps, tees, crosses or end-to-end connections. Split-bolt connectors will not be acceptable.
- C. Fixture Connections: Splice fixture wire to circuit wiring with solderless connectors as specified above in paragraph A.
- D. Terminating Lugs: Conductors from size No. 6 AWG to 750 Kcmil, copper, shall be terminated using tin plated hydraulically operated crimping tools and dies as stipulated by the lug manufacturer. Lugs shall be 3M "Scotchlok" series 30000, Burndy Type Ya-L series, or equal.
- E. Splicing and Insulating Tape (600 volts and below): General purpose electrical tape shall be suitable for temperatures from minus 18 degrees C to 105 degrees C, shall be black, ultraviolet proof, self-extinguishing, 7 mil thick vinyl with a dielectric strength of 10,000 volts. Apply 4 layers half-lap with 2" over-lay on each conductor.
- F. Insulating Putty (600 volts and below): Pads or rolls of non-corrosive, self-fusing, one eight inch thick rubber putty with PVC backing sheet. Putty shall be suitable for temperatures from minus 17.8 degrees C to 37.8 degrees C and shall have a dielectric strength of 570 volts/mil minimum.
- G. Insulating Resin: Two Part liquid epoxy resin with resin and catalyst in pre measured, sealed mixing pouch. Resin shall have a set up time of approximately 30 minutes at 21.1 degrees C, and shall have thermal and dielectric properties equal to the insulation properties of the cables immersed in the resin.
- H. Terminal Strip Connectors: Terminate wire in locking tongue style, pressure type, solderless lug where applicable.

2.04 WIRING DEVICES

- A. Switches: Specification grade, flush mounting, quiet operating AC type, with toggle operator, heat resistant plastic housing and self grounding metal strap. Silver or silver alloy contact. Rated 20A at 120-277V and capable of full capacity on tungsten or fluorescent lamp load. Design for up to #10 wire. Use single pole, double pole, three-way, four-way, lighted, pilot, or keyed type, as indicated on drawings or required. Provide white color unless otherwise noted.
Manufacturer: Leviton, Arrow Hart, or Hubbell.
- B. Receptacles: Specification grade, flush mounting receptacles with nylon face. High grade brass alloy triple wipe contacts. Provide 2 pole, 3 wire grounding type with a green colored brass hexagonal equipment grounding screw. Grounding shall be rivetless, single piece brass with no mechanical connections in the primary path between point of ground wire termination and ground blades. Use 20A rated receptacles, white in color, unless otherwise noted.
Manufacturer: Leviton, Arrow Hart, or Hubbell.

1. Isolated Ground - Provide separate path to ground, with orange faceplate or triangle to indicated isolated ground
 2. GFCI - Equipped with diagnostic indicator for miswiring.
 3. Weatherproof - GFCI type, outdoor rated, with metal lockable while in use cover
- C. Faceplates: Provide nylon cover faceplates for wall receptacles, outlets, and switches. Include thermal mounting screws that match plate and device color. Manufacturer: Leviton, Arrow Hart, or Hubbell.

2.05 OUTLET BOXES

- A. Standard outlet boxes: Galvanized, die formed or drawn steel, knock-out type of size and configuration best suited to the application indicated on the plans. Minimum box size, 4 inch square by 1-1/2 inch deep, indoor use. FS cast boxes are required for outdoor use.
- B. Cast Metal Outlet Boxes: FS/FD cast boxes are required for outdoor use. Malleable iron alloy with threaded hubs and mounting lugs as required. Boxes shall be furnished with cast cover plates of the same material as the box and neoprene cover gaskets. Thomas and Betts, Crouse-Hinds, Appleton or equal.
- C. Conduit Outlet Bodies: Electrogalvanized, cast iron alloy. Obround conduit outlet bodies with threaded conduit hubs and neoprene gasketed, cast iron covers. Outlet bodies shall be used to facilitate pulling of conductors or to make changes in conduit direction only. Splices are not permitted in conduit outlet bodies. Thomas and Betts, Crouse Hinds Form 8 Condulets, Appleton form 35 Unilets, or equal.

2.06 PULL AND JUNCTION

- A. Sheet Metal Boxes: Use standard outlet or concrete ring boxes wherever possible; otherwise use minimum 15 gauge get metal, NEMA 1 boxes, sized to code requirements with covers secured by cadmium plated machine screws located 6 inches on centers. Circle AW Products, Hoffman Engineering Co., or equal.
- B. Cast Metal Boxes: Use standard cast malleable iron outlet or device boxes wherever possible; otherwise use electrogalvanized, cast malleable iron junction boxes with bolt-on, interchangeable conduit hub plates with neoprene gaskets. Appleton FS/FD series; Crouse Hinds FS/FD series, or equal.

2.07 DISCONNECT SWITCHES

- A. All disconnect switches shall be heavy-duty type and have the number of poles, voltage rating, and horsepower rating as required by the motor or equipment. Disconnect switches shall be in enclosures to suit conditions, NEMA 3R for outdoor and NEMA 1 for indoor. Disconnect switches shall be fused unless otherwise noted on the drawings. As manufactured by: Square D - Class 3110, ITE Seimens, or equal.

2.08 FUSES

- A. Dual Element, Time Delay, UL Class RK5. Rejection type. Size and Voltage as indicated on equipment. Bussman, Little Fuse, or approved equal.

2.09 ELECTRICAL SUPPORTING DEVICES

- A. Concrete Fasteners: Hilti Kwik Bolt TZ or equal, self drilling expansion type concrete anchor.
- B. Conduit Straps: Hot-dip galvanized, cast malleable iron, two hole type strap with cast clamp-backs and spacers as required. OZ/Gedney, Thomas & Betts, or equal.
- C. Construction Channel: 1-1/2 inch by 1-1/2 inch 12 gauge galvanized steel channel with 17/32 inch diameter bolt holes, 1-1/2 inch on center, in the base of the channel. Kindorf 905 series, Unistrut P-1000-HS or equal.
- D. Cable Ties and Clamps: Thomas and Betts Co. "Ty-Raps" Panduit "Pan-Ty" or equal one piece, nylon, reusable type lashing ties.
- E. Fasteners (General) : Wood screws for fastening to wood. Machine screws for fastening to steel. Toggle bolts for fastening to hollow concrete block, gypsum board, or plaster walls. Expansion anchors for attachments to pre-poured concrete.

F. See structural Sheet S0.0 for other fasteners.

2.10 IDENTIFYING DEVICES

- A. Nameplates: Type NP: Engraved black bakelite, 1 inch by 3-1/2 inch, 1/8 inch high white letters, machine screw retained. For permanent identification of all switchboards, panelboards, circuit breakers in separate enclosures, motor starters, relays, time switches, disconnect switches and other cabinet-enclosed apparatus including terminal cabinets or match existing as closely as possible.
- B. Legend Plates: Type LP: Die-stamped metal legend plate with mounting hole and positioning key for attachment to panel mounted operators' devices. Engraved paint-filled characters as specified.
- C. Wire & Terminal Markers: Self-adhering, pre-printed vinyl with self-laminating wrap around strip. Markers shall be legible after termination. Brady B191 series, Thomas & Betts WSL series or equal.
- D. Conductor Phase Markers: Thomas & Betts WCPHAS series or similar in addition to colored marking as specified under this section of the specifications.

