

SECTION 16000

GENERAL PROVISIONS

PART 1 GENERAL

1.1 THE WORK

- A. Location of the Work is at the City of Albany Raw Water Pump Station (RWPS), which is owned and operated by the City of Albany, the project OWNER.
- B. The Work consists of furnishing all labor, materials, services, and equipment necessary for the installation of one generator and automatic transfer switch (ATS) at the RWPS. Work also includes coordinating with Pacific Power & Lighting (power company) for disconnecting power to the RWPS for shutdowns.
 - 1. The work generally consists of the installation of one generator and ATS, at location listed above, which are OWNER furnished and CONTRACTOR installed, installation of new power conductors and conduit, custom-sized junction boxes for power conductors, battery charger and block heater branch circuit conduit and conductors, re-wiring an existing supply air fan, generator start signal control cabling to the automatic transfer switch, and generator signal cables to existing PLC. Concrete work involves extending an existing outdoor switchboard housekeeping pad, new generator housekeeping pad, site excavation, and trenching and backfilling. Commissioning work involves supporting the manufacturer during testing of generator, testing all new cables, and verifying proper generator, automatic transfer switch, and PLC functions.
 - 2. The above general outline of principal features of the Work does not in any way limit the responsibility of the CONTRACTOR(s) to perform all work and furnish all equipment, labor, and materials required by the specifications and drawings. The drawings and specifications shall be considered and used together. Anything appearing as a requirement of either shall be accepted as applicable to both even though not so stated therein or shown.
 - 3. No attempt has been made in these specifications or drawings to segregate work covered by any trade or subcontract under one specification. Such segregation and establishment of subcontract limits will be solely a matter of specific agreement between the CONTRACTOR and its subcontractors and shall not be based upon any inclusion, segregation, or arrangement in or of these specifications.

1.2 ACTIVITIES BY OTHERS

- A. OWNER, utilities, and others may perform activities within limits of the Work while the Work is in progress. Schedule the Work with OWNER, utilities, and others to minimize mutual interference.
- B. Activities which may affect performance of the Work include:

1. Continuous operation and routine maintenance of the existing operation of the Raw Water Pump Station.
 - C. CONTRACTOR shall inspect and promptly report apparent discrepancies or defects in work performed by others that affects proper execution or causes conflict with the Work.
- 1.3 COORDINATION OF WORK
- A. Maintain overall coordination of the Work.
 - B. Obtain construction schedules from each subcontractor and require each subcontractor to maintain schedules and coordinate modifications.
- 1.4 CONTRACTOR'S RESPONSIBILITY FOR FIELD VERIFICATION OF EXISTING CONDITIONS
- A. The CONTRACTOR shall be responsible for performing field verification of the existing conditions prior to bidding. The nature of this work inherently requires field observation to understand the existing conditions and scope of work.
 - B. Failure to observe the existing conditions or ignorance of existing conditions shall be the responsibility of the CONTRACTOR alone. Additional services shall not be authorized due to the CONTRACTOR'S lack of understanding of the existing conditions.
- 1.5 CONTRACTOR'S RESPONSIBILITY FOR SHUTDOWNS AND MAINTAINING EXISTING SYSTEMS
- A. Shutdowns of any Division 16 system shall be coordinated with the OWNER prior to performing the shutdown. The CONTRACTOR shall provide the OWNER with a written schedule identifying the system, duration, and impact on the OWNER'S facility.
 - B. Existing Division 16 systems not impacted by the work in this project shall be protected and maintained during construction. Any system not identified on the Drawings or within these specifications shall be brought immediately to the attention of the ENGINEER and OWNER.
 1. The CONTRACTOR shall be responsible for bearing the cost of repairing or restoring all electrical systems that are disrupted or damaged during construction. The system shall be repaired and restored to their original condition.
- 1.6 GENERAL CONSTRAINTS ON SEQUENCE AND SCHEDULING OF WORK
- A. Coordinate construction schedule and operation with OWNER.

- B. Coordinate proposed work with OWNER and ENGINEER before implementing any system shutdowns. Under no circumstances cease work at the end of a normal working day if such actions may inadvertently cause a cessation of any facility operating process; in which case, remain on-site until necessary repairs/work are complete.
- C. Do not close lines, open valves, or take other action that would affect the operation of existing systems, except as specifically required by the Contract Documents and after approval of OWNER and ENGINEER.
- D. CONTRACTOR shall not operate any of the existing equipment without written permission from the OWNER naming the specific piece of equipment and dates the CONTRACTOR may use the equipment. The CONTRACTOR is liable for any loss or damage caused to property or equipment or any personal injury resulting from or related to this usage.
- E. CONTRACTOR shall have all equipment and parts necessary to finish the Work and be prepared to reinstall temporary or existing removed equipment upon short notice if for any reason service needs to be restored.
- F. The OWNER may determine the order of preference and the time and season at which any portion or portions of the Work shall be commenced and carried on in order to ensure proper completion of the Contract or proper operation of new or existing facilities.

1.7 SITE ACCESS AND PARKING

- A. Restrict access, parking, staging, and the use of the Site to within the property boundary and as designated by the OWNER.
 - 1. CONTRACTOR shall restore all disturbed areas affected by construction activities, even if such areas are not identified as such.
 - 2. The CONTRACTOR is responsible for coordinating and obtaining adequate staging areas for materials and equipment in excess of that already shown.
 - 3. The CONTRACTOR is responsible for coordinating and scheduling the Work.
 - 4. Use of properties other than the Project Site must be coordinated directly with the property owners. CONTRACTOR shall notify PROJECT MANAGER of any agreements made with local property owner. It is not anticipated that the CONTRACTOR will need the use of other properties other than the Project Site for this project.

1.8 OWNER'S USE OF THE SITE

- A. The RWPS continually pumps raw water. In addition to the specified work restrictions specified herein, coordinate the Work to avoid interference with the normal operation of the treatment equipment and processes.
 - 1. OWNER operations personnel will require unobstructed access to the pump station at all hours.

1.9 PERMITS, FEES AND SERVICE CHARGES

- A. CONTRACTOR shall pay all fees necessary to obtain Structural and Electrical permits. The OWNER shall arrange for all testing required thereof. All required permits, licenses, and fees not previously obtained by OWNER, shall be applied for and obtained by CONTRACTOR.
- B. CONTRACTOR shall be responsible for compliance with all permit provisions and shall accommodate and coordinate all special inspections required thereof, all at no subsequent expense to the OWNER beyond prices as bid.
- C. The CONTRACTOR shall coordinate and provide for the installation and operation of franchise utility service (including any telephone and/or leased lines specified) as required during construction, startup, testing, and operation of the work until substantial completion.

1.10 OUTAGE PLAN AND SCHEDULE

- A. All the power distribution equipment affected by this project is considered critical to the operation of the RWPS. Due to the time-sensitive nature of this project, the maximum permitted time allowance for the following tasks shall be as follows:
 - 1. Main switchboard shall be permitted to be de-energized for no more than forty eight (48) hours.
 - 2. Shutdowns shall be continuous. There shall be only one shutdown and one startup.
- B. The PROJECT MANAGER and the RWPS Operations Staff shall observe the start of the shutdown. The CONTRACTOR shall initiate a shut down only on a weekday (Monday through Thursday) and only between the hours of 7 A.M. and 5 P.M. The specific date and time shall be scheduled with the PROJECT MANAGER.
- C. The PROJECT MANAGER and the RWPS Operations Staff shall observe all excavation work. Excavation shall occur only on a weekday (Monday through Thursday) and only between the hours of 7 A.M. and 5 P.M. The specific date and time shall be scheduled with the PROJECT MANAGER.
- D. The electrical testing shall be scheduled with the PROJECT MANAGER to occur only on a weekday (Monday through Thursday) and only between the hours of 7 A.M. and 5 P.M. The specific date and time shall be scheduled with the PROJECT MANAGER.
- E. The PROJECT MANAGER and the RWPS Operations staff shall observe the completion of the shutdown. The CONTRACTOR shall complete a shut down only on a weekday (Monday through Thursday) and only between the hours of 7 A.M. and 5 P.M. The specific date and time shall be scheduled with the PROJECT MANAGER.

- F. The CONTRACTOR shall submit a detailed schedule for approval to the PROJECT MANAGER and the ENGINEER. The CONTRACTOR shall not energize/de-energize any existing electrical equipment without written authorization from the PROJECT MANAGER.

1.11 OUTAGE MANAGEMENT CONSTRUCTION SCHEDULE

- A. The CONTRACTOR shall submit a temporary power construction schedule to the ENGINEER and PROJECT MANAGER within 30 days after the contract is awarded. This schedule shall be in addition to the overall construction schedule required above. The schedule shall be typewritten and shall include time-scaled bar charts depicting the critical project paths. The schedule shall indicate the order in which the CONTRACTOR proposes to carry out the work, the dates on which the important features of the work will start, and the final completion date, at a minimum. The shutdown schedule shall include the following:
 1. Equipment to be disconnected from the plant's power distribution network.
 2. Site preparation, excavation, trenching.
 3. Conduit and junction box installation
 4. ATS & Generator installation
 5. Conductor installation
 6. Testing
 7. Time and date of start of shut down.
 8. Time, date, and duration of all tasks identified in the Sequence of Operations within this Section.
 9. Time, date, and duration to re-connect equipment to the plant's power distribution network.
- B. Once the power outage plan has been approved by the PROJECT MANAGER, it shall constitute the basis for all work to be done by the CONTRACTOR.
- C. All construction work requiring station wide power outages require written approval from the PROJECT MANAGER.

1.12 LINE LOCATES

- A. CONTRACTOR shall provide all line locates.
- B. All utilities that interfere with the installation of new underground feeders shall immediately be identified and brought to the attention of the PROJECT MANAGER.

1.13 OUTAGE SEQUENCE OF OPERATIONS

- A. The following is a proposed sequence of operations for the transformer shutdown. The CONTRACTOR shall use the sequence of operations as a basis for creating the outage management construction schedule.
- B. The OWNER shall provide all diesel for the generator.

1. The CONTRACTOR shall include 10 business days within their construction schedule to allow the City to fill up the tank prior to operating the generator.
- C. Prior to the shutdown, perform the following work:
1. Site excavation
 2. Conduit trenching, underground conduit installation, backfilling, concrete slurry installations
 3. Concrete housekeeping pad installations
 4. Install ATS & Generator
 5. Indoor conduit installation (to extent possible)
 6. Outdoor exposed conduit installation (to extent possible)
- D. Day 1
1. Disconnect power to the main EUSERC switchboard with PP&L. This will de-energize power to the entire RWPS.
 2. Disconnect existing service entrance conductors as shown on the drawings.
 3. Terminate new conduits in EUSERC switchboard
 4. Terminate new conduits in RWP-SBW01 Switchboard.
- E. Day 2
1. Install new service entrance conductors between main EUSERC switchboard and new ATS.
 2. Conductor / cable testing.
 3. Install new feeder conductors between ATS and RWP-SBW01 switchboard.
 4. Install barrier in RWP-SBW01 feeder section.
 5. Re-energize main EUSERC switchboard with PP&L.
 6. Test phase rotation.
- F. After the plant is re-energized, complete the following:
1. Complete installation.
 2. Demonstration, testing and training.
 3. Punch list

1.14 RESCHEDULES

- A. Should the CONTRACTOR miss a scheduled power outage that has been confirmed and approved by the PROJECT MANAGER, the CONTRACTOR shall resubmit a revised plan showing the new proposed schedule for written approval by the PROJECT MANAGER. The CONTRACTOR shall submit the revised power outage plan to the PROJECT MANAGER at least ten (10) days prior to the proposed power outage

1.15 COORDINATION OF WORK

- A. The CONTRACTOR shall plan his work in coordination with the other trades and with the power and telephone utility authorities.

- B. The CONTRACTOR shall field verify all dimensions of equipment to be installed or provided by others so that correct clearances and connections may be made between the work installed by the CONTRACTOR and equipment installed or provided by others.
- C. The CONTRACTOR shall arrange all conduit runs so that they do not interfere with piping, structural members, etc.
- D. All working measurements shall be taken from the sites, checked with those shown on the drawings, and if they conflict, reported to the ENGINEER at once, and before proceeding with the work. Should the CONTRACTOR fail to comply with this procedure, he shall alter his work at his own expense as directed by the ENGINEER.
- E. No additional payments will be allowed where obstructions in the work of other trades, or work under this contract requires offsets to conduit runs.
- F. The CONTRACTOR is responsible for all alterations in the work to accommodate equipment differing in dimensions or other characteristics from that shown or specified.
- G. The CONTRACTOR shall provide all temporary power necessary for existing site equipment and for all construction needs.

1.16 QUALITY ASSURANCE

- A. Submit copies of permits required by the governing jurisdiction to PROJECT MANAGER prior to initiating the affected Work.
- B. In lieu of the permit, if allowed by the governing jurisdiction, the affected Work may be started following PROJECT MANAGER's receipt of copies of applications for the required permits as accepted by the governing jurisdiction.
- C. Submit a request for interpretation before proceeding with the Work if a manufacturer's instructions conflict with the Contract Documents.
- D. Use crew members experienced in performing the work successfully to the specified level of workmanship.

1.17 QUALITY CONTROL

- A. Provide quality control submittals.
- B. Provide all electrical inspections and testing as described within Division 16.
- C. Coordinate with the City for Owner-provided testing for rock, concrete, and seismic anchoring.

- D. Submit copies of reports documenting the results of inspections required by the governing jurisdiction to PROJECT MANAGER no later than the progress meeting immediately following the inspection.
- E. Submit copies of final approval required by the governing jurisdiction to PROJECT MANAGER prior to Substantial Completion.
- F. Provide required testing for electrical, instrumentation, mechanical, and related equipment as specified in each specification section.
- G. Notify PROJECT MANAGER 24 hours in advance of compaction tests and the placement of asphalt cement concrete.
- H. Costs incurred by OWNER related to failed tests or work not ready to test will be deducted from CONTRACTOR's Application for Payment.

1.18 CODES

- A. Work shall conform to the National Electrical Code (NEC), and State Codes and other applicable codes, even though not specifically mentioned for each item. These shall be regarded as the minimum standard of quality for materials and workmanship.

