RFP
Attachment 17: EPC SPECIFICATIONS

CURRANT CREEK 2 POWER PROJECT

Documents are located on the PacifiCorp website:

http://www.pacificorp.com/sup/rfps.html

EXHIBIT "A"

STATEMENT OF WORK AND SPECIFICATIONS

Issued for the

All Source Request for Proposal

2016 Resource

CURRANT CREEK 2 POWER PROJECT

Revision 5

PACIFICORP ENERGY

CURRANT CREEK 2 POWER PROJECT
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SECTION 1.0

INTRODUCTION

1.1 GENERAL PLANT DESCRIPTION

The Currant Creek Power Project is a natural gas-fired, electric generating plant. The site is located in Juab County, approximately 80 miles south of Salt Lake City and 1 mile west of Mona, Utah, at an elevation of 5051ft. The existing Currant Creek 1 (herein referred to as Block 1) plant is a nominal 500MW power block consisting of the combined cycle operation of two (2) GE 7FA combustion turbines, two (2) Heat Recovery Steam Generators, and one steam turbine generator with an air-cooled condenser. This specification shall address the addition of a second 2 X 1 combined cycle power plant (Currant Creek 2) at the existing site.

The Currant Creek 2 power plant shall consist of two (2) natural gas fired GE Model 7FA.05, Siemens SGT6-5000F(5) or MHI M501GAC combustion turbine generators (CTGs) equipped with dry low NOx combustors, fast start capability and evaporative inlet air coolers. The gas turbine generators shall be new equipment (no gray market equipment) which is in current production at that point in time that will meet the delivery date and the project completion schedule. Exhaust gas from each CTG shall be directed into a dedicated heat recovery steam generator (HRSG) for the generation of high-pressure, intermediate-pressure, and low-pressure steam. Contractor shall optimize the design of the plant based on rated output, heat rate, and parasitic energy costs. This optimization shall include evaluation of economically attractive equipment such as natural gas preheater, HRSG duct firing and CTG output. Supplementary firing capability shall be provided at Bidder's discretion in each HRSG to generate additional steam for peak power production. Supplementary heat input to each HRSG's duct burners shall be limited to the constraints of the proposed permit conditions for each gas turbine manufacturer's configuration. The steam generated in the HRSGs shall be supplied to a single tandem-compound, reheat bottom exhaust, steam turbine generator. Exhaust steam from the steam turbine shall be condensed in an air-cooled steam condenser (ACC).

Auxiliary cooling shall be accomplished through an air cooled, elevated heat exchanger with fan cooled sections that can be individually isolated, and two, 100 percent capacity Closed Cooling Water pumps.

The CTGs will be equipped with dry low-NO_X combustors. Each of the HRSGs shall have a selective catalytic reduction (SCR) system to further control NO_X emissions and an oxidation catalyst for carbon monoxide (CO) and volatile organic compounds (VOC) emissions control. The CTGs and HRSG duct burners, if provided, will burn only natural gas.

The gas turbine-generators and HRSG's shall be installed as "outdoor units". The gas turbines shall include dedicated enclosures furnished with the equipment. The steam turbine/generator shall be installed in a building and shall include an overhead crane for maintenance. Other equipment such as boiler feed pumps, auxiliary boiler, fire pumps, diesel generator, fuel gas dew point heater, and water treatment shall be installed in enclosures. The existing administration building/warehouse provided with Block 1 shall be shared by both plants.

Power produced by the generators will pass through step-up transformers for delivery to the electrical transmission grid through a 345 kV switchyard.

Natural gas will be supplied to a single site interface point.

Raw Water will be supplied from the Owner's existing raw water supply well(s) to a new Raw Water Storage Tank.

Wastewater and discharge water shall be collected in small sumps, classified by quality and piped to existing on-site evaporation pond basins. One of the existing evaporation pond basins will be selected to collect water with a quality acceptable for discharge from the site. This discharge water shall be routed thru a "controlled" overflow and piped to Currant Creek

The "Fast Start" plant shall include latest technology and ancillary equipment required to minimize startup emissions. Bidder's proposal shall include a description of the guaranteed startup time and equipment being provided to meet this requirement.

1.1.1 Specifications

General

The purpose of the Technical Specifications is to define the minimum scope, plant features, and quality standards for the design, procurement, construction, startup, and testing of the combined cycle power plant.

The Owner has provided a conceptual plant design for the purpose of permit applications and specifying the minimum scope and features of the facility. The conceptual design includes process flow diagrams, one-line diagrams, arrangement drawings, and plant water balances. The conceptual design is included in Appendix C through Appendix E as a part of the Technical Specifications. Contractor shall verify all aspects of the conceptual design and shall provide final design and detailed specifications and drawings for the plant in conformance with these Specifications. Contractor shall be responsible for all design of the power plant based upon this conceptual design. All conceptual drawings shall become the Contractor's responsibility, and Contractor shall modify or recreate all conceptual drawings to reflect actual design throughout the design and construction phases of the project. See Process Flow Diagrams included in Appendix D for a basic overview of the steam cycle and other major systems.

Appendices to Exhibit A

These specifications include Appendices which contain information, data, conceptual drawings, and Owner Standards which shall be incorporated into the Contractors design, procurement, start-up and testing of the Currant Creek 2 installation.

The appendices included with this Exhibit A are as follows:

Appendix A – Abbreviations: This appendix provides a description for the abbreviations used in the text of these specifications.

Appendix B – Approved Vendor List: The Contractor shall utilize Vendors from this list whenever applicable. For equipment listed in the list, alternate vendors may only be used with the Owners approval.

Appendix C – Conceptual Site Arrangements and Reference Drawings: The Conceptual Arrangements, included in the appendix, are provided to show the minimum scope and features of the facility. The Reference Drawings, included in this appendix, provide information necessary to describe portions of the project scope.

Appendix D – Conceptual Process Flow Diagrams and Water Mass Balance: The drawings included in this appendix provide a basic conceptual overview of the stream cycle and other major systems.

Appendix E – Conceptual one-Line Diagrams: The drawings included in this appendix provide a basic conceptual overview of thee electrical and control systems.

Appendix F – PacifiCorp Material Specifications/Standards – Substation Design: This appendix includes Owners Standards for various equipment and materials associated with the design, procurement and installation of the Substation (Currant Creek 2 Switchyard) and purchase and installation of the major transformers. The Contractor shall verify that all Contractor furnished equipment and materials, covered by the standards included in this appendix, are in compliance with the requirements of these documents. Any variances from these requirements are subject to approval y the Owner.

Appendix G – PacifiCorp Equipment, Material and Process Specifications/Standards – Plant Design: This appendix includes Owners Standards for various equipment, materials and processes associated with the design, procurement and installation of the Power Plant. The Contractor shall verify that all Contractor furnished equipment, materials and processes, covered by the standards included in this appendix, are in compliance with the requirements of these documents. Any variances from these requirements are subject to approval y the Owner.

Appendix H – Report of Geotechnical Exploration: This appendix includes a Preliminary Report of Geotechnical Exploration which the Owner has completed at the Currant Creek site.

Appendix I – Water Analysis: This appendix includes a Water Analysis of the Water Supply. ,.

Appendix J – Fuel Analysis: This appendix includes an analysis of the Natural Gas Fuel Supply at the Currant Creek site.

Appendix K – Data to be Submitted With Contractors Bid: This appendix includes a Table, "Exhibit 1 to Appendix C of the Resource RFP". The Bidder shall include the requested data as a part of his proposal.

Appendix L – Facility Interconnection Requirements: This appendix includes a "Large Generation Interconnection Agreement (LGIA)" and "Facility Connection Requirements for Transmission Systems (36kV and above) – Power Delivery policy 139". The Contractor shall verify that the facility provided is in compliance with the requirements of these documents.

Appendix M – Mechanical Completion, Substantial Completion, Final Completion, Performance Guarantees and Performance tests: This appendix includes the criteria for determining the Mechanical Completion, Substantial Completion, and Final Completion. It also includes the requirements for Performance Guarantees, required Performance Tests and formula for calculating Liquidated Damages.

Appendix N – PacifiCorp Standard - Engineering Documents, Drawings and Other Deliverables: This appendix includes the Owners requirements related to preparation of engineering documents, drawings and other deliverables. The Contractor shall verify that all data, documents and drawings, covered by the standards included in this appendix, are in compliance with the requirements of these documents. Any variances from these requirements are subject to approval y the Owner.

Appendix O – PacifiCorp Standard - Hazcom Compliance - Document 1037: This appendix includes the Owners instructions for complying with the Occupational Safety and Health Act in reference to potential chemical hazards.

Appendix P – Security Conduit Termination Locations Drawing: This appendix includes a drawing which locates the conduit terminations associated with the interconnection of Plant Security System between Block 2 and Currant Creek 2.

Appendix Q – Schedule of Permits and Governmental Approvals: This appendix includes a table which outlines the anticipated permits and documents which may be required for the Currant Creek 2 installation. The Contractor shall determine when the permits and approvals are required and incorporate them into the design or the facility.

Appendix R – Substation General Information and Scope of Work: This Appendix includes a description of the Scope of Work for the Currant Creek 2 Substation (Currant Creek 2 Switchyard).

Appendix S – Substation Engineering Documents, Drawings and Other Deliverables: This appendix includes the Owners requirements related to preparation of engineering documents, drawings and other deliverables for the Currant Creek Substation (Currant Creek Switchyard). The Contractor shall verify that all data, documents and drawings, covered by the standards included in this appendix, are in compliance with the requirements of these documents. Any variances from these requirements are subject to approval y the Owner.

Appendix T – Proposed UPDES Permit Application: This appendix includes a copy of the UPDES Discharge Permit the Owner has filed with the appropriate agencies. This document lists the water quality limits for discharge of waters to Currant Creek/Mona Reservoir.

Appendix U – Owner Prepared Data for Air Permit Application: This appendix includes data which has been developed by the Owner and incorporated into the modeling performed for an Air Permit application. The Contractor shall include these restraints in the design of the facility. Any deviation from these restraints will require Owner approval.

Appendix V – Contractor Provided On-Site Training Program: This appendix includes a description of the requirements for training the Owners personnel in the operation and maintenance of the facility.

Appendix W – NERC CIPS Work Scope: This appendix includes

1.2 OVERALL SCOPE DESCRIPTION

1.2.1 General Scope

Contractor shall design, procure, fabricate, install, test, and commission a complete, functional, operating, power plant facility as specified herein with a high degree of reliability, integrity, maintainability, efficiency, and environmental compatibility which conforms to normally accepted standards for utility owned power generating facilities.

Except as specified otherwise, provide all equipment, materials, transportation services, labor, labor supervision, technical field assistance, scheduling, consumables, construction equipment, construction tools, special tools, construction utilities, permanent utilities, testing services, spare parts, and other services and items required for, or incidental to the engineering, design, procurement, installation, construction, startup, testing, commissioning, and training for the facility.

Design, fabricate, install, inspect, examine, and test each system in accordance with the specified industry standards and applicable Laws. Comply with all requirements of the Applicable Laws and Applicable Permits as specified in the Contract.

Perform specified, code required, and Contractor's standard quality assurance testing, inspection, examination, and documentation.

Submit design, fabrication, and quality assurance documentation, and operating and maintenance manuals in accordance with the submittal requirements of Section 4.0 of these Specifications.

Except as specified otherwise, provide all transportation services required to transport equipment and materials from point of manufacture or point of origin to the Project Site and provide transportation on the Project Site to the area of installation as required to erect the equipment complete. Transportation services shall include supply and installation of any temporary or permanent transportation facilities required on or off Site as required to facilitate the delivery (i.e., road improvements and the like).

Except as specified otherwise, provide all technical assistance, equipment, and supplies required, specialized and non-specialized, for erection, testing, start-up, and commissioning of all components of the facility including those supplied by the Owner.

Coordinate start-up and commissioning operations with Owner's operating maintenance personnel and involve Owner's personnel in start-up and commissioning activities to the extent desired by the Owner.

Train Owner's operators and maintenance personnel on all operating and maintenance aspects of the facility prior to system start-up in accordance with Section 10.0 of this Exhibit A of the contract

Provide all planning, coordination, arrangements for leasing temporary equipment, installation of temporary equipment and commissioning of the project.

Fire protection during plant construction shall meet the requirements of NFPA 241. All fire protection systems shall be subject to the review and approval of the state and local fire department authorities.

Provide all special tools and lifting devices for equipment supplied by the Contractor as required for maintenance and operations for the intended life.

At the start of the project and continuing thereafter provide all technical advisories such as Technical Information Letters and Service Bulletins applicable to major equipment. Until the end of the warranty period all corrective measures available for known issues affecting operation, reliability or safety shall be supplied. For clarity, it is understood that this obligation would not include any product improvements or upgrades not necessary for safe and reliable operation.

Contractor shall complete all information requested in Appendix K – Data to be submitted with Bid and turn in as a part of Contractors proposal

1.2.2 Work by Others

Others will be performing work at the Site as part of this Project. Contractor shall coordinate with other contractors as to avoid interference in operations, conduct operations to minimize inconvenience to these contractors, and confine operations to areas within the Contract limits. Construction laydown and parking areas shall be provided for these other contracts and shall be shared with these contractors.

1.2.3 Terminal Points

Boundaries associated with the scope of work for the Project are defined in the following paragraphs. The Contractor shall coordinate with all other contractors to fully define interface requirements and shall provide all facilities as defined and as required to provide a fully functional plant including interface with off-site systems provided by others.

345kV Mona Substation

Conceptual details of the electric transmission terminal points are shown on "Reference Drawings" included in Appendix C of these documents. Others will furnish and install the takeoff structures and insulators within the Mona Substation for both Block 1 and Currant Creek 2. Contractor shall be responsible for the transmission line deadend structures outside the Mona substation fence, including all insulators, connectors, grounding, etc.

Contractor shall design, procure, and install all equipment required of the “Transmission Customer” compliant with the Large Generator Interconnection Agreement (Appendix L).

The Contractor shall use the existing Block 1 deadend structure outside the substation fence as the deadend structure for the new Currant Creek 2 electric transmission line. The Contractor shall verify that the design of the existing deadend structure is adequate to accept the new Currant Creek 2 electric transmission line load. The Contractor shall string the OPGW to the new deadend structure and allow for termination at the structure in a new termination box mounted on that structure (Structure 1).

The Contractor shall design, furnish and install a new deadend structure outside the Mona Substation to receive the relocated Block 1 electric transmission line and relocate the existing Block 1 electric transmission line from the existing deadend tower to the new deadend tower (Structure 8), extending the conductor as necessary. The Contractor shall restring the existing OPGW as necessary to allow for termination at the structure east of new deadend structure, in a new termination box mounted on that structure (Structure 2).

Contractor shall design, furnish and install the conductor spans between the Block 1 deadend structure outside the Mona Substation fence and the takeoff structure within the Mona Substation. Contractor shall design, furnish and install the span between the Currant Creek 2 deadend structure outside the Mona Substation fence and the takeoff structure within the Mona Substation.

<u>Relaying and Metering Interface</u>: Others will provide all protection, control, metering, and communication facilities within the Mona Substation. Contractor shall provide all facilities required for relaying and metering interface inside the power plant, between the power plant and the Currant Creek 2 switchyard, and within Currant Creek 2 and the switchyard, except as described in the Large Generator Interconnection Agreement (Appendix L). Contractor shall coordinate transmission line protection requirements with Others to ensure integration between the schemes and devices between the Currant Creek 2 switchyard and Mona Substation. Facilities shall include, but not be limited to, ductbank, fibers, wiring, programming, controls, relaying equipment and metering equipment.

<u>Block 1 Switchyard</u>

Contractor shall install fiber optic cable between the existing Block 1 switchyard control building and the new Currant Creek 2 switchyard control building.

Contractor shall extend the Block 1 switchyard grounding system to connect the new 345kV Currant Creek 2 switchyard grounding system, solidly connecting the two switchyard ground grid systems.

<u>Natural Gas Pipeline</u>

Contractor shall connect to the existing Block 1 gas metering station for the supply of natural gas to Currant Creek 2 as indicated on the conceptual site arrangement drawings included in Appendix C. Provide all facilities downstream of this connection required by these

Specifications, including but not limited to, pressure control, flow metering for Currant Creek 2, moisture scrubbers, gas heating, filters/separators, cathodic protection, and piping.

Water Supply Pipeline

An 8-inch raw water supply pipeline already exists to the Block 1 Raw Water/Fire Water Storage Tank. The Contractor shall connect to this line near the Raw Water/Fire Water Tank, install valves required to allow raw water to be supplied to the Block 1 Raw Water/Fire Water Tank, to the Currant Creek 2 Raw Water System and, in case of loss of raw water from the well field, the Block 1 and Currant Creek 2 raw water systems can be intertied and shared. The approximate location of this connection is shown on the conceptual site arrangement drawings included in Appendix C. The Contractor shall route an 8 inch underground raw water pipe to the boundary between Block 1 and Currant Creek 2 and install a flanged valve in an underground valve box at this location. The Currant Creek 2 service water supply shall be a continuation of the line from this valve. Contractor shall provide all facilities downstream of the supply line connection as required by these Specifications including but not limited to, water flow meters, water storage tanks, water treatment systems, and water distribution systems.

1.2.3.1 Underground Fire Water Distribution

The Contractor shall connect to the existing Block 1 fire water system at the two points indicated on the conceptual site arrangement drawings included in Appendix C. The Owners underground piping at these two locations is terminated with an isolation valve and blind flange. The terminal point for Currant Creek 2 fire water system is at these two valves and blind flanges.

1.2.3.2 Demineralized Water

The Contractor shall connect to the existing Block 1 Demineralized Water Pump Discharge Line near the existing Demineralized Water Tank and route an underground demineralized water line to the boundary between Block 1 and Currant Creek 2. The connection shall include valves to allow the Block 1 and Currant Creek 2 demineralized water storage systems to be shared. At the boundary the Contractor shall install a flanged valve in an underground valve box. The Currant Creek 2 demineralized water supply/return shall be a continuation of the line from this valve box.

1.2.3.3 <u>Process Water Discharge</u>

CTG wash water shall be collected in separate covered drain sumps which shall be provided with hose connections for truck disposal. Concentrated chemical area drainage shall be collected and disposed off-site by use of a sump pump or vacuum truck. Equipment/floor drains shall be routed to an Oil/Water Separator. Process water from the Oil/Water Separator, evaporative cooler, water treatment backflush, RO and EDI reject, and excess condensate shall be classified by quality and routed to collection sumps. The classification of wastewater and discharge water to the sumps shall be based on whether the water is acceptable for discharge to Currant Creek or not acceptable for discharge to Currant Creek. The sumps containing water that, when discharged from the existing evaporation pond basin, is acceptable for discharge to Currant Creek shall be gravity fed to one of the existing evaporation basins selected by the Owner. This basin shall be modified by addition of a "controlled" overflow, including quality monitoring and emergency shutoff, which shall gravity flow to a Discharge Structure at Currant Creek. The sumps containing water that is not acceptable for discharge to Currant Creek shall be gravity fed to one of the existing evaporation basins selected by the Owner. Contractor shall provide all facilities required for the collection, transfer, control and discharge, including the outfall structure at Currant Creek for the process water discharge.

The HRSG blowdown water shall be recycled for reuse in the Unit 2 cycle makeup treatment system.

1.2.3.4 <u>Telephone and Data Communications</u>

<u>Communications</u>: Telephone and data communication systems for the facility will be furnished and installed by the Contractor. The telephone and data communications system will be inter-connected with the systems already existing for the Block 1 plant. The new systems shall be compatible with those already installed. Provide panel boards in the administration building for connection by the telephone and data communications service provider. Provide all facilities, including but not limited to, wiring, jacks, switches, controls and phones to PacifiCorp standard using Siemens Commscope, CAT-5e structured wirings, on the plant side of the communications panels as required to provide a complete and functional plant communications system for both telephone service and data communications service in compliance with PacifiCorp Standard 8B.3.1-Data and Voice Network Infrastructure Wiring Guidelines (Appendix G).

Provide a conduit system from site interface point identified on General Arrangements Drawings to the location of the panel boards for installation of the communications wiring by others.

1.2.4 Owner-Furnished Equipment and Systems

The following equipment will be directly purchased by Owner:

1. Permanent Plant Spares – Owner will provide permanent plant spare parts as required to maintain an operating plant after plant start-up. Contractor shall supply all spare parts required to start-up the facility through Substantial Completion. Contractor shall provide a list of recommended permanent spare parts including unit price, pricing validity timeframe, quantity, description, OEM and OEM part number. The spare parts list shall include a list of all spare parts anticipated for three years of operation.

2. Plant Security System – With the exception of the Contractors scope of work described in Article 8.17 Plant Security System, Owner will provide and install the permanent plant security system. Contractor shall provide conduit runs from and to locations as shown in Appendix P.

3. Communication Systems and Equipment – Owner will purchase and install additional communication wiring and communication equipment.

4. OSI and PI - Owner will purchase additional PI licenses and configure the PI server to support additional data tags.

1.2.5 Noise Levels

1.2.5.1 Equipment Noise Requirements

Equipment shall be purchased to meet near-field and/or far-field sound level specifications as necessary to support compliance with the Guaranteed Noise Emissions detailed in Appendix M.

1.2.6 Mechanical Scope

The Mechanical Scope is summarized below and requirements are more fully described in Section 5 of these specifications.

Contractor shall supply, install, and commission all equipment and systems necessary for a complete and fully functional facility. The equipment and systems shall include, but shall not be limited to, the following:

1. Combustion Turbine-Generators and systems.
2. Steam Turbine-Generator and systems.
3. Heat Recovery Steam Generators (HRSGs).
4. HRSG Vents and Drains.
5. Steam Systems (including bypass system).
6. Air Cooled Condenser (ACC).
7. Condensate System.
8. Feedwater System.
9. Service and Raw Water Systems including Raw Water Storage Tanks.
10. Water Treatment System and Demineralized Water Storage Tank.
11. Cycle Makeup and Storage System.
12. Closed Cooling Water System.
13. Potable Water for eyewash stations and as required.
14. Aqueous Ammonia Storage and Transfer System.
15. Fire Protection System for Block 2 with new storage tanks and fire pumps.
16. Chemical Treatment and Injection System.
17. Sampling System.
18. Bulk Gas Storage Systems (CO_2, H_2 and N_2).
19. Fuel Gas System.
20. Instrument/Service Air System.
21. Heating, Ventilating, and Air Conditioning (HVAC) System.
22. Plant Blowdown System.
23. Plant Drains System.
24. Wastewater and Water Discharge Treatment System.
25. Wastewater and Water Discharge Collection and Disposal (including oily water discharge).
26. Auxiliary Boiler.
27. Sanitary Drainage System (if required).
28. All Miscellaneous Mechanical Systems and Equipment.
29. All temporary facilities and systems needed to implement this work.

1.2.7 Electrical Scope

The Electrical Scope is summarized below, and requirements are more fully described in Section 8 of these Specifications.

Contractor shall supply all equipment and systems necessary for a complete and fully functional facility. The equipment and systems to be provided shall include, but shall not be limited to, the following:

1. Generator Step-up and Auxiliary Transformers.
2. Low Side CTG Generator Breakers.
3. Isophase Bus Duct System.
4. Medium-Voltage System including switchgear and MCCs.
5. Low-Voltage System including switchgear and MCCs.
6. Direct Current (DC) Power System.
7. Uninterruptible Power Supply (UPS).
8. Communication System expansion.
9. Security System expansion.
10. Emergency generator.
11. Lighting.
12. Grounding.
13. Cathodic Protection.
14. Heat Tracing.
15. Data/telephone expansion.
16. Lightning Protection.
17. All Miscellaneous Electrical Systems and Equipment.
18. Construction Power System.

1.2.8 Instrumentation and Control Scope

The Instrumentation and Controls Scope is summarized below, and requirements are more fully described in Section 9 of these Specifications:

1. Fully Integrate Currant Creek 2 Control Room equipment into existing Block 1 Central Control Room utilizing equipment and programs similar to those used on Block 1.
2. Distributed Control Systems and PLC's.

3. Recording devices and Historians.
4. Sequence of Events Recording.
5. Hard-Wired Emergency Trips and Critical Interlocks.
6. Continuous Emission Monitoring Systems.
7. OSI Data Historian Interface through the DCS.
8. Instrumentation and Control Devices.

1.2.9 Civil Scope

The Civil Scope is summarized below, and requirements are more fully described in Section 6 of these Specifications:

1. Geotechnical Investigations.
2. Topographic Construction Surveys.
3. Site Preparation.
4. Permanent Site Drainage.
5. Drainage during Construction.
6. Interface with existing water discharge basins and discharge to Currant Creek.
7. Construction Wastewater and Water Discharge Treatment and Disposal.
8. All Sub-grade Work and Foundations.
9. All Final Grading.
10. Roads and Paving including Parking Areas.
11. Fencing.

1.2.10 Structural and Architectural Scope

The Structural and Architectural Scope is summarized below, and requirements are more fully described in Section 7 of these Specifications:

1. Structural Materials.
2. Concrete.
3. Steam Turbine-Generator Building.
4. Overhead crane.
5. Steel including Pipe Racks and Supports.
6. Siding and Roofing.
7. Miscellaneous Buildings.
8. Water Sample Laboratory.

9. Painting.

1.2.11 Construction Facilities and Services

General

Contractor shall furnish and maintain temporary construction facilities and provide construction services including, but not limited to the following:

1. Temporary Storage Areas and Facilities at the Site for the proper unloading and storage of all plant material delivered to the Site. If adequate area and facilities are not available on site, such material shall be stored at suitable offsite facilities (e.g., warehouses, storage yards, etc.). Areas available for laydown and storage are indicated on the Conceptual Arrangement drawings in Appendix C. The existing, "100' X 150' metal pole barn with a concrete floor", warehouse in the area North of the new Currant Creek 2 addition may be available for use by the Contractor. Installed electric power at this existing warehouse can only feed the lighting. The Contractor shall coordinate use of this warehouse with the Owner.
2. Contractor to provide all permits required for construction. (see Article 2.4.1)
3. Construction Power and Distribution. Contractor shall be responsible for all electric power tie-ins at the Site.
4. Temporary communication system
5. Temporary lighting system
6. Site drainage, erosion and sedimentation control, and dewatering systems
7. Temporary roads
8. Fire protection service (until Substantial Completion)
9. Construction sanitary facilities including construction offices
10. Temporary water supply and distribution (potable and non-potable). Potable water shall be high quality bottled water.
11. Parking Facilities. Contractor shall furnish adequate parking facilities to accommodate all construction work forces. These facilities shall be located within the areas indicated as Construction Laydown and Storage on the Conceptual Arrangement Drawings in Appendix C.
12. Site Security. Contractor shall be responsible for providing the fencing, guarding, and watching the Site as necessary for protection during construction (until Final Completion).

13. Construction testing services (e.g. weld NDE, hydro testing, megger testing, concrete strength and placement, compaction testing, steel testing etc.).
14. Construction Materials - Contractor shall supply all the equipment, tools, consumables, instruments, etc., necessary for the construction and erection of the plant. The supply of the construction equipment shall include fuel, lubricants, spare parts, and any other elements or service required for operation and maintenance.
15. Site environmental compliance and protection.
16. First Aid Services. Contractor shall provide onsite first aid services in conjunction with arrangement for offsite first aid transportation and treatment as necessary during the construction of the plant.
17. Temporary Construction Facilities at the site to support Contractor's construction staff and labor force, and the delivery, unloading and storage of equipment and materials.
18. Temporary offices for the owner's use. Temporary offices shall include, but not be limited to, a minimum 12 foot by 70 foot office trailer with lighting, space heating and cooling, and wired for telephone service.

1.2.11.1 <u>Coordination</u>

Contractor and any other parties involved in the construction of the project shall attend such pre-construction and construction meetings as may be requested by Owner. At the initial meeting, Contractor shall present a construction plan including, but not limited to, the following: safety, procurement plan, major equipment receipt plan, construction sequence, methods and equipment to be used in all phases, tentative access and right-of-way roads, locations of staging areas, regrading of roads, moving of equipment/property that will interfere or impact construction and a construction schedule showing all activities for the entire construction phase of the project. All construction related activities shall be in compliance with PacifiCorp's "Construction Coordination Agreement".

Contractor shall be responsible for contacting all involved utility companies prior to starting any work to determine schedule of work and location of all temporary and permanent facilities in the project area.

Contractor shall prepare an outage plan for all scheduled interruptions of electrical power or other utilities-interference that would affect third parties. This plan shall be submitted by Contractor to Owner and the affected parties at least thirty (30) days prior to outage.

Representatives of Contractor shall attend weekly coordination meetings to discuss matters relative to the progress and execution of the construction and startup of the project. Current week progress and three-week look ahead schedules (Level 2 or better) shall be presented by the Contractor and reviewed at these meetings in addition to other site coordination items.

1.2.11.2 Safety

Contractor shall implement and maintain, throughout the construction period, a written safety and accident prevention program which meets the requirements of federal, state, and local codes and regulations, and all other authorities having jurisdiction over this work. Subcontractors and vendor-supplied service organizations will each be required to implement a safety program commensurate with the work to be performed and in compliance with Contractor's Site Safety Plan.

Contractor's Safety, Health, and Accident Prevention Program shall be submitted to Owner for approval and shall include disciplinary procedures and safety orientation training procedures applicable to the Contractor and his subcontractor personnel. Special emphasis shall be applied to ensure the use of personal safety equipment and strict adherence to fall protection standards.

Contractor shall include a qualified on-site health, safety and security coordinator who, unless otherwise approved by the Owner in writing, shall have no other duties. The health and safety coordinator shall be on-site during all hours of construction and shall have authority to:

1. Identify unsafe conditions or practices to Construction management for correction.
2. Instruct Construction management when a work stoppage is necessary to correct an unsafe act or condition. Work with Construction management to develop a safe work approach to correction unsafe site conditions.
3. Investigate and respond to Owner identified safety concerns.

The Contractor shall hold regular scheduled safety meetings to instruct his personnel and subcontractor personnel in safety and health practices. The Contractor shall maintain accurate accident and injury reports and shall furnish Owner a monthly summary of injuries and man-hours lost due to injuries and copies of all accident and injury reports.

1.2.11.3 Security

Contractor shall prepare and implement a Site Security Plan. Contractor shall cooperate with the Owner on all security matters. A copy of the Site Security Plan shall be provided for information to the Owner.

1.2.11.4 Fire Protection

Only work procedures which minimize fire hazards to the extent practicable shall be used. Combustion debris and waste materials shall be collected and removed from the site each day. Fuels, solvents, and other volatile or flammable materials shall be stored away from the construction and storage areas in well marked, safe containers. Good housekeeping is essential to fire prevention and shall be practiced by the Contractor throughout the construction period. The Contractor shall follow the recommendations of the AGC "Manual of Accident Prevention in Construction" regarding fire hazards and prevention and the provisions of NFPA 850.

Formwork, scaffolding, planking, and similar materials which are combustible but which are essential to execution of the work shall be protected against combustion resulting from welding sparks, cutting flames, and similar fire sources.

Contractor shall provide qualified personnel for fire control as appropriate. Contractor shall provide adequate fire protection equipment in each warehouse, office and other temporary structures, and in each work area that he is occupying. Access to sources of firewater shall be kept open at all times. Suitable fire extinguishers shall be provided in enclosed areas, in areas that are not accessible to fire water, or in areas that may be exposed to fire that cannot be safely extinguished with water. Each fire extinguisher shall be of a type suitable for extinguishing fires that might occur in the area in which it is located. In areas where more than one type of fire might occur, the type of fire extinguisher required in each case shall be provided. Each extinguisher shall be placed in a convenient, clearly identified location that will most likely be accessible in the event of fire.

Contractor alone shall be responsible for providing adequate fire protection of the construction areas. Failure of Contractor to comply with, or Owner or Owner's Engineer to enforce, the above requirements shall not relieve Contractor from any responsibility or obligation under this Contract.

1.2.11.5 Cleanliness

Special attention shall be given to keeping the structures and surrounding grounds clean and free from trash and debris. The Contractor shall require all disciplines to thoroughly clean their work areas each working day. The Contractor's Construction Manager shall be responsible for Site maintenance and cleanliness. This shall include sweeping the floor, collecting and disposing of trash, and all other functions required to keep the site clean. All hoses, cables, extension cords, and similar materials shall be located, arranged, and grouped so they will not block any accessway and will permit easy cleaning and maintenance.

A roll-up of all hoses, welding leads and electrical cords will be executed once a month as a minimum or as determined by site management. Material and equipment not required for immediate use or installation will be stored in designated laydown and warehouse areas.

All trash, debris, and waste materials shall be collected, sorted, and deposited in waste collection receptacles near the work. These receptacles shall be emptied regularly and the waste properly disposed of off-site.

Promptly upon the completion of a construction task, the Contractor shall thoroughly clean the equipment or structure affected by the task activity by removing all accumulations of dirt, scraps, waste, oil, grease, weld splatter, insulation, paint, and other foreign substances. The Contractor, without additional cost or burden to the Owner, shall properly and adequately restore surfaces damaged by deposits of insulation, concrete, paint, weld metal, or other adhering materials.

1.2.11.6 Signs and Barricades

All signs and barricades shall be provided and maintained by Contractor and shall be in accordance with jurisdictional regulations for accident prevention.

1.2.11.7 Dust Control

Contractor shall be responsible for dust control at the Site. Contractor shall prevent the spread of dust during its operations. Contractor shall moisten all surfaces with water to reduce the risk of dust becoming a nuisance to the public and neighbors. Contractor shall furnish all labor and equipment necessary for dust control including tank trucks and hoses to apply Owner furnished water. Contractor shall conform to all requirements of the Applicable Permits.

1.2.11.8 Open Burning

On Site open burning will not be permitted.

1.2.11.9 Cooperation with Other Contractors

During the process of the work, it may be necessary for other contractors to be present on or about the site. Contractor shall afford all reasonable cooperation to such other contractors.

Contractor, if required, shall exchange with other contractors furnishing associated equipment, all necessary drawings and other information required to be furnished under the specifications of the respective contracts. Three (3) copies of all drawings and correspondence relating to information exchanged between Contractor and other contractors shall be sent to Owner.

1.2.11.10 Energized Facilities

Contractor may encounter at the site existing energized facilities, operating machinery, and systems, which must remain energized and functional during the execution of the work.

Contractor shall be completely responsible for the safety and protection of his personnel, Owner's personnel, and the public on the site of the Work and shall employ all methods necessary to achieve such safety and also assure continuity of all service systems encountered. These methods shall include, but not be limited to, providing barriers, guard structures, insulating guards and sleeves, warning signs, and prevention of unauthorized access to service system areas.

1.2.11.11 Reference Points

Contractor shall establish baselines, monuments, and reference points for construction as necessary to proceed with layout of the work. Contractor shall be responsible for laying out the work to such lines and grades indicated on the drawings, and shall protect and preserve the established reference points, subject to changes as the Owner may direct.

1.2.11.12 Dangerous Materials

Contractor shall not use explosives, radioactive, or other dangerous material without prior notification to the Owner. Contractor shall be responsible for the proper handling, transporting, storage, and use of such materials. When the use of such materials or methods is necessary, Contractor shall exercise the utmost care and carry on such activities under supervision of its properly qualified personnel. Contractor, at its expense, shall repair any damage caused by its handling, transporting, storage, and use, and shall be responsible for obtaining permits as applicable.

1.2.11.13 Waste Disposal

Contractor shall keep Project Site free at all times from accumulations of waste materials and rubbish. Special attention shall be given to keeping the structures and surrounding grounds clean and free from trash and debris. Contractor shall require all disciplines to thoroughly clean their work areas each working day. Contractor's Construction Manager shall be responsible for Site maintenance and cleanliness. This shall include sweeping the floor, collecting and disposing of trash, and all other functions required to keep the site clean. All hoses, cables, extension cords, and similar materials shall be located, arranged, and grouped so they will not block any accessway and will permit easy cleaning and maintenance.

A roll-up of all hoses, welding leads and electrical cords will be executed once a month as a minimum or as determined by site management. Material and equipment not required for immediate use or installation will be stored in designated laydown and warehouse areas.

All trash, debris, and waste materials shall be collected, sorted, and deposited in waste collection receptacles near the work. These receptacles shall be emptied regularly and the waste properly disposed of off-site.

Promptly upon the completion of a construction task, Contractor shall thoroughly clean the equipment or structure affected by the task activity by removing all accumulations of dirt, scraps, waste, oil, grease, weld splatter, insulation, paint, and other foreign substances. Contractor, without additional cost or burden to Owner, shall properly and adequately restore surfaces damaged by deposits of insulation, concrete, paint, weld metal, or other adhering materials.

1.2.11.14 Hazardous Material Management

Contractor shall be responsible for managing hazardous materials and hazardous wastes. Contractor shall be responsible for designating and managing storage areas, preparing plans, obtaining necessary permits, record keeping and reporting requirements in compliance with applicable, local, state and federal regulations.