2.11 GROUNDING AND BONDING

- A. Ground Rods
 - 1. Manufacturer: Blackburn, Erico, or approved Equal
 - 2. Size: 3/4" x 10' Ground Rods
- B. Grounding Electrode Conductor, 2/0 for foundation foots, and per NEC.
- C. Grounding Well - Christy Box, G5 Traffic Valve Box.

PART 3 EXECUTION

3.01 CONDUIT AND RACEWAY APPLICATIONS

- A. Rigid Steel Conduit: Use rigid steel conduit for the following locations or conditions:
 - 1. All exterior applications
 - 2. All conduits larger than 2" trade diameter.
 - 3. All conduits indoor below eight (8) feet above finished floor.
- B. Electrical Metallic Tubing (EMT): EMT is allowed for the following conditions:
 - 1. Interior only and above eight (8) feet from finished floor.
 - 2. Interior only and when entering a panel from above.
- C. Liquidtight Flexible Metallic Conduit: Use Liquidtight for the following conditions:
 - 1. In damp and wet locations for connections to motors, transformers, vibrating equipment and machinery.
 - 2. Connections to all pump motors, flow switches, and similar devices.
- D. Rigid Non-Metallic Conduit, Polyvinyl Chloride (PVC) Schedule 40:
 - 1. Underground installation.

3.02 CONDUIT INSTALLATION

- A. General
 - 1. All conduit runs shown on the plans are sized based on the use of rigid steel conduit and THWN copper conductors. If conductor type is changed the contractor shall be responsible for resizing conduits to meet code. In no case is conduit to be sized smaller than 3/4" trade diameter.
 - 2. Low voltage wiring shall be installed in conduit, minimum 3/4" trade diameter.
 - 3. Conduits shall be tightly covered and well protected during construction using metallic bushings and bushing "pennies" to seal open ends.
 - 4. In making joints in rigid steel conduit, ream conduit smooth after cutting and threading.
 - 5. Clean any conduit in which moisture or any foreign matter has collected before pulling in conductors. Paint all field threaded joints to prevent corrosion.

6. In all empty conduits or ducts, install an 1100 pound tensile strength polyethylene pulling rope.
 7. Conduit systems shall be electrically continuous throughout. Install code size, uninsulated, copper grounding conductors in all conduit runs, grounding conductor shall be bonded to conduit, equipment frames and properly grounded.
- B. Layout:
1. All new conduits shall be concealed. Any field conditions that does not allow concealment of conduits shall be reviewed with the Architect prior to rough-in.
 2. Locations of conduit runs shall be planned in advance of the installation and coordinated with concrete work, plumbing and framing.
 3. Where practical install conduits in groups in parallel vertical or horizontal runs and at elevations that avoid unnecessary off-sets.
 4. Low voltage conduit shall be grouped separately and labelled every 10 ft interval as to system (i.e. fire, control, etc). Work to be performed by C-10 licensed contractor only.
 5. Exposed conduit shall be run parallel or at right angles to the centerlines of the columns and beams.
 6. Conduits shall not be placed closer than 12 inches from a parallel hot water or steam line or three inches from such lines crossing perpendicular to the runs.
 7. In long runs of conduit, provide sufficient pull boxes per CEC inside buildings to facilitate pulling wires and cables. Support pull boxes from structure independent of conduit supports. These pull boxes are not shown on the plans.
- C. Supports:
1. All raceway systems shall be secured to building structures using specified fasteners, clamps and hangers spaced according to Code.
 2. Support single runs of conduit using two hole pipe straps. Where run horizontally on walls in damp or wet locations, install "clamp blocks" to space conduit off the surface.
 3. Multiple conduit runs shall be supported using "trapeze" hangers fabricated from 3/8 inch diameter, threaded steel rods secured to building structures. Fasten conduit to construction channel with standard two hole pipe clamps. Provide lateral seismic bracing for hangers.
 4. Installation
 - a. Locate and install anchors, fasteners, and supports in accordance with NECA "Standard of Installation".
 - 1) Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
 - 2) Do not drill or cut structural members.
 - b. Rigidly weld support members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
 - c. Install surface-mounted cabinets and panelboards with minimum of four anchors.
 - d. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1 inch off wall.
 - e. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- D. Terminations and Joints:
1. Raceways shall be joined using specified couplings or transition couplings where dissimilar raceway systems are joined.
 2. Rigid conduit connection to enclosures shall be made by Myers type grounding hubs only. EMT connections to enclosures shall be made with compression connector with grounding lock-nuts or bushings.
 3. Conduit terminations exposed at weatherproof enclosures and cast outlet boxes shall be made watertight using appropriate connectors and hubs.
 4. Install expansion couplings where any conduit crosses a building separation or expansion joint.
 5. Install cable sealing bushings on all conduits originating outside the building walls and terminating in switchgear, cabinets or gutters inside the building. Install cable sealing

bushings or caulk conduit terminations in all grade level or below grade exterior pull, junction or outlet boxes.

- E. Penetrations:
1. Furnish and install metal sleeves for all exposed interior conduit runs passing through concrete floors or walls. Following conduit installation, seal all penetrations using non-iron bearing, chloride free, non-shrinking, dry-pack, grouting compound for listed rated assembly.
 2. Install specified watertight conduit entrance seals and membrane clamps at all below grade wall and floor penetrations. Conduits penetrating exterior building walls and building floor slab shall be insulated rigid steel.
 3. Conduits penetrating rated walls, floors, etc. shall be fireproofed. Listed rated assembly.

3.03 CABLE AND WIRE INSTALLATION

- A. Examination
1. Verify that interior of building has been protected from weather.
 2. Verify that mechanical work likely to damage wire and cable has been completed.
 3. Verify that raceway installation is complete and supported.
 4. Verify that field measurements are as indicated.
- B. Preparation
1. In existing conduits that will be reused, pull out existing conductors.
 2. Completely and thoroughly swab raceway before installing wire.
 3. Use 50/50 solution of Simple Green. Use CO₂ to blow water and soap into conduit - let soak to break up dried out pulling compounds, then pull conductors. Pull one conductor at a time if will not pull all out together.
- C. General:
1. Conductors shall not be in conduit until all work of any nature that may cause injury is completed. Care should be taken in pulling conductors that insulation is not damaged. U.L. approved non-petroleum base and insulating type pulling compound shall be used as needed.
 2. All cables shall be installed and tested in accordance with manufacturer's requirements and warranty.
 3. Block and tackle, power driven winch or other mechanical means shall not be used in pulling conductors of size smaller than AWG # 1.
- D. Splicing and Terminating:
1. All aspects of splicing and terminating shall be in accordance with cable manufacturer's published procedures.
 2. Make up all splices in outlet boxes with connectors as specified herein with separate tails of correct color to be made up to splice. Provide at least six (6) inches of tails packed in box after splice is made up.
 3. All wire and cable in panels, control centers and equipment enclosures shall be bundled and clamped.
 4. Encapsulate splices in exterior outlet, junction and pull boxes using insulating resin kits. All splices for exterior equipment in pump rooms shall be made up watertight.
 5. Insulate mechanical compression taps AWG #1/0 and larger using pre-molded heat shrink tubing ITCSN Heaving Wall rated to 600V. Heating process should start from the middle of the heat shrink tubing and move to its ends.
- E. Identification:
1. Securely tag all branch circuits, noting the purpose of each. Mark conductors with vinyl wrap-around markers. Where more than two conductors run through a single outlet, mark each circuit with the corresponding circuit number at the panelboard.
 2. Color code conductors size #6 and larger using specified phase color markers and identification tags.
 3. All terminal strips are to have each individual terminal identified with specified vinyl markers.