1.19 INTENT OF DRAWINGS AND SPECIFICATIONS

- A. Riser and other diagrams are schematic and are intended to show the approximate location of equipment, and the general alignment of conduits and piping, and shall not be used for obtaining quantities. Dimensions given on the plans shall take precedence over scaled dimensions and all dimensions whether in figures or scaled, shall be verified in the field.
- B. The electrical drawings do not show complete details of the site conditions. The CONTRACTOR shall check actual conditions.
- C. The exact location of apparatus, fixtures, equipment, conduit and piping shall be ascertained by the CONTRACTOR in the field, and the work shall be laid out accordingly. Should the CONTRACTOR fail to ascertain such locations or coordinate with work performed by other trades, the work shall be changed at no additional cost to the OWNER when so ordered by the ENGINEER. The ENGINEER reserves the right to make minor changes in the location of conduit, piping and equipment up to the time of installation without additional cost to OWNER.
- D. CONTRACTOR shall provide all labor, materials, equipment, machinery, and tools necessary to provide all electrical equipment specified and shown on the Drawings. All items not specified in detail or shown on the Drawings but necessary for complete installation shall be provided by the CONTRACTOR.

1.20 SUBMITTALS

- A. Submit a Work Sequencing Plan detailing the complete sequence of construction for all activities contained herein.
- B. Submit a two-week “look ahead” schedule during progress meetings.
- C. Identify the following in the Work Sequencing Plan:
 - 1. Major work activities to occur.
 - 2. Provide contract information of key CONTRACTOR and subcontractors personnel including after hour contact telephone numbers, email, etc.
 - 3. General schedule when work will occur. Submit separately a detailed schedule. Incorporate materials in detailed schedule and work sequencing plan.
 - 4. Proposed modifications to normal facility operations for each major work activity.
 - 5. Number and duration of process shutdowns required (if required).
 - 6. Facility, equipment, or utility to be shutdown.
 - 7. What assistance will be required of OWNER’s operating personnel during shutdowns.
 - 8. Contingency backup plan identifying what action will be taken if activities during a shutdown cannot be completed within the allotted times.
 - 9. Name of individual in charge of CONTRACTOR’s activity during shutdown.
 - 10. Temporary Power Construction Plan.
- D. The CONTRACTOR shall provide submittals including shop drawings, schedules, drawings, and such other information as may be necessary for the prosecution of the work in the shop and in the field as required by the contract documents or the ENGINEER’s instruction. There may be other submittals required elsewhere in these Specifications that are not necessarily included or mentioned in this Section.
- E. The ENGINEER will review shop drawings to determine compliance with the design concept of the project and return them to the CONTRACTOR within the period established in the shop drawings schedule. The ENGINEER may hold shop drawings in cases where partial submission cannot be reviewed until the complete submission has been received or where shop drawings cannot be reviewed until correlated items affected by them have been received. When such shop drawings are held, the ENGINEER will advise the CONTRACTOR in writing that the shop drawing submitted will not be reviewed until shop drawings for all related items have been received.
- F. The CONTRACTOR shall submit to the ENGINEER, for review, digital (PDF) copies each of such shop drawings, electrical diagrams, and catalog information for fabricated items and manufactured items required for construction. The ENGINEER will review the submitted data and shop drawings and will make notations thereon indicating “No Exception Taken,” “Make Corrections Noted,” “Rejected,” “Revise and Resubmit,” or “Submit Specified Item.” The ENGINEER will then return two copies of the submitted data and shop drawings to the CONTRACTOR. The

CONTRACTOR will respond to any shop drawing marked as "Make Corrections Noted," "Rejected", "Revise and Resubmit" or "Submit Specified Item" within one week. The ENGINEER's review of submittals and shop drawings is not a check of any dimension or quantity and will not relieve the CONTRACTOR from responsibility for errors of any sort in the submittals and shop drawings.

- G. When shop drawings and/or submittals are required to be revised or corrected and resubmitted, the CONTRACTOR shall make such revisions and/or corrections and resubmit those items or other materials in the same manner as specified above.
- H. Submitted data shall be sufficient in detail for determination of compliance with the Contract Documents. Color samples for all items for which colors are to be selected shall be submitted at the same time. No equipment or material for which listings, drawings, or descriptive material is required shall be installed until the CONTRACTOR has received review from the ENGINEER.
- I. Regardless of corrections made in or review given to the drawings by the ENGINEER, the CONTRACTOR shall be responsible for the accuracy of such drawings and for their conformity to the drawings and specifications. The CONTRACTOR shall check all submittals before submitting them to the ENGINEER and shall stamp its approval on all copies of the shop drawing documents. Any submittals received by the ENGINEER which do not bear the CONTRACTOR's approval shall be returned without review. If more than two submissions are required to meet the project specifications, the cost of reviewing these additional submissions may be charged directly against the CONTRACTOR and the OWNER may withhold the funds necessary to cover these costs.
- J. Materials and equipment shall be ordered a sufficient time in advance to allow time for reviews and shall be available on the job site when needed. Last minute review will not be given for inferior substitutes for material or equipment.
- K. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.
 - 1. The product data shall be provided as individual PDFs for each Section, unless otherwise noted for specific items. Each PDF shall be numbered to match the specification Section numbers. Submittals not itemized and labeled as specified will be rejected as incomplete.
 - 2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16000.A01) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
 - 3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not

- clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.
4. Submittals in PDF shall include an index, table of contents, or bookmarks with hyperlinks to the associated page of all submitted items. Index shall include each product specified with their corresponding Reference Keynote Number. Electronic submittals not containing a linked index, table of contents, or bookmarks will be rejected as incomplete.
- L. Submittals shall be in accordance with the requirements of these Contract Documents and shall include the following:
1. Submittals shall include information and literature as required for all equipment and materials provided under this and related sections.
 2. Shop Drawings: Shop drawings shall include the following along with any special requirements listed in the individual Specification Sections:
 - a. Installation instructions and drawings
 - b. Wiring schematics with termination point identification
 - c. Motor information
 - d. Materials of construction
 - e. Manufacturer's name and model
 - f. Manufacturer's catalog data
 - g. Supplementary structural framing for electrical equipment including design loads, member size and location. When supplementary framing is indicated, verify that dimensions are suitable for the equipment furnished. Provide additional strength when equipment furnished is heavier than that specified.
 3. Manufacturers' Literature: Literature indicating the compliance of the products with the Specifications shall be included with all submittals. This shall include catalogs and other descriptive bulletins. Relevant portions of the literature shall be clearly identified by highlighting or underlining.
 4. Test Logs: The CONTRACTOR shall submit test logs as outlined below and as specified in subsequent electrical sections and drawings.
 - a. A log of the complete results of tests for shorts and grounds for each circuit. All circuits and tests shall be clearly identified.
 - b. A log of complete results of insulation resistance measurements of each circuit. All circuits and tests shall be clearly identified.
 5. Schedules—The CONTRACTOR shall prepare and submit to the ENGINEER, at the pre-construction meeting, a practicable schedule showing the order in which the CONTRACTOR proposes to carry out the work, the dates on which the important features of the work will start, and the contemplated dates for completing same. In addition to a time-scaled bar chart schedule depicting the project critical path, the CONTRACTOR shall submit a detailed CPM logic diagram. The activities shall be separately identifiable by coding or use of sub-networks or both. The duration of each activity shall be verifiable by manpower and equipment allocation, in common units of measure, or by delivery dates and shall be justifiable by the CONTRACTOR upon the request of the ENGINEER. Detailed sub networks will include all necessary activities and logic connectors to describe the work and all restrictions to it. In the restraints, include those

activities from the project schedule which initiated the sub network as well as those restrained by it. CONTRACTOR'S attention is drawn to typical local climatic weather patterns and the CONTRACTOR shall coordinate work accordingly. The CPM diagram and time-scaled bar chart shall include the following:

- a. Construction activities.
 - b. Submittal and approval of material samples and shop drawings.
 - c. Procurement of critical materials.
 - d. Fabrication, installation, and testing of special material and equipment.
 - e. Duration of work, including completion times of all stages and their sub-phases.
 - f. Temporary Power Construction Schedule.
6. Breakdown of Contract Price—The CONTRACTOR shall, at the preconstruction meeting, submit a complete breakdown of all lump sum bid items showing the value assigned to each part of the work including an allowance for profit and overhead adding up to the total lump sum contract price. Breakdown of lump sum bids shall be coordinated with the items in the schedule. Preparatory work, bonds, and insurance required in setting up the job will be allowed as a separate entry on the cost breakdown but shall not exceed 5 percent of the total base bid. Upon acceptance of the breakdown of the contract price by the ENGINEER, it shall be used as the basis for all requests for payment.
7. Operation and Maintenance Instructions.
- a. Before acceptance of the installation, the CONTRACTOR shall submit four hard copies of complete operation and maintenance instructions for all equipment supplied in addition to electronic copies in approved format on in electronic (PDF) format. All binders and folders shall have clear plastic pockets on the front of the cover and the spine to allow for insertion of identifying information. The equipment manufacturer may furnish instruction manuals prepared specifically for the equipment furnished or standard manuals may be used if statements like “if your equipment has this accessory...” or listings of equipment not furnished are eliminated. Poorly reproduced copies are not acceptable. Operation and maintenance instructions shall contain the following as a minimum:
 - 1) Approved shop drawings and submittal data.
 - 2) Model, type, size and serial numbers of equipment furnished.
 - 3) Equipment and driver nameplate data.
 - 4) List of parts showing replacement numbers.
 - 5) Recommended list of spare parts.
 - 6) Complete operating instructions including start-up, shutdown, adjustments, cleaning, etc.
 - 7) Maintenance and repair requirements including frequency and detailed instructions.
 - 8) Name, address, and phone numbers of local representative and authorized repair service.

8. Programming instructions for any controllers or other programmable equipment. Copies of the any required software, including registration cards, shall be provided with the O&M manuals.
- M. The CONTRACTOR shall indicate on the submittals all variances from the Specifications.
- N. Record Drawings. After the completion of construction, the CONTRACTOR shall provide one set of “as-built” drawings to the ENGINEER as specified herein showing the location of buried conduits and all changes or deviations from the original drawings.
- O. After the completion of construction, a printout and electronic copy of any programming and/or set-points for controllers, PLCs, meters or other programmable equipment.
- P. Final inspection certificates shall be submitted prior to final payment.

1.21 CONSTRUCTION FACILITIES

- A. Staging Area and Access
 1. Lock CONTRACTOR’s field office, if applicable; and storage facilities during periods when the Work is not being performed, or when the area is unattended.

1.22 PRODUCT REQUIREMENTS

- A. Basic Product Requirements
 1. Provide new products, unless specified otherwise in the Contract Documents.
 2. Equipment and other products of the same or similar nature shall be of the same manufacturer.
- B. Design Requirements
 1. Products shall meet the requirements of the codes in effect in the jurisdiction of the Work at the time of the Bid.
 2. Products and mountings shall comply with applicable sections of the NEC and IBC.
- C. Specified Products, Approved Equal and Substitutions
 1. If a product is specified and no specific product manufacturer is indicated, CONTRACTOR may submit on, and incorporate the product of a manufacturer meeting the specification, in the opinion of PROJECT MANAGER.
 2. If product is specified with manufacturers named, CONTRACTOR shall submit on, and incorporate the appropriate product(s) manufactured by the specified manufacturer(s).
 3. In the event the CONTRACTOR desires to substitute the specified product(s) with another product(s) prior to the Bid closing date, the procedures in Instructions to Bidders must be followed.

4. In the event CONTRACTOR desires to substitute the specified product(s) with another product(s) following the execution of the Contract, Sections 00160 – Source of Materials and 00165 – Quality of Materials must be followed.

D. Delivery, Storage, and Handling Requirements

1. Deliver products and equipment pursuant to the current progress schedule and coordinated to avoid conflict with the Work and conditions at the Site.
2. Direct deliveries to the staging area. Deliveries shall not be accepted or conducted at any other location without the written approval of PROJECT MANAGER.
3. OWNER's staff will not provide assistance in directing the delivery or unloading the products/equipment.
4. Unload products in accordance with manufacturer's instructions for unloading, or as specified. Include delivery date, quantity, and condition of products/equipment on CONTRACTOR's daily reports.
5. Handle products/equipment by methods to prevent bending or over stressing.
6. Lift components only at designated lifting points.
7. Handle materials and equipment with suitable equipment pursuant to manufacturer's recommendations. Do not drop, roll, or skid products/equipment off delivery vehicles.
8. Do not drop, roll, or skid products/equipment into place. Use cranes, hoists, or other suitable equipment intended for the purpose.
9. Remove damaged products/equipment from the Site and expedite delivery of suitable replacements so as to not delay the progress of the Work.
10. Handle products/equipment in accordance with manufacturer's written instructions, and in a manner to prevent damage. Upon delivery, store products in accordance with manufacturer's instructions with labels intact and legible in the staging area
11. Provide manufacturer's recommended maintenance during storage, installation, start-up, and commissioning until products/equipment are accepted for use by OWNER

E. Owner Furnished Products

1. CONTRACTOR is responsible for the following as it relates to OWNER furnished products:
 - a. Receive and unload products at the Site.
 - b. Handle, store, install, and finish products.
 - c. Repair or replace items damaged by CONTRACTOR.
 - d. Schedule, coordinate, and assist in performing starting, adjusting, commissioning, demonstration, and training activities related to items furnished by OWNER. Vendor charges related to these activities will be sent directly to OWNER.
 - e. Provide diesel fuel for all factory startup and testing. Fuel tanks for both generators shall be full at the completion of the project.

1.23 TESTING, TRAINING, AND SYSTEM START-UP

A. Contract Requirements

1. Testing, training and start-up services are requisite to the satisfactory completion of the Work.
2. Complete all testing, training, and start-up within the Contract Times.
3. Furnish all necessary labor, power, chemicals, tools, equipment, instruments, and services required for and incidental to completing functional testing, performance testing, and operational testing.
4. Provide competent, experienced technical representatives of equipment manufacturers for assembly, installation, testing, and operator training.
5. Generator testing shall comply with NFPA 110.