Proper storage and disposal of all materials, waste and contaminants such as debris, paints, solvents, lubricants, oils, etc. will be required at all times. No materials, wastes or contaminants shall be disposed of on-site. Records of all disposals shall be retained and provided to Owner at the end of the project. Contractor shall maintain material safety data sheets (MSDS) information for all materials brought to the site. All wastes must be handled in accordance with the applicable local, state and federal regulations.

1.2.11.15 Adjoining Utilities

Contractor shall make necessary efforts to protect any and all parallel, converging, and intersecting electric lines and poles, telephone lines and poles, highways, waterways, railroads, and any and all property from damage as a result of its performance of the work. Contractor shall bear all liability for and shall at its expense repair, rebuild or replace any property damaged or destroyed in the course of its performance of the work.

1.2.12 Production Inputs

Owner will provide the following Production Inputs:

1. Fuel gas for startup and commissioning of the plant, with quality as indicated in Appendix J.
2. Water for construction and commissioning of the plant with quality and quantity as indicated in Appendix I. Water required for construction and commissioning in excess of those quantities shall be provided by Contractor.
3. Electricity input into the plant for startup and commissioning of the plant from the auxiliary transformers or backup power source. Construction power shall be provided by Contractor.

Contractor shall provide the following Production Inputs:

1. All Chemicals including, but not limited to, water treatment chemicals, boiler treatment chemicals, ammonia, and ethylene glycol for operation of systems during startup and commissioning of the plant.
2. All Gases including, but not limited to Nitrogen, Carbon Dioxide, Hydrogen, and CEM gases for operation of systems during startup and commissioning of the plant.
3. Lube oils necessary for flushing and operation of systems during startup and commissioning of the plant.

1.2.13 Operating Consumables

Until Substantial Completion is reached, Contractor shall provide (at Contractor's cost) all Operating Consumables, including initial fill and other consumables required for preparation, startup, and commissioning of the power plant including but not limited to the following:

1. Demineralized water.
2. Water Conditioning Chemicals.
3. Grease.
4. Lubricants.
5. Chemicals required during construction of the plant (such as boiler chemical cleaning chemicals).
6. Purging gases.
7. Filters.
8. Strainers.
9. Spare parts such as gaskets, filter cartridges, light bulbs, lamps, fuses, and related items.
10. NOx control reagent (aqueous ammonia).
11. Compressed air and other gases.

1.3 PLANT OPERATING PROFILE

1.3.1 Plant Load Definition

For the purpose of these Specifications, the following plant load definitions shall be used.

Load Point	Gas Turbine Output	HRSG Output	Steam Turbine Output

Peak	2 @ Base Load	Maximum Duct Burning	Turbine Follow/Sliding Pressure
Base	2 @ Base Load	No Duct Burning	Turbine Follow/Sliding Pressure
Minimum	1 @ OEM operating minimum	No Duct Burning	Turbine Follow/Pressure Control
Bypass	2 @ Base Load	No Duct Burning	Steam Turbine Bypassed

1.3.2 Plant Operating Profile

Operating conditions are expected to vary seasonally with periods of cyclic operation to minimum load or shutdown at night and periods of base load operation with daily duct firing for peak operation.

Contractor shall provide a plant designed to operate continuously at all load conditions between Minimum and Peak operation as indicated above and meeting all the requirements of the Contract, and operating within the limits of all Applicable Permits at any operating point within this range.

Annual plant starts to be utilized for design are as follows:

Cold – ambient (below 32 degrees F)	2
Cold (> 72 hour shutdown)	8
Warm (24-72 hour shutdown)	50
Hot (< 24 hour shutdown)	230

Contractor shall provide a system designed to start-up, shutdown, and operate as required and within the time frames specified in the Contract.

Contractor shall provide a plant designed to allow continuous bypass operation as defined above, with all steam being bypassed around the steam turbine to the ACC system and without any steam being vented to the atmosphere. Plant shall be capable of full bypass operation while allowing Owner to work on non-operating unit (except STG).

1.3.3 Plant Operating Philosophy

Design plant with suitable equipment, automation, and controls to allow plant to start-up, operate normally at any load between Minimum load and Peak load, and shutdown with one operator in the control room and one operator in the plant. Provide plant with suitable automation consistent with the requirements.

1.3.4 Plant Reliability

As required by Prudent Industry Practice, EPC Contractor shall provide redundant components and systems. Where redundant (standby) equipment is supplied, the idle component shall be capable of automatic and immediate initiation into operation upon failure of one or more of the operating components. Necessary instrumentation shall be supplied to sense a failure of one or more of the operating components.

1.3.5 Plant Performance

Design plant to optimize performance (output and heat rate) at the Plant Design Base Load conditions with capability of operating at all other design loads between the Minimum and Peak Loads.

Design plant to provide maximum Peak output at the Plant Design Peak Load conditions indicated in Table 2-1.

SECTION 2.0

SITE DESIGN CONDITIONS

The Currant Creek Power Project Site is located approximately 80 miles south of Salt Lake City, Utah. A Site location map is included in Appendix C, CONCEPTUAL SITE ARRANGEMENTS.

Specific Site design conditions are summarized in Table 2-1.

Table 2-1

Site Design Conditions

Plant Design Base Load Ambient Conditions: (Ambient Dry Bulb Temperature/ Coincident Relative Humidity)	95°F DBT 20 Percent
Plant Design Peak Load Ambient Conditions: (Peak Dry Bulb Temperature/Coincident Relative Humidity)	95°F DBT 20 Percent
Maximum Ambient Design Conditions: (Maximum Dry Bulb Temperature/Coincident Relative Humidity)	110°F DBT 6.5 Percent
Minimum Ambient Design Conditions: (Minimum Dry Bulb Temperature/Coincident Relative Humidity)	-21°F DBT 0 Percent
Elevation	5051 ft above mean sea level
Location	Mona, Utah
Seismic Criteria	See Section 7.2.4 of this specification
Wind Design	See Section 7.2.3 of this specification
Precipitation	
Average Annual Precipitation	14.5 in. *
Maximum 24 hr Precipitation	1.85 in. *

Average Annual Snowfall	44.5 in.*
Maximum 24 hr Snowfall	19 in.*
Design Maximum Rainfall Rate	25 year/24 hour storm
Design Frostline:	30 Inches
Fuel	
Primary	Natural Gas (See Fuel Gas Analysis in Appendix J, Fuel Analysis
Backup	None
Preheating for starting	As specified by the gas turbine manufacturer.
Preheating for performance	As required by CTG Manufacturer
Supply Pressure at Owner interface point (control by contractor)	Since the beginning of 2007 the gas pressure to site has ranged from 887 psig minimum to 1230 psig maximum with an average pressure of 1035 psig.
* Data from the Western Regional Climate Center for Nephi, Utah.	

2.1 GEOTECHNICAL CONDITIONS

Results from the Preliminary geotechnical Investigation completed at the Currant Creek site are contained in APPENDIX H, GEOTECHNICAL REPORT. Contractor shall be responsible for dealing with the Geotechnical conditions at the site and may at its option, rely on the GEOTECHNICAL REPORT furnished by Owner. If Contractor believes that additional geotechnical investigations are necessary, it is Contractor's responsibility to perform any additional studies required at no additional cost to Owner. Relying on Owner's GEOTECHNICAL REPORT will not release Contractor from responsibility for the geotechnical integrity of the constructed facilities. Any subsurface anomalies discovered by the Contractor shall be reported immediately to the Owner.

2.2 SITE SECURITY

From the time of initial mobilization to Substantial Completion, Contractor is responsible for security and entrance to the power plant construction area, office trailer area, construction parking area, and laydown areas (Others will control access to switchyard areas). Security will include fencing areas as they come under construction and are completed, secured warehousing of plant equipment and materials and security guards, Contractor is responsible for controlling visitor access and site visits.

2.3 SITE ACCESS

Contractor shall establish a temporary access point into the site and to any temporary staging/laydown areas, as required. Contractor shall construct and maintain access to laydown area(s). Laydown areas will be rough graded by Contractor. Any additional preparation required for the laydown areas shall be Contractor's responsibility. Contractor shall restore the laydown area to Owner's satisfaction upon completion of use.

Construction of the proposed facility will follow all permit requirements and engineering design specifications. Owner and/or his representatives will be onsite continuously to monitor that construction is in compliance with all permit and design specification requirements. The plant shall be constructed without obstructing public thoroughfares. All warning and traffic signs shall be provided and maintained. A safe workplace environment shall be maintained. The proposed facility site and roadway layout is shown on the site plan and general arrangement drawings. Contractor is required to meet the safety requirements outlined in paragraph 4.9 of the Contract.

2.4 SITE ENVIRONMENT

Contractor shall be responsible for protecting and maintaining the site, which shall include but not be limited to the following:

Proper storage and disposal of all materials, waste and contaminants such as debris, paints, solvents, lubricants, oils, etc. will be required at all times. No materials, wastes or contaminants shall be disposed of on-site. Records of all disposals shall be retained and provided to Owner at the end of the project. Contractor must maintain MSDS information for all materials brought to the site. All waste must be handled in accordance with the applicable local, state, and federal regulations.

Contractor shall maintain the project site in a neat and clean condition at all times. Materials shall be protected from damage due to dirt, debris or the elements. Upon completion, all temporary buildings, rubbish, unused materials and other equipment and materials belonging to and used in the performance of the work shall be disposed of. During construction, storm water and fugitive dust emissions shall be controlled by use of proper construction practices or other suitable means.

2.4.1 Permits and Licenses

The Contractor shall design and construct, consistent with requirements and conditions of all permits and local, state, and federal regulations, codes, and standards.

Owners Permit Responsibilities

The Owner will apply for and obtain the permits indicated in Table 2-2. Copies of these permits will be supplied to the Contractor when they are received by the Owner. These permits will include conditions which the Contractor shall comply with.

Table 2-2
Owner Provided Permits

Agency	**Permit/Approval**
Utah Division of Water Quality	UPDES Permit to Discharge Process Wastewater
Utah Division of Air Quality	Approval Order

Contractor Permit Responsibilities

Permitting requirements shall be reviewed by the Contractor as early as possible to determine at what stage of construction the permit application needs to be submitted, and whether supporting information from the Owner or the Owners' Engineer is required for the application submittal. The permits must be carefully reviewed for permit expiration dates, reporting requirements, and other conditions that require action by the Owner, Owner's Engineer, or Contractor.

A summary of the expected permits and approvals required for power plant construction and that shall be obtained by the Contractor are shown in the Table included in Appendix Q. The table lists the permit required and the agency requiring the permit. It will be necessary for the Contractor to determine when permits and approvals will be required for construction and incorporate this list into the final Contract. The Owner does not guarantee that all permits and approvals are listed in Appendix Q and it shall be the Contractor's responsibility to make a determination whether or not additional permits and approvals are required aside from those listed in the table. If additional permits or approvals are required the Contractor shall be responsible for their acquisition.

The Contractor shall be responsible for all costs associated with permits, governmental approvals, certificates and licenses. The Contractor shall include such fees and costs in his normal billing process.

In addition to the permits listed in Appendix Q, there will be conditions designated in the environmental permits obtained by the Owner that the Contractor must comply with, as well as contractual requirements the Contractor must meet. These requirements may include, but are not limited to, the following:

- US Army Corps of Engineers Section 404 Permit.
- US Corps of Engineers Section 10 Permit to install an intake or discharge pipe into a navigable water.
- UPDES Permit to Discharge Process Wastewater.

<u>Air Permit</u>

The Owner intends to apply for Air Permits for the various gas turbine configurations as allowed for under this specification. The expected emissions rates, equipment sizes, and height and size of emission points for each configuration, expected to be included in the Owner's Permit Application, are indicated on the Tables included in Appendix Q. The location of the various emission points, expected to be included in the Owner's Permit Application, are shown on the Conceptual Arrangement Drawings included in Appendix C.

2.4.2 Water Quality

Makeup water quality and Block 1 water data is summarized in Appendix I.

SECTION 3.0

CODES, STANDARDS, AND REGULATIONS

The editions and addenda of the following Codes and Publications effective as of the effective date of the Contract shall apply to all work performed under this Contract:

AASHTO	American Association of State Highway and Transportation Officials.
ABMA	American Boiler Manufacturer's Association.
ACI	American Concrete Institute.
AFBMA	Anti-Friction Bearing Manufacturers Association.
AGA	American Gas Association.
AGMA	American Gear Manufacturers Association.
AISC	American Institute for Steel Construction.
AISI	American Iron and Steel Institute.
AITC	American Institute of Timber Construction.
AMCA	Air Moving and Conditioning Association.
ANSI	American National Standards Institute.
API	American Petroleum Institute.
ASCE	American Society of Civil Engineers.
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers.
ASME	American Society of Mechanical Engineers.
ASNT	American Society for Nondestructive Testing.
ASTM	American Society for Testing and Materials.
AWWA	American Water Works Association.
AWS	American Welding Society.
BOCA	Building Officials and Code Administrators International.
CAGI	Compressed Air and Gas Institute.
CMMA	Crane Manufacturers Association of America.
CFR	Code of Federal Regulations.
CTI	Cooling Tower Institute.
DEP	Division of Environmental Protection.
EEI	Edison Electrical Institute.

EJMA	Expansion Joint Manufacturing Association.
EPA	United States Environmental Protection Agency.
FAA	Federal Aviation Agency, Department of Transportation.
FED	Federal Standards.
FM	Factory Mutual.
HEI	Heat Exchange Institute.
HI	Hydraulic Institute Standards.
IBC	International Building Code (2009).
IEEE	Institute of Electrical and Electronics Engineers.
IES	Illuminating Engineers Society.
IMC	International Mechanical Code.
IPC	International Plumbing Code.
IPCS	Insulated Power Cable Society.
ISA	Instrument Society of America.
LPC	Lightning Protection Code.
MBMA	Metal Building Manufacturers Association.
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry.
NAAMA	National Association of Architectural Metal Manufacturers Metal Bar Grating Manual.
NACE	National Association of Corrosion Engineers.
NAFM	National Association of Fan Manufacturers.
NBBPVI	National Board of Boiler and Pressure Vessel Inspectors.
NIBS	National Bureau of Standards.
NEC	National Electric Code.
NEMA	National Electrical Manufacturers Association.
NESC	National Electric Safety Code.
NETA	National Electrical Testing Association.
NFPA	National Fire Protection Association.
NSF	National Sanitation Foundation.
OSHA	Occupational Safety and Health Administration.
PPI	Plastic Pipe Institute.
PFI	Pipe Fabrication Institute.
RMA	Rubber Manufacturers Association.

SAE	Society of Automotive Engineers.
SDIS	Steel Deck Institute Standards.
SJIS	Steel Joist Institute Standard.
SMACNA	Sheet Metal and Air Conditioning Contractors National Association.
SSPC	Steel Structures Painting Council.
TEMA	Tubular Exchanger Manufacturers Association.
TIMA	Thermal Insulation Manufacturers Association.
UL	Underwriter Laboratories Incorporated.
UMC	Uniform Mechanical Code.
UPC	Uniform Plumbing Code.
UUBSAR	Utah Uniform Building Standard Act Rules, R156-56.

State of Utah Department of Environmental Quality

Juab County Ordinances and local municipal codes as applicable

Contractor shall obtain Owner approval for any deviations to these standards or alternative standards. Request for deviation or alternate shall include an explanation why such change is necessary and how compliance is to be achieved. Owner reserves the right to reject any such request for any reason. If Contractor discovers any conflict between any code, standard, or regulation, Contractor shall notify Owner of such conflict. Owner, in its sole discretion, shall then choose which provision shall take precedence over such conflicting provision.

SECTION 4.0
ENGINEERING SCOPE

4.1 GENERAL REQUIREMENTS

This Section covers the scope of the engineering services to be provided by the Contractor. Contractor (or Contractor's Engineer) shall perform all design engineering work including but not limited to the following items:

1. Prepare design documents, size equipment, generate drawings and specifications, and other supporting activities to the degree of detail required to fully and clearly define manufacturing and construction work requirements and minimize design engineering work in the field.
2. Prepare calculations as required for design decisions, equipment and material selection, and preparation of construction drawings.
3. Prepare system descriptions indicating equipment data, operating characteristics, functions, flow rates, and other process information for all plant systems.
4. Prepare mechanical, electrical, and instrument equipment lists with summary descriptions, vendors, and pertinent data.
5. Develop the detailed Site arrangement including provisions for locations of structures, equipment, and permanent access routes.
6. Develop and maintain a detailed electronic 3-D model of the plant. The 3-D model shall be used in design and in scheduled and unscheduled reviews and coordination meetings to assure that unnecessary interfences and rework are avoided.
7. Prepare arrangement drawings for Owner's Review and finalize arrangement drawings for construction.
8. Prepare Piping and Instrumentation Diagrams (P&ID's) for all Mechanical Plant Systems.
9. Provide all civil, electrical, instrument and control, mechanical, and structural construction drawings for the plant and supporting systems, including, but not limited to, the following:
   A. Site Arrangement.
   B. Plant Arrangement.

C. Control Room and Electrical Room Arrangements.

D. Access Roads, Curbs, Walkways, and Parking.

E. Evaporation and/or Retention Ponds (if required).

F. All Grading.

G. All Site Fencing.

H. Modifications to existing Wastewater Evaporative Ponds (if required).

I. Discharge Water Pipeline including discharge structure at Currant Creek.

J. Final overall water mass balance for Block 2.

K. All Drainage.

L. Foundations and Equipment Pads.

M. Ductbanks and Manholes.

N. Structural Steel, Platforms, and Stairs.

O. Architectural Plans, Elevations, and Details.

P. Water, Wastewater, and Water Discharge Supply and Treatment Systems.

Q. Equipment Location Plans and Elevations.

R. Above Grade Piping 2-1/2 Inches and Larger.

S. All Below Grade Piping.

T. Steam Blow and Cycle Flush Piping.

U. Pipe Supports Including Hanger Designs.

V. Conduit, Cable, and Raceway.

W. Fire Protection Systems.

X. One-Line Electrical Diagram.

Y. Three-line Electrical Diagram (generator and auxiliary voltages only).

Z. Underground Utilities and Yard Piping.

AA. Grounding Protection.

BB. Lightning Protection.

CC. OEM Packages.

DD. Lighting and Communication.

EE. Power and Control Wiring.

FF. CEM Systems.

GG. Instrument Location Plan and Installation Details

HH. Electrical Schematics and Interconnect Diagrams

II. Instrumentation Lists, DCS System Architecture Drawings to include all interfaces by hardwire and software to peripheral systems, DCS Control Loops, Logic Diagrams, Conceptual Graphic Displays, and related items.

10. Prepare technical specifications and other documentation to support all equipment procurement, materials, and construction requirements.
11. Obtain necessary plan approvals and building permits from appropriate state, county and local building authorities. Fees to building authorities shall be paid by Contractor.
12. Maintain a document control system on site from which updated documents and drawings shall be provided to the Owner as soon as update is issued.

All Architectural, Civil, Structural, Mechanical, Electrical, and Instrument and Control design documents that are issued for construction or procurement shall be prepared by or under the direct supervision of a registered professional engineer or architect according to the requirements in the State of Utah. Each engineer responsible for the design shall stamp or certify that the design documents have been prepared by or under his direction. Such design documents shall include, but are not limited to, all purchase and construction specifications, arrangement drawings, elevations, structural drawings, civil drawings, foundation designs, P&ID's, equipment arrangements, piping layouts, pipe stress analysis, electrical three-line diagrams, and electrical one-line diagrams.

Equipment, piping, valves, instrumentation etc. shall have consistent nomenclature throughout the documents.

Owner reserves the right to review all engineering documents and records produced by Contractor at any time.

A set of design and vendor drawings and specifications shall be issued to the Owner one year before the scheduled commercial date for use by the Owner's O&M team.

Contractor shall cause the design of the switchyard and transmission line to be performed by a consultant listed as a pre-qualified switchyard and transmission line engineering consultant in Appendix F. Design of the switchyard and transmission line shall be included in this Contract at Contractor's expense.

Upon completion of the Project, provide an as-built technical engineering library including all engineering calculations, design documents, and other technical records produced by Contractor. The as-built technical library shall be in hard copy and electronic form.

4.1.1 Architectural Design

Provide architectural design for all buildings, areas, and spaces described in these Specifications in accordance with the applicable specifications and code requirements.

Review local codes and prepare preliminary conceptual drawings for review by regulatory bodies to obtain building permits, and other permits for construction related activities.

4.1.2 Civil/Structural Design

Provide all design engineering and technical support for final arrangements, site grading, roads, site drainage, storm water diversion channels, parking, Site security, final paving, site improvements, site utilities, and construction surveys within the Site boundary.

Design yard piping and prepare yard piping drawings for all underground piping.

Provide all design engineering for construction facilities including access roads, laydown areas, parking lots, drainage, evaporation ponds, and construction utilities.

Provide analysis and detailed design for major plant equipment foundations.

Provide detailed design for structures including foundations, concrete and reinforcing steel, structural steel, platforms, stairs, and enclosures.

Provide architectural plans and sections for all building indicating general layout, permanent fixtures, finishes, and other architectural features.

4.1.3 Mechanical Design

Prepare plant heat balances to reflect in-progress and final design for both 2x1 and 1x1 operation. Heat balances shall be provided for Minimum Load, Base Load, and Peak Load (as defined in Section 1.3.1), with and without duct firing, operating at the following Ambient Conditions:

0°F, 20°F, 40°F, 51°F, 60°F, 80°F, 95°F and 100°F

Additionally, heat balances shall be provided for Bypass Load (as defined in Section 1.3.1) for -10°F and 100°F ambient conditions. Heat balances shall include evaporative cooling / chillers at temperatures at 59°F and above. If provided, heat balances should be provided reflecting this option. Company and EPC Contractor to agree on up to 50 heat balances.

Prepare plant water mass balances to reflect in-progress and final design for both 2x1 and 1x1 operation. Water balances shall be provided for Minimum Load, Base Load, and with duct firing. Company and EPC Contractor shall agree on the conditions to be used for preparing the water balances.

Prepare plant flow diagrams to reflect proposed, in-progress, and final design.

Clearances shall be provided around equipment for ease of operation and maintenance in accordance with OSHA requirements and good engineering practices.

Prepare P&ID's showing equipment, equipment tag numbers, piping, pipe line numbers, valves, valve tag numbers, piping specials, system codes, connection numbers, heat tracing, equipment sizing/key performance, line sizes, valve sizes, material references, insulation references, instruments and controls, and conceptual control logic. Pipe material, wall thickness, and insulation required shall be included in the pipeline list with references to pipeline codes on the P&ID's.

Prepare plant equipment arrangements and elevations dimensionally locating centerlines of all equipment included in the plant in all planes.

Prepare equipment installation detail drawings for all plant equipment.

Prepare detailed isometric drawings showing above grade piping 2-1/2 inches in diameter and larger. Isometrics shall include dimensional information necessary to fabricate the piping and shall indicate piping line tags, pipe sizes, instrument connections, and attachments such as welded lugs. Isometrics shall include a detailed Bill of Material with material quantities and specifications for all materials required to fabricate the piping. Standard details shall be provided to show insulation supports and weld end preparation details. Piping 2 inches in diameter and smaller shall be shown schematically on appropriate drawings.

Design and provide schematics and plan drawings for all plant plumbing systems.

Design pipe hanger systems for piping 2-1/2 inches in diameter and larger and for pipe 2 inches and smaller that operates at greater than 300^{o}F. The location for each hanger shall be shown on the piping drawings for space control and for coordination with other equipment and components. Provide detailed hanger design drawings indicating the hanger installation requirements and including a detailed Bill of Materials with all component specifications indicated.

Provide design engineering and prepare drawings for plant facility HVAC systems.

Provide design engineering and prepare drawings for fire protection and control systems for plant facilities.

Design all piping and equipment insulation and lagging systems.

4.1.4 Special HRSG Requirements - Life Assessment and Other Analyses Required Prior to Release for HRSG Fabrication

A Life Assessment and Other analyses, as described herein, shall be performed prior to release for fabrication of the HRSG.

Purpose: The purpose of this section is to consolidate all the issues concerning life assessment and other structural/mechanical analysis requirements. It is also the intent of this section to put forth a basic understanding of key issues, what items shall be addressed and the suggested methodology to be used.

Methods for Performing Fatigue Life Assessment and Other Analyses Required: The European Standard for Water-Tube Boilers EN 12952-3, Section 13 – Fatigue shall be used to perform the fatigue assessment. The fatigue evaluation shall utilize the stress concentration factors in EN 12952-3 Clauses 13.4.5 and 13.4.7. The results shall be provided in tabular form per Annex C. Allowable superheater outlet header steam temperature ramp rates and inner surface to midwall ΔTs, allowable saturation temperature with corresponding pressure ramp rates, and allowable HP drum inner surface to midwall ΔTs versus HP pressure curves are to be provided for use in DCS programming. The life fraction for fatigue per the EN standard is allowed to go to 1.0, but for this evaluation all curves shall be based on an end-of-life expenditure after completing all of the specified design numbers of cold-ambient, cold, warm and hot startup-shutdown cycles using a life fraction (LF) of 0.75 for the HP Drum. For the HP superheater and reheater outlet headers the end-of-life LF shall be limited to 0.12 to account for severe creep-fatigue interaction. The EN code calculation incorporates factors of 1.5 on stress and 10 on cycles which are inappropriately termed "safety" factors but actually only account for normal deviations from measured mean fatigue endurance properties.

The Owner shall retain the right to require additional analyses after the CTG model, steam turbine model and selected HRSG design details are known.

Operating Curve Data: Curves of maximum permissible inner-wall to mid-wall ΔT for the HP superheater outlet headers and HP drum wall, and also for the HP drum top mid-wall to bottom mid-wall ΔT as well as predicted start up curves of HP superheater and reheater outlet steam pressures, temperatures and flows versus time during each of cold ambient, cold, warm and hot startups and normal shutdowns for the HRSG based on the specified number of design shutdown-startup cycles shall be provided. This information is provided to Owner for information purposes and for evaluation of anticipated actual operating requirements.

Components That Shall be Included in the Basic Fatigue Life Assessment Evaluation

- HP Superheater Outlet Header Nozzle and Tube Attachments.
- HP Superheater Outlet Manifold with branch connections.
- Reheater Outlet Header Nozzle and Tube Attachments.
- HP Drum Nozzle Attachments.

Operating Life and Cycle Requirements

The Life Assessment Evaluations shall be based on the following operating life and estimated cycles:

- Design Life: 40 years.
- Operating hours: 6000 hours/year or 240,000 hours/40 years.
- Cycles as described in Section 1.1.2 and as follows:

1. CTG load changes: 1,500/year or 60,000 total excluding startups and shutdowns.
2. CTG Trips with Hot Restart in 2 hours: 5/year or 200 total.
3. Load rejections to house load: 1/year or 40 total.
4. Rapid HRSG cool down for emergency access: 4/year or 160 total (for information purposes only).

- Actual CTG start up and shutdown curves for the model selected shall be utilized in the analysis. All operating conditions as defined in the HRSG Life Assessment Checklist shall be addressed in the curves.
- Transient operation of the HRSG shall be evaluated based on the EPC Contractor's start up curves to determine the response of critical components to the defined events.
- Life Fractions per special event such as CTG Trips, Load Rejections and Emergency Shutdowns shall be provided.

Tube-to-tube temperature difference: Before materials are purchased or manufacture commences, if required by the Owner, calculations that demonstrate that the previously submitted side-to-side tube design limit temperature differences are compatible with the design life specified shall be provided.

Temporary tube temperature thermocouples in the economizers, superheaters and reheaters to verify that peak temperature differences between tubes in the same row remain at all times within the design limit shall be provided. Where measurements, taken during commissioning, indicate that temperature differences between tubes in the same row differ, even transiently, by more than the design limit nominated previously by the Contractor, the Contractor shall demonstrate by calculation methods acceptable to Owner that the components meet the specified design cyclic life. If the Owner is not satisfied by the calculation results or methods, Contractor shall implement, at his expense, design modifications necessary to reduce the tube temperature differences to achieve the specified cyclic design life.

High-Pressure Superheater and Reheater Drain Systems: A written description of the methodology used to determine the appropriate drain sizes shall be provided with the first drawing submittal.

Attemperators: Before materials are purchased or manufacture commences, the following shall be provided, for the Owner's approval:

- Description of the control logic proposed for the HP superheater and reheater interstage attemperators.
- Results of a series of steady state heat balance models, and a series of dynamic heat balance models, across the CTG and duct burner load ranges to demonstrate to the Owner that the proposed combined HP superheater and reheater heating surface arrangement is thermodynamically capable of maintaining the minimum required superheat of 50ºF (28ºK) at the attemperator outlets while also avoiding overshoot of HRSG design outlet steam temperatures as the CTG is loaded during startup, and the duct burner is loaded to maximum heat input after the CTG has reached full load.
- Description of the methods used to run the foregoing heat balance models.
- Detailed results from those heat balance case sets for dynamic conditions at startups when superheat at superheater attemperator outlet is closest to the minimum acceptable superheat of 50º F (28º K).
- The design temperature rise during full load operation to be achieved in the primary HP superheater stated as a percentage of the sum of the temperature rises in each HP superheater section.
- The design temperature rise during full load operation to be achieved in the secondary HP superheater stated as a percentage of the sum of the temperature rises in each HP superheater section.
- The design temperature rise during full load operation to be achieved in the primary reheater stated as a percentage of the sum of the temperature rises in each reheater section.
- The design temperature rise during full load operation to be achieved in the secondary reheater stated as a percentage of sum of the temperature rises in each reheater section.
- Proposed attemperator hardware selection.
- Proposed HP superheater and reheater attemperator turndown ratios, and anticipated minimum and maximum spray-water flows, and proposed design values to be specified for superheater and reheater attemperators.

Steam Drums: Before materials are purchased or manufacture commences, the Contractor shall provide, for the Owner's approval, the results of calculations and the methods used in sizing the HP, IP and LP steam drums, including a transient analysis. All assumptions, parameters, and capacity requirements including number of minutes of feed flow available at baseload flow, with and without duct firing between normal working level and low water alarm level, also between high alarm level and low alarm level, shall be clearly indicated in the calculations.

Analysis and Modeling – Duct Burners

The Contractor shall provide the results of CFD analysis to demonstrate that the exhaust gas velocity profile into the duct burner remains within the duct burner OEM's requirements under all operating conditions where duct burners may be operating.

The Contractor shall demonstrate to the Owner's satisfaction that the CFD model's accuracy, relative to the proposed design, has been adequately verified via field-testing on a similar unit.

The Contractor shall run a set of heat balance models, across the duct burner turndown range, to confirm that exhaust gas temperatures into the duct burner remain within the requirements of the duct burner supplier under all steady state operating conditions with duct burners firing, and during transient conditions with the duct burner ramping up its load at the maximum rate specified by the duct burner supplier. The dynamic analyses shall introduce a fictitious "leak" between the HP evaporator and the primary superheater to simulate the time lag in additional steam production (and time lag before increase in superheater steam flow rate) measured during field tests on similar HRSGs with similar duct firing during rapid loading of the duct burner. The Contractor shall determine, using these analyses or field tests or other methods approved by the Owner, the maximum duct burner load ramp-up rate permitted to maintain metal temperatures in the first heat transfer coil downstream of the duct burner within design limits. The Contractor shall specify the maximum duct burner load ramp-up rate permissible and the metal temperatures (fin and tube) in the downstream tube row on which it is based. The DCS shall be configured to limit duct burner firing ramp rate to this maximum value.

The Contractor shall perform analyses as necessary to determine peak flame temperatures, maximum flame lengths, and verify that no flame impingement will occur during any steady state or transient operating condition. The Contractor shall present the results of such analyses for acceptance by the Owner prior to release for fabrication.

4.1.5 Electrical Design

Prepare a complete set of plant one-line diagrams of electrical systems rated at 480 volts and higher and a complete set of three-line diagrams for the medium voltage (including generator voltage) electrical system.

Prepare reports documenting electrical system studies performed for equipment selection, grounding design, cable sizing, and protective relay settings.

Prepare conduit, cable and raceway arrangement drawings for conduit, electrical cable trays, wire ways, and underground duct banks.

Prepare grounding drawings showing grounding method and connections to all equipment and building structures.

Prepare raceway and circuit lists for electrical and instrumentation installation and termination as required for construction only.

Prepare schematic/wiring/interconnection diagrams showing schematics and terminations for cables including all external connection terminal block numbers. Wiring drawings shall include connection drawings both internal and external, NEMA Standard across-the-line industrial control schematic drawings for all control systems provided or designed by Contractor, physical location drawings for all terminal blocks, power requirements, and other related items. Final electrical drawings shall include circuit numbers, wire designations, and similar features, marked on approval drawings by Engineer. Electrical drawings made for this Project shall have NEMA Standard symbols.

Provide power and instrument transformer connection and polarity diagrams.

Provide bushing and lightning arrestor outline drawings for switchgear and surge protection equipment.

Prepare lighting and communication system drawings.

Prepare power distribution drawings.

Prepare lightning protection and cathodic protection drawings.

4.1.6 Instrumentation and Controls Design

Contractor shall:

1. Provide design engineering for fully integrated microprocessor based Distributed Control Systems (DCS) to provide control, alarm, historical data archiving and performance monitoring functions for the major plant systems. Contractor shall design and specify all plant instrumentation, control, and monitoring devices.
2. Prepare contract instrumentation Lists.
3. Prepare DCS style logic diagrams for all control algorithms executed within the DCS.
4. Prepare control narratives to describe DCS logic on a system-by-system basis and keep updated as the control logic changes.
5. Prepare Instrument Installation Details.
6. Prepare location plans for all field devices including, but not limited to, control valves, transmitters, thermocouples, pressure and temperature gauges and flow elements.
7. Develop instrument data sheets for review and future use by Owner.
8. Design duct burner management systems including purge, burner control, and fuel safety systems.
9. Design CEMS systems as required by the project air quality permits and 40 CFR 60 and 40 CFR 75.
10. Design communications links for all FDIs (Foreign Device Interfaces) including, but not limited to, Fuel Gas Regulating Station Flow Computer, miscellaneous PLCs, and Remote Dispatching RTU.

4.2 DESIGN REVIEWS

Design Reviews shall be performed jointly by Contractor and Owner as part of the engineering execution of the work. PDS Model review will be the primary mechanism used for review of physical plant features. Design reviews will take place when engineering is about 20 percent, 50 percent, and 70 percent complete.

The Contractor and HRSG Supplier shall make the appropriate technical people available to the Owner, or his representative, for meetings and discussions necessary to expedite the review.

4.3 DRAWING AND SPECIFICATION REQUIREMENTS

The type, preparation, approval, indexing, and distribution of drawings, specifications, and data shall be governed by this section. Drawings and specifications shall be sufficiently complete to ensure that the Project will conform fully to the requirements of these Specifications and the Contract. All final drawings and specifications shall be provided on an indexed compact disk (CD). Final as-built drawings, including OEM drawings, shall be submitted to Owner on CDs per PacifiCorp drawing standards as referenced below. All drawings shall be in the same version of the software. Contractor's specifications shall be prepared using Microsoft Word 2007 software. All drawings, including also OEM and sub-vendor system drawings, shall reference and be compatible with all interfacing drawings. Drawings (both electronic and hard copy) shall be modified to show the complete as-built facilities, including any modifications made to the facility during the warranty period resulting from defects corrected under the warranty. Quantities of copies to be provided are listed in Table 4.3-1.

All documents, drawings, and other engineering deliverables shall be provided in accordance with Appendix N - "Engineering Documents, Drawings and Other Deliverables". All drawings shall be prepared per PacifiCorp Energy's Drafting Standards and Documents (zip file entitled "PCorpThermalStandardsVendor.zip").

4.3.1 Drawing and Specification Schedule

Contractor shall submit a Drawing and Specification Schedule to the Owner for review.

The Drawing and Specification Schedule shall list all drawings and specifications to be produced by Contractor and shall include, but is not limited to, the following information:

1. Schedule date for the first issue for Owner's Review.
2. Schedule date for return of Owner's Review comments.
3. Schedule date for issue for design, procurement, or construction.
4. Actual date of issue.
5. Actual revision dates.

Contractor shall revise and submit to Owner the Drawing and Specification Schedule monthly, including notation of approval dates, revisions, additions, and deletions.

4.3.2 Drawing and Specification Submittals

Contractor shall submit timely and descriptive information, which relates to the technical aspects of the Scope of Work set forth in the Contract. Such submittals shall be adequate to convey to Owner system arrangement, operating modes, output performance, emission control, selection of construction materials, and all other information as required by Owner to determine Contractor adherence to these Specifications.