4. All identification shall be legible and readable after completion of installation.
5. Provide labeling for all switches and receptacle outlets. Self-adhering machine clear tape with black letters.

3.04 INSTALLATION:

- A. Route wire and cable as required to meet project conditions.
 1. Wire and cable routing indicated is approximate unless dimensioned.
 2. Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.
 3. Include wire and cable of lengths required to install connected devices within 10 ft of location shown.
- B. Install wire and cable in accordance with the NECA "Standard of Installation."
- C. Use wiring methods indicated.
- D. Pull all conductors into raceway at same time.
- E. Use suitable wire pulling lubricant for building wire 4 AWG and larger.
- F. Protect exposed cable from damage.
- G. Support cables above accessible ceiling, using spring metal clips or metal cable ties to support cables from structure or ceiling suspension system. Do not rest cable on ceiling panels.
- H. Use suitable cable fittings and connectors.
- I. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- J. Clean conductor surfaces before installing lugs and connectors.
- K. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- L. Terminate aluminum conductors with tin-plated aluminum-bodied compression connectors only. Fill with anti-oxidant compound before installing conductor.
- M. Use suitable reducing connectors or mechanical connector adaptors for connecting aluminum conductors to copper conductors.
- N. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.
- O. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
- P. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
- Q. Trench and backfill for direct burial cable installation as specified in Underground Structure Section. Install warning tape along entire length of direct burial cable.
- R. Identify and color code wire and cable. Identify each conductor with its circuit number or other designation indicated.

3.05 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

3.06 INSTALLATION OF BOXES

- A. General:
 - 1. Leave no un-used openings in any box. Install close-up plugs as required to seal openings.
 - 2. Exposed outlet boxes and boxes in damp or wet locations shall be cast metal with gasketed cast metal cover plates.
- B. Box Layout:
 - 1. Outlet boxes shall be installed at the locations and elevations shown on the drawings or specified herein. Make adjustments to locations as required by structural conditions and to suit coordination requirements of other trades.
 - 2. Install junction or pullboxes where required to limit bends in conduit runs to not more than 360 degrees or where pulling tension achieved would exceed the maximum allowable for the cable to be installed. Consult wire and cable manufacturer.

3.07 INSTALLATION OF WIRING DEVICES

- A. General
 - 1. Install all devices flushmounted unless otherwise noted on the drawings. Comply with layout drawings for general locations. Consult Architect or University's Representative for locations that have conflict with other devices or manner not suitable for installation. Avoid placing devices behind open doors.
 - 2. Install all devices flushmounted unless otherwise noted on the drawings. Comply with layout drawings for general locations. Consult University for locations that have conflict with other devices or manner not suitable for installation. Avoid placing devices behind open doors.
 - 3. Align devices horizontally and vertically. Device plates shall be aligned vertically with tolerance of 1/16". All four edges of device plates shall be in contact with the wall surface.
 - 4. Mounting height as indicated on the drawings and according to ADA requirements.
 - 5. Install device plates on all outlet boxes. Provide blank plates for all empty, spare, and boxes for future use.
 - 6. Securely fasten devices into boxes and attach appropriate cover plates.
 - 7. Caulk around edges or outdoor device plates and boxes when rough wall surfaces prevent raintight seal. Use caulking materials approved by Architect. Fireproof around opening of devices located or penetrating fire rated construction assemblies. Listed rated for assembly.
 - 8. Fireproof around opening of devices located or penetrating fire rated construction assemblies. Listed rated for assembly Hilti/3m or equal.
- B. Switches
 - 1. Where switches are indicated to be installed near doors, corner walls, etc. mount not less than 2 inches and not more than 18" from trim. Verify exact location with Architect or Engineer prior to rough-in.
 - 2. Coordinate the location of switches to insure locations at the strike side of doors.
 - 3. Furnish and install engraved legend of each switch that controls exhaust fans, motors, equipment systems, etc. not located within sight of the controlling switch.
 - 4. Ganging of Switches - provide barriers for switches of difference phases and voltages. Otherwise switches shall be gauged in one faceplate.
- C. Receptacles
 - 1. Mount receptacles vertically with U-shaped ground position on bottom.

2. Do not combine GFCI protected circuits with other circuits in the same raceway. Limit number of GFI protect circuits in any one raceway to a maximum of one (1) circuit.
- D. Identification
1. Label all outlets and switches. Mark each wiring device where circuits and panel supply is derived from.
 2. All identification shall be legible and readable after completion of installation

3.08 INSTALLATION OF FUSES AND DISCONNECT SWITCHES

- A. Fuses shall be installed where noted on plans. Sizes are based on design data provided by equipment mfg. Listed or labeled equipment must be in accordance with instructions included in the listing or labeling. Be sure to observe maximum branch circuit fuse size labels.
- B. Disconnect switches shall be mounted on the equipment, where possible. Coordinate with mechanical contractor to ensure switches are not mounted on a removable access panel.
- C. Label each disconnect fuse with equipment tag as indicated in the single line diagram, or as directed.

3.09 ELECTRICAL EQUIPMENT GROUNDING

- A. Ground non-current carrying metal parts of electrical equipment enclosures, frames, conductor raceways or cable trays to provide a low impedance path for line-to-ground fault current and to bond all non-current carrying metal parts together. Install a ground conductor in each raceway system in addition to conductors shown. Equipment ground conductor shall be electrically and mechanically continuous from the electrical circuit source to the equipment to be grounded. Size ground conductors per CEC 250 unless larger conductors are shown on the drawings.
- B. Grounding conductors shall be identified with green insulation, except where a bare ground conductor is specified. Where green insulation is not available, on larger sizes, black insulation shall be used and suitably identified with green tape at each junction box or device enclosure.
- C. Install metal raceway couplings, fittings and terminations secure and tight to insure good ground continuity. Provide insulated grounding bushing and bonding jumper where metal raceway is not directly attached to equipment metal enclosure and at concentric knock-outs.
- D. Motors shall be connected to equipment ground conductors with a conduit grounding bushing and with a bolted solderless lug connection on the metal frame.
- E. Conduit terminating in concentric knockouts at panelboards, cabinets and gutters shall have insulated grounding bushings and bonding jumpers installed interconnecting all such conduits and the panelboard cabinet, gutter, etc.
- F. Performance:
 1. Measure the resistance to ground of each ground rod before connection to the other ground rods. The resistance shall not exceed 25 ohms.
 - a. A single electrode which does not have a resistance to ground of 25 ohms or less shall be augmented by additional electrode(s).
 2. Measure the resistance to ground of the total ground system with all connections completed. The resistance shall not exceed 2 ohms for primary services or 5 ohms for secondary services.
 3. Tests of the resistance to ground shall be made using either the three point method or the fall-of-potential method.
 4. Perform a continuity check from equipment ground bus bars and ground lugs to the ground system.