B. Equipment Installation

1. Inspect all equipment and systems following installation and prior to start-up and operational testing.
2. Provide written certification that mechanical, electrical and instrumentation systems furnished are installed to manufacturer requirements prior to start-up and testing.

C. General Start-up and Testing Procedures

1. Mechanical Systems: Complete the following as applicable.
 - a. Remove rust preventatives and oils applied to protect equipment during construction.
 - b. Flush lubrication systems and dispose of flushing oils. Recharge lubrication systems with lubricant recommended by manufacturer.
 - c. Flush fuel system and provide fuel for testing and start-up.
 - d. Install and adjust packing, mechanical seals, O-rings, and other seals. Replace defective seals.
 - e. Remove temporary supports, bracing, or other foreign objects installed to prevent damage during shipment, storage, and erection.
 - f. Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting driver.
 - g. Perform cold alignment and hot alignment to manufacturer's tolerances.
 - h. Adjust V-belt tension and variable pitch sheaves.
 - i. Inspect hand and motorized valves for proper adjustment. Tighten packing glands to ensure no leakage but permit valve stems to rotate without galling. Verify valve seats are positioned for proper flow direction.
 - j. Tighten leaking flanges or replace flange gasket. Inspect screwed joints for leakage.
 - k. Install gratings, safety chains, handrails, shaft guards, and sidewalks prior to operational testing.
2. Electrical Systems
 - a. Perform insulation resistance tests on wiring except 120-volt lighting, wiring, and control wiring inside electrical panels.
 - b. Perform continuity tests on grounding systems.

- c. Test and set switchgear, ATS, and circuit breaker relays for proper operation.
- d. Check motors for actual full load amperage draw. Compare to nameplate value.

D. Functional Testing

1. Functionally test mechanical and electrical equipment for proper operation after general start-up and testing tasks have been completed.
2. Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration. Perform initial checks in the presence of and with the assistance of the manufacturer's representative.
3. Demonstrate proper operation of each instrument loop function including alarms, local and remote controls, instrumentation, and other equipment functions. Generate signals with test equipment to simulate operating conditions in each control mode.
4. Coordinate with OWNER, equipment suppliers and manufacturer's representatives as necessary to accommodate all OWNER pre-purchased testing assistance services.

E. Certificate of Proper Installation

1. At completion of functional testing, furnish written report prepared and signed by manufacturer's authorized representative, certifying equipment:
 - a. Has been properly installed, aligned, adjusted and lubricated.
 - b. Is free of any stresses imposed by connecting piping or anchor bolts.
 - c. Is suitable for satisfactory full-time operation under full load conditions.
 - d. Operates within the allowable limits for vibration.
 - e. Controls, protective devices, instrumentation, and control panels furnished as part of the equipment package are properly installed, calibrated, and functioning.
 - f. Control logic for start-up, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly functioning.
2. Furnish written report prepared and signed by the electrical and/or instrumentation subcontractor certifying:
 - a. Control logic for equipment start-up, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly operating.
3. Co-sign the reports along with the manufacturer's representative and subcontractors.

F. Record Keeping

1. Maintain and submit to ENGINEER the following records generated during start-up and testing phase of Project:
 - a. Daily logs of equipment testing identifying all tests conducted and outcome.
 - b. Logs of time spent by manufacturer's representatives performing services on the Project site.
 - c. Equipment lubrication records.
 - d. Electrical phase, voltage, and amperage measurements.
 - e. Insulation resistance measurements.

- f. Data sheets of control loop testing including testing and calibration of instrumentation devices and set-points.

1.24 HAZARDOUS MATERIALS LOCATED AT THE SITE

- A. Provide PROJECT MANAGER with a list of hazardous materials kept at the Site by CONTRACTOR and the subcontractors, and the applicable material safety data sheets.
- B. Secure CONTRACTOR's hazardous materials, and other substances inappropriate to be left accessible, in the staging area and store them pursuant with applicable laws and regulations, and the Contract Documents.

1.25 CLOSEOUT SUBMITTALS AND PROCEDURES

- A. Delivery of Closeout Submittals
 1. Provide closeout submittals.
 2. Deliver spare parts to OWNER.
 3. Deliver the closeout submittals and record drawings to OWNER.
 4. Provide seven days written notice to PROJECT MANAGER prior to delivering spare parts.
 5. PROJECT MANAGER will inventory the spare parts with CONTRACTOR and provide a receipt for the equipment received in good condition.
 6. Request final payment.

PART 2 PRODUCTS

2.1 PORTABLE OR DETACHABLE PARTS

- A. The CONTRACTOR shall retain in his possession and shall be responsible for all portable and detachable parts or portions of installations such as fuses, key locks, adapters, blocking chips and inserts until completion of his work.
- B. These parts shall be delivered to the ENGINEER and an itemized receipt obtained. This receipt, together with 2 copies of the final inspection certificate, shall be attached to the CONTRACTOR's request for final payment.
- C. All equipment shall be demonstrated to operate in accordance with the requirements of this specification and the manufacturer's recommendations.

2.2 NEW PRODUCTS

- A. All products shall be new without defects and covered by Manufacturer's warranty. Products shall be re-used only where indicated on the Drawings.
- B. All products shall be listed, labeled, and certified by a testing agency approved by the state of Oregon.

- C. All equipment of the same type and capacity shall be by the same manufacturer.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS FOR EXECUTION OF WORK

- A. Maintain overall coordination of execution of Work.
- B. Obtain all necessary permits for the Work regarding construction permits.
- C. Obtain schedules from subcontractors and suppliers and assume responsibility for correctness.
- D. Incorporate schedules from all parties into Progress Schedule to plan for and comply with sequencing constraints.

3.2 IDENTIFICATION

- A. All identification labeling shall be in compliance with Section 16075 Electrical and Control Identification.

3.3 WORKMANSHIP & COORDINATION

- A. All work shall be performed by personnel skilled in the particular trade in a workmanlike manner. Workmanship shall conform to the standards of the NEC and the National Electrical Installation Standards (NEIS).
- B. The ENGINEER shall be the sole judge as to whether or not the finished work is satisfactory; and if in his judgment any material or equipment has not been properly installed or finished, the CONTRACTOR shall replace the material or equipment whenever required, and reinstall it in a manner entirely satisfactory to the ENGINEER without any increase in cost to the OWNER.
- C. The CONTRACTOR shall coordinate and verify the installation of all equipment furnished by him to other trades, or equipment provided and installed by other trades that is connected to the electrical or control systems. Work shall include the furnishing of all labor, materials, and equipment required for the installation of a complete and operable system as hereinafter specified and as indicated on the drawings. The Contract Documents are complementary and what is called for by any one shall be as binding as if called for by all. Unless otherwise specifically stipulated, the term "furnished and installed complete" shall be considered a part of this section.
- D. Controls and systems shall be complete with transformers, switches, relays, contactors, control valves, control devices, instrument piping, fittings, valves, control wiring, thermometers, pressure gauges, thermostats, damper operators, miscellaneous control cabinets to fill the intent of the Specifications and shall

provide control for the various units and systems. All control valves and motorized dampers shall be provided with position indicators.

- E. Unless otherwise specified or shown on the drawings, switches or relays shall be installed in, or adjacent to the motor starter or other electrical device to which they are to be connected. Control and interlock wiring shall be included as necessary from breakers specified herein or shown on the drawings.
- F. Each control schematic intended to control a series of motor operated louvers, fans, and thermostats shall contain a switch for maintenance to meet the NEC requirements regarding disconnect switches for motors. This switch shall be local if any unit controlled is out of sight of the switch. This switch shall disconnect all power to all motor operated devices within the circuit.

3.4 SUPPORT BACKING

- A. Provide any necessary backing required to properly support all fixtures and equipment installed under this contract.

3.5 CUTTING, PATCHING AND FRAMING

- A. The CONTRACTOR shall determine in advance the locations and sizes of all sleeves, chases, and openings necessary for the proper installation of his work.
- B. Whenever practical, inserts or sleeves shall be installed prior to covering work. Cutting and patching shall be held to a minimum. All required holes in concrete construction shall be made with a core drill and patched with non-metallic non-shrink grout.
- C. Cutting, fitting repairing and finishing of carpentry work, metal work, or concrete work, and the like, which may be required for this work shall be done by craftsmen skilled in their respective trades. When cutting is required, it shall be done in such a manner as not to weaken walls, partitions, or floors; and holes required to be cut in floors must be drilled without breaking out around the holes.

3.6 TESTS

- A. The CONTRACTOR shall furnish all labor, material, instruments and tools to make all connections for testing of the electrical and instrumentation installation. All equipment shall be demonstrated as operating properly prior to the acceptance of the work. All protective devices shall be operative during testing of equipment. The tests shall be made under the supervision of the ENGINEER. All deficiencies or unsatisfactory conditions as determined by the ENGINEER or inspecting authorities shall be corrected by the CONTRACTOR in a satisfactory manner at his own expense.
- B. After visual inspection of joints and connections and the application of tape and other insulating materials, all sections of the entire wiring system shall be thoroughly

tested for shorts and grounds. A log of results for each circuit shall be kept by the CONTRACTOR and presented to the ENGINEER.

- C. A phase rotation check shall be made to demonstrate that all power receptacles, service feeders, main power feeders and auxiliary power generators have the same A - B - C phase rotation and ground relationships.
- D. Equipment shall be tested by operating all electric motors, relays, controls, switches, heaters, etc., sufficiently to demonstrate proper installation and electrical connections. Control and emergency conditions shall be artificially simulated where necessary for complete system or subsystem.

3.7 CLEANING AND TOUCH-UP PAINT

- A. Upon completion of work, all electrical equipment shall be cleaned.
 - 1. Vacuum all dirt, metal shavings, and foreign materials from all enclosures. The use of compressed air shall not be acceptable.
 - 2. All stains, dirt, and fingerprints shall be removed from switchboards, motor control centers, panelboards, light fixtures, enclosures, and all other electrical equipment covers.
- B. Provide touch-up paint on equipment that has been scraped, scratched, or chipped during construction. Paint color shall match color of equipment.

END OF SECTION

SECTION 16057
ELECTRICAL SYSTEMS ANALYSIS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. The section includes the requirements for a Short-Circuit Study, Protective Device Coordination Study, Arc Flash Study, and Arc Flash Warning Labels.

1.2 REFERENCES

A. Referenced Standards:

1. American National Standards Institute (ANSI).
2. Institute of Electrical and Electronics Engineers (IEEE):
 - a. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
 - b. 399, Recommended Practice for Industrial and Commercial Power System Analysis.
 - c. 1584, Guide for Performing Arc Flash Hazard Calculations.
3. National Electrical Manufacturers Association (NEMA): Z535.4, Product Safety Signs and Labels.
4. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - b. 70E, Standard for Electrical Safety in the Workplace.
5. Occupational Safety and Health Standards (OSHA): 29 CFR, Part 1910, Subpart S, Electrical.

1.3 SUBMITTALS

- A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.

B. Submittal Format:

1. The product data shall be provided as individual PDFs for each Section, unless otherwise noted for specific items. Each PDF shall be numbered to match the specification Section numbers. Submittals not itemized and labeled as specified will be rejected as incomplete.
2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16000.A01) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.

3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.
4. Submittals in PDF shall include an index, table of contents, or bookmarks with hyperlinks to the associated page of all submitted items. Index shall include each product specified with their corresponding Reference Keynote Number. Electronic submittals not containing a linked index, table of contents, or bookmarks will be rejected as incomplete.

C. Product Data:

1. Pursuant to 01300 Submittal Procedures.
2. Arc Flash Warning Label templates.

1.4 QUALITY ASSURANCE

- A. Short circuit, protective device coordination, and arc flash studies shall be provided by a corporately and financially independent, unbiased, testing authority. The testing authority shall be independent of manufacturers, suppliers, and installers of equipment being tested. The testing authority shall have a minimum of five (5) years experience testing similar projects.

1.5 SEQUENCING AND SCHEDULING

- A. Initial complete protective device coordination and arc flash studies shall be submitted within 90 days after approval of initial short circuit study.
- B. Revised short circuit, protective device studies, arc flash studies, and arc flash labels shall be submitted 10 days before energizing electrical equipment.
- C. Final short circuit, protective device studies, and arc flash studies shall be completed prior to project completion. Final version of study shall include as-built equipment, materials, and parameter data or settings entered into equipment based on study.
- D. Submit final arc flash labels described herein and in compliance with NEMA Z535.4 prior to project completion.

1.6 GENERAL STUDY REQUIREMENTS

- A. The equipment required to be modeled in the Study is shown on the Drawings and identified as follows:
1. Main service
 2. Generator & ATS
 3. Raw water pumps
 4. Distribution panels and panelboards
 5. PLC control panel

- B. The Study shall demonstrate the following:
 - 1. The study shall comply with the current edition of the Oregon Electrical Specialty Code and NFPA 70E, and Article 701 Legally Required Standby System.
 - 2. Arc flash hazard levels without the arc flash maintenance reduction switch engaged.
 - 3. Arc flash hazard levels with the arc flash maintenance reduction switch engaged.
 - 4. Short circuit current levels and ratings of all electrical equipment.

- C. The CONTRACTOR shall be responsible for providing all information to the Agent responsible for performing the Study. At minimum, the CONTRACTOR shall provide the following:
 - 1. Service transformer nameplate information
 - 2. Service entrance feeder conductor size, type, length and feeder conduit size, type, and length.
 - 3. Service entrance equipment nameplate information.
 - 4. Motor load nameplate information.
 - 5. Distribution feeder size, type, and length.
 - 6. Overcurrent protection device nameplate information and trip settings.
 - 7. Panelboard nameplate information.
 - 8. Any other information requested by the testing Agent.

- D. Equipment and component titles used in the studies shall be identical to equipment and component titles shown on the Drawings.

- E. Perform studies using one of the following electrical engineering software packages:
 - 1. SKM Power Tools for Windows
 - 2. ETAP
 - 3. EDSA
 - 4. Easy Power

- F. Perform complete fault calculations for all new and future loads indicated on the Drawings.

- G. Provide individual protective device time-current characteristics for the low voltage distribution system.