Submittals shall be of suitable quality for legibility and reproduction purposes. Every line, character, and letter shall be clearly legible. All words and dimensional units shall be in the English language or in English units. Where standard documents are furnished which cover a number of variations of the general class of equipment, the document shall be annotated to clearly indicate exactly which parts of the drawing apply to the item for which the Submittal is intended. If conforming Submittals cannot be obtained, such documents shall be retraced, redrawn, or photographically restored as necessary to meet these requirements. Contractor's failure to satisfy the legibility requirements will not relieve Contractor from meeting the required schedule for submittal nor will it be cause for delay in the Project schedule.

All submittals for design, Owner reviews, or information shall be in Adobe Acrobat PDF format. All final "as-built" drawings for record shall be AutoCAD format per these specifications. Identify each Submittal by Project name and number, and indicate equipment or component tag number on each submittal drawing or document.

Owner will, by a notice to Contractor, classify the reviewed submittal to indicate the acceptance or rejection of the documents. Following are definitions of the action categories which will be used by the Owner and the associated meaning and requirements of the Contractor:

1. REVIEWED – NO COMMENT – Signifies that Equipment or Material represented by the Submittal conform to the design concept, comply with the intent of the Contract and Specifications, and are acceptable for incorporation in the Work. Contractor is to proceed with Work based upon

the content of the Submittal. Final copies of the Submittal shall be transmitted to Owner as indicated below.

2. REVIEWED – NOTE COMMENTS – Signifies that Equipment or Material represented by the Submittal conform to the design concept, comply with the intent of the Contract and Specifications, and are acceptable for incorporation in the Work with Owner's comments indicated. Contractor is to proceed with Work based upon the content of the Submittal with all comments incorporated. Contractor shall submit a revised Submittal responsive to Owner's comments.
3. REJECTED – INADEQUATE INFORMATION – Signifies that Equipment or Material represented by the Submittal appear to conform to the design concept and appear to comply with the intent of the Contract and Specifications. However, the Submittal is lacking in adequate detail and information or contains discrepancies, which prevent Owner from completing his review. Contractor shall not proceed with Work until Owner approval is obtained. Contractor shall revise the Submittal responsive to Owner's comments and resubmit for approval.
4. REJECTED – NOTE COMMENTS – Signifies that Equipment or Material represented by the Submittal do not conform to the design concept, do not comply with the intent of the Contract and Specifications, and are disapproved for incorporation in the Work. Contractor shall not proceed with Work until Owner approval is obtained. Contractor shall revise the Submittal responsive to Owner's comments and resubmit for approval.
5. FOR REFERENCE, NO APPROVAL REQUIRED – Signifies the Submittals are for supplementary information only. Owner reviews such Submittals for general content, but not for substance.
6. FINAL – Signifies that Submittal has been previously approved and is being accepted as a final Submittal. Submittal is approved for incorporation by Contractor into the final project documents (O&M manuals, Technical Libraries, etc).

In resubmitting a Submittal which has been reviewed by Owner subject to compliance with comments, or which has been disapproved by Owner, Contractor shall state the action taken on each comment by indicating in his forwarding letter that the comment has been complied with, or by explaining why the requested alternative was not made, and Contractor is proceeding at his own risk.

Resubmit Submittals the number of times required to obtain the REVIEWED – NO COMMENT action on the Submittal. Allow the Owner the time indicated above in the Drawing and Specification Schedule section for each submittal and resubmittal. The requirement for any number of resubmittals will not be grounds for an extension in Key Dates provided the Owner completes his reviews in the time frame specified.

Any resubmittal incorporating changes from the previous submittal shall have changes clearly marked or highlighted in both the hard copies and the electronic format. Any changes made to equipment or systems after receiving approval shall be indicated on the documents and the documents resubmitted for approval.

Contractor shall provide the quantities of Submittals indicated in the following and in the format indicated or in a format approved by Owner in the Project Administration Manual per 4.3.5 of this section:

DOCUMENT FORMAT & QUANTITY
Table 4.3-1

Type	**Abbreviation**	**Prints**	**Ftp Server**	**To**
Issue for Owner's Review	IOR	1	1	Owner
Issue for Information	IFI	1	1	Owner
Issue for Design	IFD	1	1	Owner
Revisions	REV	1	1	Owner
Issue for Bids	IFB	1	1	Owner
Issue for Purchase	IFP	1	1	Owner
Issue for Construction	IFC	1	1	Owner
As-Built	AB	1	3 on CD	Owner

The documents to be submitted by Contractor shall include but are not limited to the following:

Mechanical Submittals Table 4.3-2	
Submittal Description	**Schedule**
Heat and mass balances for all guarantee points and minimum and maximum site conditions at Peak Load, Base Load and Minimum Load.	IOR, IFC, REV,IFD, AB
Plant fuel consumption at guarantee points and for Peak Load, Base Load, and Minimum Load.	IOR, IFC, REV, IFD, AB
Water balances for guarantee points and minimum and maximum site conditions	IOR, IFC, REV, IFD, AB
P & Ids	IOR, IFC, REV, IFD, AB
System Descriptions	IOR, IFC, REV, AB
Equipment arrangements and locations	IOR, IFC, REV, IFD, AB
Piping Plans & Sections	IOR, IFI, IFC, REV, AB
Piping Isometrics	IFI, IFC, REV, AB
Hanger Location Drawings	IFI, IFC, REV, AB
Hanger Detail Drawings	IFI, IFC, REV, AB
Steam blow and cycle flush piping (temporary piping)	IOR, IFC, REV
Fire system drawings	IOR, IFC, REV, AB
Piping Line List	IOR, IFC, REV, AB
Equipment list	IOR, IFC, REV, AB
HVAC layout	IOR, IFC, REV,IFD, AB
Procurement specifications	IOR, IFB, IFP, REV
Construction specifications	IOR, IFC, REV
Startup, commissioning, and test procedures	IOR, IFC, REV

Mechanical Submittals Table 4.3-2	
Submittal Description	**Schedule**
All vendor drawings and submittals (P&ID's, electrical one-lines and equipment outlines for review, all other drawings for information)	IOR, IFC, REV, IFI, AB
Operation and Maintenance Manuals	IOR, IFC, REV, AB
Pipe Stress Analysis	IFI, IFC, REV
Calculations or methodology to determine HRSG drain design to meet specified drain time.	IOR
Fatigue Life Assessment	IOR
Methods for Performing Fatigue Life Assessment and Other Analyses	IOR
Max Delta T Operating Curve Data	IOR
Life Cycle Calculations	IOR
Tube to Tube Temperature Difference Calculations	IOR
Specified Attemperator Analyses	IOR
Steam Drum Calculations	IOR
Duct Burner CFD Analyses	IOR
All pump characteristic curves	IFI, IFC, REV, AB
List of all Special Tools for construction and maintenance	IFI, IFC, REV
Requirements for storage and protection of equipment	IFI, IFC, REV
Valve list	IFI, IFC, REV, AB
Lubrication list	IFI, IFC, REV, AB
Chemicals and Consumables list	IFI, IFC, REV, AB

Civil Submittals Table 4.3-3	
Submittal Description	**Schedule**
Site arrangement	IOR, IFC, REV, IFD, AB
Plant arrangement	IOR, IFC, REV, IFD, AB
Access roads, curbs, parking, walkways, and fencing	IOR, IFC, REV, IFD, AB
Grading Plans and Topography	IOR, IFC, REV, IFD, AB
Wastewater and Water Discharge Ponds (including modifications to existing evaporation basins) Design and Plans	IOR, IFC, REV, IFD, AB
Construction Drainage Plan	IOR, IFC, REV
Final Drainage Plan	IOR, IFC, REV, AB
Water Discharge Structure Design and Plans	IOR, IFC, REV, AB
Yard piping, including water discharge to Currant Creek	IOR, IFC, REV, AB
Underground electrical duct bank	IOR, IFC, REV, AB
Site construction utilities	IFI, IFC, REV
All Site surveys	IFI, IFC, REV
Laydown and temporary facility Plans	IOR, IFC, REV
All construction specifications	IOR, IFC, REV
Geotechnical Reports	IFI, IFC, REV

Electrical Submittals Table 4.3-4	
Submittal Description	**Schedule**
Electrical Plans and Elevations	IOR, IFC, REV, AB
Conduit, cable, and raceways	IOR, IFC, REV, AB

Electrical Submittals Table 4.3-4	
Submittal Description	**Schedule**
One-Line Diagrams	IOR, IFC, REV,IFD, AB
Three-Line Diagrams (generator and auxiliary medium voltages only)	IOR, IFC, REV, AB
All electrical Calculations including short circuit, load flow, relay coordination studies, etc.	IOR, REV
All Lighting and Communication Drawings	IOR, IFC, REV, AB
Plant Grounding System and Lightning Protection	IFI, IFC, REV, AB
Power and Control Wiring Diagrams	IOR, IFC, REV, AB
Electrical Schematics and Connections	IFI, IFC, REV, AB
Motor List	IFI, IFC, REV
All Motor Manufacturer's Data	IFI, IFC, REV
Switchboard Panel Layout	IOR, IFC, REV
Procurement Specifications	IFB, IFP, REV
Vendor Drawings (one-line and outline drawings as well as vendor manuals for review all other for information)	IOR,IFI, REV, IFC, AB

Instrument and Controls Submittals Table 4.3-5	
Submittal Description	**Schedule**
Instrument list	IFI, IFC, REV, AB
Control Valve and Relief Valve Lists	IFI, IFC, REV, AB
All Procurement Specifications including data sheets for all instruments, control valves, and relief valves	IFB, IFP, REV

Instrument and Controls Submittals Table 4.3-5	
Submittal Description	**Schedule**
Control System Architecture Diagram	IFB, IOR, IFC, REV, AB
DCS Control Loops	IOR, IFC, REV, AB
Control Logic Diagrams and Control Narratives	IOR, IFC, REV, AB
Conceptual and Final Graphic Displays	IOR, IFC, REV, AB
Instrument Loop Diagrams	IFI, IFC, REV, AB
All Vendor Drawings and Data	IOR, IFC, REV
Instrument location plans	IOR, IFC, REV, AB
Instrument installation details	IOR, IFC, REV

Structural Submittals Table 4.3-6	
Submittal Description	**Schedule**
All Structural Steel Design Drawings	IOR, IFC, REV, AB
Foundation Location Plans and Foundation Drawings	IOR, IFC, REV, AB
All Structural Steel Fabrication Drawings	IFI, IFC, REV
All Rebar Drawings	IFI, IFC, REV
All Structural Calculations	IFI, IFC, REV
All Procurement Specifications	IFB, IFP, REV
All Construction Specifications	IOR, IFC, REV
Foundation Design Calculations	IFI, IFC, REV
All Structural Material Specifications	IFI, IFC, REV

Architectural Submittals Table 4.3-7	
Submittal Description	**Schedule**
Building Layout Drawings	IOR, IFC, REV, AB
Building Architectural Drawings	IOR, IFC, REV, AB
Building Interior and Exterior Finish Samples and Color Samples	IOR, IFC, REV
Building Technical Specifications	IOR, IFC, REV

Miscellaneous Submittals Table 4.3-8	
Submittal Description	**Schedule**
Plant Manuals	IOR, IFI, REV, AB
Manufacturers Instruction Books	IOR, IFI, REV
Start Up, Commissioning, and Test Procedures	IOR, IFI, REV
Critical Path Schedule	IOR, IFI, REV (monthly)
Project Status Reports	IOR, IFI (monthly)
Plant Administrative Manuals	IOR, IFI, REV
Project Summary Book	AB

Distribution of drawings shall be to multiple parties as defined in the Project Administration Manual.

4.3.3 Plant Manual and Instruction Books

Plant Manual

Manufacturers instruction books shall be integrated into a single plant manual with multiple volumes and provided final on five (5) CD copies in MS Word and/or PDF format and five (5) printed paper copies sized to fit a standard three-ring binder. All paper copies of the manual shall be thoroughly indexed and placed in high quality binders with volumes and content clearly marked on the cover and spine.

The plant manual shall contain site specific information on the plant operation. Normal operating sequences (including startup and shutdown) shall be described together with normal running inspections for all supplied equipment and systems. Cold, Warm, and Hot startup sequences and shutdown sequences shall be described in sufficient detail to identify all major steps, timeline for the steps, initiation of the step (i.e. operator, OEM controls system or DCS), permissive criteria for initiating the step, and mode of control for the step (i.e. OEM control system, DCS, manual). Troubleshooting and diagnostic recommendations shall also be included. Special notes and cautionary statements shall be included and highlighted throughout the manual to enable easy recognition of special procedures and techniques which must be followed to ensure correctness and safety for equipment and personnel. Two review copies of the manual shall be submitted for Owner review and approval 90 days before start of training and final copies shall be submitted within 30 days of receipt of Owner comments.

Plant manual shall contain the latest as-built information for the facility. Contractor shall obtain all as-built information for all vendors' equipment including Owner purchased equipment. Manuals (both hard copy and electronic) shall be updated with any modifications to equipment or systems made to the facility during the warranty period resulting from defects corrected under the warranty. Equipment, instrument, and parts lists shall be provided in Excel format (latest version). Parts list shall have been reviewed by Contractor, then submitted to Owner and reviewed and approved before initial submittal of the Plant Manual (90 days before start of training).

Manufacturer's Instruction Books

Manufacturer's instruction books shall be provided for all electrical, mechanical, hydraulic, pneumatic, and electronic equipment and instrumentation that requires explicit information and instruction for proper operation and maintenance. Instruction books shall be integrated into a plant manual as described above.

Commercial documents are acceptable to Owner, provided that the specific equipment used in the construction is clearly identified and that the following are included for all components and sub-components of a complex assembly:

1. Installation, start-up and initial test instructions.
2. Manufacturer Test Reports.
3. Start-up Test Reports.
4. Operating instructions, including safety precautions.
5. Maintenance procedures and routine adjustments.
6. Parts illustrations, including parts lists adequate for the purpose of identifying and ordering replacement parts and lists of recommended spare parts for three (3) years of operation of any given component.
7. Wiring schematics for electrical equipment.
8. Hydraulic diagrams for hydraulic equipment.
9. Detailed descriptions of the functions of each principal component of a system.
10. Performance and nameplate data.
11. Alignment instructions if required.
12. Safety precautions.
13. Maintenance and major overhaul instructions, which shall include detailed assembly drawings with parts numbers, parts lists, instructions for ordering spare parts, and complete preventative maintenance instructions required to ensure satisfactory performance and longevity of the equipment involved.
14. Lubrication instructions, which shall list points to be greased or oiled, shall recommend type, grade, and temperature range of lubricants, and shall recommend frequency of lubrication.

4.3.4 System Startup & Commissioning Test Procedures and Reports

Startup and commissioning test procedures and reports shall be prepared by Contractor for all systems in accordance with the Contract and submitted for Owner review and approval 90 days before startup and commissioning is to begin. These procedures shall identify step-by-step actions to be taken to verify that systems operate in accordance with design intent and that all protection, control, indication and alarm functions are operational. Design criteria and acceptable levels (flow, pressure, temperature, and time as appropriate) shall be identified in the procedure and provisions for recording of actual criteria observed during the startup will be included. Each step upon its completion shall require a signoff of both Contractor's Test Engineer and Owner's Representative. Five

(5) hard copies and three (3) CD of the test procedures and of the test results shall be provided to Owner.

4.3.5 Project Administration Manual

Within 60 Days of notice to proceed, Contractor shall prepare and submit for approval a Project Administration Manual indicating a responsibility matrix; key Project contacts; document distributions; Project scope; Project organization; execution plan; administrative procedures; quality control procedures; Project schedule; equipment, piping, and instrument tagging procedures; design criteria; and other key Project administration functions.

4.3.6 Critical Path Schedule

Contractor shall provide to Owner and update monthly a Critical Path Schedule per the Contract. Critical Path Schedule shall satisfy the requirements set forth in the Contract.

4.3.7 Project Status Reports

Contractor shall prepare and submit to Owner monthly Project Status Reports.

4.3.8 Project Summary Book

The Contractor shall furnish a Project Summary Book. The Project Summary Book shall be submitted for Owner review 30 days after completion of performance and emissions tests and final copies shall be submitted 30 days after receipt of Owner comments. The Project Summary Book shall include the following:

1. Project description with descriptions of all systems and capacities of major equipment including equipment data, operating characteristics, functions, flow rates, and other process information for all plant systems.
2. Plant arrangement drawings.
3. Site arrangement drawings.
4. P&IDs.
5. Pipeline list.
6. Electrical one-line drawings.
7. Electrical load list.
8. Auxiliary load calculation.

9. Mechanical, electrical, and instrument lists with summary descriptions, vendors, and pertinent data.
10. Heat balance diagrams.
11. Water mass balance diagrams.
12. "As-built" project milestone schedule.
13. Procurement packages list with summary of major equipment and manufacturers.
14. Performance Test Report.
15. Emissions Test report.
16. List of permits obtained by Contractor.
17. Index of Contractor drawings.

The final Project Summary Book shall be provided final on five (5) CD copies in MS Word and/or PDF format and five (5) printed paper copies sized to fit a standard three-ring binder. All paper copies shall be thoroughly indexed and placed in high quality binders with volumes and content clearly marked on the cover and spine.

4.3.9 Coordination Meetings

Representatives of Contractor shall attend coordination meetings relative to the progress and execution of this Contract. At the initial meeting, Contractor shall present a plan including, but not limited to, the following: safety, project design parameters, constraints, assumptions, sequence and methods to be used in all phases of design; and detailed Project schedule showing major activities for each system for the entire Project.

Contractor and any other parties involved in the construction of the Project shall attend such pre-construction meetings as may be requested by Owner. At the initial meeting, Contractor shall present a construction plan including, but not limited to, the following: safety, procurement plan, major equipment receipt plan, construction sequence, methods and equipment to be used in all phases, tentative access and right-of-way roads, locations of staging areas, regrading of roads, moving of equipment/property that will interfere or impact construction and a construction schedule showing all activities for the entire construction phase of the Project.

Contractor shall be responsible for contacting all involved utility companies prior to starting any work to determine schedule of work and location of all temporary and permanent facilities in the Project area.

Contractor shall prepare an outage plan for all scheduled interruptions of electrical power or other utilities interference that would affect the Currant Creek operating plant. This plan shall be submitted by Contractor to Owner for approval at least 30 days prior to outage. The plan shall include all reasonable efforts shall be taken to minimize impact on existing operations including sequencing of work to minimize outage time and work during off peak hours such as night and weekends.

Representatives of Contractor shall attend weekly coordination meetings to discuss matters relative to the progress and execution of the construction and startup of the Project. Current week progress and three-week look ahead schedules shall be presented by the Contractor and reviewed at these meetings in addition to other Site coordination items.

Contractor Acquired Permits

Contractor shall provide Owner three (3) copies of all Contractor Acquired Permit applications as they are being submitted to the responsible agency. Contractor shall provide Owner two (2) copies of all issued Contractor Acquired Permits upon approval from the responsible agency.

4.4 QUALITY ASSURANCE

Provide all equipment and products conforming to applicable Specifications, codes, standards, and requirements of regulatory agencies.

Design, fabricate, and assemble in accordance with the best engineering and shop practices.

Owner and Owner's representative shall have the right to inspect equipment and work at any time or place.

Contractor shall furnish all factory and field test procedures and reports to Owner for information.

At Owner's request, Contractor shall make available all manufacturers quality control documentation.

Contractor shall notify Owner of all Witness Tests at least two weeks in advance of such tests. Owner or Owner's representative may choose to witness test at no additional cost or schedule impact. Contractor shall provide list and schedule of Witness Tests to Owner for review.

SECTION 5.0
MECHANICAL SCOPE

5.1 GENERAL REQUIREMENTS

This section provides requirements for major mechanical equipment, mechanical systems, and mechanical interfaces with other plant systems and off-Site facilities.

It is the intent of this specification that the plant shall be operated at all times and during all transients within the design basis and supplier's recommendations of all equipment and systems. The EPC Contractor shall ensure that no conflicting or out of limit design or operating conditions exist between any plant equipment and/or systems during all transient operating conditions, normal and predictable occasional abnormal, as well as steady state conditions. Where abnormal operating conditions due to casualty of equipment or operator error could expose the equipment to out of limit operation the EPC Contractor shall provide effective means to automatically detect and prevent out of limit operation. Particular attention shall be given to effective integration between major equipment (CTG, HRSG, ST, Condenser, Dump Systems, etc.) during all transient and steady state operating conditions. The EPC Contractor shall coordinate the activities of other contractors and suppliers in optimizing integration of plant systems and equipment.

5.1.1 General Sizing Criteria

All mechanical equipment and systems shall be designed to continuously operate in a stable manner at all operating conditions from Peak Load to Minimum Load including full STG bypass mode. Mechanical equipment, systems, and piping shall be sized based on the operating performance parameters (pressure, temperature, flow rate, and the like) contained in Contractor's heat balances. Contractor shall evaluate the Project for the full range of operating loads including Peak Load, Base Load, and Minimum Load at the full range of design ambient conditions to determine the equipment and system sizing criteria. Contractor shall evaluate and define transient operating conditions (i.e. startup, shut down and plant trip scenarios) in design of mechanical systems.

All equipment shall have sufficient design margins based upon good engineering practice. Following is a listing of the minimum design margins for select equipment and systems that shall be applied to the sizing criteria conditions (flow, head, duty, and the like):

Equipment/System	Minimum Design Margin
General Service Pump	10 percent flow, 5 percent head
Condensate Pumps	5 percent flow, 10 percent head
Boiler Feed Pumps	5 percent flow, 5 percent head
Closed Cooling Water Pumps	10 percent flow, 5 percent head
Closed Loop Heat Exchangers	15% Excess Heat Transfer Area
Fuel Gas Supply	5 percent flow at lowest anticipated heating value and pressure.

Line sizes and equipment capacities shall be determined based on flow rates and the specific performance criteria for each system. All sizing values (flow, horsepower, temperature, pressure, diameter, etc.) contained in these Technical Specifications and Conceptual Design Documents contained in Appendices B through E are preliminary. Contractor shall be responsible for final sizing and providing all mechanical equipment, systems, and piping to meet all requirements specified herein.

5.1.2 Piping

Contractor shall size lines to provide fluid velocities that are in accordance with good engineering practice. The following tables indicate maximum pipeline velocity guidelines that shall not be exceeded without Owner's approval. The final selection and specification of piping materials shall be suitable for long term durability and shall satisfy all system design and code requirements.

Table 1

Recommended Maximum Steam & Gas Velocities in Pipes

Notes:

(1) All steam and gas velocities are specified in feet per minute.

(2) For pipe sizes between tabular values, velocity associated with the larger pipe size may be used.

(3) For all compressible fluids, the following constraints shall be met:

- System differential pressure requirements must be satisfied. In many cases, this will constrain pipe size.

- Equipment velocity limitations must be satisfied.

- Noise requirements may constrain velocity in some cases, most notably in non-small bore air piping.

(4) System specific allowable velocities shall be used where available and shall supersede the velocities provided herein:

(5) This note only applies where specifically stated as being applicable in the table. Where Note 5 is applicable, the velocity listed in the table only applies for continuous full-load operation. Higher velocities are allowed during part-load and intermittent operation. The velocity during part-load and intermittent operation must satisfy the following constraints:

- Velocity shall not exceed one third sonic velocity.

- Velocity shall not result in a velocity pressure greater than 20 psi.

- Velocity shall not exceed equipment (especially valve) manufacturer's velocity constraints.

	Pipe Inside Diameter				
Service or Type of Fluid	**2 inches**	**8 inches**	**14 inches**	**20 inches**	**24 inches**
Superheated Steam					
Subcritical (2,400 psi, 1,000° F) (Note 5 applies)	9,000	15,000	18,000	22,000	22,500
Supercritical (3,500 psi, 1,000° F)	6,000	9,000	11,000	12,000	12,000
Saturated Steam	3,000	6,000	7,000	9,000	10,000
Subatmospheric Steam	20,000	20,000	25,000	30,000	30,000
All Other Gases	3,000	4,000	5,000	5,000	5,000

Table 2
Recommended Maximum Water Velocities in Pipes

Notes:

(1) All water velocities are specified in feet per second.

(2) For pipe sizes between tabulated values, the velocity associated with the larger pipe size may be used.

(3) Boiler feed pump suction velocities shall satisfy both transient analysis and NPSH requirements.

(4) Applicable to "open" cooling water systems only.

(5) Includes most water systems not covered elsewhere in this table.

(6) Fire protection detailed piping designs that are upstream of the releasing valves shall comply with the velocity limitations specified in this table for General Service Water systems. Piping downstream of the releasing valves shall be supplied by the vendor or sized in accordance with NFPA codes and standards.

		Nominal Pipe Sizes (Note 2)				
Service or Type of Fluid		**2" (50 mm)**	**8" (200 mm)**	**14" (350 mm)**	**20" (500 mm)**	**>24" (600 mm)**
Boiler Feedwater	Pump Suction (Note 3)	5	8	12	14	18
	Pump Discharge	10	20	25	30	30
Condensate	Pump Suction (at design flow)	2	4	4	4	4
	Pump Discharge	5	10	12	15	15
General Service Water (Note 5)	Pump Suction	2	5	6	8	10
	Pump Discharge	5	10	12	15	15
Noncontinuous Minimum Flow Recirculation Lines		8	15	18	20	20
Auxiliary Cooling Water (Note 4)		4	6	8	12	12
Gravity Drains		3	4	5	8	12

5.1.3 General Arrangements

The location of equipment and valves, and routing of pipe shall be based on safety, economics, ease of maintenance, and operation. Sufficient space shall be provided for maintenance of all equipment including equipment removal without excessive rigging or removal of surrounding equipment, piping, and valves. Where possible, locate valves to be safely accessible from walkways, accessways, or platforms.

5.1.4 Platforms

Reasonably convenient access, including a minimum of 78" clearance, shall be provided to all valves, instruments and equipment for both operation and maintenance in accordance with the Class I and Class II criteria described below. Portable ladders are not permitted for access to permanent plant equipment.

Implement commercially reasonable efforts and prudent industry practice to provide platforms to access equipment, instruments, engineered valves, start-up vent and drain valves, and other components requiring access for periodic maintenance, start-up, operation, inspection, observation or maintenance. Provide stair access to maintenance areas that require bulky or heavy tools.

The Contractor shall review Gas Turbine-Generators, Steam Turbine Generator, HRSGs, and Air Cooled Condenser layouts and provide any additional access required to comply with the Manufacturers requirements.

The following paragraphs define the general requirements of where platforms shall be provided. A description of the minimum requirements for platforms and the design and construction criteria are defined in Section 7.0 Structural and Architectural Scope.

Equipment and system components which can be operated locally shall be located and/or arranged as follows:

(a) Valves. Valve operators shall be located and oriented for manual operation within the normal reach of operating personnel from permanent walk-ways, platforms or ladders. Permanent extension operators of conventional design may be used on a case-by-case basis only as approved by Owner.

(b) Local Instrumentation. All local instrumentation indicating pressures, temperatures, levels, flows, etc., or indicating the position or status of equipment shall be clearly visible and readable to operating personnel from permanent walk ways, platforms or ladders.

(c) Motor Controls. Local motor controls shall be located within reach of operating personnel from permanent walkways, platforms or ladders and hall place the operating person in a position to observe the equipment and the instrumentation critical to its starting or stopping.

(d) Testing Devices. Testing devices shall be located in a position accessible to the operating or testing personnel and oriented where the equipment and instrumentation critical to its testing can be observed.

(e) Visible Inspection and Tending. Portions of equipment requiring visual inspection, lubrication and tending activities shall be safely accessible and adequately lighted to assure proper operation and servicing.

Maintainability

The Project shall be designed and constructed to minimize the complexity and time required for maintenance. The following general criteria shall be followed to achieve this objective:

(a) Plant equipment shall be of a low maintenance and current design and shall be easily maintainable.

(b) Plant equipment shall be designed to be maintained in place with minimum disassembly of surrounding equipment and minimum usage of temporary scaffolding and handling equipment.

(c) Permanent maintenance platforms shall be provided where required to assure safety and efficiency.

(d) Platforms shall be provided where equipment checks or lubrication are required.

(e) Equipment arrangements, pipe routings and cable tray locations shall be designed for maximum equipment accessibility and to allow the following types of access:

(1) Space shall be provided to allow plant personnel easy access to all equipment, which may require maintenance.

(2) Space shall be provided to allow unobstructed access for maintenance tools and equipment required for maintenance on permanently installed equipment.

(3) Space shall be provided to motor-operated equipment areas for work cans.

(4) Ample space shall be provided to allow removal and laydown of any equipment that cannot be maintained in a place or may require replacement.

(5) Ample space shall be provided to allow cleaning and removal of heat exchanger tubes.

(f) Lifting eyes shall be provided on equipment to facilitate installation and removal for maintenance.

(g) Beams and trolleys shall be provided where necessary for maintenance, including removal of all major pieces of equipment. Portable lifting equipment may be provided only as approved in writing by Owner in some cases to serve multiple plant equipment. All beams, trolleys and lifting equipment shall be marked with capacity ratings per OSHA requirements.

(h) Techniques for minimizing corrosion of structures and equipment exposed to chemically or environmentally corrosive atmospheres shall be incorporated into the equipment design. Removable panels with lifting eyes on enclosures shall be provided where required.

(i) Special attention shall be given to providing appropriate enclosures, curbs, drip guards and collection system for fugitive water, hose spray water, chemicals and oils.

(j) Transmitters shall be located and oriented to allow access and maintenance by maintenance personnel from permanent walk ways, platforms or ladders.

(k) Air/Water/Electrical/Welding. Adequate provisions shall be included for compressed air, service water, general purpose electrical outlets and welding receptacles to support maintenance activities.

(l) Flanged piping shall not be located above electrical equipment.

(m) Equipment and systems shall be provided with isolation capability for personnel safety during maintenance activities. Design shall facilitate lock out, tag out, double block and bleed, etc., to satisfy requirements of OSHA 1910.269 and 147.

(n) Equipment removal paths shall be shown on design drawings and these paths shall be maintained clear of obstructions and interferences.

(o) Provisions shall be made for easy access and removal of rotating elements, including generator rotor, combustion hardware, gearboxes, bearings, etc. for all; major equipment.

(p) Access doors shall be provided in buildings to accommodate maintenance of major plant equipment.

Provide platforms as required in the following to access elevated components not accessible from grade, unless specified otherwise:

1. Class 1 Areas – Regularly attended areas for daily or weekly lubrication, start-up, operation, inspection, observation, or maintenance.
   A. Provide platforms a minimum of 3 feet wide, clear of all obstructions with length as required (minimum 4 feet).
   B. Provide stairs to access the platforms.
   C. Provide emergency escape ladders for platforms as required by OSHA for platforms having dead ends.
2. Class 2 Areas – Maintenance areas requiring access monthly or annually for lubrication, repair, inspection, calibration, or maintenance.
   A. Platforms shall be adequately sized to allow two men to work simultaneously with tools and equipment internals (minimum of 20 square feet – 4 feet x 5 feet).
   B. Platforms shall be accessible by stair or ladder. Areas requiring maintenance with heavy or bulky tools (heavier than 25 lbs) shall be provided with stair access.

As a minimum, areas requiring access as defined above shall include, but not be limited to, the following:

3. Class 1 Areas:

A. HRSG steam drums and associated level gauges and instrumentation.

B. HRSG, STG, CTG, and other equipment observation ports.

C. Gas turbine borescope inspection ports.

D. Internal and external platforms to provide access to all doors and maintenance access panels provide by CTG manufacturer.

E. Steam turbine operating deck.

F. Top of steam turbine-generator lube oil tank.

G. Ductburners.

4. Class 2 Areas:

A. Calibrated instruments including block valves necessary to isolate the instruments for safe routine maintenance and calibration.

B. Steam turbine bypass and desuperheating valves.

C. Stack CEM port and sample ports.

D. CTG inlet filter plenums.

E. Pressure indicators and gauges.

F. Pressure safety valves.

G. Sample ports.

H. Control valves.

I. Elevated equipment manholes.

J. Motor operated Isolation Valves.

K. Air actuated isolation valves.

L. Top manholes and gauging wells on large tanks.

M. Relief valves and instrument on top of the ammonia storage tanks.

N. Top of field erected tanks (provide a ladder).

Provide a 3-foot minimum wide, continuous catwalk platform on the steam pipe rack. Platform shall extend between the HRSGs to provide access between the HRSG platforms and between the inner most HRSG and the steam turbine deck to provide access from the HRSG platforms to the steam turbine deck. Pipe Rack catwalk shall be accessible from each HRSG and the STG without descending to grade. Provide stairs at changes in elevation for pipe rack catwalks.

5.1.5 Accessways and Clearances

Contractor shall finalize the maintenance laydown areas, show them on general arrangement drawings, and obtain the Owner's approval of the general arrangements prior to detailed design.

Contractor shall provide an area to pull the generator rotor on the steam turbine operating level. The pull area shall have a strong back.

<u>Horizontal Clearances (Minimum):</u>

Horizontal clearances (clear of all piping and accessories) shall be maintained as follows (unless approved otherwise by Owner):

1.	Crane Accessways	25'- 0"
2.	Fork Truck / Pick-up Truck Accessways	15'- 0"
3.	Operating Aisles	4'- 0"
4.	Elevated Maintenance Platforms	3'- 0"
5.	All Around Pumps & Blowers	3'- 0"
6.	All Around Boiler Feed Pumps	5'- 0"
7.	All Around Heat Exchangers	3'- 0"
8.	Heat exchanger pull space	As required
9.	All Around Tanks	5'- 0"
10.	Around other Major Equipment	5'- 0"
11.	One Side of Control Valve Stations	3'- 0"
12.	Back Side of Control Valve Stations	1'- 6"

Provide fork truck / pick-up truck aisles on access side of all equipment with motors, large manholes, or endplates and next to all equipment requiring chemical addition or replacement of totes.

<u>Vertical Clearances (Minimum):</u>

Overhead clearances (clear of all piping and accessories) shall be maintained as follows (unless approved otherwise by Owner):

1.	In buildings	7'- 6"
2.	Normal operating or maintenance access areas	8'- 0"
3.	Elevated Platforms	7'- 6"
4.	Control Valves	As required to remove actuator and pilot (12-inch minimum)
5.	Plant access & maintenance roads & crane	17'- 0"Accessways
6.	Railroad crossings	25'- 0" above the top of the rails

5.2 MECHANICAL SYSTEMS AND EQUIPMENT

5.2.1 General

Provisions shall be included in the design of all mechanical systems to allow the performance of all routine maintenance without requiring a plant shut down. Provisions shall include but not be limited to redundant equipment, isolation valves, and access spaces.

Contractor shall:

1. Receive, inspect, store, unload, erect, clean, lubricate, align, and prepare all equipment in accordance with equipment manufacturer's instructions before initial operation.
2. Provide lifting lugs on all equipment components or system components requiring removal for maintenance and weighing over 25 lbs.
3. Provide OSHA approved guards on all rotating components.
4. Select materials of construction and design equipment and systems to provide a minimum of a 30-year operating life at all operating conditions specified.
5. Provide major system components designed for a 30-year life without the need for major repairs or replacement. Only routine maintenance items (i.e. belts, couplings, bearings, seals, pump impellers and the like) shall require replacement at increased frequencies.
6. Provide grounding lugs and ground all equipment and structural components.
7. Care shall be taken to assured that piping connections are made to equipment and machinery so that no reactions or moments in excess of those allowed by the manufacturer are imposed during installation, test, or operation.
8. Provide access doors on equipment and systems as required to adequately clean, inspect, and maintain all system components. In general, access doors

shall be bolted and sealed. Access doors over 25 lbs. shall be hinged or supplied with a davit.

9. Extend all grease or lubrication lines for equipment or instruments to be accessible from grade or operating platforms.

10. Provide actuators on all start-up drain and vent valves on the steam turbine, HRSG, steam piping, and boiler feed pump, and elsewhere to enable remote start-up and shutdown of the units.

5.2.2 Pumps - General

General service pumps shall be designed and fabricated in accordance with the recommendations of the Hydraulic Institute and be suitable for the service. All end suction pumps shall be in accordance with ANSI standards.

Horizontal pumps shall have motor and pump mounted on a common baseplate and connected with a flexible spacer coupling and non-sparking coupling guard. Baseplate shall include a containment rim to contain 115 percent of the maximum amount of lubricant contained in the pump. Provide a drain valve and plug on the baseplate.

All pumps shall be supplied with mechanical seals designed for the service. Similar parts of duplicate pumps shall be completely interchangeable. Equipment and piping arrangement, and nozzle orientation, shall be selected for ease of maintenance and to minimize the dismantling or removal of piping and electrical connections for maintenance.

Supplied impeller on all pumps except the boiler feedwater pumps shall be a minimum of ½-inch smaller than the maximum impeller for the pump casing.