3.10 BONDING

- A. Bonding shall be provided to assure electrical continuity and the capacity to conduct safely any fault current likely to be imposed.
- B. Bonding shall be in accordance with CEC Article 250, Part V.

3.11 WORKMANSHIP

- A. Preparation, handling, and installation shall be in accordance with manufacturer's written instructions and technical data particular to the product specified and/or accepted equal except as otherwise specified. Coordinate work and cooperate with others in furnishing and placing this work. Work to reviewed shop drawings for work done by others and to field measurements as necessary to properly fit the work.
- B. Conform to the National Electrical Contractor's Association "Standard of Installation" for general installation practice.

3.12 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

END OF SECTION

Humboldt State University
HSU Critical Electrical Generation

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Warning signs and labels.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

- A. Identification for Equipment:
 - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
- B. Identification for Conductors and Cables:
 - 1. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
 - 1. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
 - 2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 - 3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
 - 4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
 - 5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
- B. Identification Labels:
 - 1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 - 2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

2.03 WARNING SIGNS AND LABELS

- A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- B. Warning Signs:
 - 1. Materials:
 - a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
 - b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
 - 2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
 - 3. Minimum Size: 7 by 10 inches unless otherwise indicated.
- C. Warning Labels:

1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 1. Surface-Mounted Equipment: Enclosure front.
 2. Flush-Mounted Equipment: Inside of equipment door.
 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 4. Elevated Equipment: Legible from the floor or working platform.
 5. Interior Components: Legible from the point of access.
 6. Conductors and Cables: Legible from the point of access.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Secure rigid signs using stainless steel screws.

END OF SECTION

Humboldt State University
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SECTION 26 08 02
ELECTRICAL ACCEPTANCE TESTING

PART 1 - GENERAL

1.01 OVERVIEW

- A. The purpose of these specifications is to assure that all tested electrical equipment and systems are operational and within applicable standards and manufacturer's tolerances and that the equipment and systems are installed in accordance with design specifications.
- B. The work specified in these specifications may involve hazardous voltages, materials, operations, and equipment. These specifications do not purport to address all of the safety problems associated with their use. It is the responsibility of the independent testing agency to review all applicable regulatory limitations prior to the use of these specifications.
- C. Perform the visual inspections, manual operations and tests on systems and equipment as described in Part 2, "Execution" and per NETA specifications.
- D. Tests shall be performed and documented by an independent testing agency.
- E. Perform these tests in addition to other electrical tests delineated in other Sections.

1.02 REFERENCES

- A. All inspections and field tests shall be in accordance with the latest edition of the following codes, standards, and specifications except as provided otherwise herein.
 - 1. American National Standards Institute - ANSI
 - 2. American Society for Testing and Materials - ASTM
 - 3. Institute of Electrical and Electronic Engineers - IEEE
 - 4. Insulated Cable Engineers Association - ICEA
 - 5. InterNational Electrical Testing Association - NETA
 - 6. National Electrical Manufacturer's Association - NEMA
 - 7. National Fire Protection Association - NFPA
 - 8. Occupational Safety and Health Administration - OSHA
 - 9. State and local codes and ordinances
 - 10. Underwriters Laboratories, Inc. - UL
 - 11. International Electrical Testing Associations - NETA ATS/MTS.

1.03 SUBMITTAL

- A. The testing organization shall submit appropriate documentation to demonstrate that it satisfactorily complies with the following. An organization having a "Full Membership" classification issued by the InterNational Electrical Testing Association meets this criteria.
 - 1. The testing organization shall be an independent, third party, testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing organization.
 - 2. The testing organization shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.
- B. The testing organization shall utilize technicians who are regularly employed for testing services.
- C. Each on-site crew leader shall hold a current registered certification in electrical testing applicable to each type of apparatus to be inspected or tested. The certification in electrical testing shall be issued by an independent, nationally-recognized, technician certification agency. The following entities shall qualify as independent, nationally-recognized, technician certification agencies:
 - 1. InterNational Electrical Testing Association (NETA)
 - 2. Accepted certifications:
 - 3. Certified Technician/Level III
 - 4. Certified Senior Technician/Level IV

1.04 TEST REPORTS

- A. Provide written test reports, signed and dated, for all tests prior to acceptance of the tested equipment by the Owner. Test reports on megger, dielectric absorption and high potential tests shall include the ambient temperature and relative humidity existing at the time of the tests.

PART 2 - EXECUTION**2.01 EQUIPMENT LIST TO RECEIVE TESTS**

- A. Switchboards
- B. Transformers
- C. Panelboards
- D. Circuit Breakers
- E. Vacuum Switch Interrupters
- F. Motor Control Centers
- G. Meters
- H. Protective Relays
- I. Cables - Low and Medium Voltage
- J. Grounding Systems

2.02 VISUAL INSPECTIONS

- A. Prior to any testing, perform visual inspections to verify the following:
 1. The equipment is completely and properly installed
 2. The equipment is free from damage and defects
 3. Shipping blocks and restraints have been removed
 4. Electrical terminations have been properly tightened
 5. The equipment has been properly aligned
 6. The equipment has been properly lubricated
 7. The ventilation louvers are open and unobstructed
 8. The equipment is ready to be tested

2.03 MANUAL OPERATION

- A. Prior to any testing, mechanical devices shall be exercised or rotated manually to verify that they operate properly and freely.

2.04 PRIMARY CABLE TESTS (UNDER 2000V)

- A. Perform a continuity test, 2,500-volt DC megger test, AC high potential test, and a second 2,500-volt DC megger test on primary cables. The high potential test shall be performed at 45kV for new cable installations, and at 30kV when new cable has been spliced to existing cable.

2.05 POWER CABLE TESTS

- A. Perform a continuity check and a 1,000 volt DC megger test on 600 volt power cables No. 4 AWG and larger.
 1. The megger test shall be performed between each pair of conductors and from each conductor to ground.
 2. The megger test shall be performed for 15 seconds or until the insulation resistance value stabilizes.
 3. The insulation resistance between conductors and from each conductor to ground shall be 100 megohms minimum in one minute or less. In addition, the lowest insulation resistance value shall not differ from the highest value by more than 20 percent.

2.06 CONTROL CABLE TESTS

- A. Perform a continuity check on control and instrumentation wiring.