PART 2 STUDIES AND PRODUCTS

2.1 SHORT CIRCUIT STUDY

- A. General
 - 1. Prepare a Short Circuit Study in accordance with IEEE 39.
 - 2. Cable impedances shall be based on copper conductors.
 - 3. Bus impedances shall be based on copper buses.
 - 4. Cable and bus resistances shall be calculated at 25 degrees Celsius.
 - 5. Medium voltage cable reactance shall be based on typical dimensions for standard cables with 133% insulation levels.

6. 600-volt cable reactance shall be based on the typical dimensions of THWN-2 conductors.
 7. Transformer impedances shall be 92.5% of nominal impedance based on tolerances specified in IEEE C57.12.00.
- B. The Short Circuit Study final report shall include the following:
1. Basic description, purpose, and scope of the study.
 2. Descriptions of the scenarios evaluated and identification of the scenario used to evaluate short circuit ratings.
 3. Explanation of bus and branch numbering system.
 4. Prevailing conditions.
 5. Selected base per unit quantities.
 6. Source impedance data, including electric utility system, generator, and motor fault contribution characteristics.
 7. Impedance diagrams.
 8. Zero-sequence impedance diagrams.
 9. One line diagrams and associated tabulations of data used to model the system components.
 10. Calculation methods and assumptions.
 11. Typical calculations.
 12. Tabulation of calculation quantities.
 13. Results, conclusions, and recommendations.
- C. The short circuit interrupting and momentary (when applicable) duties for an assumed three-phase bolted fault shall be calculated at each:
1. Utility Service point.
 2. Medium Voltage Switchgear.
 3. Low Voltage Switchgear.
 4. Switchboard.
 5. Motor Control Center.
 6. Automatic Transfer Switch.
 7. Distribution Panel.
 8. Branch Circuit Panelboard.
 9. Future load contributions as shown on the One-Line Diagram.
 10. Any additional point within the power distribution system as specified by the Engineer.
- D. The Short Circuit Study shall be used to verify the following:
1. Equipment and protective devices are applied within their ratings.
 2. Adequacy of distribution equipment bus bars to withstand short circuit stresses.
 3. Cable and bus way sizes for ability to withstand short circuit heating, in addition to normal current loads.
- E. Provide a tabulation of equipment short circuit versus available fault duties. The tabulation shall identify percentage of rated short circuit current and clearly identify equipment with insufficient ratings.
1. General Data

- a. Short circuit reactance of rotating machines.
 - b. Cable and conduit material data.
 - c. Bus data.
 - d. Transformer data.
 - e. Circuit resistance and reactance values.
 - 2. Short Circuit Data
 - a. Fault impedances.
 - b. X/R ratios.
 - c. Asymmetry factors.
 - d. Motor contributions.
 - e. Short circuit kVA.
 - f. Symmetrical and asymmetrical fault currents.
 - 3. Equipment Evaluation
 - a. Equipment bus bracing, equipment short circuit rating, transformer, cable, busway.
 - b. Maximum fault current available.
- F. Provide a written summary at the end of the Short Circuit Study, which shall include the following:
- 1. Selected equipment deficiencies.
 - 2. Results of short circuit study.
 - 3. Conclusions and recommendations.
- G. The Contractor shall be notified in writing of existing circuit protective devices improperly rated for new fault conditions.
- H. The Short Circuit Study data shall be revised for as-built conditions.

2.2 PROTECTIVE DEVICE SETTINGS STUDY

- A. General
- 1. The Protective Device Settings Study shall be used to determine recommended circuit breaker settings that provide a balance between equipment protection and selective device operation that is optimum for the electrical system. Provide an analysis of all possible operating scenarios which will be or have been influenced by the proposed or completed additions or changes to the system. The study shall be prepared in accordance with ANSI/IEEE 399 and ANSI/IEEE 242.
- B. The Protective Device Settings Study shall include the following:
- 1. Basic description, purpose, and scope of the study.
 - 2. Descriptions of the scenarios evaluated and identification of the scenario used to evaluate short circuit ratings.
 - 3. Prevailing Conditions.
 - 4. One Line Diagrams.
 - 5. Explanation of bus and branch numbering system.
 - 6. Calculation methods and assumptions.
 - 7. Typical calculation.

8. Tabulation of calculated quantities.
 9. Time-current curves for overcurrent protection devices.
 10. Results, conclusions, and recommendations.
- C. The Protective Device Settings Study shall be used to verify the following protective device time-overcurrent settings:
1. Long Time Delay Pick Up.
 2. Long Time Delay.
 3. Short Time Delay Pick Up.
 4. Short Time Delay.
 5. Instantaneous Trip.
 6. Ground Fault Pick Up.
 7. Ground Fault Delay.
 8. Current Transformer (CT) Ratios.
 9. Time-Dial Multiplier.
 10. Tap Settings.
- D. Tabulation of calculated data shall include the following:
1. General Data
 - a. Overcurrent protection device location, manufacturer, type, range of adjustment, IEEE device number, CT ratio.
 2. Equipment evaluation
 - a. Recommended settings or device size.
 - b. Referenced time-current curve.
- E. Provide a written summary at the end of the Protective Device Settings Study, which shall include the following:
1. Selected equipment deficiencies.
 2. Results of coordination study.
 3. Conclusions and recommendations.

2.3 ARC FLASH STUDY

- A. Perform an Arc Flash Hazard Study after short circuit and protective device setting recommendations have been completed, reviewed, and accepted by the Engineer. Perform the analysis under worst-case arc flash conditions for all modes of operation. Provide an analysis of all operating scenarios which will be or have been influenced by the proposed or completed additions to the subject system.
- B. The Arc Flash Hazard Study shall be performed in accordance with NFPA 70E, OSHA 29 CFR, Part 1910 Subpart S, and IEEE 1584.
- C. The Arc Flash Hazard Study shall include the following:
1. Basic description, purpose, and scope of the study.
 2. One Line Diagram.
 3. Short Circuit Study.
 4. Protective Device Settings Study.

5. Calculation methods and assumptions.
 6. Typical calculation.
 7. Evaluation summary spreadsheet.
 8. Conclusions and recommendations.
- D. Base Calculation: For each major part of the power distribution system, the following shall be determined:
1. Flash hazard protection boundary.
 2. Limited approach boundary.
 3. Restricted approach boundary.
 4. Prohibited approach boundary.
 5. Incident energy level.
 6. Personal protection equipment (PPE) hazard/risk category.
 7. Type of PPE required.
- E. Produce arc flash warning labels that list items in Part C above and provide the following additional items:
1. Bus name.
 2. Bus voltage.
- F. Produce detail sheets that list items in Part C above and the following items:
1. Bus name.
 2. Upstream protective device name, type, and settings.
 3. Bus-to-line voltage.
- G. Produce arc flash evaluation summary sheet listing the following additional items:
1. Bus name.
 2. Upstream protective device name, type, and settings.
 3. Bus-to-line voltage.
 4. Protective device bolted fault current.
 5. Arcing fault current.
 6. Protective device trip/delay setting.
 7. Breaker opening time.
 8. Solidly grounded column.
 9. Equipment type.
 10. Gap.
 11. Arc flash boundary.
 12. Working distance.
 13. Incident energy.
 14. Required protective fire rated clothing type and class.
- H. Analyze short circuit, protective device coordination, and arc flash calculations and highlight equipment that is determined to be underrated or causes incident energy values greater than 40 cal/cm². Provide proposals to reduce energy levels.
- I. Provide a written summary at the end of the Arc Flash Hazard Study, which shall include the following.

1. Equipment manufacturer's information used to prepare study.
2. Assumptions made during study.
3. Copy of one line diagram.
4. Arc flash evaluations summary spreadsheet.
5. Bus detail sheets.
6. Arc flash warning labels printed in color on adhesive backed labels.

2.4 ARC FLASH WARNING LABELS

- A. Provide arc flash warning labels per NEC 110.16
- B. All identification labeling shall be in compliance with Section 16075 Electrical and Control Identification.

PART 3 EXECUTION

3.1 GENERAL

- A. Adjust relay and protective device settings according to reduce arc flash while maintaining coordination between downstream circuit breakers and the upstream main circuit breaker.
- B. Perform minor modifications to equipment as required to accomplish conformance with short circuit study.
- C. Notify Contractor in writing of required major equipment modifications.
- D. Provide laminated one-line diagrams (minimum size 11" x 17") to post on interior of electrical room doors.
- E. Provide arc flash warning labels on equipment as specified on this Section.

END OF SECTION

SECTION 16060
GROUNDING AND BONDING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes.

1. The section includes requirements for grounding electrodes, equipment grounding and electrical bonding.

1.2 SUBMITTALS

A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.

1. The product data shall be provided as individual PDFs for each Section, unless otherwise noted for specific items. Each PDF shall be numbered to match the specification Section numbers. Submittals not itemized and labeled as specified will be rejected as incomplete.
2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16060.G01) typewritten in the upper right-hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.
4. Submittals in PDF shall include an index, table of contents, or bookmarks with hyperlinks to the associated page of all submitted items. Index shall include each product specified with their corresponding Reference Keynote Number. Electronic submittals not containing a linked index, table of contents, or bookmarks will be rejected as incomplete.

B. Product Data

1. Manufacturer's data including materials of construction, methods of installation and related information for each item specified in PART 2 PRODUCTS.

PART 2 PRODUCTS

2.1 MATERIALS

A. **Ground Rods (16060.G01).**

1. Ground rods shall be provided as shown on the drawings.
2. Ground rods shall be copper clad.
3. Ground rods shall be a minimum of 5/8 inch diameter.
4. Ground rods shall be a minimum of 10 feet long.

B. Compression Connectors (16060.C20).

1. Compression connections shall be provided as shown on the drawings and as required for bonding end-use equipment.
2. Compression connections shall be compress-deforming type, extruded copper material.
3. Compression connections shall be tin electroplated for corrosion resistance.
4. Compression connections shall be ring-type connectors. Forked connectors shall not be used on grounding conductors.
5. Provide Burndy products, or approved equal.

C. Mechanical Connectors (16060.C21).

1. Mechanical connectors shall be provided as shown on the drawings and as required for bonding to pipes.
2. Mechanical connectors shall be UL 467 Listed, copper material.
3. Mechanical connectors shall be sized to match the pipe being bonded.
4. Mechanical connector clamps shall permit parallel or 90° cable connection.
5. Mechanical connectors installed below-grade shall include silicon bronze hardware.
6. Provide Burndy GAR3902 series for above-ground installations or approved equal.
7. Provide Burndy GAR-BU series for below-grade installations, or approved equal.

D. Ground Test Well (16060.G60).

1. Ground test wells shall be provided as shown on the drawings.
2. Provide Utility Vault box type # 3VB-1012B, or approved equal.
3. Provide Utility Vault traffic cover # 1/3 VCB-C1 cover with custom "GROUND" marking on cover, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. General.

1. All identification labeling shall be in compliance with Section 16075 Electrical and Control Identification.
2. Bond separately derived systems, including generators, to the grounding electrode system.
3. Maintain equipment ground continuity throughout the facility by means of a grounding conductor routed in all raceways.
4. Provide grounding conductors pursuant to Section 16121. Conductors shall be copper and shall be sized per the Drawings or the NEC, whichever is greater.

5. Provide ground bushings for all conduits that do not terminate in a hub type fitting and install at the source of power with a bonding conductor fastened to the ground bushing.
 6. Provide ground bar kits as shown on the Drawings and where two (2) or more grounding conductors are terminated in a box or enclosure.
 7. Install ground rods at the locations and in the number shown on the Drawings or per the NEC, whichever is greater.
 8. Bond the grounding electrode system to all metallic water and wastewater piping.
- B. Grounding Conductors.
1. Brush grounding conductors clean of debris before connections are made.
 2. Strip insulated conductor insulation in a neat, workman like manner where insulated conductors are used.
 3. Fasten all conductors securely.
- C. Connections.
1. Install connectors according to the manufacturer's directions, using the proper dies, tools, molds, shots, loads, etc. designed specifically for this purpose.
 2. Provide irreversible welded type connections to ground rods, re-bar, lightning protection box, building steel etc.
 3. Provide compression connector type connections to end use equipment and bolt to the equipment using washers and split lock washers for secure fastening. Bolts shall be grade 5 for grounding connections and shall be tightened to the manufacturer's recommend torque.

END OF SECTION

SECTION 16070
HANGERS AND SUPPORTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. This section includes requirements pertaining to electrical equipment anchoring and electrical equipment hanging and support.

1.2 SUBMITTALS

A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.

1. The product data shall be provided as individual PDFs for each Section, unless otherwise noted for specific items. Each PDF shall be numbered to match the specification Section numbers. Submittals not itemized and labeled as specified will be rejected as incomplete.
2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16070.H01) typewritten in the upper right-hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.
4. Submittals in PDF shall include an index, table of contents, or bookmarks with hyperlinks to the associated page of all submitted items. Index shall include each product specified with their corresponding Reference Keynote Number. Electronic submittals not containing a linked index, table of contents, or bookmarks will be rejected as incomplete.

B. Product Data.

1. Manufacturer's data including materials of construction, equipment weight and related information for each item specified in PART 2 PRODUCTS.

C. Work Area Requirements

1. Refer to Section 16000 – Common Work Results for Electrical, for additional information.

PART 2 PRODUCTS

2.1 MATERIALS

A. **Stainless Steel Hardware (16070.H01).**

1. Bolts shall be 316 or 304 stainless steel and sized for the load served and have a hex head unless specifically specified otherwise elsewhere.
2. Nuts shall be 316 or 304 stainless steel hex nut.
3. Washers shall be 316 or 304 stainless steel, USS pattern flat washers.
4. Split lock washers shall be 316 or 304 stainless steel.
5. Threaded rods and couplings shall be 316 or 304 stainless steel.
6. Eye-bolts, u-bolts, bent-bolts and similar connecting hardware shall be 316 or 304 stainless steel.