Pump head curves shall rise continuously from design head to shut-off head. Shut-off head for Boiler Feed Pumps shall be a minimum of 115 percent of the rated head at design condition and a maximum of 130 percent of rated head at design condition. Shut-off head of all other pumps shall be a minimum of 115 percent of the rated head at design condition and a maximum of 150 percent of rated head at design condition. For condensate and boiler feed pumps, maximum shut-off head shall be 140 percent of rated head at design condition.

Pumps shall operate at the left of the best efficiency point at design conditions.

Motors shall be sized for end of curve conditions for supplied impeller. Motor service factor may be used in determining motor size for end of curve conditions. Motor service factor shall not be used in selecting motor for operating or rated conditions.

5.2.3 Tanks and Vessels - General

Two new 300,000 gallon Fire Water Storage Tanks shall be added for serving Block 2. The contractor shall ensure that NFPA and local fire protection recommendations and requirements are met.

One new Raw Water Storage Tank shall be provided. The tank shall be sized to serve Block 2 but the distribution system shall be interconnected so that new and existing Raw Water Storage Tanks shall be tied together. Isolation valves shall separate the two blocks for either combined or separate operation

One new 200,000 gallon Demineralized Water Storage Tank shall be provided. Field erected tanks shall be designed, fabricated, inspected, examined, and tested in accordance with API 650 or AWWA Standard D-100.

All roof seam seams shall be fully seal welded. Roof seams on demineralized water tanks shall be butt joints. Interior welds on demineralized water tanks shall be ground smooth. The tank exterior and interior shall be protected with a suitable lining or coating material.

Tanks and vessels with a design pressure over 15 psig shall be designed, fabricated, inspected, examined, tested and stamped in accordance with ASME Section VIII, Division I, Boiler and Pressure Vessel Code.

Carbon steel water storage tanks shall be lined or coated on the inside and outside for corrosion protection. Lining and coatings selected shall be suitable for the intended service. Linings and coatings shall be applied in accordance with coating manufacturer's recommendations. Condensate Receiver Tank shall be insulated.

Tank and vessel construction materials shall be selected for the intended service to minimize corrosion and provide an extended life as defined for the plant. Provide a minimum corrosion allowance of 1/16-inch on all carbon steel tanks and vessels.

Contractor shall:

1. Provide cathodic protection for all tanks and vessels as recommended by a corrosion engineer after reviewing soils conditions for the Site. Obtain Owner's approval of cathodic protection design prior to executing work. Block 2 Cathodic Protection System shall be compatible with the existing plant cathodic protection system.
2. Provide a minimum of two manways on each field-erected tank. Manways shall have a minimum opening size of 30 inches diameter. One manway shall be located on the side of the tank or vessel and shall be accessible from grade. The other shall be accessible from the top of the tank or vessel. Provide supports, gaskets, belts, vents, standpipes, interior and exterior piping, overflows, wear plates, nozzles, piping connections, level gauges, platforms, stairs, walkways, and an exterior stairway and landing platform with handrails for access to the top of each tank.
3. Provide one manway with a 24-inch minimum opening for shop-fabricated tanks or vessels that are over 36 inches in diameter. Smaller vessels shall be provided with two 6-inch diameter hand holes. Provide a ladder to access the top of all tanks over 10 feet high.

Tank level gages shall be clearly visible from the tank loading area.

5.2.4 Heat Exchangers - General

Shell and tube heat exchangers shall be designed, fabricated, inspected, examined, tested and stamped in accordance with ASME Section VIII, Division I and TEMA, Class C. Shell and tube heat exchangers shall be supplied with flanged channels and flanged channel covers to facilitate access to both the shell and the tube sides for maintenance and cleaning. Provide valved shell and tube-side vents and drains on each exchanger. Provide double-groove, rolled tubes on all heat exchangers.

Plate and frame heat exchangers shall be designed, fabricated, inspected, examined, tested and stamped in accordance with ASME Section VIII. Plate exchangers shall be of the removable plate design and shall be provided with a frame and rollers to support the backplate during plate removal. Frames shall be sized to allow the addition of a minimum of 50 percent more plates.

Carbon steel components on heat exchangers shall be supplied with a 1/16-inch minimum corrosion allowance. Heat exchangers shall not contain copper.

5.2.5 Gas Turbine Generator (CTG) System

General: Contractor shall provide two (2) combustion turbines for combined cycle operation including all materials, services, and required labor necessary for a complete functional installation including all requirements for startup and testing. Gas turbines must meet all latest TIL/Service Bulletins relating to product reliability, design or manufacturing defects as implement on currently manufactured or shipped by the OEM. Equivalent starts penalty factor for trips from load (75 percent or greater) shall be twenty (20) or less.

The equipment shall be designed and manufactured for the application at the specified conditions without overstressing any components. The unit shall be designed to automatically maintain itself in a standby condition ready for immediate operation at all times. Contractor shall provide all necessary connections for measuring pressure drop across filters, compressor pressure ratio, turbine exhaust pressure and temperature, inlet air temperature, inlet pressure drop and turbine firing temperature. All control signals shall have a range of 4-20 mA unless specified otherwise.

Capacity of Unit: The gas turbine-generator unit base net output capacity at the ambient conditions specified after unit auxiliary power is deducted from gross output. The capacity, defined as "base rating" shall be that load obtained at the specified ambient conditions and operated at a Turbine Inlet Temperature level consistent with maximum achievement of anticipated parts life. Provide performance correction curves with the Proposal which plot the effect back pressure, barometric pressure steam or water injection, gas turbine inlet air temperature, inlet air pressure drop, and relative humidity on turbine-generator output, air flow, heat rate, and exhaust temperature. These correction curves will be used for performance testing correction to guarantee conditions.

Fuel: Gas turbine-generator units shall be designed to operate satisfactorily at all loads when firing natural gas. See Appendix J for Fuel Gas analysis information.

Combustion System: CTGs shall be provided with dry low NOX burners. System shall include thermal barrier coated liners, transition pieces, flame detectors, and a dynamic combustion monitoring system.

Bleed Heat: CTG's shall be equipped with bleed heat from compressor to air inlet to prevent freezing of moisture in turbine inlet.

Sound Criteria: Contractor shall guarantee noise limits per Section 1.

Exhaust Emissions: Contractor shall submit with the Proposal a statement of guarantee that the gas turbine unit and auxiliaries are designed and constructed to operate in compliance with the aforementioned standards.

Evaporative Air Cooler: Shall be 85 percent effective and designed to work in conjunction with an inlet air filtration system. A conductivity control system shall be provided.

Control of Unit: Each CTG shall be supplied with a dedicated turbine control system. The turbine control system contains the unit metering, protection, and control logic required for safe and reliable turbine operation. Standard control of each gas turbine generator, as provided by the manufacturer, shall be from each respective supplied local station and from a common remote station. Remote operator station shall have identical hardware and software as the local operator station and shall also be equipped with multiunit capability to allow for the control and operation of each turbine. In addition, to being designed for starting from the local station located in a control enclosure adjacent to each unit, and remotely from a common remote control station, the unit shall be designed for starting remotely through the DCS. A command to "start" the unit from either the local or remote control station or the DCS shall initiate the automatic start-up sequence to start unit, bring the unit up to speed, synchronize, and pick up a preset minimum load. Controls shall be designed to integrate the starting and stopping of any fuel gas compressor into the automatic start-up and shutdown sequence, if a compressor is required. Controls shall be designed so unit can be loaded from the local or remote station, or DCS. When unit is on-the-line, the following functions may be performed from the local or remote station, or DCS:

Manual load (governor) control
Manual voltage (excitation) control
Manual stopping of unit

Operation of the manual "stop" switch on the local or remote station or remote DCS shall initiate the automatic shutdown sequence to safely shutdown the unit. The unit shall be automatically shut down in a safe manner in the event of abnormal, injurious, or faulted condition in any part of the gas turbine-generator unit, or its associated mechanical and electrical auxiliary equipment, either during start-up or during "on-line" operation. Unit shall be designed for complete remote and automatic operation. Each condition preventing operation or causing shutdown of unit shall be specifically identified by an alarm on the local, remote control station and DCS. Shutdown sequence shall be complete, including reset ready for automatic restarting. The turbine control system shall include provisions for HRSG interlocks. Provide variable inlet guide vanes on compressor inlet. Guide vanes shall be automatically controlled. Provide vane position indication at both local and remote control stations. Additional turbine control description is provided in SECTION 5.2.5.19. Additional interface description to the DCS is provided in SECTION 9.

Start-Up of Unit: Starting sequence for the unit shall be interlocked to prevent operation when conditions are not normal in all parts of the unit for satisfactory and safe operation. Upon actuation of the unit, start control from the control board or remotely:

1. Gas turbine auxiliaries are automatically energized in correct sequence.
2. If there are no malfunctions of the auxiliaries, the turbine is brought up to speed; otherwise the equipment is automatically shutdown, and an alarm is transmitted to the local control, remote control and the DCS.
3. Automatic governor and excitation control establishes the generated voltage at correct potential and frequency for synchronizing.
4. The equipment furnished shall assure that the generator voltage matches the bus voltage within limits safe to the equipment, with the bus voltage level within +5 percent of set point.
5. Generator breaker shall close automatically under control of automatic synchronizing equipment.
6. Provide selection locally at unit for synchronizing automatically or manually by synchroscope and remotely from the remote station.
7. Upon automatic closure of the generator breaker, the unit shall load to a preset value.

5.2.5.1 Gas Turbine and Accessories

Summary: Gas Turbine-Generator unit shall be a gas turbine mechanically coupled to the electrical generator. Gas turbine-generator unit shall be a factory-assembled "package type" designed for automatic operation and shall be manufacturer's standard design as far as is consistent with the intent of these specifications.

Applicable Codes and Standards: Design, fabricate, assemble, install, and test equipment so that when operated in accordance with manufacturer's recommended procedures, it will conform to the applicable provisions of, but not limited to, the following standards:

1. National Electrical Manufacturers Association (NEMA):
   SM33 - Gas Turbine Sound
2. American Society for Mechanical Engineers (ASME):
   Boiler and Pressure Vessel Code for Unfired Pressure Vessels
   B31.1 - Code for Pressure Piping
3. American Society for Testing and Materials (ASTM):
   A53 - Welded and Seamless Steel Pipe
   A312 - Seamless and Welded Austenitic Stainless Steel Pipe
4. Society for Protective Coatings (SSPC) Surface Preparation Specifications:
   SP-10 - Near-White Blast Cleaning: At least 95 percent of every 9 square inches shall be free of visible residues
   SP-11 - Power Tool Cleaning to Bare Metal

Factory Tests:

All standard factory tests on equipment and all tests required by the applicable codes shall be made including:

1. Rotor overspeed test at not less than 110 percent speed.
2. Vibration and mechanical balance of assembled rotating parts.
3. Lubricating system tests including hot oil flushing and bearing inspection.
4. Comprehensive tests of all systems and controls to assure proper assembly and connection, including simulation tests of all safety devices.
5. Hot oil flushing of all hydraulic and liquid fuel piping.

Notify Owner when factory tests are to be made so that they may have a representative witness the tests, if desired.

Submit certificate of completion of all other tests in triplicate.

Gas turbines shall be designed to allow continuous operation.

Compressor inlet equipment shall include air ducting with inlet filters, expansion joints, and transition sections as required, complete with airtight hinged access doors. Modulating Inlet Guide Vanes (IGV) shall be included to control air-flows during start-up for protection against compressor surge and for improved part load performance during combined cycle operation.

The gas turbine ignition system shall be automatic. The ignition system shall provide for 100 percent backup, and the unit shall be capable of successful starts with 1/2 of the ignition system out of operation.

Gas turbine compressed air system shall be provided as required for blade cooling, seals, complete with instrumentation and alarms.

Main reduction gear shall be designed to conform to AGMA standards for service and application.

Frame-type industrial gas turbines shall be provided with a turning gear to prevent adverse deflections of the shaft during the cooling-off period following shutdown. Turning gear and lift oil shall be fed from the essential services supply.

Provide cooling air if required to maintain proper turbine temperatures.

5.2.5.2 Governing System

Provide speed governing system including:

1. Speed governor on output shaft or shafts.
2. Fuel control mechanism.
3. Speed changer with provisions for remote adjustment.
4. Minimum fuel limiter.

Provide adjustable load limiter.

Provide fuel control systems, including control valves.

Provide temperature control system, including the following:

1. Temperature detectors.
2. Load limiting controls based on exhaust temperature.

3. Load limiting selector switch for selection of base or peak mode of operation.

Provide overspeed and over-temperature system, including the following:

1. Overspeed governor on turbine shaft.
2. Over-temperature detection.
3. Necessary protection equipment.
4. Fuel stop valves.

5.2.5.3 Fuel System

Provide fuel system complete and ready for operation, including the following:

1. All necessary control, trip, and stop valves.
2. Stainless steel gas piping.
3. Fuel strainers and dual filters with provisions to change filters under load. Provide differential pressure gauges for all strainers and filters.
4. Gas flowmeters with ±1 percent system accuracy for the design fuel to measure net fuel consumed. Supply meters complete with totalizer and other accessories as required to be incorporated into the manufacturer's normal unit control systems. Meter shall supply compensated electrical output proportional to flow.
5. Flowmeters shall meet accuracy requirements of CEMS / permit as a minimum.
6. Pressure switches, pressure gauges, and thermometers.
7. Electric heaters, insulation, and lagging as required.

5.2.5.4 Lubricating Oil System

Provide oil reservoirs and dual, full flow filters with replaceable-type cartridges.

Provide dual plate and frame type lube oil coolers with stainless steel plates.

Lube oil coolers and filters shall have ASME code stamp.

Provide all valves and controls necessary to regulate cooling water flow to maintain proper lube oil temperatures. Cooling water from the plant system will be used.

Provide complete lubricating oil system including the following:

1. AC Motor driven lube oil pumps
2. AC motor driven auxiliary standby lube oil pump
3. DC emergency bearing oil pump for safe shutdown of unit in the event of an AC power failure
4. Oil reservoir heaters with thermostatic controllers designed for -20°F
5. Oil piping, valves, instruments, and controls including connections to reservoir and cooling system. Lube oil supply piping shall be 304L stainless steel. Lube oil drain piping shall be carbon steel. Lube oil system valves shall have stainless steel trim.
6. Lube vent demister for mist elimination
7. Dial-type thermometers to indicate oil supply and return temperatures
8. Valves, controls, and indicating instruments as required

5.2.5.5 Starting System

Provide complete starting system capable of starting the unit over the range of ambient conditions specified.

Starting system shall be of the electric motor, or use of generator as a motor to start unit is also acceptable (also referred to as a Load Commutated Inverter or Static Frequency Converter). For applications using LCI or SFC starting, an LCI/SFC shall be provided for each combustion turbine. For applications involving an LCI or SFC, the systems shall have provision to allow cross connection so either LCI/SFC can be used to start the other combustion turbine. The LCI/SFC shall be sized to meet the start time requirements.

Electric motor starting system shall include the following:

1. Electric starting motor sized to start the unit without exceeding nameplate horsepower rating.
2. Torque converter, couplings, and clutch.
3. All required controls.
4. Cooling system.

If generator is used as motor to start unit, provide all transformers, controls and interlocks necessary to provide for safe start-up of turbine.

5.2.5.6 Special Tools

Provide one set of any special lifting slings or fixtures required for routine inspections, hot gas path inspections, and major overhauls.

Provide one set of all special wrenches and tools required for maintenance.

5.2.5.7 Inlet Air Filter

Provide self cleaning inlet air filtration system, complete with filter housing and all required ductwork to install inlet air filter.

Arrangement shall be up and forward inlet system arrangement.

Face velocity at inlets shall not exceed 600 fpm.

Provide severe duty filter media (high humidity / corrosive environments).

Housing and ductwork shall be steel with hinged access doors. Provide caged ladder access to inlet filter compartment, electric hoist with 500 lb lift capacity, and inlet filter compartment interior lighting.

Provide dust collection kit under each module.

Provide Air Processing Unit (APU) for filter cleaning. Include APU heat tracing kit.

Provide inlet system differential pressure indicator and transducer to measure pressure drop across filtration system and provide an alarm to indicate dirty filters and initiate the self cleaning cycle.

Provide frost point detector with icing alarm.

Provide steel inlet louver complete with stainless steel bird screen over inlet and stainless steel inlet silencing perforated sheet.

Inlet ducting shall include inlet silencing, expansion joint, 90 degree elbow, transition piece, compressor inlet humidity sensor, and compressor inlet temperature thermocouple.

5.2.5.8 Exhaust Connection

Gas turbine shall be provided with an axial exhaust connection.

Provide expansion joint to minimize loads on turbine from ductwork expansion. Expansion joint shall be designed for axial, lateral, or angular displacements. Expansion joint material shall be suitable for use with gas turbine exhaust temperature.

Exhaust system shall be carbon steel shell and stiffeners with stainless steel internal lagging.

5.2.5.9 Bypass Stack

No bypass stack shall be provided.

5.2.5.10 Water Wash System

Provide water and/or solvent wash system complete with all piping, valves, pumps, motors, tanks, including freeze protection, and controls.

System shall be skid mounted and enclosed. System shall allow washing of compressor while turbine is either on- or off-line. Each wash skid shall service two gas turbines.

5.2.5.11 Insulation

Furnish and install all required thermal insulation including insulation for compressor, combustion chambers, turbine casing, exhaust ducts and hoods, piping, oil tanks, and as required for personnel safety. Include lagging if insulation is exposed.

Thermal insulation shall be designed so that outside surface temperature of lagging will not exceed ambient air temperature by more than 10oC when gas turbine is operating.

All insulation materials shall be asbestos free.

5.2.5.12 Sound Control Equipment

Silencers and sound control equipment shall be designed and applied as required to attenuate all noise generating sources in the gas turbine generator unit, compressor inlet equipment, gas turbine exhaust equipment, and all auxiliaries as required to meet the guaranteed silencing criteria.

Silencers shall be durable construction with sound-absorbing media encased behind perforated panels of type of metal required for a service life equal to the normal design life of the facility.

5.2.5.13 Maintenance Access

Submittals shall include adequate data to determine size of crane required and access space required for crane.

Enclosure shall be designed and constructed so that removal and reinstallation of components can be accomplished without field cutting and rewelding. Provisions at roof joints shall be made to prevent the entry of wind driven rain.

All piping, conduit, tray and instrument tubing shall not be routed over roof panels/access covers that may be required to be removed in order to perform maintenance.

5.2.5.14 Fire Protection System

Provide fire detection system and fire protection system for turbine and accessory compartments and enclosures, including low pressure carbon dioxide supply system. Provide compartment warning signs and compartment exterior alarms. Fire detection and protection systems shall comply with the provisions of NFPA 12 and NFPA 850.

Provide fire detectors to trip the unit, actuate the fire protection system, stop ventilating fans, close ventilating louvers, and alert the operator.

System shall be of the prolonged-discharge type designed to provide proper concentrations in each protected area. Storage system shall be sized for two discharges.

Perform an acceptance test of system to verify proper operation and concentration during commissioning. Recharge all cylinders or tanks after test.

Provide hazardous atmosphere detectors and readouts for ammonia, hydrogen and natural gas.

5.2.5.15 Vibration Monitoring Equipment

Each combustion turbine shall be equipped with Bentley Nevada Vibration Monitoring Control monitoring systems in compliance with "Vibration and Analysis and Acceptance Standard"

(Appendix G). This system shall be tied to Currant Creek 2 main Bentley Nevada Vibration Monitoring System. Display data on both local and remote control station and the DCS.

5.2.5.16 Painting

Unless otherwise approved by the Owner, the Turbine-generator shall be painted as follows. The Owner will select the colors from the manufacturer's standard colors to match the existing Block 1 as closely as possible.

Turbine-generator and appurtenances shall be surface cleaned and factory prime painted in accordance with the manufacturer's standards.

Turbine-generator and appurtenances shall be field painted with one coat of manufacturer's standard coating as follows:

1. Thoroughly clean all surfaces to be painted. Prepare uncoated and damaged coating areas to manufacturer's standard quality.
2. Apply one coat of the same primer applied in the factory on all areas where shop coat has been damaged or areas which are uncoated.
3. Apply one finish coat with a minimum dry film thickness in accordance with manufacturer's standards.

5.2.5.17 Gas Turbine – Electrical and Controls

General: Electrical equipment and controls shall be manufacturer's standard pre-engineered package and shall include all special and optional accessories required for the application.

Logic apparatus for automatic control of starting, operation, and shutdown of the gas turbine unit and gas compressors shall be microprocessor based system with communication links for interconnection with other gas turbine control systems and plant DCS. Communication links shall be redundant.

Electrical equipment and controls shall include all equipment required for operation of appurtenances furnished, other specified devices, and all safety equipment required for automatic shutdown of the plant in event of malfunction.

Factory fabricate and completely assemble and wire circuit breakers and switchgear at Contractor's manufacturing location. No welding shall be required to complete field assembly of these items. Pre-engineered enclosure shall include redundant air-conditioning.

Electrical equipment shall include the following:

1. Auxiliary switchgear, motor control centers and power panels as required.
2. 125Vdc power panel for dc controls, emergency motor power, and dc motor controls.
3. 125Vdc battery of capacity required for unit.
4. Local turbine and generator control boards.
5. Excitation equipment and controls.
6. Motors as required to run necessary auxiliary equipment.
7. Provision for remote control capability.
8. Complete logic control system for starting, synchronizing, shutdown, and protection of the unit (including gas compressors).
9. Protective relays for generator.
10. Generator surge protection equipment.
11. Redundant battery chargers.
12. Static or rotary inverter equipment, if required, for ac control power for emergency shutdown conditions.
13. Other equipment as required for application.
14. A manual transfer arrangement for the 480V power supply interlocked to prevent paralleling the unit supply and the standby supply.

References:

Institute of Electrical and Electronics Engineers (IEEE):

1. No. 21 - Outdoor Apparatus Bushings, General Requirements and Test Procedures.
2. No. 32 - Neutral Grounding Devices.
3. No. 24 - Electrical, Dimensional and Related Requirements for Outdoor Apparatus Bushings.

American National Standards Institute (ANSI):

1. C37.04 - Rating Structure for ac High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
2. C37.06a - Schedules of Preferred Ratings and Related Required Capabilities for ac High Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
3. C37.09 - Test Code for Power Circuit Breakers Rated on a Symmetrical Current Basis.
4. C37.11 - Power Circuit Breaker Control.
5. C37.13 - Low-Voltage ac Power Circuit Breakers Used in Enclosures.
6. C37.16 - Preferred Ratings Related Requirements and Application Recommendations for Low-Voltage Power Circuit Breakers and ac Power Circuit Protectors.
7. C37.17 - Trip Devices for ac and General-Purpose dc Low-Voltage Power Circuit Breakers.
8. C37.20 - Switchgear Assemblies Including Metal-Enclosed Bus.
9. C37.90 - Relays and Relay Systems Associated with Electric Power Apparatus.
10. C37.100 - Definitions for Power Switchgear.
11. C57.12.00 - General Requirements for Liquid Immersed Distribution, Power, and Regulating Transformers.
12. C57.12.10 - Requirements for Transformers 230,000V and below 833/958 through 8,333 / 10,417 kVA, single phase, and 750 / 862 through 60,000 / 80,000 / 100,000 kVA three phase.
13. C57.12.70 - Terminal Markings and Connections for Distribution and Power Transformers.
14. C57.12.80 - Terminology for Power and Distribution Transformers.
15. C57.12.90a - Test Code for Liquid-Immersed Distribution, Power and Regulating Transformers.
16. C57.13 - Requirements for Instrument Transformers.
17. C76.1 - General Requirements and Test Procedure for Outdoor Apparatus Bushings.
18. C76.2 - Electrical, Dimensional and Related Requirements for Outdoor Apparatus Bushings.

National Electrical Manufacturers Association (NEMA):

1. SG1 - Electric Power Connectors.
2. SG4 - Standards for Power Circuit Breakers.

3. SG5 - Electric Switchboards.
4. LA1 - Lightning Arrestors.
5. TR1 - Standards for Transformers, Regulators, and Reactors.
6. E1-2 - Instrument Transformers.

Applicable rules of the National Electrical Code and National Electric Safety Code.

Factory Tests:

All standard factory tests on equipment and all tests required by the applicable codes shall be made including:

1. Standard ANSI dielectric tests.
2. Standard circuit breaker tests.
3. Comprehensive tests of all systems and controls to assure proper assembly and connection, including simulation tests of all safety devices.

Notify Owner and Engineer when factory tests are to be made so that they may have a representative witness the tests, if desired. Submit certificate of completion of all tests in triplicate.

PRODUCTS:

GENERAL: Design, fabricate, assemble, install, and test equipment in accordance with applicable standards specified above.

GENERATOR CONNECTION EQUIPMENT:

Provide generator surge protection equipment housed in a metal-enclosed dead-front enclosure, containing station-type lightning arresters and surge capacitors of proper rating to adequately protect the electrical apparatus. Surge protective equipment shall be physically arranged so as to be connected as close as possible to the generator terminals.

Provide generator neutral grounding distribution transformer and secondary resistor housed in a ventilated metal enclosure. Transformer and resistor shall be adequately sized for the generator based upon a one-minute rating.

RELAYING:

Provide all protective relays for the generator and auxiliaries as required for safe start-up, operation, and shutdown of the unit. See Section 8 for generator relaying requirements.

ELECTRIC MOTORS:

See SECTION 8.

SWITCHGEAR AND MOTOR CONTROL CENTERS:

480V switchgear, where provided, shall be metalclad dead front, indoor, 600V class equipment with drawout air circuit breakers and shall contain the following:

1. Air circuit breakers to have adequate interrupting capacity when fed directly from station auxiliary transformer.
2. Potential and current transformers for metering and relaying.
3. Shall be configured to allow replacement of indicating lamps without opening breakers or disconnects or opening doors.
4. Shall be configured for remote opening and closing of all switches and contactors. As a minimum, remote operation shall be designed to avoid the need for personnel to be exposed to a potential arc-flash hazard.

480V motor control centers shall be metal enclosed, dead front, NEMA Class II, Type B or C, equal to General Electric 8000 line and shall contain the following:

1. Air circuit breakers with adequate interrupting capacity when fed directly from station auxiliary transformer.
2. Motor starter and feeder circuit breakers of adequate quantity and size to supply all gas turbine auxiliary equipment.
3. Potential and current transformers for metering and relaying.
4. Shall be configured for remote opening and closing of all switches and contactors. As a minimum, remote operation shall be designed to avoid the need for personnel to be exposed to a potential arc-flash hazard.

Three-phase ac circuit breaker panelboards shall have an adequate number and size of breakers to supply all equipment furnished.

125Vdc circuit breaker panelboard shall have an adequate number and size of breakers to supply all equipment furnished, plus a minimum of two 30-ampere or larger, two-pole breaker spare for Owner's future use.

<u>BATTERY AND CHARGER</u>:

Battery ratings shall be as follows:

1. 125Vdc.
2. Nominal 2.232V per cell.
3. Calcium-alloyed, lead-acid type.
4. Sized for 3 hours operation prior to recharging.

Charger ratings shall be as follows:

1. Input Voltage: 480V, 1 phase, 60 hertz.
2. Output Voltage: 125Vdc.
3. Output Current: Output as required carry continuous load plus recharge batteries in 6 hours.

<u>TURBINE CONTROLS</u>:

Provide a redundant microprocessor based control system to perform all control, monitoring, alarming, data logging, and communications associated with the turbine. Include local operator station, and remote operator station. Control system shall include redundant communications to the plant DCS system.

The control system shall include the following functions:

1. Automatic startup and shutdown.
2. Speed/load control.
3. Temperature control.
4. Automatic synchronizing.
5. Monitoring and display of temperatures, flows, and pressures.
6. Speed, temperature, vibration, and flame protection.
7. Self diagnostics.
8. Data graphing and trending.
9. Data historian.

10. Alarm logging.
11. Redundant sensors for critical points.
12. Graphical and tabular displays.
13. Remote communication.
14. System administrative functions and security.

Relaying and Metering:

1. See SECTION 8.2 for protective relaying requirements.
2. Provide hand reset lockout relays.
3. Meters and display for generator frequency, field current, field voltage, three phase current, three phase voltage, kW, kWh, kvar, kvarh, power factor, and switchyard voltage.
4. Complete automatic synchronizing equipment for generator breaker including synchronizing relay, synchronizing check cut-off relay, speed matching, and voltage matching relays.
5. Synchroscope, lamps, and switch.
6. Generator breaker control switch and lights.

WIRING:

The gas turbine, generator, and all auxiliary equipment shall be prewired to the maximum extent possible. The interconnecting wiring between all equipment furnished, except as otherwise specified, shall be furnished and installed by this Contract.

All low-voltage wiring of 600 volts or less shall consist of insulated conductors installed in zinc-coated rigid-steel conduit.

1. Conduit shall be sized and installed in accordance with the requirements of the National Electrical Code.
2. Low voltage wiring shall conform to the requirements of SECTION 8.

All high-voltage wiring above 600 volts shall conform to the requirements of SECTION 8.

Appropriate power and control cable terminals shall be provided within the unit enclosure for external cable terminations. Arrange for grouped entrance of external control and low-voltage connections, and provide cable tray or wireway systems in unit for connection of all 600-volt wiring from point of entrance to internal equipment.

All devices for nominal 125Vdc operation shall provide satisfactory operation for a range of voltage of 100 to 140 volts with a 120oF ambient temperature.

All electrical devices and wiring located under the casing of the machine or at other high-temperature locations shall be specifically designed and constructed of suitable materials to give satisfactory operation in the high ambient temperatures involved.

Low-level instrumentation circuits shall be run in separate conduits. Instrumentation terminal points shall be isolated from other voltage levels.

5.2.6 Steam Turbine (STG)

Contractor shall provide a steam turbine generator unit complete with auxiliaries, appurtenances, and accessories, as required by the manufacturer and as specified herein, including all materials, services, and all required labor necessary for a complete functional installation, including all requirements for startup and testing.

Furnish the turbine generator unit complete with all piping between contiguous component parts, and with all wiring specified. All equipment and materials supplied shall be from manufacturers on the Approved Vendors List – Appendix B, unless approved by Owner. Contractor shall provide technical assistance and guidance for installation and placing the turbine generator unit into successful operation as specified.

Contractor shall provide technical review and coordination, shop inspection, expedition, shipping coordination, shipping inspections, receiving inspections, off-loading site storage and maintenance. Contractor shall submit an inspection program for Owner approval.

Design pressure, temperature and materials for all piping shall be based on the steam turbine manufacturer's standard, but not less than applicable ASME Boiler and Pressure Vessel Code and ANSI B31.1 requirements.

Contractor shall provide acoustical enclosures or lagging for noise control of the STG control valves to meet noise guarantees.

Applicable Codes and Standards: Design, fabricate, assemble, and test equipment so that upon installation and operation in accordance with manufacturer's recommended procedures for this application, the equipment will conform to the requirements of the applicable provisions of the standards including, but not limited to, the following or Engineer approved equivalent BS, ISO, or DIN standards:

1. American National Standards Institute (ANSI):

    A. C1 - National Electrical Code (NEC)
    B. C42.1 - Definition of Electrical Terms, Group 10 Rotating Machinery
    C. C50.10 - Rotating Electrical Machinery - Synchronous Machines
    D. C50.13 - Rotating Electrical Machinery - Cylindrical Rotor Synchronous Generators

2. American Society of Mechanical Engineers (ASME):

    A. Boiler and Pressure Vessel Code
    B. B31.1 - Power Piping
    C. TDP-1 - Recommended Practice for the Prevention of Water Damage to Steam Turbines Used for Electric Power Generation

3. American Society for Testing and Materials (ASTM):

    A. A194 - Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
    B. A437 -Alloy-Steel Turbine-type Bolting Material Specially Heat Treated for High-Temperature Service

4. Institute of Electrical and Electronics Engineers (IEEE):

    A. 4 - Techniques for High Voltage Testing
    B. 421 - Criteria and Definitions for Excitation Systems for Synchronous Machinery
    C. 421a Guide for Identification, Testing, and Evaluation of the Dynamic Performance of Excitation Control Systems
    D. 421b - Synchronous Machines, High-Potential Test Requirements for Excitation Systems

5. National Electrical Manufacturers Association (NEMA)
6. Tubular Exchanger Manufacturer Association (TEMA)
7. Hydraulic Institute (HI)

Experience: All equipment and material furnished shall have an acceptable history of satisfactory reliable service in central station use for a period of at least three years at comparable temperature, pressure, voltage, and design stress levels.

Newly-developed equipment with less than three years' actual service will be considered from established manufacturers, only if it has been adequately tested, meets the requirements of this Contract, and is approved by Owner.

Factory Tests and Reports:

Before shipment, conduct the following tests:

1. Turbine Tests:

   A. Mechanical balance
   B. Overspeed test of rotors with blades at not less than 120 percent rated speed
   C. Governor and control function operation
   D. All standard factory tests

2. Generator Tests:

   A. Mechanical inspection
   B. Rotor balance, with rotor at normal maximum operating temperature
   C. Rotor overspeed at 120 percent rated speed
   D. Measurement of cold resistance of stator and rotor windings
   E. Winding insulation resistance measurement
   F. Standard IEEE 4 dielectric tests on stator and rotor
   G. Pressure test on hydrogen-cooled stator frame for gas tightness (if provided)
   H. Resistance temperature detector test
   I. For liquid conductor cooled stators, test for flow continuity through windings

J. All standard factory tests

3. Provide Owner a list of all factory tests and a test schedule so that a representative may witness the tests.

Results of tests shall be submitted to Owner for review. All factory test results shall be available for examination by Owner upon request.

General

Provide each turbine generator unit with all accessories and features normally included with a unit for erection. Arrange equipment and appurtenances for safe and ready access for operation and maintenance. Provide access into enclosures and appearance lagging as required for operation and maintenance.

Provide adequate ventilation in enclosures and appearance lagging for proper cooling of equipment. Provide cooling systems, where required, for equipment that will not operate satisfactorily due to ambient temperature. Control, excitation, and supervisory equipment room will be air conditioned to an ambient temperature of 80^{o}F; however, in case of failure of air conditioning, equipment shall operate satisfactorily at 100^{o}F for continuous periods up to 48 hours, with peaks of 50^{o}C for 3-hour periods during the 48 hours.

Provide couplings for fans, pumps, and other motor-driven equipment as follows:

1. All couplings shall be rated at not less than 140 percent of the motor horsepower.

   Flexible drive couplings shall be as follows:

   A. Designed to prevent any external thrust from being transmitted to the driver shaft under normal operating conditions
   B. Fast gear type, flexible disc type, or approved equal
   C. Equipped with rainhood or cover for outdoor installations

2. Drive couplings shall have guards as follows:

   A. Complying with all applicable state and federal safety requirements
   B. Arranged for ease of disassembly or removal for access to coupling

C. Rigidly fastened to baseplate

D. Conform to other specific requirements of these Specifications, as applicable

3. Bolts, nuts, screws, and other standardized fasteners shall conform to the applicable ASTM A194 or A437 standards, except where higher standards for high temperature and pressure are deemed necessary by the manufacturer. Provide tools and wrenches for each nonstandard item.
4. Provide preservation and protection, suitable for overseas shipment and storage to meet site conditions as described in Table 2-1. Submit description and details of preservation and protection systems and recommended storage procedures.
5. Unit shall be designed, constructed, and balanced statically and dynamically so that vibration displacement at the bearings at synchronous speed through full-load operation will not exceed Contractor's recommended operating limits.
6. Provide one set of electric bolt heaters, all special erection tools, lifting devices, special instruments, and other special equipment required for erection and installation of the unit. Provide metal storage cabinet for all special tools, wrenches, and instruments.
7. Provide temporary valve cover plates complete with pipe spools with weld end preps, and internal protective shields as required for main stop and reheat stop valves, for steam blowdown. Provide at least one complete set, suitable for use on up to eight turbines.
8. Provide lifting lugs to facilitate disassembly and maintenance. All piping that must be removed for overhaul of turbine shall be equipped with lifting lugs that protrude through the heat insulation. Provide a lifting beam so that the crossover piping (if applicable) can easily be removed as a single unit during disassembly.
9. Hanger assemblies, anchors, and sway braces shall be designed in accordance with the latest editions of the MSS Standard Practice SP-58 and SP-69. Design for seismic zone and building code specified in Section 3.

Turbine

The turbine shall be of the multivalve, multistage type. Single governor valves are not permitted. All parts which are subject to temperature changes shall be designed and supported so as to permit free expansion and contraction in order to minimize distortion or misalignment.

Turbine Casings:

1. The casing shall be supported at the centerline, with flexible supports at the high-pressure end.
2. Provisions shall be made in the design of the turbine to control thermal stresses in the turbine casing.
3. Special provisions shall be made in all bolting 50 mm in diameter and larger for tightening.
4. The bearings shall be arranged to permit inspection without removal of the turbine casing.