2.07 SECONDARY SWITCHGEAR AND SWITCHBOARD TESTS

- A. Perform a continuity check and 1,000 volt DC megger test on buses, and on main and feeder breakers.
- B. Perform a primary current injection test and a 'Ducter' (contact resistance) test on main breakers.
- C. Perform a 1,000-volt DC megger test and a turns-ratio test on CT's and PT's.
- D. Calibrate the metering.

2.08 SERVICE, DISTRIBUTION AND MOTOR CONTROL EQUIPMENT TESTS

- A. Perform a 1,000-volt megger test on buses, motor starters and disconnect switches. This test may be combined with the feeder cable megger test by testing the devices and terminated cables together.
- B. Perform a continuity check on motor control circuits and control panel internal wiring.
- C. Perform an operational test on the controls.
- D. Perform a continuity check and a 1,000-volt DC megger test on 3 phase distribution and isolation transformers.

2.09 GROUNDING TESTS

- A. Measure the resistance to ground of each ground rod before connection to the other ground rods. The resistance shall not exceed 25 ohms.
 - 1. A single electrode which does not have a resistance to ground of 25 ohms or less shall be augmented by additional electrode(s).
- B. Measure the resistance to ground of the total ground system with all connections completed. The resistance shall not exceed 2 ohms for primary services or 5 ohms for secondary services.
- C. Tests of the resistance to ground shall be made using either the three point method or the fall-of-potential method.
- D. Perform a continuity check from equipment ground bus bars and ground lugs to the ground system.

END OF SECTION

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SECTION 26 11 13
UNIT SUBSTATION

PART 1 GENERAL

1.01 REFERENCES

- A. ANSI C37.121.1989 - Unit Substations, Requirements

1.02 SUBMITTALS

- A. Submit shop drawings indicating the following:
1. Front view of enclosure with overall dimensions
 2. Single line diagram
 3. Top and bottom conduit entrance / exit locations with dimensions
 4. Electrical characteristics of the primary equipment, transformer, and secondary equipment
 5. Specified ratings
 6. Bill-of-material
 7. Shipping splits and weights
 8. Wiring diagrams
 9. Operational instructions for keylock schemes, throw-over schemes, and other special instructions.
- B. Submit product data for each component and accessory specified.

1.03 OPERATION AND MAINTENANCE DATA

- A. Submit recommended spare parts list.

1.04 QUALIFICATIONS

- A. The unit substation shall be designed and assembled as multiple pieces of equipment and coordinated to create a single product when it is installed at the jobsite.

PART 2 PRODUCT

2.01 MANUFACTURERS

- A. IEM is the basis of design for switchboard.
- B. REX Magnetics is the basis of design for the transformer.

2.02 UNIT SUBSTATION

- A. The unit substation consists of three sections:
1. Secondary Voltage (12.47kV) distribution fusible switchgear section
 2. Transformer section
 3. Primary Voltage (480V) incoming section.
- B. These sections are to be integrated to form a single lineup of metal-enclosed structures with metal barriers separating the incoming section from the transformer and the secondary from the transformer. The manufacturer is to furnish the necessary hardware, cable(s) wires and connectors to complete the unit substation's interconnections.
- C. The equipment shall be totally adjusted and tested at the factory and sectionalized for shipment.
- D. The primary and secondary enclosures shall be NEMA 3R.
- E. The manufacturer shall provide documentation showing that the paint process meets the ASTM B117 3000 hr. salt spray test.
- F. Seismic qualification to meet site requirements to be in accordance with IEEE 344- 2004.
- G. Provide manufacturer's standard secondary distribution equipment lug connectors to terminate cables per the specifications and plans.
- H. The unit substation shall be painted ANSI 61
- I. Nameplates shall be mounted with stainless steel screws.

2.03 OUTGOING (12.47KV VOLTAGE) SECTION

- A. 12kV Secondary Voltage, Fused Load Interrupter Switch - Refer to one-line drawing.
- B. Power for the network and metering devices to come from the Low Voltage Controls Transformer.
- C. Provide Distribution Class Surge Arresters.
- D. The manufacturer shall provide documentation showing that the paint process will meet the ASTM B117 3000 hr. salt spray test.
- E. Provide thermostat controlled space heaters.
- F. Motorized operator

2.04 TRANSFORMER SECTION

- A. Dry-Type VPE Unit Substation Transformer with minimum (3) VPI dip impregnation processes.
- B. 480V - 12.47kV (step-up)
- C. 80 deg. C Temp. Rise.
- D. Fan Cooling.
- E. Standard sound level
- F. 60kV Secondary Voltage BIL
- G. 10kV Primary Voltage BIL
- H. Copper Windings
- I. Per DOE 2016 Energy Efficiency Standard.
- J. Orientation: Per Project Drawings
- K. Thermostat controlled space heaters.
- L. Provision for CTs and VTs on primary side.

2.05 INCOMING (480V) EQUIPMENT

- A. Industrial Electric Mfg. (IEM) is the basis of design.
- B. The LV distribution equipment shall be manufactured in The USA.
- C. All breakers shall be 100% rated, 2-step stored energy power circuit breakers with LSIG trip units.
- D. Provide NEMA 3R Enclosures for the Low voltage distribution equipment, as with the primary equipment.
- E. The switchboard structures shall be manufactured to UL 891.
- F. The equipment ratings are per the oneline drawings.
- G. Each NEMA 3R LV structure shall include thermostat controlled space heaters.
- H. Include a full length Cu Ground Bus.
- I. All Busses to be 100% rated silver plated copper, rated at not more than 1000A per square inch, RMS Symmetrical.
- J. Switchboard / Switchgear Frames shall be manufactured from a minimum of 11-gauge steel.
- K. All steel members and boxes, shall be painted using electrostatically applied polyester powder coated paint. Color shall be the manufacture's standard gray or specific color as indicated on the project drawings. The manufacturer shall provide documentation showing that the paint process will meet the ASTM B117 3000 hr. salt spray test.
- L. Provide full height bussing in all sections tapped to accept hardware in unused space.
 - 1. Provide hinged wiring gutter covers for easy access to load side cables, front and rear.
 - 2. All power connections shall be torqued and marked to equipment manufacture's Specification, to insure structure rigidity, before leaving assembly plant.