B. **Galvanized Hardware (16070.H11).**

1. Bolts shall be hot dipped galvanized steel and sized for the load served and have a hex head unless specifically specified otherwise elsewhere.
2. Nuts shall be hot dipped galvanized steel hex nut.
3. Washers shall be hot dipped galvanized steel, USS pattern flat washers.
4. Split lock washers shall be hot dipped galvanized steel.
5. Threaded rods and couplings shall be hot dipped galvanized steel.
6. Eye-bolts, u-bolts, bent-bolts and similar connecting hardware shall be hot dipped galvanized steel.

C. **Stainless Steel Anchors (16070.A01).**

1. Wedge or stud anchors installed in concrete or masonry shall be 316 or 304 stainless steel and sized for the load served.
2. Toggle type fasteners shall only be used in hollow sheetrock wall. The wing part of the fastener may be mild steel, but the bolt shall be stainless steel.

D. **Galvanized Anchors (16070.A11).**

1. Wedge or stud anchors installed in concrete or masonry shall be hot dipped galvanized steel and sized for the load served.
2. Toggle type fasteners shall only be used in hollow sheetrock wall. The wing part of the fastener may be mild steel, but the bolt shall be hot dipped galvanized steel.

E. **Galvanized Beam Clamps (16070.B11).**

1. Beam clamps shall be hot dipped galvanized steel and sized for the load served.

F. **Galvanized Strut Channel (16070.S01).**

1. Galvanized strut channel shall be hot dipped galvanized after fabrication and shall be a minimum of 12 gauge.
2. Galvanized strut channel shall have factory pre-drilled holes.

PART 3 EXECUTION

3.1 INSTALLATION

A. General.

1. Hardware shall be set to a torque as recommended by the manufacturer.
2. Washers and split lock washers shall be installed on all bolts, threaded rods and anchors.
3. Lead or plastic type anchors are prohibited from use on the project.
4. When threaded rods are installed in drop-in type anchors, a washer, split lock washer and a jamb nut shall be installed at the anchor to ensure stability.
5. When channel (strut) is installed as a hanger or support from threaded rod, washers, split lock washers and jamb nuts shall be installed on both sides of the strut to lock it in place.
6. Cut ends of channel, strut, threaded rods or other cut fittings shall be filed smooth before installation.
7. Cut ends of hot dipped galvanized channel and strut shall be coated with three coats of cold galvanizing compound after the channel has been filed to prohibit rust.
8. Galvanized channel and strut shall only be installed indoors in non-corrosive areas. Stainless steel channel and strut shall be installed everywhere else including outdoors and in corrosive areas.
9. Concrete anchors shall be installed as per the manufacturer's directions and set using the manufacturer's supplied tool.
10. Threaded rod shall not extend more than one (1) inch beyond the channel, strut or other material it is supporting.
11. Hangers and supports shall be installed level and plumb.
12. Hangers and supports shall be installed per the National Electrical Code, Building Code and Structural Code and shall be designed to safely support the load. The ENGINEER may request the CONTRACTOR provide a copy of their design calculations for the seismic requirements and the load served.

END OF SECTION

SECTION 16071
SEISMIC RESTRAINTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. This section includes requirements pertaining to seismic restraints for electrical equipment.

1.2 REFERENCED STANDARDS

A. The following is a list of standards which may be referenced in this Section:

1. American Society of Civil Engineers (ASCE)
 - a. ASCE 7-16 Minimum Design Loads and Associated Criteria for Buildings and Other Structures

1.3 SUBMITTALS

- A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.

B. Submittal Format:

1. The product data shall be provided as individual PDFs for each Section, unless otherwise noted for specific items. Each PDF shall be numbered to match the specification Section numbers. Submittals not itemized and labeled as specified will be rejected as incomplete.
2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16000.A01) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.
4. Submittals in PDF shall include an index, table of contents, or bookmarks with hyperlinks to the associated page of all submitted items. Index shall include each product specified with their corresponding Reference Keynote Number. Electronic submittals not containing a linked index, table of contents, or bookmarks will be rejected as incomplete.

- B. Refer to Section 16050 – Common Work Results for Electrical Submittals for additional requirements.
- C. Product Data.
 - 1. Pursuant to Section 01300 – Submittal Procedures.
 - 2. Manufacturer’s data including materials of construction, equipment weight and related information for each item specified in PART 2 PRODUCTS.
 - 3. Seismic calculations and drawings.

1.4 REQUIREMENTS

- A. This project shall comply with the current edition of the Oregon Structural Specialty Code, Oregon Electrical Specialty Code, and ASCE 7-16.
- B. The seismic restraints for the project shall be designed to the following standards:
 - 1. Seismic Design Category D.
 - 2. All electrical systems shall have an Importance Factor of 1.25.
- C. The following electrical systems shall be provided with engineered seismic restraints:
 - 1. Generators and automatic transfer switches
 - 2. All other Electrical Systems required by ASCE 7-16 and the Oregon Structural Specialty Code.
- D. The CONTRACTOR shall pay for and obtain the services of a licensed Structural ENGINEER in the State of Oregon. The ENGINEER shall provide the following:
 - 1. Restraint, bracing, and anchorage calculations and details. These details shall be project specific. Typical bracing details for commonly used restraint systems shall be acceptable.
 - a. The details and calculations shall be suitable for a deferred submittal to the AHJ for the purposes of obtaining an electrical permit.
 - b. Number, size, capacity, and location of seismic restraints.
 - c. Backing material to be used in stud wall applications.
 - d. The details and calculations shall be suitable for installation by the CONTRACTOR.
 - 2. The Structural ENGINEER shall provide shop drawings for review and approval by the ENGINEER and ARCHITECT. The shop drawings shall include:
 - a. Project-specific restraint details.
 - b. Project-specific calculations
 - c. Wet stamped/signed documents.
 - 3. The Structural ENGINEER shall perform an on-site inspection of the seismic restraint installation performed by the CONTRACTOR. The Structural ENGINEER shall provide a written report of the inspection, including identifying any deficiencies. The report shall be submitted to

the ENGINEER for review and approval. The inspection shall be performed by the ENGINEER prior to the bracing being covered. The CONTRACTOR shall bear the responsibility of scheduling this inspection.

- a. The CONTRACTOR shall be responsible for installing all seismic restraints per the Structural ENGINEER's requirements. Make all corrections required by the Structural ENGINEER.

PART 2 PRODUCTS

2.1 MATERIALS

A. **Seismic Restraints (260545.R01).**

1. Restraints shall be provided as directed by the Structural ENGINEER.
2. Material type shall confirm with the requirements of 26 05 29 Hangers & Supports for Electrical Systems.

PART 3 EXECUTION

3.1 INSTALLATION

A. General.

1. Install all restraints as directed by the Structural ENGINEER and as required by Code.

END OF SECTION

SECTION 16075

ELECTRICAL AND CONTROL IDENTIFICATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. Requirements for identification of electrical, safety, measurement, data, fire alarm, security, monitoring, control and related components and equipment.

1.2 SUBMITTALS

A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.

1. The product data shall be provided as individual PDFs for each Section, unless otherwise noted for specific items. Each PDF shall be numbered to match the specification Section numbers. Submittals not itemized and labeled as specified will be rejected as incomplete.
2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16075.S21) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.
4. Submittals in PDF shall include an index, table of contents, or bookmarks with hyperlinks to the associated page of all submitted items. Index shall include each product specified with their corresponding Reference Keynote Number. Electronic submittals not containing a linked index, table of contents, or bookmarks will be rejected as incomplete.

B. Product Data

1. The initial submittal shall contain all the products, samples and data base specified. An initial submittal that does not contain all the specified data shall be returned as incomplete.

C. Samples

1. Provide a sample of each type and size of nameplate, label, tag and means of attachment specified for approval by the OWNER.

D. Quality Assurance / Quality Control Submittals

1. The CONTRACTOR shall be responsible for submitting a data base of all identification nameplates, labels, panel schedules and tags required for the Work. The data base shall be developed in the most current edition of Microsoft Excel for the OWNER's future use.
- E. Closeout Submittals
1. As-built electronic copy of the identification Excel data base.

PART 2 PRODUCTS

2.1 MATERIALS

- A. **Circuit Breaker Panel Schedules (16075.S21).**
1. Shall be created in Microsoft Excel software. One copy of each schedule shall be included in the closeout submittals.
 2. Shall be printed on 60 - 70 lb white card stock.
- B. **Plastic Nameplates (16075.P05).**
1. Shall have a black background with white engraved letters. Nameplates for emergency functions shall be red background with white engraved letters. The nameplates shall have self adhesive rated for the environment which they are installed. The font type shall be consistent on all nameplates.
 2. Provide products supplied by E.R. Perry Signs & Engraving, or approved equal.
- C. **Conduit Tags (16075.S35).**
1. Shall be 316 or 304 stainless steel.
 2. Nominally 0.75 inches high by 3.0 inches long.
 3. Characters shall be 0.25 inches high. And shall be machine punched or durably embossed.
 4. Conduit tags shall be products readily available and manufactured for this purpose.
 5. The stainless steel conduit tags shall be attached with stainless steel cable ties.
 6. Provide Panduit Permanent Identification System products, or approved equal.
- D. **Epoxy Gel (16075.E05).**
1. Shall be a two component, 100 % solids, moisture tolerant, high modulus, high strength, structural epoxy paste adhesive.
 2. Provide Sika type Sikadur 31, Hi-Mod Gel, or approved equal.
- E. **Conduit Trench Marker Tape (16075.T21).**
1. Shall be a minimum of six (6) inches wide, polyethylene tape manufactured for this purpose.
 2. Color code for tape shall be as listed below and the verbiage on the tape shall identify the type of system i.e. "Caution Buried Electric Line Below".
 - a. Electric Power – RED
 - b. Fiber Optic – ORANGE
 - c. Data/Phone – ORANGE
 - d. Control – ORANGE

3. Provide products manufactured by Seaton Identification Products, Harris Industries, or approved equal.

F. Conductor and Cable Identification Sleeves (16075.T31).

1. The identification sleeves shall be properly sized for the cable or conductor.
2. Sleeves shall be white with black machine generated characters.
3. Provide Brady wire and cable sleeves, or approved equal.

G. Flexible Identification Tape (16075.T56).

1. Shall be white, red, yellow, clear or as otherwise specified tape with black characters.
2. Standard tape size shall be 0.5 inch high unless specified otherwise and shall have extra strength adhesive rated for indoor and outdoor use.
3. Provide products manufactured by Brother, or approved equal.

H. Conductor Color Coding (16075.C89).

1. Conductors shall be colored as specified in the table below. The technical specification requirements for the conductors are specified elsewhere.

Conductor Color Coding

System	Conductor	Color
All Systems	Equipment Grounding	Green
24 Volt AC	Hot Leg	Red
	Neutral	White
	Discrete Input Line (hot leg) Side	Red
	Discrete Input Switch Leg	Red w/Blue Stripe
120 Volt AC Control	Hot Leg	Red
	Neutral	White
	Discrete Input Line (hot leg) Side	Red
	Discrete Input Switch Leg	Red w/White Stripe
	Discrete Output Line (hot leg) Side	Red
120/240 Volt Single Phase	Discrete Output Switch Leg	Red w/Orange Stripe
	Hot Leg # 1	Black
	Hot Leg # 2	Red
	Neutral	White
480 Volt Three Phase	Phase A	Brown
Wye or Delta Corner Tap	Phase B	Purple
	Phase C	Yellow
	Neutral	Gray

PART 3 EXECUTION

3.1 INSTALLATION

A. Circuit Breaker Panel Schedules

1. CONTRACTOR shall request panel schedules in Microsoft Excel software and printing instructions from ENGINEER. CONTRACTOR shall update the panel schedules to reflect as-built conditions. Print schedules on 60 - 70 lb white card stock with black ink.
2. Schedules shall be neatly trimmed with 1/8" white space borders.
3. The finished schedules shall be laminated and neatly trimmed with 1/8" of laminate border.
4. A sample layout shall be submitted to OWNER for approval prior to installation.
5. Attach white Velcro to the panel door and the back of the panel schedule. Velcro shall, at a minimum, be attached to all four corners of the panel schedule.

B. Plastic Nameplates

1. Provide plastic nameplates for panelboards, motor control centers, motor starters, disconnects, variable frequency drives, control panels and similar equipment. The verbiage on the nameplate shall be as identified on the Contract Drawings. The CONTRACTOR shall request the required verbiage from the ENGINEER should it not be available on the Contract Drawings.
2. In addition to the nameplate identifying the equipment, a second nameplate shall be provided that identifies the source of power for the equipment i.e. "Fed From PNL208-1".
3. Typically the nameplates shall be centered and installed near the top of the equipment.
4. Nameplates shall be black with white characters unless specified otherwise.
5. Nameplates on emergency panels shall be red with white characters.

C. Conduit Tags

1. Provide stainless steel conduit tags at each point that a conduit terminates at or within an enclosure or box. The stainless steel tag shall be attached with stainless steel cable ties.
2. Where conduits enter a vault and are installed flush with the walls, the conduit tag shall be installed directly above the conduit entry and attached to the wall of the vault with epoxy gel.
3. The verbiage on the tag shall be as identified on the Contract Drawings. The CONTRACTOR shall request the required verbiage from the ENGINEER should it not be available on the Contract Drawings.
4. Where conduits terminate at a box in an inaccessible location such as behind a sheetrock wall, conduit labels are not required.

D. Conduit Trench Marker Tape

1. Provide conduit trench marker tape for single or multiple buried conduits. The color and verbiage shall match the type of system installed. If the trench contains several systems, one of which is electric power, the tape shall be for electric power.