Turbine Rotor:

1. The rotor shall be of forged construction, with wheels forged integrally with the shaft, as required by design operating conditions. Dovetailed grooves shall be turned in the wheels to securely hold the individual blades.
2. The completed turbine rotor shall be balanced in the manufacturer's plant in order to run smoothly and without excessive vibration.
3. Provisions shall be made in the design and manufacture of the rotor to minimize stress concentrations.

Turbine blading shall be stainless steel and shall be securely and adequately anchored and shall be readily renewable. Welding of blading to wheel disc will not be acceptable in any stage.

Diaphragms:

1. All diaphragm blading shall be of stainless steel.
2. Each diaphragm shall be split along the horizontal centerline and a doweled tongue and groove joint shall be provided to assure correct alignment and prevent interstage leakage.
3. The diaphragm halves shall be securely positioned in the casing of inner element.

Bearings:

1. All bearings shall be designed for pressure lubrication and shall operate without injurious temperature rise or undue wear.

2. All bearings shall be split to permit removal for inspection and shall be removable without removing the rotor.
3. All main bearings shall be provided with a positive visual check for oil flow through the bearings via sight flow indicators. Leakage of oil or oil vapors from the bearing housings shall be minimized.
4. A double-acting tilting pad, multisegment thrust bearing shall be provided to align and maintain the correct axial relationship between the rotating and the stationary parts.

All turbine drains and low point pipe drains will be piped to the condenser. The drain valve controls will be per the manufacturer's recommended design and in general accordance with ASME TDP-1.

Complete control and protective valve system including the following:

1. Main stop valves designed to withstand boiler hydrotest pressure of 1.5 times HRSG drum pressure.
2. Control valves automatically controlled by governor system.
3. Turbine anti-motoring sensor.
4. Devices as required for use with control and monitoring systems specified below to allow sequential remote testing of main stop valves, and control valves, while turbine is in operation.
5. Provide first-stage pressure sensor, for steam flow measurement.
6. Coarse mesh screens with removable fine mesh start-up screens, removable without disturbing inlet piping, or permanent fine mesh strainers, for main stop valves.
7. Proximity switches for main stop valves, and control valves, with two N.O. and two N.C. electrically separate pairs of contacts for Owner's use at each end of each valve mechanism with space for additional special switches specified below.
8. Hydraulic system trip interlock pressure switch with two electrically separate contacts for Owner's use, for tripping of generator and electrical auxiliary system upon tripping of turbine, if such tripping interlock scheme is recommended by the manufacturer. Provide indication of what caused the turbine to trip.
9. Power-operated drain valves, equipped with solenoid valves and limit switches on each valve if pneumatically operated, and piping between turbine and drain

valves. Valves will be operated from the turbine control system. If motor-operated valves are furnished, provide position transmitters in addition to limit switches on each valve. Provide double valves at all steam drains above 400 psig. Where power-operated valves are provided, the first valve shall be manually-operated and provided with a locking device. High-pressure steam drain valves shall have the following:

A. Pressure seal bonnet for valves 4 inches and larger, no bonnet or welded bonnet for valves 3 inches and smaller
B. Butt-welding ends for valves 2½ inches and larger, socket weld ends for valves 2 inches and smaller
C. to 14 percent chromium steel trim
D. Stellited or 11.5 to 14 percent chromium disc and seat facings.
E. Integral stellited or 11.5 to 14 percent chromium back-seating surface
F. 600-, 900-, 1500-, or 2500- class cast steel or forged steel bodies, complying with applicable ANSI standards
G. Valves shall be manufactured by vendor listed in Appendix B – Approved Vendor List

10. Piping between main stop valves and turbine as required to locate valves either out from under the turbine and its foundation, or above its foundation, including all necessary hangers and supports for the valves and piping.

Exhaust casing spray nozzles with automatic control and internal turbine piping. Include diaphragm (or solenoid) control valve and sensing element for control.

Motor-operated or hydraulically operated turning gear including the following:

1. Turbine control system shall be capable of automatically starting and engaging turning gear.
2. Provide for local manual turning gear (or hydraulic oil pump) motor starting and turning gear engagement should the automatic feature fail.
3. Interlock with lubrication system to prevent operation without bearing lubrication.
4. Zero speed device to prevent automatic starting or engagement while rotor is turning.
5. Electrically separate alarm contacts to indicate zero speed and turning gear disengagement.

All required protective devices including the following:

1. Exhaust hood atmospheric relief diaphragms.
2. Exhaust hood high-temperature alarm.
3. Thrust bearing failure detector with trip function.
4. HP/IP Shell casing packing dump valve if required.

Provide all instruments required to monitor operation of the turbine unit. Instruments shall include at least the following:

1. Thermocouples for at least the following:

    A. Turbine shells, exhaust hoods, valve casings, and as otherwise required for controlled starting and warm-up
    B. Thrust bearing shoes
    C. Main bearing metal temperatures including generator bearings
    D. Main bearing oil drains including generator bearings
    E. Thrust bearing oil drains
    F. Oil inlet and oil outlet of oil coolers
    G. Hydraulic fluid in and out of coolers
    H. Lube oil reservoir

2. Thermometers for at least the following:

    A. Main bearing drains including generator bearings
    B. Thrust bearing drains
    C. Exhaust hood

3. Pressure gauges for at least the following:

    A. Exhaust hood water spray
    B. Gland condenser vacuum
    C. Steam chest
    D. First-stage steam
    E. HP turbine exhaust steam
    F. LP turbine exhaust steam
    G. Gland steam header

4. Electronic pressure transmitters for the following:

    A. Lube oil header
    B. Throttle (before stop valve)
    C. Control valve chest (between stop and control valve)
    D. Turbine First Stage
    E. LP inlet stage
    F. Turbine Exhaust
    G. Electrohydraulic control fluid pressure
    H. Gland steam pressure

5. Provide smart transmitters per the requirements in SECTION 9.

Rotor ground device and grounding pad on exhaust hood and/or bearing standard.

Heat retention insulation for the following:

1. Upper and lower turbine shells.
2. Steam valve bodies.
3. Exhaust casings where required.
4. All steam piping furnished with unit.
5. Horizontal and vertical joints. Provide reusable blankets.

Insulation jacketing as follows:

1. Aluminum jacket for all insulated piping.
2. Removable insulation-filled stainless steel covers for the following:

    A. Main stop valves.
    B. Valve flanges at turbine shells.
    C. Flanges in crossover pipes.

Metal appearance lagging over HP turbine shells and associated stop and control valves and piping to shells.

Moisture protection system for low-pressure stages.

Exhaust connection suitable for welding to condenser neck.

Shims, subsole plates, leveling plates, seating plates, and sole plates.

Electrohydraulic Control System

System shall automatically position the various valves listed above as required to control the turbine-generator speed and load under varying conditions plus trip the unit when overspeed or other abnormal conditions occur. Provide means to initiate and monitor sequential remote testing of the valves and other protective and trip devices during operation of the unit.

Hydraulic portion of the system shall be independent of lubricating oil system complete with reservoir, multiple ac motor-driven pumps, hydraulic fluid coolers, accumulators, filters, strainers, instruments, controls, valves, and all required supply and return hydraulic fluid piping to the main turbine.

1. Instruments and controls in the hydraulic portion of the system shall include at least the following:

   A. Suction and discharge pressure gauges on all pumps and on the discharge header.
   B. Pressure switches for control of all electrohydraulic fluid pumps.
   C. Thermometers on electrohydraulic fluid lines at the inlet and discharge of coolers.
   D. Temperature controllers and cooling water control valves to regulate electrohydraulic fluid temperature at the discharge of each cooler.
   E. Instrument and sensors to provide electrically separate alarm contacts for Owner's use for the following:

      1) Electrohydraulic fluid reservoir high level.
      2) Electrohydraulic fluid reservoir low level.
      3) Electrohydraulic fluid reservoir low-low level.
      4) Electrohydraulic fluid system low pressure.
      5) Electrohydraulic fluid temperature high.
      6) Electrohydraulic fluid system filters dirty.
      7) Others as required by the turbine supervisory and control systems.

Instruments and sensors as required by the turbine supervisory and control systems for operation of turbine.

2. All piping shall be stainless steel with welded joints and a minimum of flanged connections. Piping shall be cleaned internally and then sealed using weld caps or blind flanges before shipment.
3. System shall use turbine manufacturer's standard fire resistant fluid or Owner approved equal.

Turbine Control System

The control system shall provide supervisory control of turbines, turbine auxiliaries, generators, and generator auxiliaries. The system shall provide startup, operation, load change, and shutdown, as well as monitoring, alarming, and safety trips for the steam turbine generator unit.

The turbine control system shall be interfaced to the plant DCS control system through a redundant communications link. All operator functions shall be capable from the plant DCS control system. Contractor shall provide a turbine control system that meets the following requirements and the DCS control system requirements in SECTION 9.

The turbine control system hardware will be installed in close proximity to the steam turbine. Provide a remote operator station for the main control room and a local operator station for the electrical equipment room. Remote operator station shall have identical hardware and software as the local operator station.

Provide means to initiate and monitor sequential remote testing of the valves and other protective and trip devices during operation of the unit.

Provide all sensors, transducers, and transmitters required by the system.

Provide all control, logic and input-output modules, associated power supplies, and related items, installed in a system cabinet assembly, to perform the control functions specified herein.

Provide electrically separate alarm contacts for the DCS use for at least the following:

1. Turbine trip
2. Pre-trip and trip alarm contacts for every turbine trip condition
3. System power supply failure

4. Others as required or recommended by manufacturer

Provide capability of operating in any of the following modes as selected by the operator:

1. Coordinated Boiler-Turbine Mode using a load demand signal generated by Owner's automatic load dispatching system.
2. Coordinated Boiler-Turbine Mode using a load demand signal manually generated from DCS.
3. Boiler Following Mode with turbine valves maintaining speed or load.
4. Turbine Following Mode with turbine valves controlling throttle steam pressure.

Provide a hard wired interface from the turbine control system to DCS for all critical controls, indicators, and interlocks.

Provide controls to allow DCS to immediately reduce the load on the steam turbine generator. The immediate response of the system shall be impeded upon only by the constraints of the hydraulic system.

Turbine Rotor Stress Monitoring

System shall automatically and continuously calculate rotor stresses that occur when temperatures change with machine loading.

System shall operate on the turbine control system hardware.

System shall be capable of operating in at least two separate modes. These modes are:

1. Monitor: In this mode, the system makes available to the operator data required for safe and proper operation of the turbine-generator unit. In this mode, system performs no control functions and all decisions regarding changes in speed or load, rates of change, and other variables are left to the operator.
2. Control: In this mode, the system shall automatically prevent the operator from changing unit load or turbine speed if limits established by the automatic control program or by the operator are exceeded. The system shall also be capable of automatically ramping the turbine from turning gear speed to a target speed, initiating a signal to automatically synchronize the turbine-generator unit, and loading the unit to a target load at a rate selected by operator or as limited by the automatic control program.

Provide all sensors and transducers required by the system.

Turbine Supervisory System

System shall automatically monitor at least shaft vibration, vibration phase angle, eccentricity, differential casing and rotor expansion, metal temperatures, speed, and control valve position. Display essential values continuously and alarm any abnormal condition during start-up and operation.

Provide all sensors and transducers required by the system.

Display all information on the turbine control system interface and plant DCS display.

Display vibration information on the Block 2 Bentley Nevada system vibration monitoring system.

Provide alarms for at least the following:

1. High vibration for all bearings.
2. Rotor eccentricity off normal.
3. Differential expansion off normal.
4. Rotor position alarm.

Lubrication System

The turbine lube oil system shall be installed, cleaned, and flushed according to the manufacturer's specifications. Lube oil type and purity shall be in accordance with the steam turbine generator manufacturer's specifications.

Provide a complete lubrication system including but not limited to the following:

1. Oil reservoir with oil level indicator and oil level alarms. Reservoir shall have adequate capacity above maximum lube oil high level alarm to receive the flow back from the lube oil system under tripout conditions
2. Full-capacity positive-displacement or centrifugal-type main oil pump, either shaft-driven or with ac motor drive
3. Full-capacity positive-displacement or centrifugal-type auxiliary oil pump with ac motor drive

4. Positive-displacement or centrifugal-type emergency oil pump with dc motor drive and starter
5. Oil coolers, either two full-capacity or one three-section type with two sections capable of carrying full capacity
6. Transfer valve so that one tube bundle or section can be removed while remaining cooler or sections are in operation
7. Vapor extractor with ac motor drive
8. Lube oil demister
9. Removable strainers for use during start-up at each bearing inlet and at oil return to reservoir, and at other locations as required by manufacturer
10. Lube oil heater interlocked with a low oil reservoir liquid level switch for alarm and to trip the heater to prevent a fire

Provide instruments required for operation. Instrument signals shall be integrated into the turbine control system. Instruments shall include at least the following:

1. Pressure gauges on all pump suction and discharge lines and on the lube oil header
2. Pressure switches for control of all lube oil pumps
3. Thermometers on oil lines at the inlet and discharge of lube oil coolers
4. Thermocouple complete with well for control of cooling water flow
5. Lube oil reservoir level high
6. Lube oil reservoir low level switch
7. Lube oil reservoir level transmitter
8. Differential pressure switch across filters
9. Emergency lube oil pump running
10. Redundant pressure switch to start dc emergency oil pump. Switch shall be located at a different location from the other pressure switch.
11. Others as required by the turbine control system
12. Loss of ac power relay to start dc emergency pump

Provide all required lube oil supply and return piping. Oil pressure piping shall be seamless steel with welded joints, and a minimum of flanged connections. Oil piping shall be thoroughly cleaned by pickling and then sealed using weld caps or blind flanges before shipment. For protection against fire, oil piping shall be suitably shielded with no flanged joints located above or adjacent to hot surfaces. All lubricating oil piping under pressure in high temperature areas shall be contained within a drain or return line, or within a tight housing which is suitably drained back to a reservoir. Drains shall have adequate capability of returning the oil supplied to any area in the event of a complete rupture of the oil supply pipe in that area. All drain pipes shall be sloped to provide complete drainage of the system back to the lubricating oil reservoir.

Gland Steam System

Provide a complete gland sealing system including but not limited to the following:

1. Steam seal pressure control valves, one for each steam source and one for dump to condenser
2. Full-flow gland steam condenser with two ac motor-driven exhausters, both permanently mounted to the condenser
3. Power-operated diaphragm shutoff and bypass valves with remote position indicators as required to manually control gland steam from the turbine control system should regulators fail
4. Valves and all required piping from pressure control valves to turbine and from turbine to gland condenser
5. The gland sealing system shall have the following features:

    A. The gland sealing system shall not require an external source of steam other than main steam at throttle conditions, or drum steam after pressure reduction. An auxiliary supply of saturated steam shall be provided by Contractor to seal the turbine prior to start-up.
    B. Gland leakage shall be returned to the cycle by the gland sealing system provided, except such portions as may be contaminated by air or oil vapor.
    C. Gland steam valves shall be of an Owner-approved type with stellite or 11.5 to 14 percent chromium seats.
    D. Provide removable flanged spool piece at each connection to the turbine gland seal piping to facilitate steam cleaning of the gland steam system in accordance with the manufacturer's recommendations.

6. Provide all instruments required for operation. Instrument signals shall be integrated into the turbine control system. Instruments shall include at least the following::

   A. Low steam seal pressure switch
   B. High water level switch in gland steam condenser
   C. Gland steam temperature sensor

5.2.7 Combustion and Steam Turbine Electrical Generator

General:

Generators shall be cylindrical rotor type designed, constructed, and rated in accordance with applicable standards for specified service conditions.

All three generators will be connected in a high resistance grounded wye configuration through a neutral grounding transformer with neutral grounding resistor connected in the transformer secondary. The high voltage winding of all Generator Step-up (GSU) transformers will be solidly connected grounded type wye configuration.

The steam turbine generator will be connected to the delta wound low voltage winding of the GSU Transformer. The unit will by synchronized across the high voltage side switchyard breaker. See SECTION 8 for additional requirements.

The gas turbine generators will be connected to a generator breaker that is connected to the delta wound low voltage winding of the GSU transformer. The unit will be synchronized across this generator breaker. See Section 8 for additional requirements.

Applicable Codes and Standards

Design, fabricate, assemble, and test equipment so that upon installation and operation in accordance with manufacturer's recommended procedures for this application, the equipment will conform to the requirements of the applicable provisions of the standards (or equivalent IEC standards) including, but not limited to, the following:

1. American National Standards Institute (ANSI):

   A. B31.1 - Code for Pressure Piping - Power Piping

B. C1 - National Electrical Code
C. C42.1 - Definition of Electrical Terms, Group 10 Rotating Machinery
D. C50.10 - General Requirement for Synchronous Machines
E. C50.13 - Cylindrical Rotor Synchronous Generators
F. C57.13 - Requirements for Instrument Transformers

2. American Society of Mechanical Engineers:

A. Boiler and Pressure Vessel Code
B. B31.1 - Power Piping

3. American Society for Testing and Materials (ASTM):

A. A194 - Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
B. A437 - Alloy-Steel Turbine-Type Bolting Material Specially Heat Treated for High-Temperature Service

4. Institute of Electrical and Electronics Engineers (IEEE):

A. 4 - Techniques for Dielectric Tests
B. 21 - Outdoor Apparatus Bushings, General Requirements and Test Procedure
C. 32 - Neutral Grounding Devices
D. 421 - Criteria and Definitions for Excitation Systems for Synchronous Machinery
E. 421a - Guide for Identification, Testing, and Evaluation of the Dynamic Performance of Excitation Control Systems
F. 421b - Standard for High-Potential Test Requirements for Excitation Systems for Synchronous Machines

5. National Electrical Manufacturers Association (NEMA).
6. Tubular Exchanger Manufacturer Association (TEMA).

Quality Assurance

All equipment and material furnished shall have an acceptable history of satisfactory reliable service in central station use for a period of at least three years at comparable temperature, pressure, voltage, and design stress levels.

Newly-developed equipment with less than three years' actual service will be considered from established manufacturers, only if it has been adequately tested, meets the requirements of this Contract, and is approved by Owner.

Factory Tests

All standard factory tests on equipment and all tests required by the applicable codes shall be performed including:

Mechanical inspection.

1. Rotor balance, with rotor at normal maximum operating temperature.
2. Rotor over-speed at 120 percent rated speed.
3. Measurement of cold resistance of stator and rotor windings.
4. Winding insulation resistance measurement.
5. Standard IEEE 4-1978 dielectric tests on stator and rotor.
6. Pressure test on hydrogen-cooled stator frame for gas tightness (if provided).
7. Resistance temperature detector test.
8. Lubricating systems including hot oil flushing and bearing inspection.
9. Comprehensive tests of all systems and controls to assure proper assembly and connection, including simulation tests of all safety devices.

Provide Owner and Engineer a list of all factory tests and a test schedule so that they may have a representative witness the tests, if desired.

Submit certificate of completion of all tests and test reports for all tests. All factory test results shall be available for examination by Owner upon request.

Submittals

Submittals required shall include all manufacturers' drawings necessary for design, installation, and operation of equipment furnished, including the following:

1. General outline, base plans, and general arrangement drawings
2. Detailed installation drawings showing foundation details, location connections, weights, and all clearances required for erecting, operating, and dismantling
3. Complete loading diagrams covering static and dynamic loadings for all conditions of operation
4. Schematic wiring diagrams showing all external connection terminal block numbers
5. Complete connection diagrams showing all internal wiring
6. Power and instrument transformer connection and polarity diagrams
7. Instrument transformer performance curves and data
8. Bills of material
9. Drawings showing additional detail if requested by Engineer, or if otherwise required for installation and maintenance

Wiring drawings shall include connection drawings both internal and external, NEMA Standard across-the-line industrial control schematic drawings for all control systems provided or designed by Contractor, physical location drawings for all terminal blocks, and power requirements.

Products

GENERAL: Generator stator core shall be so designed and constructed (or flexibly mounted) as to minimize the effects of 120-cycle vibrations on stator frame, foundation, and other structures.

Generator cooling system shall be totally enclosed hydrogen cooled or Totally Enclosed Water Air Cooled (TEWC) with Class F insulation on stator and rotor and limited to Class B temperature rise.

GENERATOR:

1. Minimum net continuous rating of 105 percent of the turbine peak output at 85 percent lagging to 95 percent leading power factor
2. General output voltage ±5 percent of nominal
3. TIF maximum (1960 weighting), balanced: 40
4. TIF maximum (1960 weighting), residual: 30
5. Minimum short circuit ratio at rated hydrogen pressure: 0.5.

COOLING SYSTEM:

1. The internal generator cooling air shall be adequately filtered and controlled to permit operation without adverse effects on the service life of the insulation or condensation and corrosion of generator iron.

EXCITATION SYSTEM:

1. Provide self-excited main exciter of brushless or static type, having stabilized voltage.
2. Provide control system with fast-acting response, and suitable voltage regulator arranged for local and remote control.
3. Provide excitation control breaker and field discharge or field suppression contactor and resistor.
4. Provide all necessary current transformers, potential transformers, relays, protective devices, and supervisory safety monitoring devices.
5. Exciter shall be capable of supplying 110% of nominal rated field continuously and 200% excitation ceiling voltage 150% ceiling current for a minimum of 10 seconds.
6. Generator excitation equipment shall be housed in a metal-enclosed NEMA dead-front enclosure and contain the following:

   A. Excitation control circuit breaker or field suppression control
   B. Linear field discharge resistor if required
   C. Voltage regulator
   D. Ammeter shunt
   E. Regulator shall be equipped with tie-line power factor compensation, cross-current compensation, and maximum and minimum excitation limits
   F. Provisions to interface with distributed control system (DCS) for remote reactive power and voltage control
   G. Redundant hot back-up thyristor bridge.

7. General:

   All excitation system voltage response ratios stated herein are to be as defined and recommended in IEEE 421, and shall be determined with the excitation system connected to the generator field, or an equivalent resistive load as described by IEEE 421a. A factory test or an analytical method may be used in determining acceptance of the voltage performance.

8. Provide a complete excitation system of one of the following types:

   A. Static type including the following:

      1) Provide separate dry-type power potential transformer in a free-standing metal enclosure provided with high voltage bushings and flanges for connection to isolated phase bus duct. Overcurrent relay and associated CTs for transformer protection shall be provided.
      2) Collector enclosure with internal illumination, hinged access doors, observation windows, and ventilation system.
      3) Metal-enclosed excitation cubicles with voltage regulator, generator supply breaker, field ground detector, silicon rectifiers, and all required control circuits and accessories.

   B. Brushless rotating rectifier type including the following:

      1) Permanent magnet pilot exciter, ac exciter, and a diode and fuse wheel directly connected to the generator shaft. Each diode must have series fuse.
      2) Exciter enclosure with internal illumination, hinged access doors, observation windows, and cooling system.
      3) Metal-enclosed excitation cubicles with voltage regulator, exciter supply breaker, automatic field ground detector, and all required control circuits and accessories.
      4) Furnish an excitation system communication interface to the plant distributed control system to allow operator to monitor and control the excitation system.

9. Provide the following special excitation system features:

   A. Ten additional auxiliary contacts on exciter field breaker. This may be by the addition of a multi-contact auxiliary relay
   B. Provide field ground detection relays for main generator and exciter field

C. Fuses and terminal blocks for all components of excitation system requiring 220 volts ac or 125 volts dc station service power

D. Line drop compensation for voltage regulator

E. Maximum and minimum excitation limit equipment

F. Two-step maximum volts per hertz excitation protection and limiter

G. Provisions for the addition of supplemental excitation controls to control excitation in response to generator rotor angle

H. Dual input power system stabilizer utilizing integral of accelerating power with system studies, settings, and field tuning

I. Provide main generator field ground detection relay with proper sensitivity and adequate security to use to trip the unit. Provide unit with time delay to prevent trip for momentary field ground

J. Automatic regulator tracking control for manual regulator.

K. Regulator and power system stabilizer output status contacts to Owner's SCADA system.

L. Provide transducers with 4 to 20 mA output to Owner's DCS for exciter field voltage and current.

M. Hydrogen/temperature Limiter Compensation.

N. Overvoltage trip.

O. Provide field overcurrent protection system that has characteristics similar to the thermal capability of the rotor so as to permit full utilization of the rotor thermal capability, but that will positively prevent overcurrent which could damage the rotor. An offline field current limiter shall be provided

P. Field flashing system for operation using station 125V battery, or separate 460-volt, 3-phase system.

Q. The exciter shall be capable of maintaining 2.0 pu., or greater, excitation voltage while generator terminal voltage is 0.5 pu

R. Power factor and VAR automatic control.

S. Communication ports to Owner's DCS.

T. Off line excitation protection.

U. Display panel with self diagnostics

<u>HYDROGEN SYSTEM</u>: (As applicable if provided by OEM for cooling)

1. Provide hydrogen coolers arranged and sized with adequate capacity to provide 80 percent generator capability with one isolatable cooler, or section (as

applicable), out of service. All fasteners (nuts, bolts, and similar items) exposed to the cooling water shall be stainless steel. Arrange cooler vents for convenient access below the operating floor

2. Provide hydrogen bottle manifold including pressure gauges, shutoff valves, mounting brackets, bottle connectors, piping and a single shutoff valve. Provide a flanged removable section of pipe between the hydrogen shutoff valve and generator for removal while performing generator maintenance.
3. Provide carbon dioxide and nitrogen bottle manifolds including pressure gauge, shutoff valves, mounting brackets, bottle connectors, and single shutoff valve.
4. Provide piping, valves, regulators and analyzer as follows:

   A. Generator hydrogen pressure regulator with shutoff valves and bypass line
   B. Purging control valve assembly
   C. Purging gas analyzer
   D. Welded steel gas control system piping

5. Provide instrument and controls as follows:

   A. Electronic transmitters as follows:

      1) Generator hydrogen purity
      2) Generator hydrogen pressure
      3) Generator fan differential pressure
      4) Hydrogen density
      5) Hydrogen dewpoint

   B. Sensors as required to provide at least the following alarms at the hydrogen controls cabinet.

      1) Generator hydrogen purity high and low
      2) Generator hydrogen pressure high and low
      3) Hydrogen supply pressure low
      4) Generator hydrogen temperature high
      5) High Hydrogen dewpoint
      6) Others as required by manufacturer

C. Temperature detectors to include the following: (Detectors listed below are for Owner's use. Any that are required by the turbine control or supervisory system dual detectors shall be furnished.)

1) One RTD for each hydrogen cooler gas inlet and outlet.
2) One thermocouple and well in combined gas stream on the outlet of coolers for control of Owner's cooling water valve.
3) Two RTDs in combined gas stream on the outlet of hydrogen coolers.

6. Provide hydrogen control cabinet including the following:

A. Generator hydrogen pressure indicator.
B. Generator hydrogen purity indicator.
C. Fan differential pressure indicator.
D. Generator gas density indicator.
E. Generator cold gas temperature indicator.
F. Seal oil differential pressure indicator.
G. Stator coils water flow indicator, if applicable.
H. Stator coils water tank pressure indicator, if applicable.
I. Stator coils water pressure differential indicator, if applicable.
J. Conductivity recorder for conductor liquid cooling system (if applicable).
K. Hydrogen system SCAM-Panalarm Series 80 solid-state annunciator or
L. Engineer's approved equal with isolated alarm contact output for each window for Owner's use.
M. Complete internal panel piping and wiring.
N. Provide space heater and thermostatic alarm control for auxiliary panels.

7. Redundant trains shall have isolation valves to allow maintenance with one train out of service.

<u>MISCELLANEOUS</u>:

1. Provide the following materials equipment and instruments:

A. Six high voltage bushings

B. Temperature detectors to include six RTD's per phase embedded in stator windings
C. Generator field flux probe permanently mounted
D. Field retaining ring Material shall be 18 Mn 18 Cr
E. Partial Discharge Detectors mounted in stator slots
F. Fiber optic end winding mounted accelerometers
G. Grounding pads
H. Terminals for testing bearing and seal housing insulation on at least one
I. Foundation plates, shims, and sub-sole plates
J. Metal appearance lagging from floor to centerline of generator
K. Set of lifting slings, special tools and wrenches, air gap shim, and field shoe for assembly of rotor, and one set of lifting or jacking trunions
L. Generator casing liquid detector
M. Bushing current transformers shall be as follows:

    1) Provide bushing current transformers as required for relaying and metering
    2) Bushing current transformers shall meet ANSI accuracy class of C-800 for relaying, or 0.3B1.8 for metering

N. Bushings designed and arranged for termination of isolated phase bus duct
O. Neutral terminals shall be interconnected and completely enclosed in a properly ventilated enclosure with provision for connection to neutral grounding equipment
P. Field temperature indicator transmitter including field current shunt in dc bus, if applicable
Q. Vibration monitoring probes
R. Generator balanced voltage wave shape shall limit the open circuit telephone influence factor to the current standards, based on 1960 weighting factors, or provide at no additional cost all necessary accessories with isolated phase construction required to meet the standards
S. Generator stator and windings, including series loops and end turns (end turns not fully insulated on gas-cooled stators), shall be fully insulated so as to be satisfactorily tested in accordance with the high potential tests

required by IEEE Standard 4, and in a manner satisfactory to Engineer. Contractor shall submit details of insulation for review and approval prior to award of Contract

HEAT EXCHANGERS:

1. Exchangers with water source from treated raw water:

   A. Tubes shall be 20 BWG minimum, stainless steel
   B. Tube sheets shall be Contractor's standard
   C. Channels and cover plates shall be aluminum bronze
   D. Water sides of coolers to be designed for the pressure and cooling water temperature as required by Contractor's design
   E. Minimum tube size shall be 5/8 inch nominal diameter

2. Exchangers in condensate cycle (Refer to SECTION 5):

   A. Tubes shall be adequate for design pressure as required by Contractor's design
   B. Tubes for gland steam condenser shall be stainless steel
   C. Tube sheets shall be Contractor's standard material
   D. Channels shall be fabricated steel
   E. Designed for the water temperature ranges as required by Contractor's design
   F. Minimum tube size shall be 5/8 inch nominal diameter

3. Exchangers in bearing cooling water system (Refer to SECTION 5):

   A. Designed for design pressure and temperature as required by Contractor's design
   B. Tubes shall be stainless steel minimum 22 BWG
   C. Tube sheets shall be Contractor's standard material
   D. Channels shall be fabricated steel
   E. Minimum tube size shall be 5/8 inch nominal diameter

ELECTRICAL DEVICES:

1. Electric indicating instruments shall be semi-flush mounting, long-scale type, 5 inches square with black metal case.
2. Position and limit switches shall be suitable and adequate with mountings and actuators as required to provide reliable operation.
3. Alarm switches shall have contact ratings of at least 0.25 amperes at 125 volts dc and shall close for alarm.
4. All control devices such as relays and solenoids for nominal 125-volt dc operation shall provide satisfactory operation for a range of voltage from 90 to 140 volts with a 50oC ambient temperature where obtainable.
5. All electrical devices and wiring located under the casing of the machine shall be specifically designed and constructed of suitable materials to give satisfactory operation in the high ambient temperatures involved.
6. All electrical equipment and devices furnished on the turbine generator unit and its auxiliaries shall be wired out to conveniently located, oversized, terminal boxes for Owner's external wiring connections. Terminal boxes shall be NEMA 12. Terminals shall be marked as designated by Owner.
7. Motors shall conform to SECTION 8 and the following:

    A. Size motor to operate at less than nameplate horsepower over the capability range of the driven equipment
    B. Motor insulation shall be NEMA Class F, with Class B temperature rise in accordance with NEMA MG1
    C. Suitable for across-the-line starting
    D. Provide TENV or TEFC enclosures for all motors

8. Provide disconnect-type combination motor starters, completely wired, for all dc motor-driven auxiliaries provided by this Contract.

CONTROL PANEL EQUIPMENT:

1. Construction:

    A. Provide panels and cabinets, totally enclosed, self-supporting
    B. Provide hinged access doors and/or removable panels as required

C. Factory mount all instruments, control switches, and other devices at locations approved by Owner

D. Smooth, fill, prime and paint panels with two coats of finish paint of manufacturer's standard color subject to the approval of Engineer

E. Wire and tube completely in factory

F. Provide panels or insert panels to match Owner's panels provided under other contracts

2. Panel Wiring Terminal Blocks:

A. Terminate all connections requiring external wiring at terminal blocks, suitable for ring-tongue type connectors

B. Identify each terminal on each block by stamping or painting the circuit identification number

C. Provide manufacturer's standard terminal blocks subject to approval of Owner

3. Panel Wiring:

A. Wire with no splices and with all connections made on equipment studs or terminal blocks. Make all connections with insulated, ring-tongue terminals

B. Provide standard conductor switchboard wire insulated for 600 volts

C. Provide extra flexible hinge wire in areas subject to flexing such as hinged panels and doors

D. Install in wiring troughs or channels with removable covers for easy accessibility to interior panel wiring

GENERATOR SURGE PROTECTION AND POTENTIAL TRANSFORMER EQUIPMENT:

1. Ratings:

   A. Potential Transformers:

      1) Voltage and BIL as required, 60 Hz.
      2) Thermal capacity of at least 1000-volt amperes and metering accuracy of 0.3 for burdens W, X, Y, Z, and ZZ, when applied at rated voltage. VT burden shall be under 100 VA
      3) Thermal capacity of at least 580-volt amperes and metering accuracy of 0.3 for burdens W, X, Y, and J.6 for burden Z, when connected line-to-neutral. Generator VT burden shall be under 40VA.

   B. Surge Arresters:

      1) Proper rating design for rotating machine protection of the generator. Furnish an operation counter with each arrester.

   C. Surge Capacitors:

      1) Rated for the application and sized at 0.25 micro farads or as recommended by manufacturer.

   D. Provide with dual secondary windings: One winding connected in a wye configuration and the other connected in an open delta configuration.
   E. Provide loading resistors across secondaries.

2. Type and Design:

   A. Equipment will be located in line terminal cabinet and will be drawout type connected wye-wye, with current limiting primary fuses, secondary fuses, and necessary primary and secondary disconnecting devices and connections. Transformers shall be designed and constructed in accordance with ANSI C57.13.
   B. Surge arresters to be metal-oxide station type, General Electric Tranquell or Ohio Brass Dynavar.

C. Furnish complete NEMA 2 steel enclosure cubicle with floor plate for above equipment with necessary primary and secondary connections, wiring, terminal blocks, and insulator supports and mounted on I-beam base so as to be self-supporting when resting on concrete floor or foundation.

D. Furnish flanged connection with seal-off bushings at equipment enclosure and non-segregated bus extension to generator terminal enclosure.

E. Furnish a ground bus at least 1 inch by ¼ inch cross section to the full width of each enclosure. Furnish connector for 250-MCM copper cable at each end of each ground bus.

F. Arrange for entrance of external secondary circuit wiring from below.

G. Surge capacitors and transformers shall not contain any PCB insulating fluid.

GENERATOR NEUTRAL GROUNDING EQUIPMENT:

1. Ratings:

A. As recommended by Contractor

B. Voltage as required, 60 Hz,110-kV BIL

2. Grounding Resistor:

A. Sized for high resistance ground system

B. Voltage rating suitable for connection to 220-volt transformer secondary

3. Type and Design:

A. Transformer to be sealed dry type 300oF rise

B. Resistor to be cast-grid or stainless steel type

C. Furnish steel enclosure for housing transformer and resistor, with full height, hinged access doors, floor plate, and I-beam base so as to be self-supporting when resting on concrete floor or foundation. Provide adequate ventilation louvers in enclosure

D. Include wiring to terminal block in terminal compartment or cabinet for remote relaying connections, arranged for wiring entrance from above

E. Furnish connectors on transformer terminals and other provisions for connection of cable from generator neutral terminals, and for two connections to station ground grid by 250-MCM copper cable

GENERATOR TERMINAL ENCLOSURE:

1. Furnish one terminal enclosure.
2. Construct enclosure of heavy-gage sheet aluminum with internal stiffeners as required for rigidity.
3. The enclosures and/or the terminal attachment flanges at the top should be able to accommodate an approximate construction variation in the calculated bus centerline-to-terminal vertical and horizontal distances of plus or minus 3/4 inch.
4. Construct with large removable access covers to permit removal and replacement of the disconnect links at the main terminals.

ACCESSORIES:

1. Provide generator with at least six stator temperature detectors of resistance type, 100 ohms at 77^{o}F, and at least two temperature detectors to measure cooling air inlet and discharge temperatures wired to terminal box.

5.2.8 Heat Recovery Steam Generator (HRSG) System

Contractor shall provide two (2) complete and functional HRSGs including all materials and labor required to design, fabricate, install, startup, and test the HRSGs. The HRSGs shall be a three pressure, natural circulation, water tube type designed for gas turbine exhaust. Each HRSG shall be complete with inlet ductwork from combustion turbine exhaust connection, including expansion joint, HRSG exhaust duct, and exhaust stack.