3. Switchboard / Switchgear structures shall be front aligned, unless otherwise shown on the project drawings.
 4. Provide unit mounted surge protection rated 180kA.
 5. Customer Metering.
 - a. Include Electro-Industries Shark 200 Power Meter, mounted in an isolated, hinged front cover metering compartment as indicated on the Project Drawings.
 - b. Route CAT6A cabling to nearest IDF closet.
- M. Shall be non-walk-in type.
- N. Provision for CTs and PTs on line and load side of main circuit breaker.
 1. CTs shall be 3000:5
 2. PTs shall have fused voltage taps.
- O. Motorized operator

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

- A. By Others

END OF SECTION

Humboldt State University
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SECTION 26 13 33
DIESEL GENERATOR SETS – 2000KW

GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
- B. SUMMARY
1. This Section includes packaged engine-generator sets suitable for use in mission critical applications with the features as specified and indicated. Engine generators will be used as the Standby power source for the system, but shall be capable of providing reliable power with no run-time limitations while the primary source of power is unavailable.
- C. DEFINITIONS
1. Emergency Standby Power (ESP): Per ISO 8528: The maximum power available during a variable electrical power sequence, under the stated operating conditions, for which a generating set is capable of delivering in the event of a utility power outage or under test conditions for up to 200 hours of operation per year with the maintenance intervals and procedures being carried out as prescribed by the manufacturers. The permissible average power output (Ppp) over 24 hours of operation shall not exceed 70 percent of the ESP unless otherwise agreed by the RIC engine manufacturer.
 2. Prime Power (PRP): Per ISO 8528: The maximum power which a generating set is capable of delivering continuously whilst supplying a variable electrical load when operated for an unlimited number of hours per year under the agreed operating conditions with the maintenance intervals and procedures being carried out as a prescribed by the manufacturer. The permissible average power output (Ppp) over 24 hours of operation shall not exceed 70 percent of the PRP unless otherwise agreed by the RIC engine manufacturer.
 3. Limited Time running Power (LTP): Per ISO 8528: The maximum power available, under the agreed operating conditions, for which the generating set is capable of delivering for up to 500 hours of operation per year with the maintenance intervals and procedures being carried out as prescribed by the manufacturers.
 4. Continuous Operating Power (COP): Per ISO 8528: The maximum power which a generating set is capable of delivering continuously whilst supplying a constant electrical load when operated for an unlimited number of hours per year under the agreed operating conditions with the maintenance intervals and procedures being carried out as a prescribed by the manufacturer.
 5. Data Center Continuous (DCC): The maximum power which a generating set is capable of delivering continuously whilst supplying a variable or constant electrical load when operated for an unlimited number of hours in a data center application under the agreed operating conditions with the maintenance intervals and procedures being carried out as a prescribed by the manufacturer. The permissible average power output (Ppp) over 24 hours of operation shall not exceed 100 percent of the DCC rating.
 6. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.
- D. ACTION SUBMITTALS
1. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
 - a. Thermal damage curve for generator.
 - b. Time-current characteristic curves for generator protective device.
 - c. Sound test data, based on a free field requirement.
 2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, and location and size of each field connection.

- a. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
 - b. Wiring Diagrams: Control interconnection, Customer connections.
 - 3. Certifications:
 - a. Submit statement of compliance which states the proposed product(s) is certified to the emissions standards required by the location for EPA, stationary emergency application.
 - b. Submit statement of compliance which states the proposed product(s) are seismically certified in compliance with local requirements signed and sealed by a qualified professional engineer.
- E. INFORMATIONAL SUBMITTALS
- 1. Manufacturer Seismic Qualification Certification: Submit certification that the 4000 Gallon(s) fuel tank, the Sound Attenuated enclosure, engine-generator set, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - a. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - b. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - 2. Source quality-control test reports.
 - a. Certified summary of prototype-unit test report. See requirements in Part 2 "Source Quality Control" Article Part A. Include statement indicating torsional compatibility of components.
 - b. Certified Test Report: Provide certified test report documenting factory test per the requirements of this specification, as well as certified factory test of generator set sensors per NFPA110 level 1.
 - c. List of factory tests to be performed on units to be shipped for this Project.
 - d. Report of exhaust emissions and compliance statement certifying compliance with applicable regulations.
 - 3. Warranty:
 - a. Submit manufacturer's warranty statement to be provided for this Project.
- F. QUALITY ASSURANCE
- 1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
 - 2. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 50 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
 - 3. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
 - 4. Comply with NFPA 37 (Standard For the Installation and Use of Stationary Combustion Engines and Gas Turbines).
 - 5. Comply with NFPA 70 (National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702).
 - 6. Comply with NFPA 110 (Emergency and Standby Power Systems) requirements for Level 1 emergency power supply system.
 - 7. Comply with UL 2200.
- G. PROJECT CONDITIONS
- 1. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - a. Ambient Temperature: 0.0 deg C (32.0 deg F) to 40.0 deg C (104.0 deg F).
 - b. Relative Humidity: 0 to 95 percent.
 - c. Altitude: Sea level to 200.0 feet (61.0 m).
- H. WARRANTY

1. Base Warranty: Manufacturer shall provide base warranty coverage on the material and workmanship of the generator set for a minimum of twenty-four (24) months from registered commissioning and start-up.

1.02 PRODUCTS

A. MANUFACTURERS

1. Manufacturers: The basis for this specification is Cummins Power Generation equipment, approved equals may be considered if equipment performance is shown to meet the requirements herein.

B. ENGINE-GENERATOR SET

1. Factory-assembled and -tested, engine-generator set.
2. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
 - a. Rigging Information: Indicate location of each lifting attachment, generator-set center of gravity, and total package weight in submittal drawings.
3. Capacities and Characteristics:
 - a. Power Output Ratings: Electrical output power rating for Standby operation of not less than 2000.0kW, at 80 percent lagging power factor, 277/480, Series Wye, Three phase, 4 -wire, 60 hertz.
 - b. Alternator shall be capable of accepting maximum 7361.0 kVA in a single step and be capable of recovering to a minimum of 90% of rated no load voltage. Following the application of the specified kVA load at near zero power factor applied to the generator set.
 - c. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component. The engine-generator nameplate shall include information of the power output rating of the equipment.
4. Generator-Set Performance:
 - a. Steady-State Voltage Operational Bandwidth: 0.5 percent of rated output voltage from no load to full load.
 - b. Transient Voltage Performance: Not more than 18 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 3 seconds. On application of a 100% load step the generator set shall recover to stable voltage within 10 seconds.
 - c. Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.
 - d. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
 - e. Transient Frequency Performance: Not more than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 3 seconds. On application of a 100% load step the generator set shall recover to stable frequency within 10 seconds.
 - f. Output Waveform: At full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.
 - g. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 8 seconds without damage to generator system components. For a 1-phase, bolted short circuit at system output terminals, system shall regulate both voltage and current to prevent over-voltage conditions on the non-faulted phases.
 - h. Start Time: Comply with NFPA 110, Level 1, Type 10, system requirements.
 - i. Ambient Condition Performance: Engine generator shall be designed to allow operation at full rated load in an ambient temperature under site conditions, based on highest ambient condition. Ambient temperature shall be as measured at the air inlet

to the engine generator for enclosed units, and at the control of the engine generator for machines installed in equipment rooms.

- j. Load Sharing: Engine generator shall share real and reactive load proportionally within plus or minus 3 percent with all other engine generators in the system.
 - 1) Controller shall have remote real-time settable droop paralleling control.