2. The tape shall be installed 12 inches below finished grade and shall be laid flat and parallel to the conduits.
 3. Provide # 14 AWG, red, THWN-2 tracer wire fastened to one of the conduits. Tracer wire shall be fastened to the conduit with nylon cable ties at five (5) foot spacing or less. The tracer wire shall be brought up with the conduit to points where it terminates or enters in-ground boxes and vaults. The tracer wire shall be fastened above ground with stainless steel cable ties. Label the wire “tracer wire” and seal the end so water cannot penetrate with a heat shrink tubing type cap.
- E. Conductor and Cable Identification Sleeves
1. Provide heat shrink, machine generated, white labels with black characters for all cables and conductors. Explanation is provided below on how various systems shall be identified. In many cases the information necessary to develop the unique identification labels will be provided on the Contract Drawings. The verbiage required for the identification shall be as identified on the Contract Drawings. The CONTRACTOR shall request the required verbiage from the ENGINEER should it not be available or clear based on the information provided on the Contract Drawings.
 2. The labels shall be installed between 6 to 8 inches from the end and shrunk. Conductors shall be labeled at all splices and points of termination.
 3. Power conductors and cables, including the neutral and the ground conductors shall all be identified individually. The identification label will be developed as follows: The first set of characters will be the equipment code identifying the source of power “PNL208” followed by the circuit number “CKT 12” and a forward slash followed by the room number where the utilization is located and then the utilization equipment. Using the first sequential unit heater in room 2334 as an example, the label would read “PNL208-CKT 12/ 2334-UH-1”.
 4. Control conductors, including grounds, shields, etc. shall be identified individually. The label shall identify the point of origin and the utilization equipment it serves. The identification label will be developed as follows: An sample label for a conductor fed from terminal strip 2, terminal block 33 in control panel # 1 (CP-1) to an terminal strip 1, terminal block 4 in automatic transfer switch # 1 (ATS-1) would read CP-1 TS2-TB33 / ATS-1 TS1-TB4.

END OF SECTION

SECTION 16080
ELECTRICAL TESTING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes
1. Electrical and control testing forms and requirements.

1.2 SEQUENCING

- A. ENGINEER shall issue written acceptance of the following certifications submitted by the CONTRACTOR before utility power is supplied to conductors, cables, or equipment.
1. Megger Test
 2. Continuity Test
- B. CONTRACTOR shall verify to ENGINEER that every function of the electrical, measurement, and control systems are operating properly.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Site Tests, Inspection
1. CONTRACTOR shall be responsible to become familiar with the test and certification requirements of the Contract Documents for this project. It is the intent of these requirements that the Work will be systematically checked to verify that the functions required or implied, work properly to insure safety for the personnel, environment, and equipment associated with the Work.
 2. CONTRACTOR shall complete the certification forms that are supplemental to this section and submit the forms to ENGINEER for approval.
 3. All site test and inspection certificates and schedules shall be contained in a 3-ring binder(s).
 - a. Size 8½ inches by 11 inches.
 - b. Paper: 20-pound minimum, white for typed pages.
 - c. Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.
 - d. Provide each manual with title page to include “Process Electrical Testing”, typed table of contents with consecutive page numbers. Where more than one binder is used, consecutively title each with a volume number. The first binder

shall be labeled Volume 1 and consecutively numbered as required to include all test documentation.

- e. Tab sections for each required section of testing and acceptance certification.
4. CONTRACTOR shall notify ENGINEER seven days in advance of scheduled testing and facilitate the witnessing of those tests by ENGINEER.
5. CONTRACTOR shall provide ENGINEER with current as-built documentation for electrical and measurement and control commissioning with submittal of test certification.
 - a. Systems operating at or above 200-volts to ground or more shall be included in the Megger Test Certification. Minimum duration for each test shall be one minute, at 1000 VDC, and minimum acceptable results shall be 50 mega ohms.
 - b. Conductors and cables shall be included in the Continuity Test Certification. No continuity to ground is the only acceptable result of the test.
 - c. Conductors, cables, or equipment failing to meet the minimum requirements shall be replaced with new. Repair will not be acceptable.

3.2 SUPPLEMENTS

- A. Schedule 16080 - A; Continuity Test Certificate

END OF SECTION

SUPPLEMENT 16080 - A
CONTINUITY TEST CERTIFICATE

				Project Number:
Test Equipment Manufacturer:		Model Number:		Project Name:
Test Equipment Last Calibration Date:		Serial Number:		Accepted By:
Testing Personnel:		Calibration Certificate:		Date:
		Test Date:		Drawing Reference:
				Title:
				Tag:
Permanent Tag Number	Function	Temporary Tag Number	Device ID Number	Ohms to Ground

SUPPLEMENT 16080 - B
CONTINUITY TEST CERTIFICATE

				Project Number: 12345	
Test Equipment Manufacturer: <i>Fluke</i>		Model Number: 53G		Project Name: <i>Water Division</i>	
Test Equipment Last Calibration Date: <i>Unknown</i>		Serial Number: 638842		Accepted By: <i>S.E. Davis</i> Date: 01/01/2003	
Testing Personnel: <i>John Doe</i>		Calibration Certificate: <i>No</i>		Drawing Reference: <i>E-501</i>	
		Test Date: 12/30/02		Title: <i>Conduit Schedule</i>	
Permanent Tag Number	Function	Temporary Tag Number	Device ID Number	Ohms to Ground	
<i>016-34-PNL</i>	<i>Level Indicator</i>	<i>34</i>	<i>016-34</i>	∞	

END OF SECTION

SECTION 16121

600 VOLT CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes.
 - 1. The section includes the requirements for conductors and cables used to conduct potentials of 600 volts and less.
 - 2. All conductors and cables shall be installed in conduit or approved raceways regardless of which Division the conductors or cables are specified.

1.2 REFERENCES

- A. The following is a list of Standards which may be referenced in the Section.
 - 1. American Society for Testing and Materials (ASTM).
 - a. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
 - 2. National Electrical Contractors Association, Inc. (NECA): National Electrical Installation Standards (NEIS).
 - 3. National Electrical Manufacturers Association (NEMA).
 - a. WC 3, Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - b. WC 5, Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - c. WC 7, Cross Linked-Thermosetting Polyethylene Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - d. WC 55, Instrumentation Cables and Thermocouple Wire.
 - 4. National Fire Protection Association (NFPA). 70, National Electrical Code (NEC).
 - 5. Underwriters Laboratories, Inc. (UL).
 - a. 13, Standard for Power-Limited Circuit Cables.
 - b. 44, Standard for Safety Rubber-Insulated Wires and Cables.
 - c. 62, Standard for Safety Flexible Cord and Fixture Wire.
 - d. 510, Standard for Safety Insulating Tape.
 - e. 854, Standard for Safety Service-Entrance Cables.
 - f. 910, Standard for Safety Test Method for Fire and Smoke Characteristics of Electrical and Optical Fiber Cables Used in Air Handling Spaces.
 - g. 1277, Standard for Safety Electrical Power and Control Tray Cables.
 - h. 1581, Standard for Safety References for Electrical Wires, Cables and Flexible Cords.

1.3 SUBMITTALS

- A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.

1. The product data shall be provided as individual PDFs for each Section, unless otherwise noted for specific items. Each PDF shall be numbered to match the specification Section numbers. Submittals not itemized and labeled as specified will be rejected as incomplete.
2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16121.C01) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.
4. Submittals in PDF shall include an index, table of contents, or bookmarks with hyperlinks to the associated page of all submitted items. Index shall include each product specified with their corresponding Reference Keynote Number. Electronic submittals not containing a linked index, table of contents, or bookmarks will be rejected as incomplete.

B. Product Data.

1. Manufacturer's data including materials of construction, weight, and related information for each item specified in PART 2 PRODUCTS.

PART 2 PRODUCTS

2.1 MATERIALS

A. Single Conductors (16121.C01).

1. Conductors shall be rated for 600 volts and conform to applicable requirements of NEMA.
2. Conductors shall be stranded copper.
3. Insulation type shall be THWN-2. XHHW-2 in #10 AWG or smaller.
4. Conductors shall be sized per the Drawings and the NEC, whichever is greater.
5. Rome Cable Corporation, Southwire Company, Okonite Company, or approved equal.

2.2 ACCESSORIES

A. Colored Tape (16121.T01).

1. Colored tape shall be used to identify individual conductors larger than # 6 AWG.
2. 3M colored tape, or approved equal.

B. Cable Ties (16121.T05).

1. Cable ties shall be nylon, adjustable, self-locking, and properly sized for the bundle and force implied.

2. Thomas and Betts, Panduit, or approved equal.

C. Pulling Compound (16121.P01).

1. Pulling compound shall be non-corrosive, noncombustible, nonflammable waxed based lubricant listed for this use.
2. Ideal Company, Polywater, Inc., or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. General.

1. All identification labeling shall be in compliance with Section 16075 Electrical and Control Identification.
2. Conductor and cable installations shall meet or exceed the NECA National Electrical Installation Standards.
3. CONTRACTOR shall not exceed the manufacturer's recommendations for maximum pulling tensions or minimum bending radii for respective conductors or cables.
4. Pulling compound is recommended for all conductor or cable installations and shall be used on all installations requiring a mechanical pulling device.
5. CONTRACTOR shall furnish and use a dynamometer on all conductor or cable installations requiring the use of a mechanical pulling device. The dynamometer shall be used to verify the maximum pulling tensions are not exceeded. Should the pulling tensions be exceeded, the conductor or cable shall be removed from the raceway and discarded. It shall not be reused under any circumstance on the project. The CONTRACTOR shall be responsible to make the alterations necessary before attempting to re-pull new conductors or cables.
6. Immediately after pulling in conductors or cables, the pulling compound shall be completely removed from the conductors or cables, from boxes, enclosures, floors, walls, etc.
7. Conductor and cable installations shall be continuous without splices or intermediate terminations unless specifically identified on the Drawings or prior written approval from the ENGINEER.
8. Where conductors or cables are routed in boxes enclosures or cable tray they shall be neatly bundled with cable ties at intervals not to exceed 12 inches on center. The tension for the cable ties shall be set with a tool specifically manufactured for that purpose and of the same manufacturer as the cable tie. Side cutters, linemen pliers and similar tools shall not be used to cut the tail end of the cable tie. The CONTRACTOR shall only use the tool specifically manufactured for this purpose and of the same manufacturer as the cable tie.
9. Conductors and cables shall not be installed until the raceway, boxes, enclosures, conduit bushings, etc. have all been installed. Where conductors or cables have been installed prior to meeting this requirement, the ENGINEER shall at their discretion elect to have the conductors or cables removed, disposed of and replaced with new product.

10. Should the outer jacket of any conductor or cable be damaged in any way, they shall be removed, disposed of and replaced with new product.
11. An equipment grounding conductor shall be installed in all raceways. Size shall be as identified on the Drawings or the NEC, whichever is greater, but in no case shall it be less than # 16 AWG for under 50 volts and no less than # 14 for 50 volts or above.

END OF SECTION

SECTION 16131
CONDUIT AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. The Section includes the requirements pertaining to conduits and fittings used to contain electrical conductors and cables.
2. All conductors and cables shall be installed in conduit or approved raceways regardless of which Division the conductors or cables are specified.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this Section.

1. American National Standards Institute (ANSI).
 - a. C80.1, Rigid Steel Conduit-Zinc Coated.
2. American Society for Testing Materials (ASTM).
 - a. A123 E1, Standard Specification for Zinc-Coated (Galvanized) Coatings on Iron and Steel Products.
3. National Electrical Contractors Association (NECA).
 - a. National Electrical Installation Standards (NEIS).
4. National Electrical Manufacturers Association (NEMA).
 - a. RN 1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Coated and Intermediate Metal Conduit.
 - b. TC 3, PVC Fittings for use with Rigid PVC Conduit and Tubing.
 - c. TC 6, PVC and ABS plastic Utilities Duct for Underground Installation.
5. Nation Fire Protection Association (NFPA).
 - a. 70, National Electrical Code (NEC).
6. Underwriters Laboratories, Inc. (UL).
 - a. 6, Standard for Safety Rigid Metal Conduit.
 - b. 514B, Standards for Safety Fittings for Conduit and Outlet Boxes.
 - c. 651, Standard for Safety Schedule 40 and 80 PVC Conduit.
 - d. 651A, Standard for Safety Type EB and Rigid PVC Conduit and HDPE Conduit.
 - e. 1660, Standard for Safety Liquid-Tight Flexible Nonmetallic Conduit.
 - f. 360, Standard for Safety Liquid-Tight Flexible Metallic Conduit.
 - g. 797, Standard for Safety Electrical Metallic Conduit.

1.3 SUBMITTALS

- A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.

1. The product data shall be provided as individual PDFs for each Section, unless otherwise noted for specific items. Each PDF shall be numbered to match the specification Section numbers. Submittals not itemized and labeled as specified will be rejected as incomplete.
2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16131.C01) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.
4. Submittals in PDF shall include an index, table of contents, or bookmarks with hyperlinks to the associated page of all submitted items. Index shall include each product specified with their corresponding Reference Keynote Number. Electronic submittals not containing a linked index, table of contents, or bookmarks will be rejected as incomplete.

B. Product data

1. Pursuant to Section 01300 - Submittal Procedures.
2. Manufacturer's data including materials of construction, equipment weight and related information for each item specified in PART 2 PRODUCTS.

C. Work Area Requirements

1. Refer to Section 16000 – Common Work Results for Electrical, for additional information.

1.4 QUALITY ASSURANCE

A. PVC Coated Galvanized Rigid Steel Conduit Installation Training and Certification.

1. All installers of PVC Coated Galvanized Rigid Steel Conduit shall be factory trained and certified prior to the installation of any PVC Coated Galvanized Rigid Steel Conduit. CONTRACTOR shall provide written proof of current factory certification for all installers.

- B. All PVC Coated Galvanized Rigid Steel Conduit shall be warranted for three (3) years, minimum.

PART 2 PRODUCTS

2.1 PLANT AREA WORK REQUIREMENTS

- A. Provide all Electrical Work in accordance with the following table, unless otherwise specifically indicated on the Drawings.

- B. Provide NEMA 3R enclosures and supports, and RGS conduit type for all Electrical Work not included in the following table unless otherwise specifically indicated on the Drawings. Conduit type definitions are listed under Section 16131, Conduit and Fittings.