The HRSG process design concept is illustrated in Heat Balances and Conceptual Process Flow Diagrams, Appendix D. The HRSG shall be designed and constructed in compliance with the ASME Boiler and Pressure Vessel Code, Section I and NFPA 85.

The Scope of Supply shall include but not limited to the following:

1. Two complete modularized Heat Recovery Steam Generators.
2. Inlet ductwork from combustion turbine exhaust, with expansion joint including gasket, bolts and nuts.

3. HRSG exhaust duct with expansion joint, including gaskets, bolts and nuts.
4. Individual Exhaust Stacks with test ports and CEM monitor ports.
5. Motor actuated stack dampers and nearby manway doors for inspection of dampers.
6. Internally insulated HRSG casing with complete liner.
7. Flow distribution device(s) and flow modeling as required.
8. Triple pressure HRSG with HP, IP, & LP drums, superheaters, evaporator and economizer sections, superheater attemperators, reheater attemperators.
9. Complete Duct burners system including all required piping, valves, instruments and complete PLC based burner management system. Alternatively, the burner management controls can be included in the plant DCS. All external duct burner fuel piping shall be insulated and heat traced.
10. Selective catalytic reduction (SCR) system, including vaporization skid, piping, valves instrumentation, ammonia injection grid and catalyst, also CO catalyst.
11. HP, IP, and LP Drum end enclosures which shall be insulated, heated and ventilated. Insulation shall include floors to allow for the mounting of instrumentation without concerns of freezing.
12. LP economizer recirculation pumps, valves, piping and temperature control system.
13. Structural Support System, including access platforms, ladders and stairways. Ladders shall be located on both sides of the HRSG.
14. All structural steel supports to grade for ductwork and stack, as required.
15. All vents, drains, Blowdown, chemical feed, and chemical cleaning connections.
16. All Steam safety valves with silencers vent piping to meet noise requirements specified in Section 1. Vents to be a minimum of 10 ft above the highest platform.
17. All safety valve above seat drains and drip pan drains shall be routed to a safe area.
18. Steam sparging system in HP, IP and LP evaporators.
19. Each heat transfer section shall be completely drainable and ventable. All valves that must be opened or closed as a part of startup, shutdown or transient conditions shall be power operated. All other vents & drains shall have manual valves. Drain valves shall be located at grade.
20. Continuous and Intermittent blowdown piping and power operated valves. Blowdown system shall not be a cascading system. Blowdown shall be routed to dedicated blowdown tanks for each HRSG.

21. Sample connections shall be provided for the water and steam from the HP, IP, and LP steam drums, reheater outlet, LP economizer inlet, and LP economizer outlet.
22. All piping between equipment and components furnished with the HRSG.
23. Temperature test connections (including thermowells) shall be provide for monitoring temperature of water inlet and outlet of each heat transfer sections.
24. Two (2) valved test connections on HRSG gas-side between each heat transfer section.
25. Stainless steel chemical feed connections with check and isolation valves for the HP and IP steam drums.
26. Complete set of all controls and instrumentation including, but not limited to, steam flow elements, temperature well, thermocouples, and transmitters.
27. Each HRSG shall be provided with a monorail and powered hoist and trolley with a stainless steel cable, rated for routine maintenance, and installation and removal of SCR catalyst.
28. Technical advisors for field installation and erection, finish painting, boilout, hydrostatic testing, startup and testing of the HRSG, SCR system and all auxiliaries, including all electrical raceways, cables, and any other equipment or special accessories and services required for a complete installation.
29. Contractor shall design the HRSG with adequate drains and controls to eliminate the buildup of condensate during startup, shutdown, and standby conditions. Thermocouples shall be supplied on all drain lines to allow the Owner to monitor condensate buildup. The size of the drain lines, quantity of drain line connections, the location of drains, and operating recommendations provided by the Contractor shall generally follow the EPRI recommendations provided in EPRI document 1014196 "Guidelines on Optimizing Heat Recovery Steam Generator Drains". Contractor shall provide with their proposal a discussion on the means and methods included in their design to address the recommended drain system arrangement and operational requirements provided in the subject EPRI document.
30. Creep and fatigue life calculations shall be performed for steady state and cyclic operating condition requirements. Owner must agree to the assumptions and methods for these calculations before they are performed.
31. Each HRSG shall be provided with pipe penetrations (minimum of 4" size) in the roof (outside of casing) for threading skyclimber and/or bosun chair supports during maintenance.

Each HRSG shall be capable of a full range of plant continuous operation between each of the following cases, at the design ambient temperature ranges:

1. 50% or minimum CTG load that Contractor will guarantee emissions, single unit operation.
2. Base CTG load with maximum duct firing, single unit operation
3. 50 percent or minimum CTG load that Contractor will guarantee emissions, two unit operation
4. Base CTG load with maximum duct firing (if provided), two unit operation

The following operation shall be provided for:

- The combined cycle plant shall be capable of steam turbine operation in sliding pressure mode during normal operation in load following situations with either one or two CT/HRSG trains in service. The combined cycle plant shall also be capable of steam turbine operation in fixed inlet pressure control mode during times when only one CT/HRSG train is in service, and in variable inlet pressure control mode during every normal shutdown or during startups, when the steam turbine is operating below 50 percent of the rated steam turbine throttle pressure or any other control modes that require fixed or variable pressure operation.
- The HRSG shall be capable of withstanding major upsets caused by a trip of the steam turbine or a trip of one CTG without causing cascade trip in the operating CTG(s) due to high or low drum level excursions in the HP, IP or LP steam drums.
- Cycling duty to follow combustion turbine daily load swings from no load to full generation capability.
- A steady rate of load change (both increasing and decreasing) up to 10 percent of the maximum steam generating capability of the unit per minute, without causing steam temperature at HP superheater or reheater outlet to exceed the respective design outlet steam temperature of HP superheater and reheater, or causing the steam temperature at the outlet of the HIGH-PRESSURE superheater and reheater attemperators to fall below 50°F (28ºC) superheat.
- Start-up and shutdown of one or both CTG/HRSGs without causing steam temperature at HP superheater or reheater outlet to exceed the respective design temperature of HP superheater or reheater outlet headers and steam pipes while simultaneously maintaining not less than 50°F (28ºC) of superheat in the steam at the HP superheater and reheater outlets.

- Start-up and shutdown of one HRSG while the other HRSG is in operation without causing cascade trip in the operating CTG(s) due to high or low drum level excursions in the HP, IP or LP steam drums.
- Continuous operation in steam cooled reheater steam turbine bypass mode at any CTG load up to 100 percent load. This includes bypassing main steam conditioned to cold reheat temperature to the reheater inlet and bypassing hot reheat steam to the condenser. The HP bypass shall be equipped with an adjustable setpoint to allow matching of the HP bypass outlet temperature as close as practical to the prevailing cold reheat temperature at initiation of startup.
- A 72-hour cool down period is desired for rapid access and maintenance. The Contractor shall provide recommendations for achieving this cool down period and quantify the resulting fatigue life consumption in the HP drum, HP superheater headers and manifolds, and reheater headers and manifolds. The fatigue life impact of the 72-hour cool down shall not be included in the HRSG total fatigue life analysis.

General

Design for adequate circulation through all tubes and heating surfaces to prevent overheating of any area under any load and all operating conditions. HRSG shall be designed to allow operation with a floor pressure of 750 psia at all operating conditions (including 2X1 and 1x1 operation) with the CTG at 50 percent load, HRSG unfired, and with the CTG at base load, maximum HRSG firing. All safety valve vents shall have silencers.

Each HRSG shall be designed such that no structural or acoustical resonant modes of HRSG parts exist at or are near to the CTG combustor-driven discrete frequencies. :

The design shall consider, as a minimum, the resonant modes of the ducting, structure, flow distribution grids (if any); heat transfer tubes and any other component of the HRSG where high amplitude dynamic pressure excitation by these frequencies can cause structural damage to Vendor-supplied equipment.

Sufficient space shall be provided between the foundation and the HRSG's lower casing and/or the bottom of external steam manifold insulation/lagging to permit the installation of properly sloped drainpipes, drain pots, valves, flash tanks and other components required by this specification. There shall be no interference between drain components, or other equipment and/or structures during cold, hot or transient conditions. The HRSG's elevation above its foundation shall not be finalized until the HP superheater and reheater drain system designs are completed and approved by the Owner.

Pressure Parts

Design all pressure parts for safe operation at the outlet pressure specified at all loads. Provide for expansion and contraction so that tube alignment and spacing is not affected. Furnish airtight seals as required to prevent leakage.

Provide all necessary connections for chemical cleaning operations and access to headers for tube flushing, including access through casing and insulation. All evaporator or economizer tubes shall be electric resistance welded and shall conform to the requirements of the ASME Boiler and Pressure Vessel Code. All reheater and superheater tubes shall be seamless drawn and shall conform to the requirements of the ASME Boiler and Pressure Vessel Code. LP and IP economizer and evaporator outlet tube stubs, bends, headers and risers shall be fabricated from materials, such as 1 ¼ chrome, which will minimize the risk of flow accelerated corrosion (FAC). Tubes shall be extended-surface type with continually welded fins. HRSG tubes shall be a minimum wall thickness of 0.105 inches. Tube arrangement shall facilitate cleaning and inspection without cutting of pipe. For inspection purposes, one turn in each coil shall be provided with a flanged inspection port. There shall be no more than 7 fins per in. Fins shall have a thickness of at least 0.040 inches, and shall be no more than 3/4 in. high. Fin connection to tubes shall utilize continuous high frequency welds. Provide baffles and tube supports as required to prevent acoustic vibration of tubes. No vaporization of feedwater shall take place within the economizer tubes throughout the entire operating range. Tubes shall be arranged for ease of removal and replacement of an individual tube with a minimum of disturbance to all other tubes.

Fin materials shall be as follows:

1. Carbon steel for fin tip temperatures up to 775^o F.
2. Material similar to ASME 409 SS for fin tip temperatures up to 1000^{o}F.
3. Material similar to ASME SA 213 Grade TP304 or TP316 for fin tip temperatures up to 1,500^{o}F.

Tube materials shall be carbon steel for tube temperatures up to 775oF and ASME SA213 Grade T11 for tube temperatures up to 875oF and ASME SA213 Grade T22 for tube temperatures up to 1000oF and ASME SA213 Grade T91 for tube metal temperatures greater than 1,000oF. Tube metal design temperature, for selection of the tube material, shall not be less than the maximum expected outside tube wall temperature. Calculation of maximum surface temperature shall consider unequal gas distribution, operation at off design conditions, transiently reduced steam flow rates during startups, and imbalance in tube heat absorption.

When tubes attached to two different upper superheater headers (in-line with exhaust gas flow) share a common lower header the support system shall be designed to address the longitudinal growth due to thermal expansion. The support system may use spring supports or other Owner approved design.

Welding T91 tubes to P22 headers, and welding T22 tubes to P91 headers is not permitted. Welding P91 to any alloy with less than 2¼ percent chrome is prohibited. Where possible, dissimilar chrome content welds between P91 and P22 piping shall be avoided. Where P91/P22 dissimilar chrome content welds are used, thoughtful consideration of potential stresses, weld geometry and weld procedures shall be given to minimize the potential for type 4 crack initiation. A tapered dimensional transition pieces fabricated from P91 shall be used for every P91/P22 dissimilar chrome content weld. Pipes that contain a transition from P22 to P91 must have adequate flexibility to limit bending stresses under any operating condition to 20 percent of the circumferential pressure stress in transition butt welds and minimize thermo-mechanical direct axial stresses at the transition welds. The analysis methods, input assumptions and acceptance criteria used to determine the stresses developed at each of these transition welds is subject to the approval of the Owner before materials are procured. Where possible, dissimilar metal chrome content welds shall be located outside the HRSG casing and in an accessible location for routine inspection.

When tubes attached to two different upper superheater or reheater headers (in-line with exhaust gas flow) share a common lower header, the upper headers support system shall account for potential differences in temperatures and system expansions

Tubes shall be protected from high temperatures due to uneven gas flow, upset conditions, etc., by using conservative temperature margins on material selection and by the hydraulic design of the headers and piping.

Tubing located before the de-nox SCR (hot side) shall be arranged in a square or triangular pitch to maximize heat transfer surface exposure. Tubes located after the de-nox SCR (cold side) shall be arranged in a square pitch to facilitate in-service cleaning. Fin heights, pitching, and transverse tube pitching shall be selected based upon the specified natural gas fueled combustion turbine generator.

Boiler

Design for adequate circulation through all tubes and heating surfaces to prevent overheating of any area under any load and all operating conditions. Distribution and collection manifolds and headers shall be designed to provide uniform water or steam flow to all passes of the tube bank.

Evaporators shall be of natural circulation design. Evaporators shall maintain a constant flow over the full range of steam output. Circulation ratio shall not be less than 10:1 in any part of the evaporators, except for the HP evaporator, which shall have a departure from nucleate boiling ratio (DNB) greater than 2:1.

Evaporator tube bank design shall be based on optimum arrangement for natural circulation. Tube elements in the bank shall be connected by a header. Evaporator tube banks shall be fully self-draining.

The superheater shall be of the convection type with all piping connections between the sections of welded construction. Each superheater shall be of the self-draining type.

Superheater tube metal design shall include provision for all operational and system imbalances. The tube metal shall be an alloy best suited to resist thermal chemical corrosion from the exhaust gas flow.

Headers shall be seamless drawn steel pipe or fabricated from formed steel plate with welded construction. Headers shall have seal welded plug-type handholes, welded capped inspection nozzles, or other type as approved by Engineer, as required for inspection. Inspection handholes or nozzles shall be in accessible locations.

The Contractor shall make all reasonable efforts to design HP superheater and reheater headers with wall thickness no greater than 1.25 inch (31.75mm). Multiple inlet/outlet nozzles, reinforced tube stubs, multiple parallel passes with separate headers, and other features that result in thinner header wall thickness shall be employed as appropriate.

Upper and lower headers shall allow complete drainage of tubes and headers.

Selection of manifold and header wall thickness shall take manufacturing tolerance into account.

The elevation of the lowest superheater or reheater header or manifold shall be determined during detailed design of the HP superheater and reheater drain system, and shall be approved by the Owner prior to release for fabrication of the HRSG.

A redundant pair of permanent thermocouples shall be installed in one secondary superheater outlet header within 15 inches of one of the steam outlet nozzles with one of each redundant pair located close to the inner surface (chordal) of the header and the other at header midwall position to provide continuous indication in the DCS of the temperature difference between header inner surface and midwall temperature. An access panel shall be provided to enable defective thermocouples in the superheater outlet header to be replaced during an annual outage. Redundant pairs of thermocouples shall be installed in both the top and bottom HP drum wall, with one of each pair of thermocouples located close to the inner surface of the drum and the other positioned at mid-wall. The EPC Contractor shall route the data from these thermocouples to the DCS where it shall be stored in its historian for use in periodic header remaining life analysis.

Headers shall be equipped with ports for periodic internal inspection. The inspection ports shall not be installed on the bottom of the header and they shall be accessible without cutting or welding of other structures.

Boiler lower drains shall be provided with chemical-cleaning connections.

Connections for use by Owner shall be welding connections conforming to ANSI/ASME B16.25.

If headers are within the gas stream, they shall be designed as heat absorbing surfaces and shall not be insulated. Headers shall be adequate for the gas temperature encountered without allowance for internal steam cooling. Lower headers shall allow for steam pegging to maintain higher temperature when the unit is off line.

Provide drums and headers with nozzles as required for vents, drains and instruments. Nozzles shall extend beyond the header insulation; size and weld-end preparation of nozzles for Owner's connection shall be subject to the approval of Engineer.

External casing shall be gas-tight, continuously seal welded construction and provided with packing at all piping penetrations and expansion joints. Construct casing of a minimum of ¼ inch thick A-36 carbon steel. Continuously weld all external stiffeners to the casing. Casing stiffeners shall be evenly spaced, horizontal or vertical, resulting in a uniform pattern and subject to approval by Owner. Provide 18 inch x 24-inch minimum bolted and gasketed access doors upstream and downstream of each tube bundle on both sides of the HRSG, in each transition, and as required to provide complete access to all components for maintenance and inspection.

Minimum access space between bundles shall be 24 inches. Individual tube bundles shall have provisions to facilitate repairs to the tube and header areas without cutting into adjacent tube bundles.

Bends, tees, elbows and downstream straight pipe sections in HRSG areas at high risk for flow accelerated corrosion (erosion-corrosion) shall be fabricated from material containing at least 2.25 percent chromium. HRSG selection of materials shall include proven features to prevent LP erosion/corrosion (due to flow acceleration) and shall be subject to Owner approval.

Ceramic insulation shall be used for all insulated portions of the HRSG (no mineral wool). The entire interior surface of the HRSG shall be lined, from the combustion turbine exhaust flange to the base of the exhaust stack, with steel liners, as follows:

Location	Temperature	Material	Thickness (BWG)
Walls	Up to 700°F	Carbon Steel	12 Ga.
Roof	Up to 700°F	Carbon Steel	12 Ga.
Floor	Up to 700°F	Carbon Steel	12 Ga.
Walls	701°F to 1200°F	TP 409 SS	16 Ga.
Roof	701°F to 1200°F	TP 409 SS	16 Ga.
Floor	701°F to 1200°F	TP 409 SS	12 Ga.
Walls	1201°F to 1400°F	TP 304 SS	16 Ga.
Roof	1201°F to 1400°F	TP 304 SS	16 Ga.
Floor	1201°F to 1400°F	TP 304 SS	12 Ga.

Non-steaming economizers shall be provided. Suitable recirculation piping loops shall be provided to maintain sufficient flow through the economizers to prevent steaming during startup of the HRSG. Feedwater and regulating valves shall be configured to provide reliable performance while operating at reduced flow. The LP feedwater regulator shall be positioned at the outlet of the LP economizer to minimize economizer steaming.

The HRSG exhaust stack shall be of self-supporting, carbon steel construction designed and constructed in accordance with ASME/ANSI STS-1. Corten is not acceptable. The required exhaust stack top elevation shall be based on the output of the air permitting process. Exhaust gas sampling and other stack design provisions shall meet all EPA requirements and air permit requirements. The minimum stack gas temperatures and velocity shall meet all permit requirements over the full range of operation. Provide a davit for hoisting tools and test equipment. Provide 120V and 220V single-phase convenience outlets for power tools and test equipment at all stack platforms. Provide lightning protection to minimize potential for personnel injury, structural damage or equipment damage. Provide a minimum of one access door on lower stack breaching to facilitate access for maintenance and inspection. Each exhaust stack shall be provided with a motor operated damper. Provide stack P-trap drain to remove rainwater when stack is not in operation. Each stack shall be designed with a 1/8-inch corrosion allowance for the bottom ten feet of the stack and 1/16-inch thereafter, or be provided with a stainless steel liner.

Contractor shall provide flanged EPA test ports on the stack sized and located in accordance with the air permit requirements. Provide 5 feet minimum wide, full 360^{o} access platforms with ladders to facilitate access to the sample ports. Provide FAA Aviation Lights as required for the stack.

The motor actuated stack dampers shall have multiple blades. Blades shall seal tightly when closed. Blades shall park firmly against their stops when open and shall not flutter or vibrate due to aerodynamic forces. Blades shall be aerodynamically balanced so that in the event of linkage failure the damper blades fail-open. The damper shall be equipped with drain gutters and arranged so that water does not stand on the damper when closed. The damper shall be equipped with blade position indication and control interlocks via the DCS to prevent CTG startup with the damper closed and damper operation from open to closed with the CTG shaft above turning gear speed.

Vents shall be provided on all sections of the HRSG. All high pressure vents that must operate during normal start-up and/or shutdown shall include silencers.

The drains for HP superheater and reheater shall be designed to ensure that the tubes and lower headers cannot be flooded during steam generator startup.

Drains shall be provided at various parts of the HRSG for complete water removal to facilitate maintenance. The drain system shall be designed to drain all water from the boiler to protect against freezing during periods of sustained outages and low ambient temperatures. Interconnection piping shall be sloped in the direction of steam flow to adequately sized drain pots to prevent standing water under any condition. All HRSG drain connections shall have two globe valves in series and the second root valve shall be located at grade level or at a location having permanent access. All drains shall be piped to either a condensate flash tank or a turbine drains tank. Casing drains shall be provided to continuously drain any condensation from exhaust gas. Vents shall be provided at accessible locations on the HRSG to allow air to enter to facilitate drainage prior to maintenance. Provisions shall be made for venting air during filling and startup. Provisions shall also be provided on the steam drums for nitrogen blanketing during extended shutdowns to minimize corrosion. The nitrogen connections shall be provided at grade. Vents used for plant startup shall be silenced to conform to plant noise permits and Guaranteed Noise Emissions detailed in Appendix M.

Design HRSG steam side components to be fully drainable and include valved drains on each component accessible from outside the unit. Provide drain system sized such that any single pressure level, to include the drum, economizer, superheater, tubes, headers and piping, can be drained in a maximum of 4 hours.

Provide isokinetic steam sampling nozzles per ASTM standard D1066 for measuring steam purity.

HRSG shall be designed with pinch points no less than 13°F.

Design economizers such that steaming does not occur during normal operation. Steam venting will be allowed at part load conditions, provided provisions are included in the system for venting this steam to the corresponding steam drum. Venting shall be controlled with a motor operated vent valve

Pressure drop from the economizer inlet to the superheater outlet shall be such as to support the plant's guaranteed output and heat rate.

The attemperator shall be located and designed so that under the most adverse operating conditions the temperature of the steam leaving attemperator-mixing zone will exceed the saturation temperature by at least 25°F.

Provide structural and miscellaneous steel required to frame and support the steam generator and all component parts and equipment. Provide structural steel supports for flues, ductwork, transitions, casing and stack as required. The structural steel frame shall be designed to take all piping loads of those pipes connecting to the boiler, within the boiler frame area.

The transition duct angle shall not exceed a 45° angle between floor and roof of transition. Alternate proven configurations shall be subject to approval by Owner.

<u>High-Pressure Superheater and Reheater Drain Systems</u>

Drain System Performance:

The drain system shall remove condensate at the peak rate at which it forms in HP superheater and reheater coils during startup from all pre-start HP superheater and reheater conditions. Condensate shall not be permitted to back up into drain pipes. Condensate shall not be permitted to backup into, or pool in, lower headers and/or manifolds. Discharge of steam through the drains from the HP superheater or reheater to its flash tank is not permitted.

Steam Pipe Slope:

Steam piping associated with the HP superheater and/or reheater such as cold reheat piping, saturated steam piping from HP drum to primary superheater inlet, interconnecting piping between superheater coils and piping in which interstage attemperators are installed shall be installed with a continuous fall in the direction of steam flow. A minimum fall of 2 percent shall be maintained under all operating, transient and shutdown conditions. Steam piping, shall be equipped with a low point drop pot just prior to entering the downstream (relative to steam flow) coil and immediately prior to transitioning to each vertical upward steam flow section of piping. The internal diameter of each drop pot shall not be less than 65 percent of internal diameter of the steam pipe. The drop pot shall have a drain sized to remove condensate and/or leaking attemperator spray-water at the rate such condensate formation and leakage is anticipated to occur during worst case conditions.

Drain Pipe Slope:

All drain piping associated with the HP superheater, reheater and/or their associated steam piping shall be installed with a continuous fall in the direction of steam flow. A minimum fall of 2 percent shall be maintained under all operating, transient and shutdown conditions from the drains source to its termination at the flash tank, sump, or other disposal location. Upward sloping or vertical upward flowing drain piping is not permitted.

Drain Size:

Drains connected to HP superheater and reheater coils shall be capable of draining condensate formed in the coil, plus leaking attemperator spray-water (if anticipated for that coil), at the peak rate of condensate formation plus worst-case attemperator leakage with only gravity head to move the water from the header to the flash tank.

Determination of Cold Air Stratification during Hot Pre-Start Purge Cycle:

Prior to calculating the peak condensate formation rates in HP superheater and reheater harps (coils) the Contractor shall determine, during the pre-start purge cycle prior to a hot HRSG startup, to what degree the cooler air moved into the HRSG by the CTG while cranking mixes with the hot air already in the gas path. Such determination may be made via field testing using an array of thermocouples install in an HRSG similar to that proposed and using the same CTG model. Determining the height inside the casing through which cooler purge air flows along the bottom of the stratified hot gas path shall be the first step in calculating the rate of condensate generation during hot HRSG startups.

Drain Pot Venting:

Drain pots installed on HP superheater and reheater coils positioned closer to the CTG exhaust outlet must be capable of moving larger quantities of condensate than coils located closer to the HP evaporator. The drainpipes internal to the casing from these hotter coils must be provided with cooling steam to prevent overheating during on-load operation. The "high-flow" drain pots installed on these hotter coils shall be equipped with a pressure equalizing/drainpipe-cooling line from the drain pot to the respective coil's outlet manifold or outlet interconnecting pipe. An appropriately sized pressure equalizing line is essential for the drain pot and system to perform. Without pressure equalization, when any section of the long drainpipe from bottom header or pipe to the drain pot runs full, then further increase in condensate level in the drain pot develops a back pressure in the drain pot that restricts, or intermittently curtails, further drain flow to the drain pot. The pressure equalizing/drainpipe-cooling line shall be equipped with an automated gate valve to prevent excessive superheated steam bypassing through the pressure equalizing line during on-load operation. The automated valve shall be equipped with a small diameter hole in its gate to provide a metered flow of cooling steam for drainpipe protection. The valve shall be controlled by the DCS such that it remains open during unit startup and closed during normal operation after draining is complete.

Drain Valves:

Each level detecting drain pot shall be equipped with two automated valves in the pipe between the drain pot and flash tank. The "master" valve shall provide tight shutoff when the drain system is not in use. The "martyr" valve shall provide control of condensate discharge from the drain pot to the flash tank. The master valve shall be a motorized gate valve, Y-pattern globe valve, or metal-seated ball valve. The martyr valve shall be a modulating angle control valve. The martyr valve shall be mounted directly to the flash tank inlet nozzle. A signal representing actual position of the martyr drain control valve shall be routed to the DCS. The master valve shall be located between the level detecting drain pot and the martyr valve. The master drain isolation valve shall be equipped with "open" and "closed" position detectors with signals routed to the DCS.

Drain Pot Fatigue Life:

Drain pots shall be designed using the same cycling criteria (number of cold, warm and hot starts) as used for other hot HRSG pressure parts. Drain pot volume, level probe location, drain valve size, drain valve cycle time and drain valve control logic shall be coordinated so that at no time does steam discharge through the pot to the flash tank.

Drain Pot Level Probes, Inlet Port and Outlet Port Position:

Drain pot dimensions, level probe positions, inlet port positions, and outlet port positions shall be configured to prevent "overshoot" on filling and "undershoot" while empting. Condensate shall not be permitted to backup into the drainpipe. A water seal shall be maintained at all times in the bottom of the drain pot. It is not permissible for steam to discharge through the drain pot to the flash tank. The vertical distance between the bottom of the drain pot inlet manifold and the High level probe shall exceed the condensate level overshoot above the High level probe at the peak condensate formation rate (plus attemperator leakage rate if applicable). The vertical distance between the top of the drain pot outlet connection and the Low level probe shall exceed the condensate level undershoot at the maximum drain pot discharge rate plus the minimum height of the condensate seal that must be maintained in the bottom of the pot at all times.

Automatic Control of Drains:

High-pressure superheater and reheater drains shall be automatically controlled by the DCS using inputs from the drain pot High and Low level probes. Drain valves and pressure equalization/drainpipe-cooling valves shall be equipped with open and closed position sensors. The DCS logic shall be configured to operate drain valves in a mater/martyr sequence and to present the operator with drain system fault alarms when anticipated level probe and valve positions are not obtained. The DCS logic shall be configured to ensure that the HP superheater and reheater are thoroughly drained prior to initiation of the pre-start purge cycle, that the automatic drain system is active throughout the pre-start purge cycle when the maximum rate of condensation occurs, and is active throughout shutdowns on hot standby.

Temporary Tube Temperature Thermocouples for Evaluation of Drain System Performance:

Prior to release for fabrication of HP superheater and reheater harps (coils) the Owner shall notify the Contractor of the locations at which tube temperature thermocouples are to be installed to verify that the HP superheater and reheater drains system are removing all condensate before steam flow commences through superheater and reheater. The Contractor shall install, during shop fabrication, thermocouples specified for locations that will become inaccessible after assembly of the HRSG. The Contractor shall take all steps necessary to ensure these thermocouples are working properly prior to them becoming inaccessible and that they are protected from damage during fabrication, transport and erection. The Contractor shall take all steps necessary to ensure that these thermocouples are accurately tagged with weatherproof durable labels identifying their location prior to them becoming inaccessible and that the tags are protected from damage during fabrication, transportation and erection. The Contractor shall supply for installation by the erection contractor during the final stages of erection, thermocouples specified for locations that remain accessible after assembly of the HRSG. The Contractor shall take all steps necessary to ensure that these thermocouples are working properly and that they are protected from damage prior to first fire. The Contractor shall take all steps necessary to ensure that these thermocouples are accurately tagged with weatherproof durable labels identifying their location prior to them being covered with heat shields or other structures that make them inaccessible and that the tags are protected from damage. The Contractor shall provide casing penetrations with gas seals as necessary to facilitate thermocouple wires.

Temporary Drain Pot Thermocouples:

The Contractor shall install on each HP superheater and reheater drain pot two thermocouples each (one top and one bottom) on the outer surface of the drainpipe, and under the thermal insulation, adjacent to the pot's inlet port and outlet port.

Drums

Size steam drums to provide stable operation under all load conditions including start-up, shutdown, and load variations. Size high pressure and intermediate pressure steam drums to provide a minimum of three (3) minutes of storage with no incoming water at the fired steaming rates between the normal water level and Low-Low Trip points. Contractor shall size low-pressure steam drum to provide a minimum of five (5) minutes of storage, with no incoming water, at the fired steaming rates, between the normal water level and Low-Low Trip points. HRSG gas side expansion joints shall be of a flanged, insulated design.

Drums shall be fusion-welded throughout with all welds made, tested, radiographed and stress-relieved in strict accordance with the ASME Boiler and Pressure Vessel Code, and approved by a recognized boiler inspection and insurance company.

The steam-separating drum shall be equipped with the following internals:

1. A means to assure even distribution of feedwater throughout the drum length and equal distribution of flow to the downcomers.
2. Alloy steel chemical feed piping.
3. Steam and water sample piping.
4. Steam deflecting baffles.

Vane- or centrifugal-type steam-cleaning devices designed to ensure a minimum of pressure drop, to provide maximum free space in the drum, and to limit carryover of impurities into the superheater to the level required by the steam manufacturer and in accordance with ABMA guidelines.

All drum internals shall be fabricated in convenient lengths for removal from the drum through the manholes.

Each end of the steam-separating drum shall have a manhole not smaller than 12 in. by 16 in. with a machined seat and forged steel cover hinged to swing inward. Manholes shall be complete with gaskets, arbors, and bolts. Furnish one extra set of gaskets to be turned over to the Owner.

Nozzles shall be fusion-welded to the drum, and the welds shall be stress-relieved.

Piping

All pressure parts of the boiler, superheater and economizer shall be connected together as necessary to meet the following requirements:

Piping materials for the HRSG shall be manufacturer's standard, based on appropriate design codes and standards.

Provide piping and connect to the steam generator pressure parts:

1. Nitrogen blanketing connection (single connection unless multiple connections are required to blanket entire steam generator).

All necessary piping, valves, fittings, constant force piping supports, and insulation which, when combined with the above items, will constitute a complete steam generating unit. This shall include, but is not limited to, the following:

1. Double shutoff valves at all external connections to the steam generator pressure parts. The only exceptions to this requirement are the following connections:

    a. Economizer Water inlet

2. Safety valve connections - Contractor shall furnish safety valves as required by ASME Boiler and Pressure Vessel Code. All safety valves shall be installed in piping furnished by this Contract.
3. Safety valve exhaust piping to a point 10 feet above the elevation of any platform within 25 feet.
4. All vent stacks to a point 10 feet above elevation of any platform within 25 feet.
5. All drain piping and the drum blowdown piping to a point two feet above grade elevation. Location of terminations shall be subject to Owner's approval.

HRSGs shall be provided with provisions for sampling steam and boiler water, and provisions for blowdown and chemical injection to control dissolved solids in the HRSG operation. The HRSGs shall also be provided with the capability for chemical cleaning after construction.

The Contractor shall design the HRSG for pressurized lay-up to maintain maximum pressure in the pressure parts after CTG shutdown to facilitate hot restart. The Contractor shall provide two motivated shutoff valves in series and identified for operation as a master and martyr valve pair;

(the master valve always opened first and always closed last), at the pressure boundary for all steam, feedwater, vents, blowdowns, drains, etc. in the HP section (including the HP bypass and HP startup vent, if the later is installed) and also the reheater and IP sections of the HRSG that may require operation during lay-up, startup or shutdown. These valves are to maintain tight shutoff and minimize the rate of HRSG HP pressure decay during the shutdown period. Both shutoff valves shall be supplied with position indication and be motor or pneumatically operated for control from the DCS. HP superheater outlet valves do not require second motor operated isolation valve if the second motor-operated valve is to be provided by others in BOP piping.

The HRSG shall be equipped with a steam sparging system in each evaporator.

The CTG is washed at regular intervals. Washing solution must be expected to collect at the diffuser outlet. This washing solution contains surfactants. The Vendor shall furnish a dam before the drain of at least 2" (50.8 mm) to prevent the flow of liquids into expansion joint. Drains are to be furnished 2"dia. min. (50.8 mm) at suitable locations to remove washing solution from the boiler casing.

Drains and vents shall be sized, with remotely operable valves, to allow for frequent starts and short start times and to prevent thermal quenching.

Each HRSG shall be controlled by the plant DCS and shall operate without local attendance. Visual monitoring of the drum levels shall be provided in the control room. The HRSG controls shall comply with all code requirements and shall operate to prevent injury to personnel and damage to the HRSG and other equipment, under all operating and abnormal conditions.

Contractor shall provide minimum of 3 feet clear wide access platforms on the HRSG to facilitate access all around the steam drums and to all instrumentation and elevated manual valves on the HRSG system. Drum level support steel shall not include vertical bracing. Provide a minimum of two set of stairs to access all levels of the platforms and provide alternate egress as required by OSHA.

Provide a walkway between the HRSGs at the drum level.

HRSGs and piping systems shall be designed to proportionally control the cold reheat steam flow to the high pressure steam flow to balance the cold reheat flows between multiple units at all operating conditions.

Contractor shall provide a recirculation system to maintain a minimum stack gas temperature above acid dewpoint under all operating conditions. The condensate temperature setpoint shall be selectable in the DCS.

Provide ventilated, insulated and heated drum end enclosures or other suitable protective devices to prevent freezing of the drum trim piping and instrumentation when the HRSG is not in operation and the ambient temperature is at the absolute minimum for the site. The insulation shall be certified asbestos free by the manufacturer.

Contractor shall provide all specialty valves and instrumentation required by the applicable ASME code and including, but not limited to, the following for each HRSG:

1. Drum pressure safety valves with silencers on each steam drum
2. Superheater pressure safety valves with silencers on each superheater
3. Start-up vent valves with silencer and pneumatic operators on each pressure system
4. Automatic continuous blowdown regulating valves with operators on each evaporator system.
5. Intermittent blowdown stop valves with power operator on each evaporator system.
6. Continuous drum blowdown stop valve with power operator for each drum
7. Feedwater stop valves with power operators on each evaporator system
8. Drum level control valves with operators on each evaporator system
9. Superheater drain valves with power operators on each superheater section
10. Steam stop valves with power operators on each outgoing steam line
11. Steam stop-check valves on each outgoing steam line
12. Water column, with probe type alarms: HH, H, L, LL on each drum
13. Water gauge glass on end of each drum
14. Two remote drum level indicators for each drum (one located in control room and one located at the drum level control valve bypass station)
15. Three remote drum level transmitters on each drum
16. Drum pressure transmitters on each drum
17. Drum pressure Indicators on each drum
18. Drum pressure switch on each drum
19. Four drum surface thermocouples for each drum
20. Feedwater thermocouple with well on each drum feedwater line

21. Feedwater temperature indicator with well on each drum feedwater line
22. Feedwater pressure indicator on each drum feedwater line
23. Economizer inlet and outlet thermocouple with well for each economizer
24. Economizer inlet and outlet temperature indicator with well on each economizer.
25. Superheater steam outlet temperature indicator with well for each superheated steam discharge line
26. Superheater steam outlet thermocouple with well for each superheater steam discharge line (two on high pressure steam)
27. Superheater steam outlet pressure indicator for each superheated steam discharge line
28. Cold reheat thermocouple with well
29. Cold reheat pressure indicator
30. High pressure steam and reheat steam attemperators with control valves and actuators
31. Attemperator inlet and outlet thermocouple with well for each attemperator
32. Attemperator inlet and outlet temperature indicator with well for each attemperator
33. Recirculation pump inlet and outlet pressure indicator
34. Recirculation pump outlet thermocouple with well
35. Low pressure economizer inlet thermocouple with well
36. CTG exhaust gas temperature indicators with well (two at inlet transition and one after each component section)
37. CTG exhaust gas absolute pressure indicators (one at inlet transition and one after each component section)
38. Power operated vent and drain valves.
39. Instrument isolation valves, including root valves for all pressure gauges and transmitters.