C. ENGINE

1. Fuel: ASTM D975 #2 Diesel Fuel
2. Rated Engine Speed: 1800RPM.
3. Lubrication System: The following items are mounted on engine or skid:
 - a. Lube oil pump: shall be positive displacement, mechanical, full pressure pump.
 - b. Filter and Strainer: Provided by the engine manufacturer of record to provide adequate filtration for the prime mover to be used.
 - c. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
4. Engine Fuel System: The engine fuel system shall be installed in strict compliance to the engine manufacturer's instructions
5. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
6. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity and performance.
 - a. Designed for operation on a single 240 VAC, Single phase, 60Hz power connection. Heater voltage shall be shown on the project drawings.
 - b. Installed with isolation valves to isolate the heater for replacement of the element without draining the engine cooling system or significant coolant loss.
 - c. Provided with a 24VDC thermostat, installed at the engine thermostat housing
7. Governor: Adjustable isochronous, with speed sensing. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.
8. Cooling System: Closed loop, liquid cooled
 - a. The generator set manufacturer shall provide prototype test data for the specific hardware proposed demonstrating that the machine will operate at rated standby load in an outdoor ambient condition of 40 deg C.
 - b. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 - c. Size of Radiator overflow tank: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 - d. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
 - e. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 - f. Duct Flange: Generator sets installed indoors shall be provided with a flexible radiator duct adapter flange.
9. DPF/Silencer: Selected with performance as required to meet sound requirements of the application, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
10. Air-Intake Filter: Engine-mounted air cleaner with replaceable dry-filter element and restriction indicator.

11. Starting System: 12 or 24V, as recommended by the engine manufacturer; electric, with negative ground.
 - a. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
 - b. Cranking Cycle: As required by NFPA 110 for level 1 systems.
 - c. Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.
 - d. Battery Compartment: Factory fabricated of metal with acid-resistant finish.
 - e. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation. The battery charging alternator shall have sufficient capacity to recharge the batteries with all parasitic loads connected within 4 hours after a normal engine starting sequence.
 - f. Battery Chargers: Unit shall comply with UL 1236, provide fully regulated, constant voltage, current limited, battery charger for each battery bank. It will include the following features:
 - 1) Operation: Equalizing-charging rate based on generator set manufacturer's recommendations shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - 2) Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 20 deg C to plus 40 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
 - 3) Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - 4) Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
 - 5) Provide LED indication of general charger condition, including charging, faults, and modes. Provide a LCD display to indicate charge rate and battery voltage. Charger shall provide relay contacts for fault conditions as required by NFPA110.
 - 6) Enclosure and Mounting: NEMA, Type 1, wall-mounted cabinet.

D. FUEL OIL STORAGE

1. Comply with NFPA 30.
2. Sub Base-Mounted Fuel Oil Tank: Provide a double wall secondary containment type sub base fuel storage tank. The tank shall be constructed of corrosion resistant steel and shall be UL 142 listed and labeled. The fuel tank shall include the following features:
 - a. Capacity: 4000 Gallon(s)
 - b. Tank rails and lifting eyes shall be rated for the full dry weight of the tank, genset, and enclosure.
 - c. Electrical stub up(s)
 - d. Normal & emergency vents
 - e. Lockable fuel fill
 - f. Mechanical fuel level gauge
 - g. High and low level switches to indicate fuel level
 - h. Leak detector switch
 - i. Sub base tank shall include a welded steel containment basin, sized at a minimum of 110% of the tank capacity to prevent escape of fuel into the environment in the event of a tank rupture.
 - j. Fill port with overfill prevention valve (OFPV)
 - k. 5 gallon fill/spill dam or bucket
 - l. Tank design shall meet the regional requirements for the Project location

E. CONTROL AND MONITORING

1. Engine generator control shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit.
2. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. (Switches with different configurations but equal functions are acceptable.) When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.
3. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.
4. Configuration: Operating and safety indications, protective devices, system controls, engine gages and associated equipment shall be grouped in a common control and monitoring panel. Mounting method shall isolate the control panel from generator-set vibration. AC output power circuit breakers and other output power equipment shall not be mounted in the control enclosure.
5. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
 - a. AC voltmeter (3-phase, line to line and line to neutral values).
 - b. AC ammeter (3-phases).
 - c. AC frequency meter.
 - d. AC kW output (total and for each phase). Display shall indicate power flow direction.
 - e. AC kVA output (total and for each phase). Display shall indicate power flow direction.
 - f. AC Power factor (total and for each phase). Display shall indicate leading or lagging condition.
 - g. Ammeter-voltmeter displays shall simultaneously display conditions for all three phases.
 - h. Emergency Stop Switch: Switch shall be a red "mushroom head" pushbutton device complete with lock-out/tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating.
 - i. Fault Reset Switch: Supply a dedicated control switch to reset/clear fault conditions.
 - j. DC voltmeter (alternator battery charging).
 - k. Engine-coolant temperature gauge.
 - l. Engine lubricating-oil pressure gauge.
 - m. Running-time meter.
 - n. Generator-voltage and frequency digital raise/lower switches. Rheostats for these functions are not acceptable. The control shall adjustment of these parameters in a range of plus or minus 5% of the voltage and frequency operating set point (not nominal voltage and frequency values.) The voltage and frequency adjustment functions shall be disabled when the paralleling breaker is closed. Voltage and frequency adjustments shall be remote real-time settable to allow auto-synch control.
 - o. Fuel tank derangement alarm.
 - p. Fuel tank high-level shutdown of fuel supply alarm.
 - q. AC Protective Equipment: The control system shall include over/under voltage, reverse kVAR, reverse kW, over load (kW) short circuit, over current, loss of voltage reference, and over excitation shut down protection. There shall be a ground fault alarm for generator sets rated over 1000 amps, overload warning, and overcurrent warning alarm.

- r. Status LED indicating lamps to indicate remote start signal present at the control, existing shutdown condition, existing alarm condition, not in auto, and generator set running.
 - s. A graphical display panel with appropriate navigation devices shall be provided to view all information noted above, as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall also include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.
 - t. Panel lighting system to allow viewing and operation of the control when the generator room or enclosure is not lighted.
 - u. Data Logging: The control system shall log the latest 20 different alarm and shut down conditions, the total number of times each alarm or shutdown has occurred, and the date and time the latest of these shutdown and fault conditions occurred.
 - v. DC control Power Monitoring: The control system shall continuously monitor DC power supply to the control, and annunciate low or high voltage conditions. It shall also provide an alarm indicating imminent failure of the battery bank based on degraded voltage recover on loading (engine cranking).
 - w. Paralleling Breaker control switches: The control shall include manual open and close provisions for the paralleling breaker, and LED status lamps indicating whether the breaker is open or closed.
- 6. Remote Alarm Annunciator: Comply with NFPA 110. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition.
 - 7. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.
 - 8. Controller shall be PowerCommand 3.3 Paralleling controller or approved equal.
- F. GENERATOR OVERCURRENT AND FAULT PROTECTION
- 1. Generator Overcurrent Protection: The generator set shall be provided with a UL Listed/CSA Certified protective device that is coordinated with the alternator provided to prevent damage to the generator set on any possible overload or overcurrent condition external to the machine. The protective device shall be listed as a utility grade protective device under UL category NRGU. The control system shall be subject to UL follow-up service at the manufacturing location to verify that the protective system is fully operational as manufactured. Protector shall perform the following functions:
 - a. Initiates a generator kW overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
 - b. Under single phase or multiple phase fault conditions, or on overload conditions, indicates an alarm conditions when the current flow is in excess of 110% of rated current for more than 10 seconds.
 - c. Under single phase or multiple phase fault conditions, operates to switch off alternator excitation at the appropriate time to prevent damage to the alternator.
 - d. The operator panel shall indicate the nature of the fault condition as either a short circuit or an overload.
 - e. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot greater than 120% of nominal voltage.
 - f. The protective system provided shall not include an instantaneous trip function.
 - 2. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.
- G. GENERATOR, EXCITER, AND VOLTAGE REGULATOR
- 1. Comply with NEMA MG 1.
 - 2. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
 - 3. Electrical Insulation: Class H