PLANT AREA	NEMA ENCLOSURE TYPE	EXPOSED CONDUIT TYPE	ENVIRONMENT W = WET D = DAMP C = CLEAN/DRY X = CORROSIVE H = HAZARDOUS	SUPPORT MATERIALS
Exterior	NEMA 4X SS	GRC	W	SST hardware with SST anchors
Exterior Underground Conduit Elbows which transition from below to above grade	NA	PVC-GRC	W	SST hardware with SST anchors
Interior	NEMA 12	EMT	C	GALV

2.2 MATERIALS

A. Galvanized Rigid Steel Conduit (GRC) (16131.C01).

1. Shall be mild steel, hot dipped galvanized inside and out.
2. Shall be manufactured in accordance with ANSI C80.1 – Rigid Steel Conduit, Zinc Coated, and UL-6.
3. Conduit fittings shall be hot dipped galvanized malleable iron.
4. Condulets shall form 7 type.
5. The use of three-piece couplings shall be incorporated only when unavoidable and not simply due to poor planning and layout.
6. The use of compression, setscrew and split conduit fittings is unacceptable.
7. Gaskets shall be installed on all condulet covers regardless of the environment they are installed in.
8. Conduit straps shall be hot dipped galvanized malleable iron and incorporate matching conduit spacers when attached directly to walls, ceilings and floors.
9. LTV steel, Triangle PWC, or approved equal.

B. PVC Coated Galvanized Rigid Steel Conduit (PVC-GRC) (16131.C10).

1. Shall meet the manufacturing specification of GRC before PVC coating is applied.
2. Shall be manufactured in accordance with NEMA RN1 Standard for PVC coated GRC.
3. Exterior PVC coating shall not be less than 40 mils thick.
4. The exterior coating shall be sufficiently flexible to permit field bending the conduit without cracking or flaking the coating.

5. Chemically cured two-part urethane coating, at a nominal 2 mil thickness shall be applied to the interior of all conduit and fittings.
6. Female conduit or fitting opening shall have a PVC sleeve extending one-conduit diameter or 2 inches; whichever is less, beyond the opening.
7. The inside diameter of the sleeve shall be the same diameter as the outside diameter of the conduit before the coating is applied.
8. The wall thickness of the sleeve shall be 40 mil minimum.
9. Conduit fittings, condulets, mounting hardware and accessories shall be PVC coated to the same specifications as the conduit.
10. Condulets shall be form 7 type.
11. Gaskets shall be installed on all condulet covers regardless of the environment they are installed in.
12. The screw heads on condulets shall be encapsulated by the manufacturer with a corrosion resistant material, or shall be stainless steel. All condulets shall have the same type of type of screw heads, stainless steel or encapsulated.
13. The use of three-piece couplings shall be incorporated only when unavoidable and not simply due to poor planning and layout.
14. The use of compression, setscrew and split conduit fittings is unacceptable.
15. Ocal Inc., Perma-coat, or approved equal.

C. EMT Conduit (260533.C50).

1. EMT conduit may be used in all indoor and outdoor locations. In damp and outdoor locations the fittings shall be watertight compression fittings. Set screw fittings shall be not be acceptable.
2. Conduit connectors shall have insulated throats, plastic bushings or ground bushing installed.

D. Rigid Non-metallic Conduit (PVC) (16131.C30).

1. Shall be schedule 40 PVC unless specifically called out otherwise on the Drawings.
2. Shall be sunlight resistant.
3. Shall be manufactured in accordance with UL-651 Standard.
4. Conduit and fittings shall be securely glued.
5. Provide conduit bell ends at vaults unless specifically called out otherwise on the Drawings.
6. Provide PW Pipe, Carlon, or approved equal.

2.3 ACCESSORIES

A. Threaded Hubs (16131.H01).

1. Hubs for threaded attachment of steel conduit to sheet metal enclosures:
2. Construction:
 - a. Insulated throat.
 - b. PVC coated when used in corrosive areas.
 - c. Bonding locknut.
 - d. Recessed neoprene O-ring to assure watertight and dust- tight connector.
 - e. One half (1/2)-inch through 6-inch steel zinc electroplated.
 - f. Aluminum with aluminum conduit.

3. Usage:
 - a. All conduits shall use threaded hubs for connections to metal enclosures.
 4. Provide Crouse-Hinds Myers Hub, or approved equal.
- B. Conduit Thread Lubricant (16131.L01).**
1. Shall be an electrically conductive with copper particles suspended in the product.
 2. Provide Kopr-Shield Catalog number CP8-TB, or approved equal.
- C. Conduit Duct Spacers (16131.S01).**
1. Shall be used in conduit duct banks to maintain uniform spacing of conduits.
 2. Shall be non-metallic, interlocking type manufactured for this purpose. Shall be sized to maintain a minimum of 3 inches of separation between conduits.
 3. Provide Underground Devices Wunpeece, IPEX Monoblock, or approved equal.
- D. Glue (16131.G01).**
1. Glue shall be the wet/dry rated cement commonly referred to as “Blue Glue”.
- E. Bushing Plug (16131.P90).**
1. Provide OZ Gedney type PPC bushing plug, or approved equal.
- F. Duct Seal (16131.D44).**
1. Seal all conduits passing from the interior to the exterior of a building or structure with flexible/removable duct seal.
 2. Provide Hubbell-Raco DS-XLB Duct Seal Weather Sealing, or approved equal

PART 3 EXECUTION

3.1 INSTALLATION

- A. General Requirements**
1. All identification labeling shall be in compliance with Section 16075 Electrical and Control Identification
 2. Install conduit runs in accordance with the schematic representation shown on the Drawings.
 3. Provide conduit drains installed as shown on the Drawing details and in conduit systems as identified on the Drawings. Discuss the installation details with the ENGINEER before underground conduits are covered. Changes that may become necessary in the conduit system resulting from a lack of coordination with the ENGINEER prior to covering underground conduits shall be completed by the CONTRACTOR at no additional expense to the OWNER.
 4. Minimum conduit size shall be .75 inch unless specifically called out otherwise on the drawings.
 5. Where raceways are indicated, but the routing is not identified, the routing shall be the CONTRACTOR’S choice and in accordance with the rest of the Contract Documents and the National Electrical Code (NEC).
 6. Raceways shall be electrically and mechanically complete before the conductors are installed.

7. Routing of conduits may be adjusted to avoid obstructions. Coordinate with other trades prior to installation of raceways. Lack of such coordination shall not be justification for extra compensation and removal and reinstallation to resolve conflicts shall be at the CONTRACTOR's expense.
8. Conduit joints shall be wrench tight, thoroughly grounded, secure and free of obstructions.
9. Conduits shall be reamed.
10. Strap wrenches and vises shall be used to install PVC-GRC conduit to prevent wrench marks and damage to the outer PVC coating. Conduits with damaged coating shall be replaced, repair is unacceptable.
11. Metallic threads shall all be coated with conduit thread lubricant before assembly. Failure to install the lubricant will result in removal of all conduit and reassembly with the conduit lubricant.
12. Exposed conduits shall be installed parallel or perpendicular to the structural members and surfaces and shall be level and or plumb.
13. When two or more conduits are routed in the same general direction their routing shall be parallel with symmetrical bends.
14. Conduits shall be bent with equipment specifically designed for this purpose and for the specific size and type of conduit.
15. Conduits that are creased or crushed shall be replaced.
16. Install conduits such that they do not interfere with the proper and safe operation of equipment and do not block or otherwise interfere with the ingress and egress and installation of removable hatches and covers.
17. Install expansion joints as needed across expansion joints in the structure and at other locations where necessary to compensate for thermal or mechanical expansion or contraction.
18. Conduits shall be routed at least six (6) inches from high temperature piping, ducts and flues.
19. GRC Conduits that terminate at an enclosure that does not have a threaded hub shall be installed with a Myers type hub and ground ring. No exceptions shall be permitted without prior written approval for specific locations issued by the ENGINEER. Conduits that are permitted to terminate without a Myers type hub or a threaded hub shall have a ground bushing installed. A separate bonding conductor shall be routed to all ground bushings within an enclosure and be bonded to the enclosure and grounding conductor if present.
20. All conduits shall be capped throughout construction to prevent entrance of dirt, trash, water, etc.
21. All conduits that are trade size 2.5" and larger which are routed through floors, ceilings or walls below grade shall include a large enough opening to accommodate the installation of Link-Seal. After installation and inspection of the Link-Seal, the CONTRACTOR shall install non-shrink type grout that matches the color of the surrounding material. The grout shall be installed on both sides of the Link-Seal installation.
22. Spare conduits shall be provided with a coupling and threaded male plug that matches the makeup of the conduit for the area they are installed in. The conduit shall terminate at an enclosure when one is called out and exists as part of the

Work. Where the spare conduit is stubbed up in a concrete slab for future equipment, it shall be installed flush with the finished floor. Where spare conduits are routed to other areas such as outside a building envelope, in an attic, to a vault, etc., the conduit shall have a female conduit cap installed.

23. All conduits shall be individually identified at every point they terminate. The conduit identification shall be the same as that which is used on the conduit /conductor schedule in the Drawings. Should conduits be installed that are not listed on the conduit schedules, the CONTRACTOR shall add conduit callouts to the as-built conduit schedules and label the conduits accordingly.

B. PVC-GRC Conduit Installation.

1. Strap wrenches and vises shall be used to install PVC-GRC conduit to prevent wrench marks and damage to the outer PVC coating. Conduits with damaged coating shall be replaced, repair is unacceptable.
2. Conduits installed in all outdoor locations, corrosive areas and vaults shall be PVC-GRC. PVC-GRC conduit with damaged PVC coating shall be replaced. Repair is unacceptable.

C. Underground Conduit Installation.

1. Underground conduits shall be PVC except as specifically noted differently elsewhere.
2. Underground conduits shall be routed as shown on the Drawings.
3. Power conduits shall be separated from all other conduits by a minimum of 12 inches and when required to cross other conduits it shall be done at a 90 degree angles.
4. Conduit bends greater than 45 degrees shall utilize PVC-GRC conduit for the bend.
5. Conduit runs stubbed out of concrete shall make a transition to PVC-GRC at least six (6) inches before leaving the encasement.
6. Where conduits are stubbed up out of a concrete floor or slab, the PVC-GRC conduit shall extend two (2) inches above finished floor or grade including housekeeping pads before transitioning to any other type of conduit.
7. Underground conduit shall have a minimum of 24 inches of cover unless specifically called out differently on the Drawings.

END OF SECTION

SECTION 16135
BOXES AND ENCLOSURES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes.
1. This Section includes requirements for electrical device boxes, enclosures, in-ground boxes and vaults.

1.2 REFERENCES

- A. The following is a list of Standards that may be referenced in the Section.
1. American Society for Testing and Materials (ASTM).
 - a. A123 E1 Standard Specifications for Zinc-Coated Coatings on Iron and Steel Products.
 2. National Electrical Contractors Association, Inc. (NECA).
 - a. 5055 National Electrical Installation Standard.
 3. National Fire Protection Association (NFPA).
 - a. 70 National Electrical Code (NEC)
 4. Underwriters Laboratory, Inc. (UL).
 - a. 514C Standard for Safety Non-Metallic Outlet Boxes, Flush Device Boxes and Covers.
 - b. 50 Enclosures for Electrical Equipment.

1.3 SUBMITTALS

- A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.
1. The product data shall be provided as individual PDFs for each Section, unless otherwise noted for specific items. Each PDF shall be numbered to match the specification Section numbers. Submittals not itemized and labeled as specified will be rejected as incomplete.
 2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16135.B01) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
 3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.
 4. Submittals in PDF shall include an index, table of contents, or bookmarks with hyperlinks to the associated page of all submitted items. Index shall include each product specified with their corresponding Reference Keynote Number. Electronic submittals not

containing a linked index, table of contents, or bookmarks will be rejected as incomplete.

B. Product Data.

1. Manufacturer's data including materials of construction, equipment weight and related information for each item specified in PART 2 PRODUCTS.

PART 2 PRODUCTS

2.1 DEVICE BOXES

A. Exterior Junction Box (16135.E01).

1. Shall be 12 gauge NEMA 4X Stainless Steel 304.
2. Screw on cover with slip on hinges. The door shall be both hinged and the hinges shall be removable allowing the entire cover to be removed.
3. Fixed door handle, lockable.
4. Shall be 30" tall x 30" wide x 16" deep.
5. Shall be UL50 compliant.
6. Shall have bonding stud on door and grounding stud on enclosure.
7. Provide a grounding kit.
8. Junction box shall be custom built, Fouch Electric or approved.

B. Interior Junction Box (16135.E01).

1. Shall be NEMA 4 steel 12 gauge steel, powder coated ANSI-61 Gray.
2. Screw on cover with slip on hinges. The door shall be both hinged and the hinges shall be removable allowing the entire cover to be removed.
3. Fixed door handle, lockable.
4. Shall be 30" tall x 30" wide x 16" deep.
5. Shall be UL50 compliant.
6. Shall have bonding stud on door and grounding stud on enclosure.
7. Provide a grounding kit.
8. Junction box shall be custom built, Fouch Electric or approved.

C. Galvanized Sheet Metal Boxes (16135.B15).

1. Shall comply with NEMA specifications for sheet metal boxes.
2. Shall not exceed 4-11/16 inches square.
3. Shall be used only with EMT conduit.

PART 3 EXECUTION

3.1 INSTALLATION

A. General.

1. All identification labeling shall be in compliance with Section 16075 Electrical and Control Identification.
2. Install boxes and enclosures in accordance with the schematic representation as indicated on the Drawings.
3. Boxes and enclosures shall be mounted level and plumb.
4. Boxes and enclosures shall not be altered, holes drilled, etc. in any way that may

compromise the NEMA rating of the enclosure or box.

5. Boxes and enclosures shall be mounted with stainless steel hardware.
6. Boxes and enclosures shall be bonded to the equipment grounding conductor.
7. Surface mounted enclosures and boxes shall be spaced off the surface at least $\frac{1}{4}$ inch in damp or wet locations.
8. Boxes and enclosures with threaded hubs or punched holes shall have the opening match the conduit size. The use of reducing bushings or reducing washers is unacceptable.

END OF SECTION

SECTION 16150
WIRING CONNECTIONS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes.
1. This Section includes requirements for conductor termination methods.