<u>Interstage Attemperators</u>

Attemperator Water-Spray Nozzles:
Flashing and/or cavitation are not permitted during any operating condition. Water-spray nozzle assemblies shall incorporate a thermal barrier to separate components exposed to spray-water from those exposed to steam. Circumferentially mounted (ring style) water-spray nozzles are preferred.

Attemperator water-spray nozzles shall be of the variable area (spring loaded) type and capable of opening to a minimum flow path width of 0.08 inches (2.0 mm). Spray nozzles shall be capable of removal for inspection and replacement without cutting or welding of pipe. If a probe (mast) style attemperator is utilized, the water-spray nozzles shall be positioned in the center of the steam pipe.

Water-Spray Control Valve:

Attemperator water-spray control valves shall be positioned external to the water-spray nozzle assembly. Probe style attemperators with internal control valve trim are prohibited. Attemperator water-spray valves shall utilize multiple pressure drop technology and have a Class V shutoff in accordance with ANSI/FCI 70-2-2006. Attemperator water-spray control valves shall have a minimum seat-to-plug contact force of 500 lb/linear inch (8.9 kg/linear mm) of seat circumference and maximum velocity in the trim of 100 ft/sec (30m/sec). Flashing and/or cavitation are not permitted during any operating condition.

Thermal Liner:

All attemperators shall be equipped with a thermal liner to protect the steam pipe wall from attemperator-induced thermal transients. The length of the thermal liner shall be in accordance with the attemperator manufacturer's recommendations.

Attemperator Location:

High-pressure superheater and reheater attemperators shall be located in a straight section of steam pipe. Minimum straight pipe distances upstream and downstream of the attemperator nozzle shall be in accordance with the attemperator manufacturer's recommendations. The position of the attemperator outlet temperature-sensing element shall be determined by the resident time of water droplets being carried by the steam as they exit the spray-water nozzle. If the attemperator outlet temperature-sensing element is positioned downstream of a bend after the attemperator, the element shall be installed on the intrados side of the steam pipe on straight pipe immediately downstream of the weld at the outlet of the upstream bend. No branch or inlet nozzle feeding a superheater or reheater coil shall be located upstream of the attemperator outlet temperature-sensing element.

Attemperator Drains:

All notionally horizontal interconnecting piping between the primary and secondary HP superheater and between the primary and secondary reheater shall be installed with a continuous fall in the direction of steam flow. A minimum fall of 2 percent shall be maintained under all operating, transient and shutdown conditions. Notionally horizontal steam piping, shall be equipped with a low point drop pot just prior to entering the downstream (relative to steam flow) coil and just prior to transitioning to any vertical upward steam flow piping. The internal diameter of the drop pot shall not be less than 65 percent of the internal diameter of the steam pipe. The drop pot shall have an automated drain sized to remove condensate and/or leaking attemperator spray-water at the rate such condensate formation and leakage is anticipated to occur during worst case conditions without overflowing into the downstream superheater, or reheater, coil.

Attemperator Spray-Water Block Valve:
The HP superheater and reheater attemperators shall be equipped with a spray-water block valve in accordance with ANSI/ASME TDP-1-1998.

Attemperator Control:
The HP superheater and reheater attemperator controls shall be fully automatic, requiring no operator action, input or intervention. A pre-established temperature, from the design basis heat balance, that meets the requirements of the HRSG and Steam Turbine requirements shall be selected. An input that provides the most representative indication of imminent increase in HP superheater and reheater outlet steam temperatures and steam flows shall be provided to the attemperator controls to anticipate imminent increases in HP superheater and reheater outlet steam temperatures caused by rapid changes in CTG exhaust temperature and flow. High-pressure superheater and reheater attemperators shall be brought into service when CTG exhaust temperature reaches the pre-established temperature with steam flow established and verified as the CTG loads up during unit startup, and remain in service until CTG exhaust temperature falls below the pre-established temperature during unit shutdown. HP superheater and reheater attemperators shall remain in service at minimum spray-water flow or greater (always above the spray-water control valve's minimum Cv and within the attemperator's design turndown ratio) during operation at all unit loads while CTG exhaust temperature remains above the pre-established temperature with steam flow verified. The attemperator block valve shall be controlled in accordance with ANSI/ASME TDP-1-1998. The attemperator control valve shall remain closed anytime the bock valve is not proven full open. The attemperator control valve shall reduce spray-water flow anytime the steam temperature at the attemperator outlet reaches, or falls below, the saturation temperature prevailing at the attemperator outlet for a period of 5 seconds. Upon this condition an "attemperator failure" alarm shall be presented to the operator. Spray-water flow shall be reduced until steam temperature at the attemperator outlet is no longer at saturated conditions. HP superheater and reheater attemperator controls

shall each prevent release of their respective spray-water block valve and control valve to open during HRSG startups until the both of the following two permissive conditions are established:

- the respective HP superheater or reheater outlet steam temperature exceeds the pre-established temperature and;
- the respective superheater or reheater outlet steam flow rate exceeds 25 percent of its design steam flow when operating with both CTGs at baseload and with no duct firing.

Attemperator Performance:
A minimum 50ºF (28ºK) of superheat shall be maintained at the attemperator outlet under all operating conditions, even when the HP superheater and/or reheater outlet steam temperatures exceed the attemperator control setpoints. During transient operating conditions HRSG outlet steam temperatures shall be maintained below the design temperatures for outlet tubes, headers and pipes. The HRSG shall be designed to ensure that the margin between rated operating superheater and reheater outlet steam temperatures and the design temperatures selected for outlet tubes, headers and pipes is sufficient to accommodate transient excursions above rated operating temperatures without risk of automated CTG load run-backs or trips initiated by high outlet steam temperature protection. During steady state operating conditions HRSG outlet steam temperatures shall be maintained within 10.0ºF of setpoint. Excursions of HRSG outlet steam temperatures above the design temperature of HP superheater and reheater tubes, headers and outlet piping is not permitted during any operating condition.

Ductwork, Casings and Insulation

Provide all equipment, materials and labor necessary to encase and insulate the steam generator unit.

Casings, transitions, and ductwork shall be internally insulated.

Outer casing shall be at least 3/16-inch and shall provide a gastight seal. All field joints in the outer casing shall be designed to be seal welded.

All casings, transitions, and ductwork shall be provided with external stiffeners and shall provide a gastight seal at 1.5 times the maximum operating pressure. Penetrations shall be sealed to prevent leakage.

Provide drain connection in bottom of casing to allow for water washing. Drain shall be 2-inch-minimum size, provided with a cap.

Inner casing liner shall be stainless steel. Design inner casing with adequate allowances for expansion, and to protect insulation from gas flow.

Provide gas distribution devices necessary to assure even distribution of gas across heat transfer surfaces.

Insulation

Insulation and other materials shall be in strict compliance with the applicable ASTM standard specifications. They shall be certified asbestos-free by the manufacturer.

Insulation shall be designed so that the outside surface temperature measured at any point (including hot spots) will not exceed 140oF when the ambient air temperature is 100oF 5 feet away from skin or insulation (while the steam generator is operating), with an outside surface air velocity of 5 mph. Insulation thicknesses shall be reviewed and approved by Owner.

1. Insulation shall be ceramic fiber suitable for design conditions conforming to ASTM C533 or Engineer-approved equal.
2. The binder used in the insulation shall show no deterioration at 100^{o}F above the actual operating temperature where the material is applied. Binders shall be water repellent.
3. Minimum density of any blanket or block insulation shall be 7 pounds per cubic foot.

Access

Provide Class 1 access to all areas requiring access during operation, or for normal day-to-day inspection and maintenance, including the following:

1. Observation ports.
2. Lubricated equipment.
3. Instruments.
4. Valve operators.
5. Each end of boiler drums.

Maintenance access doors shall be provided on one side of the boiler leading directly into each void space between tube bundles and access doors into all upper and lower header chambers. Upper and lower access doors shall be sufficient in number and location to allow routine inspection of all superheater and reheater headers, manifolds, inlet/outlet nozzles, and hangers.

Removable access doors and attachment mechanisms shall be provided to accommodate scaffold access, installation, and use in each void space between tube bundles.

Access doors shall be standard cast-hinged doors closed with a strong back arrangement. Provide ladder rung as a handhold above access doors, both on interior and exterior. Access doors shall be a minimum size of 14"x18". At locations where access doors are located at the bottom of the heat recovery steam generator, platforms shall be installed to allow safe access into the internals of the heat recovery steam generator.

Provide access lanes between each section of the steam generator.

Contractor shall provide expanded metal personnel protection shields or other suitable personnel protection devices at each stack access platform and anywhere else on the HRSG systems where temperatures exceed OSHA limits. Personnel protective devices shall be provided in accordance with applicable OSHA standards.

Duct Burners

Supplemental duct firing may be included in Contractor's design to maximize steam generation up to the expected heat input limits of the air permit. At maximum duct burning each HRSG shall be capable of supplying high-pressure superheated steam to the steam turbine at throttle pressures and temperatures as dictated by Contractor's design.

Duct burner design shall meet the following criteria:

1. The duct burners shall be a low-NO_X design that meets the requirements of the project air permits over the full range of plant operating loads and ambient conditions.
2. If straightening and equalization of exhaust gas flow upstream of the duct burners is required it shall be accomplished via installation of heat transfer surfaces. The installation of uncooled flow modification structures is prohibited.

The velocity of exhaust gas into the duct burner shall not exceed ±25 percent of the average free-stream velocity.

3. Superheated steam temperature spread across the HRSG shall not exceed 70°F at any point. Distance from duct burner to first row of tube bundles shall not be less than 15 feet.
4. Tube metal temperature shall not exceed the limits specified by the HRSG manufacturer at any operating condition (fired or unfired). Instrumentation shall be provided for monitoring tube skin temperature and flue gas temperature downstream of the duct burner. Skin temperatures shall be measured throughout the HRSG cross-section, including tube sections located outside of the HRSG casing. Flue gas measurement taps shall be provided at every 10 feet (vertically) from the bottom of the HRSG casing, approximately 3 feet in from the sides of the casing on both sides of the HRSG.
5. Provide a minimum of two view ports per burner (one on each side) in HRSG casings to allow viewing the duct burner flames.
6. Duct burner runner controls, scanners, and view ports shall be accessible from the platforms without requiring ladders or scaffolding.
7. Duct burners shall not utilize air augmentation.
8. The minimum oxygen level in the duct burner exhaust gases shall not be less than those specified by the burner manufacturer.
9. The duct burner control system shall be fully integrated with the plant DCS.
10. The duct burner shall provide a stable flame over a 10 to 1 automatic turndown range.
11. During duct burner firing over the entire turndown range for duct burner operation, the exhaust gas temperature entering the first heat transfer coil downstream of the duct burner shall not exceed ±100ºF (55.6ºK) of average exhaust gas temperature at inlet to the downstream coil.
12. Provide automatic isolation valve and fuel trim valve for each burner runner (elevation).
13. Duct burner flame scanners, pilot burners, and pilot igniters shall be provided. Include two 100 percent scanner cooling / purge air blowers each with an inlet air filter and silencer. Two flame scanners shall be supplied per each row of burners.
14. Include a Burner Management System (BMS) with a programmable logic controller, factory assembled, wired, and tested, including all safety interlocks and indicators as required by the applicable codes. Provide BMS system

designed for remote firing rate signals to be supplied from the main plant DCS controller. The PLC shall be in an air-conditioned enclosure.

15. The fuel gas manifold in the turbine exhaust gas flow shall be type 304 stainless steel.
16. Provide a strainer and a fuel pressure control valve with pressure transmitter for control from the DCS for conditioning of fuel gas supply to the burners. Control valve shall be located at grade or platform accessible.
17. Duct burner shall be located in a cross-section of the ductwork and the duct burner shall distribute fuel gas evenly across the duct. Each duct burner fuel nozzles shall be individually "tuned" using orifices, or other devices recommended by the duct burner supplier and approved by the Owner, to evenly balance side-to-side fuel distribution between nozzles.
18. Duct burner shall be located to prevent impingement of flames on the tube surfaces.
19. Burner elements shall be designed to allow for thermal expansion and to prevent acoustic vibration.
20. If multiple burner elements are required, provide distribution headers for fuel gas, igniter gas, and scanner cooling air.
21. Duct burner frame shall be insulated for protection from flue gas temperatures.
22. Burner ignition shall be completely automatic.
23. Ignition system shall include gas pilot burner, electric ignition electrode, electric ignition transformer, two power-operated shutoff valves, one manual shutoff valve, pilot gas regulator and strainer.
24. Each burner element shall be supplied with safety shutoff valve to allow isolation from main header without causing entire system to trip.

The duct burner controls, equipment, and installation shall meet all requirements of NEC, NFPA, Factory Mutual, and local codes.

Selective Catalytic Reduction System

A selective catalytic reduction (SCR) system shall be incorporated into each HRSG to meet the NO_X and ammonia slip emission limits specified in the air permit over the full range of operation from Peak Load to Minimum Load and the full range of ambient temperatures. The SCR system design and location shall include consideration of operating temperature requirements for proper catalyst performance, flow straightening devices, ammonia injection grids, and mixing zones. SCR shall be capable of responding in real time to allow for load level changes, up to maximum ramp rate, up or down, so as to maintain permit limits for hourly averages.

SCR system casing shall be of the same construction and cross section as the HRSG casing. Provide access manways and catalyst loading openings in the casing sufficient to facilitate removal and installation of the catalyst modules without the need for cutting or welding of any casing components. Include and integrate a monorail and hoist system to facilitate installation and removal of the catalyst sections. Hoist system shall extend out over open grade for lifting and setting materials from maintenance carts of pallets.

Include space, frame, and design consideration for 50 percent additional catalyst in the SCR system.

Provide instrumentation necessary to monitor catalyst performance. Provide NO_X sample ports upstream of the SCR Catalyst.

Contractor shall obtain from SCR catalyst Vendor a warranty that the installed catalysts will provide NO_X emissions reduction from the guaranteed combustion turbine emissions, including contribution from the duct burners (if provided), down to the permitted HRSG stack emissions for a minimum period of thirty-six (36) months after the plant Substantial Completion Date, or 22,500 fired hours of operation, whichever comes last.

Testing penetrations consisting of 2 ½ inch pipe connections shall be provided to permit performance testing of the system. The test ports shall have blind flanges. The design and configuration of the test ports shall allow traverse testing before and after each layer of catalyst in a grid arrangement. Contractor shall provide access to the test locations consisting of walkways, platforms and ladders.

The SCR catalyst shall be of the low dust type. The catalyst shall be designed to minimize pressure loss.

The catalyst shall be either a homogenous extruded material or the catalyst surface shall be supported on a metallic or ceramic monolithic base material. The catalyst modules shall not be subject to delamination or permanent deformation of the catalyst or support material due to stresses induced by the seismic conditions, vibration, pressure and thermal conditions or combinations thereof.

The catalyst shall be resistant to poisoning by trace elements. The catalyst shall be resistant to water and abrasion.

The volume of catalyst supplied shall be designed to control ammonia slip to the values guaranteed without requiring cleaning, regeneration, or replacement during the performance guarantee period.

The catalyst shall be of modular design to facilitate installation and removal of the catalyst. The catalyst modules shall be the maximum practical size to facilitate and minimize field maintenance. Any special tools required to facilitate the removal or installation of catalyst modules shall be provided. Any special tools or handling fixtures for the proper handling or unloading of the catalyst modules from a truck or rail car shall be provided.

Contractor shall provide catalyst coupons/holders. In order to monitor catalyst life and performance, a minimum of 10 test coupons shall be provided and installed in the catalyst beds as, and where, recommended by the catalyst manufacturer. Additional catalyst coupons shall also be furnished for future reference performance and composition analysis. Each catalyst coupon shall be labeled with a serial number. All catalyst coupons shall be from the same lot as the installed catalyst. These samples will be tested to evaluate catalyst activity and physical properties as the catalyst ages.

The catalyst modules shall include sealing frame and frame steel to improve the ease of catalyst replacement and installation. The frame materials shall be compatible with the catalyst material. The sealing system shall be designed to limit exhaust gas leakage past each layer of catalyst. The sealing mechanism and materials shall provide a service life equal to or greater than the catalyst.

Ammonia Injection Skid

Contractor shall provide a skid mounted aqueous ammonia (19 percent) injection system complete with all necessary equipment, including but not limited to mixers, blowers, motors, side stream heaters, piping, all valves, vent and drain piping and instrumentation. Two (2) 100 percent capacity flue gas recirculation air blowers shall be provided as well as associated valves, control valves, and NH_3/air mixer for each skid. The critical components including, but not limited to, the dilution air fans and the heaters shall have an installed 100 percent spare on the skid. The heaters and blowers shall be designed for 100 percent of maximum flow of reagent to the ammonia injection grid. Electric heaters shall not be provided.

CO Catalyst

Provide a CO catalyst system with each HRSG to meet the air emission requirements for CO and VOCs. The CO catalyst shall be designed and located in the HRSG to meet the requirements of the air permit over the full range of operation from Peak Load to Minimum Load and the full range of design ambient temperature.

Include space for 50 percent additional CO catalyst.

CO catalyst system casing shall be of the same construction and cross section as the HRSG casing. Provide access manways and catalyst loading openings in the casing sufficient to facilitate removal and installation of the catalyst modules without the need for cutting or welding of any casing components. Include and integrate a monorail and hoist system to facilitate installation and removal of the CO catalyst sections. Hoist system shall extend out over open grade for lifting and setting materials from maintenance carts of pallets. If it is intended to load catalyst from the bottom of the HRSG, then a loading platform, outside of the bottom access door, shall be provided that shall be accessible with a fork lift to load catalyst on a pallet. Provision within the HRSG's (hoists and pulleys) shall be made that allows for catalyst to be safely installed, removed, and replaced without having to physically handle catalyst blocks from elevation to elevation.

Provide instrumentation necessary to monitor catalyst performance. Contractor shall obtain from the CO catalyst Vendor a warranty that the installed catalysts will provide CO and VOCs emissions reduction from the guaranteed combustion turbine emissions, including contribution from the duct burners, down to the permitted HRSG stack emissions for a minimum of thirty-six (36) months after the plant Substantial Completion Date or 22,500 operating hours, whichever occurs last.

Ammonia Storage Tank

Contractor shall provide one (1) or more aqueous ammonia (19 percent solution) storage tank(s) with a minimum design pressure as required by Contractor's design. Total volume of the tank(s) shall be sized to contain enough ammonia for 14 days of operation under 100 percent peak load conditions or 20,000 gallons, whichever is greater. Provide a containment dike for the area surrounding the tank. Ammonia system shall be in accordance with OSHA standards and shall be provided with a nitrogen blanketing system.

Provide an ammonia unloading skid with breakaway truck connections and with automatic emergency shut-off valves on the liquid and vapor connections on tank. Provide all instrumentation required to provide for a safe, unmanned operation. Provide one (1) level transmitter and two (2) pressure transmitters on tank for remote monitoring and control. Provide a local float type level gauge on tank.

Provide a platform and ladder to access all the manual valves and excess flow valves at the top of the tank and to maintain the relief valves and other instrumentation installed at the top of tank.

5.2.9 Steam Systems

The steam system shall be based on a three-pressure reheat cycle. The steam system shall be designed to provide HP, IP, and LP steam from the HRSGs to the steam turbine generator as shown on the Conceptual Process Flow Diagrams in Appendix D.

Pressure relief valves with silencers shall be provided on the HP, reheat, and low pressure steam headers to meet code requirements for overpressure protection. Upon steam turbine trip, the primary release of steam shall be to the condenser through the steam bypass system.

The high pressure and reheat systems shall be provided with stop valves to allow isolation for safe maintenance and repair of either HRSG with the other HRSG in operation.

The steam systems shall be provided with a high-pressure drain system to remove condensate from stop and control valves and piping low points to prevent water induction into the steam turbine. Drains that require quick action during startup shall be supplied with air operated, severe service, metal-seated, ball valves. Drains not requiring quick action but are required for steam piping drains shall be supplied with inverted bucket type traps or air-operated valves. All high-pressure drains shall be discharged to the condenser or to the blowdown tank. All manual drains shall be piped to a drain header system that discharges to either the condenser or the blowdown tank if inadequate pressure exists to transport the condensate to the condenser. Steam piping shall be pitched in the direction of steam flow. All motor-operated valves, air operated valves, and steam traps shall be provided with a block valve on each side. Steam traps shall be provided with a valved bypass.

The design and construction for the drain system shall comply with the ANSI/ASME TDP-1, Recommended Practices for the Prevention of Water Damage to Steam Turbines.

The maximum pressure drop of the HP, Hot and Cold Reheat, and LP steam lines between the HRSG and the steam turbine generator interface shall be optimized during system design and shall support the guaranteed plant output and heat rate.

All attemperators, interstage, bypass and terminal point (if supplied) shall be equipped with a tell-tail drain between the spray-water bock valve and spray-water control valve for detection of seat leakage.

All main steam piping shall meet the requirement of ANSI B31.1 and the ASME Boiler and Pressure Vessel Code.

HP (Main) Steam System

HP steam shall be piped from each HRSG HP superheater outlet to the steam turbine. Each HRSG supply header shall be provided with a non-return stop check valve and a motor operated stop valve. A dedicated HP steam turbine bypass system to the cold reheat system shall be provided on each HRSG HP header for operating flexibility. HP steam bypass system shall be provided with combination pressure reducing and desuperheating valve or separate pressure reducing valve and desuperheater. The bypass piping shall be high temperature alloy pipe up to the downstream desuperheating temperature measurement. The bypass system shall be sized for the maximum HRSG output without duct firing and shall be designed for continuous operation. Bypass system valves shall be provided with an upstream block valve to allow for leakage control. Each HRSG HP superheated steam line shall also be provided with a low-pressure drop type flow element and transmitter for measuring steam flow.

A start-up vent valve shall be provided on each HRSG HP steam header. The start-up vent shall be sized to handle the difference in the HP steam flow between the maximum fired and unfired operation mode of the HRSG. The automated HP steam vent/dump control valve shall have equal percentage trim and a fast acting pneumatic actuator.

The HP main steam header shall split into two lines, routed separately to the two emergency stop valve/control valve assemblies of the ST provided by the steam turbine supplier. A strainer integrated in each of the emergency stop valve/control valve assemblies shall protect the ST.

Downstream of the HP main steam shutoff valves, the system shall be warmed mainly by warm-up lines. These warm-up lines shall branch off directly upstream of the emergency stop valve/control valve assemblies and shall be routed to the hot reheat piping system.

Additional warm-up lines shall be provided directly downstream of the HP main steam shutoff valves. These lines shall be routed to the HRSG start-up and shutdown system and are required for warming the main steam lines prior to coupling of the second HRSG.

Reheat Steam System

Cold reheat steam from the HP steam turbine exhaust shall be piped from the steam turbine to the individual HRSGs. The cold reheat line shall be provided with a power actuated stop check valve and motor operated stop valve. The cold reheat lines to each HRSG shall be provided with a modulating valve to proportion the cold reheat flows between the HRSGs and isolate the HRSGs from the common line. Contractor shall provide relief valves in the cold reheat pipe if required by entrained energy threshold to determine if relief valves are required for the cold reheat pipe between the steam turbine and the main isolation valve. IP steam from each HRSG shall be combined with the HRSG cold reheat steam return from the turbine and piped to each HRSG reheater section. The IP superheated steam line shall be provided with a non-return valve and motor operated stop valve prior to connection to the cold reheat line for isolating the HRSG IP drum. Each HRSG IP superheated steam line shall also be provided with a low-pressure drop type flow element and transmitter for measuring steam flow. The bypass system shall be capable of handling a base load trip of the steam turbine by bypassing steam to the condenser during this event; the bypass system shall maintain HRSG pressures at the level prior to the trip.

The hot reheat steam shall be piped from each HRSG to a common header feeding the steam turbine. Each HRSG hot reheat line shall be provided with a dedicated steam turbine bypass system consisting of a combination pressure reducing, desuperheating valve or separate pressure reducing valve and desuperheater for operating flexibility. Each reheat bypass line shall be routed to the ACC ductwork and provided with a diffuser for installation in the ACC ductwork. The hot reheat steam turbine bypass system shall be sized to pass the maximum volumetric flow discharged by the HP bypass, including attemperation spray-water, plus IP steam and any reheater attemperator spray-water, and with zero steam vented to atmosphere from the Hot Reheat for whichever of the following operating conditions requires the larger hot reheat dump system volumetric capacity:

- operating with the design hot reheat outlet steam pressure at 2X1 with 100 percent CTG load;

- operating during cold ambient, cold, warm and hot start-ups and initial loading of the lead CTG/HRSG and steam turbine with Cold Reheat pressure maintained below the maximum allowable specified by the steam turbine (ST) OEM during ST startup, initial loading and shutdown.

The hot reheat dump system design shall not be finalized until the HP bypass volumetric capacity has been finalized and the Steam Turbine Supplier determined his requirements and limits in respect to HP inlet steam pressure and temperature, and cold reheat pressures and temperatures during cold, warm and hot steam turbine startups have been specified. Bypass system valves shall be provided with upstream block valve to allow for leakage control.

A hot reheat startup vent to the atmosphere shall be provided on each HRSG hot reheat steam line to facilitate unit startup. The start-up vent shall be sized to accommodate 100% of the unfired steam flow generated during drum soak. The automated hot reheat steam vent/dump control valve shall have equal percentage trim and a fast acting pneumatic actuator.

Provide a motor-operated stop valve on the hot reheat line from each HRSG.

Whenever the HP reducing station is in operation, reduced HP steam is routed by way of the cold reheat piping system to the reheaters.

Two warm-up lines shall be routed from the HP main steam system to the hot reheat line upstream of the two IP ST emergency stop valve/control valve assemblies to warm up the hot reheat pipe backwards from the ST up to the branch of the IP bypass station.

Drain and warm-up lines which are routed to the HRSG start-up and shutdown system LBH are equipped with motor-operated isolating valves for warming, steam traps for removal of condensate and sludge traps for the reception of deposits.

Drain and warm-up lines which are routed to the condenser system MAG are equipped with motor-operated isolating valves for warming and for removal of condensate and sludge traps for the reception of deposits.

<u>LP Steam System</u>

LP steam from each HRSG shall be piped through a common header to the steam turbine and admitted to the LP steam turbine section. Each HRSG LP steam line shall be provided with a non-return valve and motor-operated stop valve prior to connection to the common header. The

LP steam system shall be designed to bypass the entire steam flow to the air-cooled condenser during startup, shutdown, steam turbine trip, sudden load changes, and when the steam turbine is out of service. Except for the case of steam turbine trip the bypass shall be sized for all conditions without lifting the safety valves or atmospheric vent valves. The bypass system shall be sized for the maximum HRSG output without duct firing and shall be designed for continuous operation. There shall be one LP Bypass line from each HRSG. Each LP steam bypass line shall be routed to the ACC ductwork and provided with a diffuser for installation in the ACC ductwork. Bypass system valves shall be provided with an upstream block valve to allow for leakage control. Each HRSG LP superheated steam line shall also be provided with a low-pressure drop type flow element and transmitter for measuring steam flow.

The strainer drain line shall be equipped with a motor-operated isolation valve for removal of condensate and a sludge trap for the reception of deposits.

The drain and warm-up line upstream of the ST shall be equipped with a motor-operated isolating valve for warming.

Drain and warm-up lines which are routed to the HRSG start-up and shutdown system shall be equipped with motor-operated isolating valves for warming, steam traps for removal of condensate during shutdown, and sludge traps for the reception of deposits.

Auxiliary Steam System

All required auxiliary steam systems shall be furnished and installed to result in a complete, fully operational plant. Block 1 and Block 2 auxiliary steam systems shall not be cross-tied together. Auxiliary steam shall be used for start-up steam seal supply to the steam turbine, Intermediate Pressure steam to the Cold Reheat Steam System, steam jet air ejectors, and for deaerator pegging steam. The auxiliary boiler shall be backed up with desuperheated main steam from either operating unit and supplemented with cold reheat steam for the steam jet air ejectors.

Major equipment scope shall be as follows:

Equipment Item	Quantity	Capacity of Each Unit
Auxiliary boiler and ancillaries	1	100 percent maximum system demand
Boiler feed pumps	2	Each 100 percent maximum system demand

Equipment Item	Quantity	Capacity of Each Unit
Deaerator	1	As required
Breeching and stack	1	As required
Chemical feed systems	2	Phosphate and ammonia
Sample Coolers	2	Drum and Steam Samples
Burner/igniter atomizing medium	Compressed air	
Exhaust stack		
Stack height (feet)	60 to 75	
Maximum flue gas velocity (m/s)	20	
Valves to be equipped with motor operators		
Valves requiring modulating operations during startup and/or shutdown	Required	
Drain valves	Required	
Feedwater stop valve	Required	
Main team valve	Required	
Continuous blowdown valve	In accordance with EPC Contractor's design	
Intermittent blowdown valve	Required	
Others	In accordance with EPC Contractor's design	

Performance Requirements

Fuel	Natural Gas	
Load description	Maximum Continuous Rating (MCR)	
Steam outlet conditions		
Flow rate, lb/h	By Contractor	
Pressure, psig	By Contractor	
Temperature, ^{o}F	By Contractor	

Auxiliary boiler shall comply with Attachment O, Notice of Intent Application.

Work performed under these specifications shall be done in accordance with the following codes and standards. Unless otherwise specified, the applicable governing edition and addenda to be used for all references to codes or standards specified herein shall be interpreted to be the jurisdictionally approved edition and addenda. If a code or standard is not jurisdictionally mandated, then the current edition and addenda in effect at the date of this document shall apply. These references shall govern the work except where they conflict with the Purchaser's specifications. In case of conflict, the latter shall govern to the extent of such difference:

Work	**In Accordance With**
Overall design and fabrication of auxiliary boiler and accessories	ASME Boiler and Pressure Vessel Code, Sections I & II ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, and Section IX ASME Code for Power Piping, ANSI/ASME B31.1 - Power Piping Applicable ASTM, EEI, FM, and NFPA Standards OSHA Occupational Safety and Health Standards Governing state and local regulations
Design and materials for use and installation in hazardous areas	NFPA 70 and NFPA 497, and as further described in Article 15514.2.2
Burner controls and fuel safety interlocks	Applicable ASTM standards; applicable NFPA standards, including NFPA 8501 or NFPA 8502; applicable ISA standards
Fan compressibility corrections	AMCA Standard 210
Fan shaft construction	ASTM A668
Pumps	Hydraulic Institute (NJ)
Piping and pipe supports	Applicable ASME code or ANSI/ASME B31.1 - Power Piping
Valves	ANSI B16.34, ASME B31.1
Electrical components	Applicable NEC standards, applicable UL standards
Electrical enclosures	Applicable NEMA standards
Structural design	Applicable AISC standards, applicable UBC standards
Welding procedure specifications, qualification testing, and welder qualifications	ASME Boiler and Pressure Vessel Code, Section IX; AWS D1.1
Steel stack general standards	ANSI, ASME, ASTM, AISC, AWS, OSHA
Materials, fabrication, and erection	AISC Manual of Steel Construction (ASD), Ninth Edition. Referred to as the AISC manual in these specifications.
Stack design and construction	ASME/ANSI STS-1 - Steel Stacks
Seismic design loads	ASME/ANSI STS-1 - Steel Stacks

Work	In Accordance With
Stack flue gas sample connections, emission test ports	US Federal EPA
Electrical components located within 15 feet of natural gas valves or appliances	NEC classification Class I, Division 2
Controls/Instrumentation	Instrument Society of America (ISA), Institute of Electrical and Electronics Engineers

All valves and accessories required by the above codes shall be furnished. Steam superheater shall be integral with auxiliary boiler and not an electric heater.

5.2.10 Condensate System

The condensate systems shall be provided as shown in the Conceptual Process Flow Diagram contained in Appendix D. Condensate shall be collected in the Condensate Receiver Tank. The condensate system shall pump condensate from the Condensate Receiver Tank through the gland steam condenser to the LP steam drum and other related plant systems. Makeup to the Condensate Receiver Tank shall be provided from the demineralized water storage tank.

Major equipment quantity and capacities shall be as follows:

Equipment	Quantity	Design Capacity
Condensate Pumps	2 or 3	2 X 100 percent or 3 X 50 percent of Peak Load system demand (full duct firing) – at EPC Contractor option.

The Condensate Pumps shall take suction from the Condensate Receiver at the Air Cooled Condenser and supply condensate to the LP economizer and LP drum. A control valve shall be provided to regulate the condensate flow based on LP drum level using a three-element control system. Provide a vortex breaker and dam on the condensate pump suction connection to prevent sediment from entering the pump suction lines. Provide a factory calibrated ASME flow nozzle meter on the Condensate Pump feed to each HRSG. All steam flows shall be corrected to match the flow from this meter.

Provide condensate pumps with stainless steel wetted parts and include duplex type suction strainers at the inlet of each pump. Condensate pumps shall be multistage, vertical, open line-shaft canned pumps with suction nozzles in the discharge head. Design pumps to operate continuously and include a minimum of 3 feet NPSH margin on pump assuming zero (0) NPSH at the suction nozzle.

A condensate system minimum flow recirculation line shall be provided and shall connect downstream of the gland steam condenser and discharge into the condensate receiver above the maximum water level. This line shall be designed to provide a minimum flow re-circulation protection for the Condensate Pump and the gland steam condenser. Each Condensate Pump discharge and suction connection shall be vented by individual lines back to the condensate receiver. During normal operation, makeup to the condensate receiver shall be supplied by vacuum drag from the demineralized water storage tank. The demineralized water pumps shall also be designed to supply the condensate receiver when condenser vacuum is not available.

All piping and components from the demineralized water system shall be made from corrosion resistant stainless steel capable of handling this type of water.

5.2.11 Boiler Feedwater System

The boiler feedwater system shall be provided as shown in the Conceptual Process Flow Diagram in Appendix D. The system shall be designed to deliver feedwater from the LP drum to the corresponding HRSG HP and IP drums through their respective economizers over the full range of plant operation. The feedwater pumps shall also supply spray water to plant desuperheaters and attemperators.

Two identical boiler feedwater pumps with variable speed couplings shall be provided for each HRSG (four total). Each pump shall be designed to provide 100 percent of the HRSG feedwater demand and other system demands at Peak Load operation with 100 percent duct firing of the HRSG. The HRSG feedwater pumps shall be segmented ring pumps with a main discharge providing HP feedwater and an inter-stage bleed port providing IP feedwater to the system. Using pressure letdown valves to reduce the pressure of the HP feedwater for IP service is not acceptable. The feedwater pumps shall be provided with all required auxiliary systems including warm-up system; vibration monitoring and alarms; seal water system; forced lubrication system; and NPSH protection. Provide suction strainers on each boiler feedwater pump suction inlet to protect pumps from damage. An acceptable alternate is the use of a Hellan dual screen strainer (with one strainer for each common suction line), provided that personnel access for operations and maintenance, at ground level, or by a platform and stairs is also installed. Design feedwater pumps with a minimum ratio of NPSHA / NPSHR of 1.8 to 1 at the worst case steady state operating conditions and 1.3 to 1 at the short duration transient conditions. No copper based materials will be used for the impellers (all stages).

Boiler feed pumps shall be factory-tested under full flow operating conditions prior to shipment.

The variable speed coupling and gearbox shall be designed for uninterrupted continuous operation and for rapid startup and shutdown. The drive unit shall be designed to provide infinitely variable output speeds, with the required driving torque, from approximately 25% to 100% of the maximum driving power demand of the boiler feed pump. Control of the speed shall be continuously variable. Off-load startup of the drive motor shall be possible. As constant as possible, high coupling efficiency of the whole control range shall be targeted. Vibration and shock absorbing characteristics and rapid power transmission and control response are required. The design shall include provisions for thermal expansion.

Radial bearings shall be of the split sleeve journal or tilting pad type, Babbitt metal lined. Each radial bearing shall be pressure lubricated and shall be designed to prevent oil whip and oil vapor emission. Radial bearings shall be interchangeable insofar as practical and shall be designed for removal without disturbing the bearing brackets. Radial bearing housings shall include provisions for mounting 2-plane proximity type vibration monitoring probes.