4. Temperature Rise: 125 / Class H environment.
5. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over speed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
6. Permanent Magnet Generator (PMG) shall provide excitation power for optimum motor starting and short circuit performance.
7. Enclosure: Drip-proof.
8. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified. The voltage regulation system shall be microprocessor-controlled, 3-phase true RMS sensing, full wave rectified, and provide a pulse-width modulated signal to the exciter. No exceptions or deviations to these requirements will be permitted.
9. The alternator shall be provided with anti-condensation heater(s) in all applications where the generator set is provided in an outdoor enclosure, or when the generator set is installed in a coastal or tropical environment.
10. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding. Alternators operating at voltage higher than 690VAC shall be provided with form-wound stator coils.
11. Subtransient Reactance: 13 percent maximum, based on the rating of the engine generator set.

H. OUTDOOR GENERATOR-SET ENCLOSURE

1. Description: Sound Attenuated Steel housing. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Instruments, control, and battery system shall be mounted within enclosure. Stairs and platforms shall be provided if required to meet NEC 240.24(A) breaker height requirements.
2. Construction:
 - a. Louvers: Equipped with bird screen to permit air circulation when engine is not running while excluding birds and rodents.
 - b. Hinged Doors: With padlocking provisions. Restraint/Hold back hardware to prevent door to keep door open at 180 degrees during maintenance. Rain lips over all doors.
 - c. Exhaust System:
 - 1) DPF/Silencer Location: Outside enclosure.
 - 2) Refer to DPF specification 23 51 00.
 - d. Hardware: All hardware and hinges shall be stainless steel.
 - e. Mounting Base: Suitable for mounting on sub-base fuel tank or housekeeping pad.
 - f. A weather protective enclosure shall be provided which allows the generator set to operate at full rated load with a static pressure drop equal to or less than 0.5 inches of water.
3. Engine Cooling Airflow through Enclosure: Housing shall provide ample airflow for engine generator operation at rated load in an ambient temperature of 40 deg C.
 - a. Louvers: Fixed-engine, cooling-air inlet and discharge.
4. Sound Performance: Reduce the sound level of the engine generator while operating at full rated load to a maximum of 75 dBA measured at any location 23 ft from the engine generator in a free field environment.

I. VIBRATION ISOLATION DEVICES

1. Vibration Isolation: Generators installed on grade shall be provided with elastomeric isolator pads integral to the generator, unless the engine manufacturer requires use of spring isolation.
 - a. IBC Compliance: Isolators complying with IBC requirements shall be specified in the equipment documentation, as well as the installation requirements for the unit.

J. FINISHES

1. Indoor and Outdoor Enclosures and Components: Powder-coated and baked over corrosion-resistant pretreatment and compatible primer. Manufacturer's standard color or as directed on the drawings.

K. SOURCE QUALITY CONTROL

1. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - a. Tests: Comply with NFPA 110, Level 1 Energy Converters. In addition, the equipment engine, skid, cooling system, and alternator shall have been subjected to actual prototype tests to validate the capability of the design under the abnormal conditions noted in NFPA110. Calculations and testing on similar equipment which are allowed under NFPA110 are not sufficient to meet this requirement.
2. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
 - a. Test engine generator set manufactured for this Project to demonstrate compatibility and functionality.
 - b. Full load run.
 - c. Maximum power.
 - d. Voltage regulation.
 - e. Steady-state governing.
 - f. Single-step load pickup.
 - g. Simulated safety shutdowns.
 - h. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
3. Factory testing may be witnessed by the owner and consulting engineer. Costs for travel expenses will be the responsibility of the owner and consulting engineer. Supplier is responsible to provide two weeks' notice for testing.

1.03 EXECUTION

A. INSTALLATION

1. Comply with packaged engine-generator manufacturers' written installation, application, and alignment instructions and with NFPA 110.
2. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
3. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
4. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.
5. Equipment shall be initially started and operated by representatives of the manufacturer. All protective settings shall be adjusted as instructed by the consulting engineer.
6. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.
7. On completion of the installation by the electrical contractor, the generator set supplier shall conduct a site evaluation to verify that the equipment is installed per manufacturer's recommended practice.
8. Perform full NFPA 110 tests. Provide written report detailing test performed and result for each test.
9. Provide factory recommended maintenance scheduling and tests for University in excel format.

B. ON-SITE ACCEPTANCE TEST

1. The complete installation shall be tested to verify compliance with the performance requirements of this specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests. The generator set manufacturer shall provide a site test specification covering the entire system. Tests shall include:
 2. Prior to start of active testing, all field connections for wiring, power conductors, and bus bar connections shall be checked for proper tightening torque.
 3. Installation acceptance tests to be conducted on site shall include a "cold start" test, a two hour full load (resistive) test, and a one-step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.
 4. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.
- C. TRAINING
1. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner.
- D. FIELD QUALITY CONTROL
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- E. SERVICE AND SUPPORT
1. The generator set supplier shall maintain service parts inventory for the entire power system at a central location which is accessible to the service location 24 hours per day, 365 days per year. The inventory shall have a commercial value of \$3 million or more. The manufacturer of the generator set shall maintain a central parts inventory to support the supplier, covering all the major components of the power system, including engines, alternators, control systems, paralleling electronics, and power transfer equipment.
 2. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical power system replacement parts in the local service location. Service vehicles shall be stocked with critical replacement parts. The service organization shall be on call 24 hours per day, 365 days per year. The service organization shall be physically located within 150 miles of the site.
 3. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.
- F. SERVICE AGREEMENT:
1. The supplier shall include in the base price, a one-year service agreement. The maintenance shall be performed by factory authorized service technicians capable of servicing both the engine generator set and the transfer switch (es). This agreement shall include the following:
 - a. Generator supplier must have an in-house rental fleet with equipment sized to back up this project site.
 - b. All engine maintenance as recommended by the service manual.
 - c. All electrical controls maintenance and calibrations as recommended by the manufacturer.
 - d. All auxiliary equipment as a part of the emergency systems.
 - e. The supplier shall guarantee emergency service.
 - f. All expendable maintenance items are to be included in this agreement.

- g. A copy of this agreement and a schedule shall be given to the Owner at the time of his acceptance, showing what work is to be accomplished and when.

END OF SECTION