1.2 SUBMITTALS

- A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.
1. The product data shall be provided as individual PDFs for each Section, unless otherwise noted for specific items. Each PDF shall be numbered to match the specification Section numbers. Submittals not itemized and labeled as specified will be rejected as incomplete.
 2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16150.C01) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
 3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.
 4. Submittals in PDF shall include an index, table of contents, or bookmarks with hyperlinks to the associated page of all submitted items. Index shall include each product specified with their corresponding Reference Keynote Number. Electronic submittals not containing a linked index, table of contents, or bookmarks will be rejected as incomplete.
- B. Product Data.
1. Manufacturer's data including materials of construction, applications and related information for each item specified in PART 2 PRODUCTS.

PART 2 PRODUCTS

2.1 MATERIALS

- A. **Small Compression Connectors (16150.C01).**

1. Insulated fork, ring or splicing (butt) connectors shall be provided for # 10 AWG or smaller conductors that splice together or terminate with a screw other than in a terminal block.
2. Connectors shall be properly sized for the conductor and for the stud used.
3. Burndy, Panduit, Thomas and Betts, or approved equal.

B. Medium and Large Compression Connectors (16150.C10).

1. Non-insulated copper compression connectors shall be provided for # 8 AWG and larger conductors.
2. The connector shall have a voltage and current rating equal to or exceeding the conductor.
3. The barrel shall be long enough to accommodate a minimum of two (2) circumferential crimps.
4. The connectors shall be properly sized for the conductor.
5. Burndy, Panduit, Thomas and Betts, or approved equal.

2.2 ACCESSORIES

A. Electrical Tape (16150.T40).

1. General electrical tape shall be premium grade, all weather vinyl electrical insulating tape.
2. 3M – Scotch 33+, or approved equal.

B. Heavy Wall Heat Shrinkable End Caps (16150.T20).

1. Heavy walled heat shrink tubing shall be flame retardant and made of cross-linked polyolefin.
2. The inside diameter shall be coated with an adhesive sealant to protect against moisture and corrosion.
3. The tubing shall have a minimum operating temperature of – 55 to + 135 degrees Celsius.
4. Burndy, Panduit, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. General

1. All identification labeling shall be in compliance with Section 16075 Electrical and Control Identification.
2. Care shall be taken when terminating conductors to avoid kinking, cutting or puncturing the jacket or allowing contamination by grease, oil or water.
3. Care shall be taken when terminating conductors to properly support the conductors and to avoid undue pressure on the connector or utilization equipment.
4. Conductors shall be terminated by use of lugs, pressure type connectors wire nuts or terminal blocks. Wrapping conductors around a screw type terminal is not acceptable.

5. Compression connectors shall be installed using the tool and die provided by the same manufacturer as the connectors and as per their directions.
6. Compressions on connectors used for # 8 AWG conductors and larger shall have a minimum of two (2) circumferential crimps.
7. Indenter type crimps on compression connectors shall not be used on conductors larger than # 10 AWG.
8. Connectors shall be installed as per the manufacturer's directions.
9. Where wire ducts in enclosures exist, conductors shall be grouped together and routed in the wire ducts and shall be fanned out to the terminals.
10. Conductors installed outdoors which are not terminated the same day, shall have heavy wall heat shrinkable end caps installed the same day they are pulled in. The end caps shall remain in place until the day they are terminated.
11. As connections are set with a torque wrench, a black felt marker shall be used to mark across the bolt, nut or screw indicating the torque has been set.

END OF SECTION

SECTION 16232
PACKAGED DIESEL GENERATOR

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes.
1. Requirements for a complete factory assembled generator set with digital electronic generator controls, and digital voltage regulator.
 2. The generator and transfer switch shall be of the same manufacturer.
 3. Requirements for an outdoor weather-protective enclosure.
 4. Requirements for a sub-base fuel tank.

1.2 REFERENCES

- A. The following is a list of Codes and Standards that the packaged diesel generator shall conform to. The generator set shall include necessary features to meet the requirements of these standards.
1. IEEE 446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
 2. NFPA 70 – National Electrical Code
 3. NFPA 99 – Essential Electrical Systems for Health Care Facilities, if applicable to this project.
 4. NFPA 110 – Emergency and Standby Power Systems, if applicable to this project.
 5. NEMA MG1. Alternator shall comply with the requirements of the current edition of this Standard as they apply to AC alternators.
 6. UL 142 – Sub-base Tanks.
 7. UL 1236 – Battery Chargers.
 8. UL 2200 – The generator set shall be list to UL2200.
- B. The generator control system shall comply with the following Codes and Standards.
1. EN 50082-2, Electromagnetic Compatibility, Generic Immunity Requirements, Part 2.
 2. EN 55011, Limits and Methods of Measurement of Radio Interference Characteristics.
 3. FCC Part 15, Subpart B.
 4. IEC 8528 Part 4. Control Systems for Generator Sets.
 5. IEC Std. 801.2, 801.3 and 801.5 for susceptibility, conducted and radiated electromagnetic emissions.
 6. UL 508. The entire control system of the generator set shall be UL 508 listed and labeled.
- C. .

1.3 SUBMITTALS

- A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.
- A. Submittal Format:
1. The product data shall be provided as individual PDFs for each Section, unless otherwise noted for specific items. Each PDF shall be numbered to match the specification Section numbers. Submittals not itemized and labeled as specified will be rejected as incomplete.
 2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16000.A01) typewritten in the upper right-hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
 3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.
 4. Submittals in PDF shall include an index, table of contents, or bookmarks with hyperlinks to the associated page of all submitted items. Index shall include each product specified with their corresponding Reference Keynote Number. Electronic submittals not containing a linked index, table of contents, or bookmarks will be rejected as incomplete.
- B. Refer to Section 16050 – Common Work Results for Electrical Submittals for additional requirements.
- C. Product Data
1. Seismic calculations for the concrete slab and anchor bolts required. Calculations shall be wet stamped by a Professional Engineer licensed in the State of Oregon.

PART 2 PRODUCTS

2.1 GENERATOR IS OWNER FURNISHED AND CONTRACTOR INSTALLED.

- A. Refer to the OWNER'S approved generator submittals for product information.

2.2 DIESEL AND GENERATOR TESTING

- A. The OWNER shall provide diesel fuel to fill the tank completely.
- B. If the generator fails testing due to the fault or negligence of the CONTRACTOR, then the CONTRACTOR shall provide all diesel fuel to refill the tank completely and pay for additional services to the generator Manufacturer to perform additional testing.

2.3 SEISMIC BRACING

- A. Provide seismic bracing for the generator set required by the International Building Code and Oregon Structural Specialty Code.
- B. The design of the seismic anchoring and bracing system shall be by a licensed Structural Engineer in the State of Oregon. The CONTRACTOR shall arrange and pay for the services of the licensed Engineer.
- C. Wet stamped and signed calculations and drawing of the seismic anchoring and bracing system shall be submitted to the Engineer for review and approval
- D. Include Manufacturer's seismic certificate.

PART 3 EXECUTION

3.1 INSTALLATION

- A. General.
 - 1. All identification labeling shall be in compliance with Section 16075 Electrical and Control Identification.
 - 2. Equipment shall be installed by the CONTRACTOR in accordance with the final approved submittals, manufacturer's instructions and Contract Documents.
 - 3. Installation of equipment shall include furnishing and installing all interconnecting conduits and wiring between all equipment provided for the on-site power system.
 - 4. Equipment shall be installed be permanently fastened to the concrete pad in accordance with the manufacturer's instructions which are specified to meet the seismic requirements for the environment and location installed.
- B. Field Quality Control.
 - 1. The local authority having jurisdiction shall approve the installation of the generator set and transfer switch before they are energized.
- C. Start-up and Testing
 - 1. The CONTRACTOR shall support the Manufacturer's on-site start-up and testing. The work shall include, but not be limited to, energizing/de-energizing equipment, lockout-tagout, opening and closing enclosures, equipment, and boxes, verifying continuity on wiring, and assisting with troubleshooting as required
 - 2. Refer to the Owner's approved submittals for Manufacturer's on-site start-up and testing requirements.
- D. Weekly Automatic Testing
 - 1. The generator and automatic transfer switches shall be programmed to perform automatic testing as directed by OWNER.
 - 2. Configure the testing program for automatic daylight savings compensation.

- E. Demonstration and Training.
 - 1. Not required.

END OF SECTION

SECTION 16416
AUTOMATIC TRANSFER SWITCH

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes.

1. Provide a complete factory assembled automatic transfer switch with field programmable digital electronic controls designed for fully automatic operation. Controls shall include surge voltage isolation, voltage sensors on all phases of both sources, AC powered operator, positive mechanical and electrical interlocking and mechanically held contacts for both sources.
2. The transfer switch and generator set shall be of the same manufacturer to provide a single source of responsibility for all the products provided. Technicians shall be specifically trained, tested and certified to support the products. Technicians shall be employed by the generator set supplier.

1.2 REFERENCES

- A. The following is a list of Codes and Standards that the transfer switch shall conform to.
1. UL1008 – Transfer switch. Transfer switches and enclosures shall be UL-1008 listed as a package and labeled to be suitable for use in either optional standby or legally required emergency applications.
 2. IBC2006 – Transfer switch shall be prototype tested and third party certified to comply with the requirements of the IBC group III or IV, category D/F. The equipment shall be provided with installation instructions necessary to attain installation compliance.
 3. CSA 282, Emergency Electrical Power Supply for Buildings.
 4. NFPA 70, National Electrical Code.
 5. NFPA 99, Essential Electrical Systems for Health Care Facilities.
 6. NFPA 110, Emergency and Standby Power Systems. The transfer switch shall meet all requirements for Level 1 systems.
 7. IEEE 446, Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
 8. NEMA ICS 10-1993, AC Automatic Transfer Switches.
- B. The transfer switch shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation and service in accordance with ISO9001.

1.3 SUBMITTALS

- A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.

1. The product data shall be provided as individual PDFs for each Section, unless otherwise noted for specific items. Each PDF shall be numbered to match the specification Section numbers. Submittals not itemized and labeled as specified will be rejected as incomplete.
 2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16000.A01) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
 3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.
 4. Submittals in PDF shall include an index, table of contents, or bookmarks with hyperlinks to the associated page of all submitted items. Index shall include each product specified with their corresponding Reference Keynote Number. Electronic submittals not containing a linked index, table of contents, or bookmarks will be rejected as incomplete.
- B. Refer to Section 16050 – Common Work Results for Electrical Submittals for additional requirements.
- C. Product Data
1. Seismic calculations for the concrete slab and anchor bolts required. Calculations shall be wet stamped by a Professional Engineer licensed in the State of Oregon.

PART 2 PRODUCTS

2.1 AUTOMATIC TRANSFER SWITCH

1. Owner Furnished Contractor Installed.

2.2 ENCLOSURE

- A. The enclosure shall provide wire bending space in compliance with the latest edition of the NEC. The cabinet door shall include a permanently mounted key type latch(es). Bolted covers or doors are not acceptable.
- B. Manual operating handles shall be accessible to authorized personnel only by opening the key locking cabinet door. Transfer switches with manual operating handles and /or non key operated switches located on the outside of the cabinet do meet this specification requirement and are not acceptable.

2.3 SEISMIC BRACING

- A. Provide seismic bracing for the generator set required by the International Building Code and Oregon Structural Specialty Code.
- B. The design of the seismic anchoring and bracing system shall be by a licensed Structural Engineer in the State of Oregon. The CONTRACTOR shall arrange and pay for the services of the licensed Engineer.
- C. Wet stamped and signed calculations and drawing of the seismic anchoring and bracing system shall be submitted to the Engineer for review and approval
- D. Include Manufacturer's seismic certificate.

PART 3 EXECUTION

3.1 INSTALLATION

- A. General.
 - 1. All identification labeling shall be in compliance with Section 16075 Electrical and Control Identification.
 - 2. The transfer switch shall be installed per the manufacturer's instructions.
 - 3. The transfer switch shall be installed as per the Drawings.
 - 4. The transfer switch shall be installed per the NEC.
 - 5. The mounting of the transfer switch shall meet or exceed the seismic requirements for the jurisdiction installed.
- B. Field Quality Control
 - 1. The local authority having jurisdiction shall approve the installation of the transfer switch and generator set before they are energized.
- C. Open Transition Sequence of Operation
 - 1. Transfer switch normally connects an energized utility power source (source 1) to loads and a generator set (source 2) to loads when the normal source fails. The normal position of the transfer switch is source 1 (connected to utility) and no start signal is supplied to the generator.
 - 2. Generator set exercise test with load mode. The control system shall be configurable to test the generator set under load. In this mode the transfer switch shall control the generator set in the following sequence.
 - a. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program or when manually initiated by the operator.
 - b. When the control system senses the generator set at rated voltage and frequency it shall operate to connect the loads to the generator set by opening the normal source contacts and closing the emergency source contacts at a predetermined time later. The timing sequence for the contact operation shall be programmable in the controller.

- c. The generator set shall operate connected to the load for the duration of the exercise period. If the generator set fails during this period the transfer switch shall automatically reconnect to the normal service.
 - d. On completion of the exercise period the transfer switch shall operate to connect the loads to the normal source by opening the emergency source contacts and closing the normal source contacts a predetermined time later. The timing sequence for the contact operation shall be programmable in the controller.
 - e. The transfer switch shall operate the generator set unloaded for a cool down period and then remove the start signal from the generator set. If the normal power fails at any time when the generator is running, the transfer switch shall immediately connect the system loads to the emergency source.
3. Generator set exercise test without load mode. The control system shall be configurable to test the generator set without transfer switch load connected. In this mode the transfer switch shall control the generator set in the following sequence.
- a. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program or when manually initiated by the operator.
 - b. The control system shall operate the generator set unloaded for the duration of the exercise period.
 - c. At the completion of the exercise period the transfer switch shall remove the start signal from the generator set. If the normal power fails at any time when the generator is running, the transfer switch shall immediately connect the system loads to the emergency source.

D. Start-up and Testing

1. The CONTRACTOR shall support the Manufacturer's on-site start-up and testing. The work shall include, but not be limited to, energizing/de-energizing equipment, lockout-tagout, opening and closing enclosures, equipment, and boxes, verifying continuity on wiring, and assisting with troubleshooting as required.
2. Refer to the Owner's approved submittals for Manufacturer's on-site start-up and testing requirements.

E. Demonstration and Training.

1. Not required.

END OF SECTION