Kingsbury type thrust bearings shall be provided in the pump if required, to carry unbalanced axial thrust in either direction under all conditions of operation and wear, unless the pump manufacturer's standard design includes other provisions for carrying thrust loads. For ring section pumps, a Kingsbury type thrust bearing is not required when a balancing drum design is furnished. No thrust shall be transmitted to the prime mover or drive system. If axial thrust balancing is used, balancing leakoff flow shall be piped to the pump suction flange when possible. If not possible, Contractor shall provide a flanged connection for piping back to an elevation mutually agreed upon by Contractor and Owner. For fixed rotor design, orifices and orifice tap flanges shall be furnished for installation in the balancing leakoff lines to monitor the flow. Orifices shall be properly sized and calibrated to obtain accurate flow measurements. Flow shall be transmitted to the DCS.

Boiler Feedwater Pumps shall be equipped with Bentley Nevada vibration monitoring system - X-Y Prox Probes (2 per pump bearing) and the Key Phasor Probe (1 per pump). The boiler feed pump vibration monitoring system shall be tied in to the existing main Bentley Nevada System 1.

The feedwater pumps shall be electric motor driven. A flow element, check valve, and isolation valve shall be provided in the HP and IP discharge piping of each pump. A three-element feedwater control system shall be provided to regulate the flow of feedwater to maintain IP and HP drum level. Each pump shall have a minimum flow recirculation system that discharges into the LP drum. The recirculation system shall include a modulating control valve, with a pressure break down orifice located at the LP drum, controlled from a flow element measuring flow through each pump. During low load, the control valve shall maintain minimum flow required for safe pump operation.

Boiler feedwater pumps shall be provided with mechanical seals.

A pump warm-up line shall be provided downstream of each pump discharge isolation valve to maintain an idle pump in a ready condition while the other pump is in operation. The line shall be designed to recirculate warm water from the discharge header through the idle pump casing back to the suction piping. A restriction orifice shall be provided in each warm-up line to maintain the warm up flow and reduce the pressure.

Boiler feed pumps shall be located in a heated and ventilated enclosure(s) and shall be provided with a fixed monorail(s) or shall be removable using portable lifting equipment and removable roof panels.

Hand-operated isolation valves shall be installed at the suction and discharge of each pump for maintenance. The pump HP discharge valves shall be equipped with bypass valves for first filling or pressure equalization with the header pressure after pump maintenance.

Bends, tees, elbows and downstream straight pipe sections in areas at high risk for flow accelerated corrosion (erosion-corrosion) shall be fabricated from material containing at least 0.16 percent chromium equivalent = percent chromium + 0.19 x percent molybdenum + 0.4 x percent copper.

A safety valve shall be installed on the suction side of each pump to protect this line against overpressure.

Vent and drain lines and valves used only for maintenance or first filling of the system are led to the plant drainage system GM.

5.2.12 Raw Water Supply System

The raw water supply system shall be provided to receive raw makeup water from the existing raw water system for use as firewater, service water, makeup to the evaporative coolers and makeup to the Demineralizer System. Raw water is provided from the existing well water supply. The well water quality analysis is provided in Appendix I.

5.2.13 Service Water System

The service water system shall be provided to receive service water from the raw water tank and distribute the water to the water treatment systems, service water users and stations.

Provide service water stations within 100 feet of all areas needing service water for routine maintenance or cleaning. Provide a minimum of two service stations at the boiler water treatment skids. Provide service water to all equipment requiring service water for seal flushes or other purposes.

Provide a 100-foot service water hose and hose bib at all service water stations.

5.2.14 Raw Water Treatment System

The Raw Water Treatment System shall be designed to receive and treat water from the existing raw water system. Raw water treatment shall consist of filtration by multimedia filters. The Raw Water Treatment System shall be housed completely within the Water treatment Building.

A complete filtration system shall be provided including but not limited to backwash pumps and air scour blowers. The Raw Water Treatment System shall treat the well water supply for use as makeup to the evaporative coolers and makeup to the Demineralized Water System. A coagulant feed system shall be provided to feed coagulant to the influent of the multimedia feed system.

Equipment	Total Quantity	Design Capacity
Cycle Makeup Treatment Booster Pump	2	100 percent of Design Capacity
Multimedia Filter	3	50 percent of System Capacity (with one spare 50 percent multimedia filter)
Coagulant Feed Skid	1	1 coagulant Feed System with 2-100 percent pumps

Equipment	Total Quantity	Design Capacity
Backwash Pump	2	100 percent of Design Capacity
Air Scour Blower	2	100 percent of Design Capacity

The multimedia filters upstream of the RO banks shall be designed to reduce the suspended solids present in the water as required to produce filtered water with a silt density index (SDI) level suitable for use as make-up to the RO system. The multimedia filters shall consistently produce water quality with an SDI less than 2.5 and turbidity less than 0.5 NTU.

The multimedia filter system shall be furnished with a turbidity meter that measures the product water from the multimedia filters. The system shall have automatic shutdown capability in the event the product water is out of specification.

Sample connections on the inlet and outlet of the filters shall be provided to facilitate the collection of grab samples. The filters shall be epoxy coated on the inside of the filter vessel. Internal piping and supports shall be constructed of Type 304 or 316 stainless steel. A differential pressure transmitter shall be provided across the filter bed. The backwash of each filter shall be initiated automatically by high differential pressure across the filter bed, high turbidity levels, by timer, by filter throughput, or manually by the operator.

5.2.15 Demineralized Water System

The Demineralized Water System shall consist of inlet cartridge filters, a 2-pass reverse osmosis system, first and second pass permeate break tanks with a minimum retention time of 20 minutes, an electrodeionization system (CEDI), demineralized water storage tank and all necessary pumps, piping, valves, etc. for a complete system. The system shall also include provisions for addition of a rented, offsite regenerated, mixed bed ion exchangers, including connections, instrumentation, and bypass valves. System capacity shall be sized to produce 2% of the maximum cycle steaming rate but no less than 100 gallons per minute of demineralized water. The Demineralized Water treatment System shall be housed completely within the Water Treatment Building.

The Demineralized Water System shall be designed to produce high quality demineralized water that will not exceed the following maximum guarantee limits in the effluent of the demineralization system:

Specific Conductivity:	0.1 µmho/cm
Silica:	10 µg/l

Sodium:	3 µg/l
Chloride:	3 µg/l

Major equipment capacities shall be as follows:

Equipment	Total Quantity	Design Capacity
Cartridge Filter	2	100 percent of System Capacity
1st Pass RO Feed Pump	3	50 percent of System Capacity (Including one common spare pump)
1st Pass RO Unit	2	50 percent of System Capacity
1st Pass RO Product Tank	1	20-minute 1st Pass RO permeate retention storage
1st Pass RO Product Pumps	2	100 percent of System Capacity
2nd Pass RO Feed Pump	3	50 percent of System Capacity (Including one common spare pump)
2nd Pass RO Unit	2	50 percent of System Capacity
RO Product Tank	1	20-minute 2nd Pass RO permeate retention storage
EDI Supply Pumps	3	50 percent of system capacity
RO Chemical Cleaning Skid	1	100 percent Capacity of One Unit
RO Chemical Feed Pump	2	Per chemical feed
EDI	2	50 percent of system capacity
Demineralized Water Storage Tank	1	200,000 gallons
Demineralized Water Pumps	2	As required to supply demineralized water users

Provide horizontal, centrifugal, RO feed pumps. Each pump shall be sized to provide the full capacity flow rate of the RO units.

Provide two pre-assembled, skid mounted, cartridge filter(s) at the inlet to the RO system. Provide filter housing constructed of type 304 stainless steel, minimum. Each filter shall consist of replaceable 2-inch diameter, 5-micron absolute, filter cartridge elements. Provide differential pressure transmitters across each filter to alarm control system upon detection of high differential pressure. Each filter shall be sized for 100 percent of the RO inlet flow rate.

Provide horizontal, centrifugal, RO feed pump(s) constructed of stainless steel wetted parts. Provide 2-pass RO units with all piping factory assembled, permeate discharge, and reject header for each unit.

Design each RO unit for in-place cleaning and provide permanent facilities to facilitate the cleaning, including but not limited to, a chemical solution tank, heater, cartridge filter, and horizontal centrifugal cleaning pump. Provide a post shutdown brine flush on each unit that bypasses the reject control valve while flushing is taking place and uses RO product water as the flushing source. Construct RO element housings of FRP or stainless steel. Use stainless steel piping for all interconnecting piping and headers. Provide sample connections on the inlet and each housing outlet to facilitate the collection of grab samples. Provide RO membranes with a minimum guaranteed life of three years in the intended service and with a minimum salt rejection of 99.5 percent at the beginning of membrane life with an annual salt passage increase of no more than 10 percent through membrane life. Provide pressure and flow transmitters on the inlet, permeate header, and reject connection of each RO system, and as required to allow automatic trending of membrane performance per ASTM D-4516, Standard Practice for Standardizing Reverse Osmosis Performance Data. Provide pH and conductivity meters on the RO inlet and permeate headers.

An FRP RO permeate break tank shall be provided with capacity to hold at least 20 minutes of storage of 1st Pass RO permeate. The R.O. system shall be designed to prevent back-pressurization of the R.O. system that could lead to membrane damage or failure.

The RO system shall be furnished with all necessary chemical injection systems including but not limited to a RO inlet de-chlorination (if upstream water is chlorinated), RO polymer feed and RO inlet acid feed (if required). All chemicals will be fed directly from tote containers provided by the chemical supplier using redundant chemical injection pumps. Tote containers and chemical feed skids shall be located within a containment area. Tote containers shall be located within the containment so as to provide unobstructed access to the totes for delivery by a fork truck. Valving and hoses shall be provided to connect totes to their respective feed skid and shall be designed to minimize chemical release and exposure while charging the totes.

A caustic feed skid shall be provided for injecting caustic between the 1st and 2nd Pass RO for removal of carbon dioxide (if required). The caustic feed rate shall be automatically controlled to achieve an operator selected pH level at the inlet to the 2nd pass RO banks. The caustic feed skid shall consist of two (2) 100 percent capacity feed pumps which will feed directly from portable tote containers.

An FRP RO permeate break tank shall be provided with capacity to hold at least 20 minutes of storage of 2nd Pass RO permeate. Provide two, 50 percent capacity, permanent, on-site, CEDI units to polish the effluent from the two-pass RO system. The CEDI polishers shall be sized as required to fulfill permeate requirements. Provide a pressure transmitter on the outlet of each CEDI unit. Provide a flow meter on the inlet and outlet of each EDI unit. Provide a conductivity probe on the outlet of each CEDI unit. Provide connections downstream of the common CEDI unit outlet for connection of offsite regenerated mixed bed ion exchange vessels. Include manual isolation valves and bypass valves. Provide a conductivity probe downstream in the common outlet of the rental mixed bed ion exchangers. Provide three 50 percent capacity CEDI supply pumps.

The new Demineralized Water Storage Tank shall be located in the Currant Creek 2 area. The normal operation of the new tank shall be for operation with Currant Creek 2. Controls shall be provided for the normal operating condition. For emergency operation the new and existing tanks shall be crosstied to be common to both Block 1 and Currant Creek 2 and have manually operated valves to allow either to be taken out of service for maintenance. The new Currant Creek 2 demineralizer system shall be installed adjacent to the new Currant Creek 2 Demineralized Water Storage Tank or at a location approved by Owner.

Provide horizontal, centrifugal, demineralized water make-up pumps constructed of stainless steel wetted parts. Provide a pH probe, conductivity probe, silica analyzer, and a temperature probe on the pump outlet header. Provide a flow meter on the demineralized make-up water line.

Controls for the Demineralizer System shall be integrated into the plant DCS or an Allen-Bradley PLC (ControlLogix) based control system. If the controls are provided through the PLC, the control system shall include a redundant CPU in hot standby with automatic switchover. A NEMA 12 rated I/O panel and separate HMI with panel mounted CRT shall be provided as a local operator interface. The PLC shall provide high level operating parameters to the plant DCS system for control and information. All control shall be local. The system shall be designed to shut down the make up water system on demineralizer storage tank level.

The demineralized water system shall be located inside the Water Treatment Building. Chemical storage totes shall be located indoors.

5.2.16 HRSG Blowdown Recycle.

All-volatile treatment of the steam cycles is envisioned for the station. As such the blowdown is expected to be suitable for reuse. A reuse system shall be provided to allow reuse of HRSG blowdown. The collected blowdown shall be cooled and routed to the demineralizer system for treatment prior to reuse as cycle makeup. The contractor shall supply all necessary coolers and recycle tanks, valves, and pumps necessary to accomplish reuse of the boiler blowdown. As a minimum, the contractor shall supply a flash tank for recovery of steam from the blowdown, coolers to reduce blowdown temperature to acceptable levels for reuse in the demineralized water systems, filters for removal of particulates, and a recycle tank for collection of the cooled and filtered blowdown. The system shall be automated to the greatest extent practical. Recovery of the heat in the blowdown shall be to the steam cycle to the greatest extent practical

5.2.17 Air Cooled Condensing System

Contractor shall provide an Air Cooled Condenser (ACC) System for turbine exhaust and by-pass, complete with all auxiliaries and accessories including the following:

1. Galvanized steel or aluminum fin tube bundles (with integral condensate collection/crossover headers and jacking bolts) or single row tubes
2. Lifting beam for tube bundles
3. Galvanized steel A-Frame support structure for fin tube bundles, including partition walls and doors
4. Galvanized steel fan deck
5. Galvanized steel ACC support structure, including perimeter walkway, hand-rails, and one (1) escape ladder
6. One (1) galvanized stairway from grade level to fan deck
7. Galvanized steel fan support bridges, including handrails
8. Fan rings with inlet bells
9. Galvanized steel fan guard grills
10. Axial-flow, aluminum fans
11. Gearboxes, including couplings, backstops, oil level pressure switch, and a AGMA service factor of 2.0 or greater
12. Variable speed TEFC electric motors, including space heaters and a 1.15 service factor
13. Transfer beam monorail and hoist for motor removal
14. Steam distribution header for each ACC row (with integral blanking plates for testing purposes)
15. Mechanical vibration switches (one per air moving assembly), temperature sensors, and pressure transmitters

16. Rupture disk assembly, including a platform and one (1) moveable ladder
17. Condensate collection piping and drain piping
18. Air removal headers and piping
19. Windwall (above fan deck level) and associated galvanized steel support structure
20. Steam duct from the turbine to the ACC, including expansion joints, inspection manhole, supports, and bypass connections
21. Steam duct drain pot and drain pot pumps, including level transmitters
22. Skid-mounted liquid ring vacuum pump system including integral piping, integral instrumentation, and automatic inlet valve
23. Vacuum deaeration system
24. Interconnecting bolting hardware and gaskets
25. Complete system control logic narrative
26. Training (5 days, one trip)
27. Thermal, hydraulic, mechanical, and structural design of equipment
28. Wind mitigation design and material supply.
29. Three jigs for modular construction of the cells at grade level
30. Provide means of safely accessing rupture discs and manways located in steam ducts on top of the “A” frames.

Freeze protection features

Instrumentation sensors, transmitters, and control actuating devices

Noise attenuation features/devices, as required.

Surface coatings, as follows:

1. Steam ducting, steam headers and piping to be outside primer coated.
2. Structural steel framing, including platforms, handrail, toe plate, grating, etc. shall be coated in accordance with Article 7.4.8 Painting.
3. Partition walls, windwalls and siding shall be finish painted with manufacturer’s standard coatings. (Color to be selected by the Owner)

Special maintenance and erection tools

Submittals: Contractor shall provide ACC certified performance correction curves for all applicable design parameters including, but not limited to:

1. Steam flows of 50, 90, 100 and 110 percent of guaranteed steam flows.
2. Ambient Temperature.

3. Wind velocity.

Factory Tests:

1. The ACC Condensate Tank shall be hydrostatically tested by manufacturer at 1.5 times the working pressure per ASME Section VIII.

Design Parameters

The Air Cooled Condenser shall be designed to operate for the full range of ambient conditions covering the operating envelope of the plant.

Turbine Bypass Performance Conditions: The Air Cooled Condenser shall be capable of maintaining the steam turbine manufacturer's recommended backpressure at the Steam Turbine exhaust flange during startup and while condensing full Hot Reheat Turbine Bypass and Low Pressure Steam Turbine Bypass steam flows without tripping the steam turbine or preventing a re-start of the steam turbine.

Maximum O_2 and non-condensable gases in the condensate sampled at the Condensate Pump discharge shall be less than seven (7) ppb at all operating conditions.

Equipment noise shall not exceed requirements specified in Section 1 .

ACC performance shall remain in accordance with Guaranteed Correction Curves at all operating and ambient conditions. STG exhaust steam shall be condensed in the ACC at all ambient conditions.

Air Cooled Condenser (ACC)

The air cooled condenser will be supported from grade. The condenser, accessories and components shall be supported on braced structural steel columns designed and fabricated in accordance with codes, standards, seismic and wind load conditions as required and specified. The condenser and its components shall be of proven, dependable design, of high quality new materials with first class workmanship throughout, and arranged to minimize maintenance work.

Platforms, stairs, and ladders shall be furnished to provide access to the condenser Sections, valves, controls, motors, fans and accessories. Access platforms, stairs and ladders shall be steel.

The Air Cooled Condenser shall be arranged as follows:

1. The condenser shall be designed for full vacuum and a positive pressure of standard atmospheric pressure for elevation at the jobsite.
2. Contractor shall determine the steam inlet size which results in the most economical overall condenser and auxiliaries design.
3. Adequate provision shall be made for thermal movement under the range of temperatures and pressures that will be encountered in operation. No leakage of steam or water shall be allowed. Air in-leakage shall be below industry codes and standards and within the limits to maintain the guaranteed performance. No bypassing of air around the heat transfer surfaces shall be allowed. Expansion joints with gaskets and fasteners, guides, braces, and stiffeners, etc. shall be provided as required.
4. The condenser shall be designed to allow freeze proof operation at specified minimum steam flow and concurrent minimum ambient temperature (e.g., 1 X 1 operation at minimum sustainable load). The tubes, headers, drain pots, and piping shall be sized and designed to drain freely and completely to prevent damage due to freezing. Freeze protection features shall be described in detail in the proposal.
5. The condenser shall be designed to accommodate plant load swings from maximum to minimum (1 CTG at OEM minimum load) as specified herein throughout range of ambient temperatures at the plant site. The condenser shall be capable of operating with modules shut down to maintain optimum turbine exhaust pressure.
6. The condenser shall be capable of maintaining optimum turbine exhaust pressure and plant efficiency by incorporation of various design features such as sectionalizing, etc.
7. The condenser shall be of the A-frame type with A-frames elevated sufficiently for proper air inlet distribution. Jacking bolts shall be provided on all A-frames to permit proper alignment of bundle tube sheets for purposes of seal welding.
8. The condenser and related components shall be of proven design, utilizing new materials and arranged to facilitate maintenance. Provisions shall be made in the design and construction of the condenser, condenser components, exhaust duct, piping, headers, supports and accessories for thermal movement under the range of temperatures and pressure encountered in operation. Expansion joints

at the turbine exhaust, in the ducts and piping, and at the condenser shall be designed for the service.

9. All portions of the condensing system that are associated with containing steam and condensate shall be of seal welded construction. This includes ducting, piping, tube sheet and tube-to-tube sheet connections. Gasketed joints and threaded connections are not acceptable.
10. Welding procedures, processes, equipment and craftsman shall be qualified in accordance with applicable Sections of the ASME or AWS Codes.
11. Reverse buckling rupture disc type pressure relief device for each isolatable condenser section shall be provided.

Components:

Fans:

1. Fan blades shall be secured to a common hub and shall be constructed of fiberglass reinforced polyester (FRP) or extruded aluminum, and have adjustable pitch.
2. Blades shall be axial flow aerodynamically designed type.
3. Fan blades shall be weight and moment balanced and shall be interchangeable. Fan hubs and blades shall be statically balanced prior to shipment to the jobsite.
4. A fan guard shall be provided below each fan. The fan guard shall be designed so that it can be used as a maintenance platform using plywood or wooden planks.
5. Provide a fan ring of molded fiberglass duct to house the fan and provide accurate adjustment of the blade tip clearance for optimum efficiency.
6. The fan shall be provided with means to stop backward rotation prior to fan startup.
7. Fans shall be supplied with variable speed drives (VFD's) and motors in accordance with SECTION 8.
8. Fan motors shall not exceed 250 horsepower.
9. Two single pole double throw vibration switches of the manual reset type, shall be provided for each fan drive for input into the plant (DCS) alarm system and for motor shut down. One switch shall be set at high level and the second switch shall be set at high-high level to shutdown each respective fan.

10. Each fan shall be driven through a speed reduction gearbox suitable for continuous service in a dry air cooled condenser environment.
11. The gearbox shall be designed in accordance with AGMA standards.
12. The minimum mechanical design service factor shall be 2.0 referred to motor nameplate rating.
13. A sight gage shall be incorporated to indicate oil level.
14. Bearings shall have an L-10 life of 50,000 hours or greater.
15. An oil pressure or flow switch shall be provided for each gear box.
16. Fans shall not stall under any operating or ambient conditions.
17. Maximum vibration level at fan deck shall not exceed 0.1 inch/sec.

Windwalls:

1. Windwalls shall be provided for installation around the perimeter of the A-frame section of the air cooled condenser, minimally extending from fan deck level to the top of heat exchanger bundles, to minimize air recirculation, tube freeze-up, or excessive noise.
2. If louvers and/or operable dampers are required, these shall be furnished sized and designed to withstand wind, seismic and operating loads as specified herein. Damper blades shall be horizontal, with maximum length of 6 ft. Damper actuating motors shall be supplied for each Section, sized for wind and fan loads as required by design and this specification. Louvers shall be heavy duty industrial type, suitable for outdoor operation.
3. Wind mitigation shall be provided at the perimeter of the cells, below the fan deck level, as required, to minimize fan inlet air starvation due to high ambient wind conditions.

Controls:

1. The air cooled condenser system shall be designed for automatic operation at all loads and ambient conditions.
2. The air cooled condenser controls shall be implemented through the plant's distributed control system (DCS).
3. Fan speed control shall be by use of Variable Frequency Drives (VFDs). ACC Control System shall be designed to prevent freezing of equipment.

Fin Tubes:

1. Shop installed into tube sheets by the condenser manufacturer. The manufacturer should make the method of tubing clear in the proposal.
2. Furnish and deliver the specified number of tubes suitable for the application and in conformance with the design parameters and specifications.
3. Tubes shall be constructed of hot dipped galvanized carbon steel tubes.
4. Fins shall be constructed of carbon steel with all exterior fin tube surface hot dipped galvanized or aluminum.
5. Fin tubes shall be designed such that the interspace between the fin flange and the tube is filled with zinc during the galvanizing process.
6. Fin tube bundles shall be designed to allow free thermal expansion of the tubes. Single row tubes may be supplied by Contractor.
7. Tubes shall be easily cleaned using high pressure cleaning equipment provided by Others. Contractor shall provide an optional price for an automatic cleaning system. If selected, the automatic system shall be furnished complete to include, but not limited to, pumps, nozzles, piping, valves, controls and instruments. System shall utilize raw make-up water for washing tubes.
8. Fin tube bundles shall be arranged to facilitate cleaning and minimize air side pressure drop.
9. Fins shall be capable of withstanding, without damage or deformation, frequent applications of high pressure water jet sprays directed on fins for cleaning purposes.
10. The fins shall also be capable of withstanding hail up to 1.25 in. in diameter, and localized loads applied by personnel stepping on the fins during erection or maintenance.
11. Fin pitch shall not exceed 11 fins per inch.
12. Air evacuation system shall be designed to continuously remove non-condensibles and maintain performance at all ambient conditions.

<u>Steam Duct:</u>

Contractor shall furnish a carbon steel steam duct from the turbine exhaust connection to the air cooled condenser inlets, including duct transition piece at turbine interface, expansion joints and structural supports and/or hangers, as required.

Steam duct connections shall be butt or socket welded except where bolted or flanged connections are required for maintenance and equipment connection. Flanges shall be, as minimum, steel ring flanges in accordance with AWWA Class D (150 psi). Where flanges are employed, associated fasteners and gasketing shall be provided. Access manhole(s) in the steam duct to allow for internal inspection and maintenance of the steam duct system between turbine and condenser shall be provided. Manholes shall be 24" steel pipe nozzles including an ANSI 150 lb. flange plus blind flange. Ends shall be machine beveled suitable for field welding except where field trimming is required.

Steam duct shall be designed with provisions for installing full-flow steam bypasses. Such provisions shall include a tee or thimble in which to install bypass steam diffusers so as to have no reduction in flow area of the main duct. Connections for steam diffusers shall be included.

Contractor shall add a flanged connection to the main duct to allow for the future addition of a heat exchanger using supplemental cooling from an evaporative type cooling tower. Connection shall be sized to allow for supplemental cooling up to 30 percent of the total heat load.

Low point drain pot(s) sized to collect condensation during start-up and normal operation shall be provided. Condensate shall be automatically returned to the condensate tank using two (2) 100 percent drain pumps.

The steam duct shall be designed for full vacuum and for a pressure up to 14.9 psi.

Expansion joints shall be incorporated in the steam ducting to accommodate thermal movements and to minimize loads on connection points. The expansion joints shall be metal bellows type stainless steel welded construction with tie bolts, lifting lugs and accessories, designed in accordance with Standards of the Expansion Joint Manufacturers Association, Section C. The expansion joint located at the turbine connection point may be an elastomeric type. Expansion joints shall be sized and designed to accommodate at least two (2) times the calculated lateral, axial and offset movements.

A spray curtain shall be provided in the vertical section of the main steam duct to protect the Steam Turbine from by-pass steam high temperature. Inlet water piping and control shall be supplied by others.

Condensate Receiver Tank

Contractor shall provide a Condensate Receiver Tank sized to provide a minimum of 5 minutes of storage capacity based on 0°F fired case design condensate flow. Normal water level of the tank shall not be higher than 50 percent of the total volume of the tank. Provide adequate volume in the condensate receiver tank above normal operating level to allow all condensate in the condenser to flow into the condensate receiver tank without overflowing. Condensate Receiver Tank shall be insulated and heat traced.

Condensate Receiver Tank shall be designed for standard atmospheric pressure for elevation at the jobsite to full vacuum with immersion heaters, and designed in accordance with Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code.

Condensate Receiver Tank shall be designed to include a sparger for water make up to reduce the oxygen content to 14 ppb or less at steady state operation. Maximum water make up shall be no more than 5 percent of the condensate flow.

The condensate receiver tank overflow shall be routed to a set of condensate recovery pumps to recycle overflow to the raw water storage tank.

Piping and Valves:

As a minimum, the following ducting and piping shall be furnished:

1. Steam distribution ducting from the main steam duct to individual air condenser sections.
2. Condensate collection and drain piping
3. Air removal piping
4. A pressure equalizing pipe between the main steam duct and the condensate receiver shall be provided.

Motorized condenser sectionalizing valve(s) shall be provided as required with related components, two (2) motorized fast acting (6 minutes to atmospheric) condenser vacuum breaker valves. Valves shall be sized for full line size and furnished with motor-operated actuators, including position indication. The valve body and disc shall be carbon steel and designed for tight shutoff.

Cold Weather Operation

Condenser shall be designed to allow safe operation at the specified minimum continuous steam flow and winter ambient design temperature and shall be able to operate with 10 percent steam flow during start-up period. Tubes, headers, drain pots, and piping shall be sized and designed to drain freely to prevent damage due to freezing.

Motor operated louvers and/or operating sectionalizing valves shall be furnished for cold weather operation as required.

Steam By-pass System:

The air cooled condenser shall be designed and constructed to receive full bypass steam flow from the heat recovery steam generators (HRSGs) during startup and trip conditions.

The bypass system shall be designed for the maximum HRSG steam output without duct burning and shall be designed for continuous operation.

Air Removal Equipment:

Contractor shall provide 2 x 50 percent capacity vacuum pumps for hogging and a steam jet air ejector (SJAE) holding system for condenser air removal. Design capacity shall be sufficient to reduce pressure to 6 inches of Hg in the entire Air Cooled Condensing system in less than 30 minutes. Provide a 1 x 200 percent Inter/After condenser. All venting and discharge lines shall be routed to a safe area.

Each vacuum pump unit shall include the following:

1. Two-stage rotary vacuum pump with cast-iron construction, steel shaft, liquid ring, and electric motor drive.
2. Structural steel base to accommodate pump, motor, and accessories.
3. Flexible coupling, gear-type or Falk Steelflex.
4. Coupling guard complying with all state and federal safety requirements.
5. Steel plate separator with gauge glass, automatic makeup valve, and overflow connection.
6. Automatic inlet valve for main vacuum line from condenser.
7. System vacuum switch to start standby unit.

8. Balanced check valve for separator discharge with soft seat and lever arm for air leakage test.
9. Solenoid valves for valve actuators.
10. All required vacuum and differential pressure and temperature switches.
11. Rotameter for air leakage measurement.
12. A manually operated siltation valve shall be provided at the inlet of each vacuum pump for maintenance.
13. Automated valve, strainer, rotameter, and pressure gauge for water service.
14. Heat exchanger with stainless steel double-grooved, rolled tubes sized for 100^{o}F cooling water.
15. PRV for instrument air control.
16. Complete set of integral interconnecting piping, fittings, tubing, and valves.
17. Complete interconnecting wiring with terminal box and terminal blocks for Owner's connecting wiring.
18. Painting: Shop coat all carbon steel surfaces with manufacturer's standard metal coating suitable for the outdoor service intended.

Steam Blow to Air Cooled Condenser

If Contractor uses the ACC in conjunction with steam blow for cleaning of steam piping the Contractor shall use procedures that are approved for this purpose by the ACC supplier.

5.2.18 Chemical Injection Systems

Chemical feed equipment shall be provided to supply water-conditioning chemicals to the boiler steam/water cycle systems along with plant wastewater and water discharge systems. Each system shall be skid-mounted and shall include chemical pumps, piping, instrumentation and controls. Bulk storage shall be furnished for all chemical injection skids unless specifically not practical or allowed (i.e. proprietary chemicals). All chemical tanks and totes shall be provided with containment to prevent contamination due to chemical leakage. All containment areas shall be sloped to drain to a sump providing convenient suction for the use of portable sump pump or vacuum truck hose. All chemical feed systems shall be monitored, controlled and injection rate adjusted from the plant DCS. Wherever possible, chemical feed pumps shall be identical. All chemical feed systems shall be designed for 100 percent redundancy at Peak Load. All chemical feed systems shall be located indoors.

Boiler Water Chemical Systems

The boiler water chemical treatment shall consist of all-volatile-treatment. The boiler steam/water cycle chemical injection systems shall provide for the ability to inject 19% aqueous ammonia to the condenser pump discharge. Chemical feed equipment and tanks shall be located inside a heated and ventilated building and shall be arranged to allow clear access to the chemical tanks with a fork truck or other suitable maintenance equipment. Chemical feed system shall be segregated from all other systems in the building with a barrier wall. Provide adequate ventilation to prevent the accumulation of chemical fumes per Industrial Ventilation Standards. Provide facilities suitable for stacked 500-gallon aqueous ammonia supply totes.

Provide a dedicated chemical feed system and chemical feed system enclosure for each HRSG. The descriptions included in the following paragraphs are typical of the chemical feed systems.

The aqueous ammonia feed system shall be provided to maintain a selected pH level and shall have two 100 percent metering pumps with automatic stroke positioners and variable speed drives. The ammonia feed system shall have the capability of being fed either from a dilution/day tank or a portable tote. The dilution/day tank shall be directly piped to the facility bulk storage 19 percent aqueous ammonia tank. The system shall be equipped with two 100 percent transfer pumps that will allow the transfer of aqueous ammonia from the bulk storage tank to the dilution/day tank. One pump shall feed aqueous ammonia directly from a portable tote to the steam cycle with the second pump acting as a spare. A day tank shall also be provided with a demineralized water connection for dilution of aqueous ammonia provided by tote (if operationally desired). The chemical supplier will supply the portable totes. Control of the aqueous ammonia feed will be in proportion to the condensate pH with a feedback control from condensate specific conductivity. The tote and dilution day tank shall be vented outdoors.

5.2.19 Closed Cooling Water System

Provide a closed cooling water system to supply cooling water to the various generation plant equipment heat exchangers and transfer the heat to air-cooled Component Cooling Water Heat Exchangers. The system must be capable of producing water temperature of 115°F or less at the maximum ambient temperature of 105°F. System shall be provided with all required equipment that will result in a complete, fully functional system.

Air Cooled Heat Exchanger shall meet the following design requirements:

AIR COOLED HEAT EXCHANGER DESIGN REQUIREMENTS	
Coolant Type:	50 percent Deionized water, 50 percent Glycol
Design Inlet Coolant Flow:	Per plant design requirement
Design Inlet Coolant Temperature	Per plant design requirement
Design Outlet Coolant Temperature:	115 F
Design Air Temperature:	105 F
Maximum Inlet Coolant Temperature:	150 F
Maximum Air Temperature	115 F
Minimum Air Temperature	-20 F
Inlet Coolant Pressure Range:	Per plant design requirement
Maximum Inlet Pressure	Per plant design requirement

Provide closed cooling water pumps with sufficient pumping capacity to supply cooling water to CTG/HRSG trains, the steam turbine generator, and associated balance of plant equipment, at all operating conditions.

The Component Cooling Water System shall, as a minimum, utilize the following major equipment:

Equipment Item	Quantity	Capacity of Each Unit
Closed Cooling Water Pump	2	100 percent maximum system demand
Component Cooling Water Heat Exchangers	As Required	100 percent maximum system demand
Component Cooling Water Expansion Tank	1	As required
Closed Cooling Water Chemical Mixing Pot	1	As required

A 5-gallon chemical mixing pot stem shall be provided to maintain water quality and inhibit corrosion.

For compensation of minor leakage, a refilling line equipped with a motorized valve from the Demineralized Water System shall be installed. The criterion for refilling is the pressure measured at the main cooling water line upstream of the expansion tank.

Rated water flow and system capabilities shall be based on sufficient cooling capacity for CTG/HRSG trains, the steam turbine generator, and associated balance of plant equipment, at all operating conditions.

All components shall be designed in accordance with the latest OSHA requirements. A vibration switch shall be supplied with the Component Cooling Water Heat Exchanger fan system to protect mechanical equipment against excessive damage due to malfunction of the rotating members. Containment shall be provided for the component cooling water pumps, heat exchangers and expansion tank.

Design the component cooling water system for a mixture of no less than 50 percent propylene glycol solution. Provide concrete containment with drains around the CCW pumps with a 6-inch curb all around.

The system shall be designed and constructed so that one pump is started manually from the main control room and runs continuously during normal operating conditions. System operation shall be a permissive for CTG / STG operation. The other pump shall be on auto standby. A pressure switch in the pump discharge header shall be provided to initiate an automatic startup of the standby pump if discharge pressure is below a predetermined pressure setting. Selection as to which pump will be on standby shall be a manual operation.

The component cooling water expansion tank shall be designed to maintain the required system pressure, provide system make-up and accommodate flow variations, and allow system thermal expansion. The expansion tank shall be vented to the atmosphere and shall be located at the highest point in the system to provide adequate pump NPSH.

In order to prevent or minimize corrosion of any of the component cooling water system components, a corrosion control system shall be provided. The system shall be designed as a batch system in which the required chemicals are flushed into the system by means of a manually operated slug feeder.

5.2.20 Fuel Gas System

The fuel gas system shall receive gas from the plant metering station in a range of pressures indicated in Section 2 of these specifications. An emergency shutoff valve shall be provided for gas supply to Currant Creek 2. Provide all gas heating, moisture removal, particulate filtration, and pressure control required to deliver the gas to each individual CTG fuel gas control system and HRSG duct burner and pilot at the proper conditions as required by CTG and duct burner manufacturers.

Fuel gas supply system shall be designed to ensure that the CTG manufacturer's fuel gas requirements for contaminates are met, given the worst case fuel that may be delivered to the facility; and to provide filtered, dry natural gas to the CTG and HRSG.

The Fuel Gas System shall be designed to meet all requirements and recommendations of NEC, NFPA, Factory Mutual, and local codes.

The fuel gas distribution system shall have sufficient capability to operate all CTGs and HRSG duct burners simultaneously at Peak output at any ambient condition with the design basis fuel gas composition defined in Appendix J.

Provide an auto/manual trip valve downstream of the Company/Questar fuel gas terminal point. Provide a 1 X 100 percent station knockout drum downstream of the trip valve. The knock-out drum removes any entrained liquids from the fuel gas. Level sensing and indicating devices and control valves shall be used to automatically drain any collected liquids from the knock-out drum into the liquid drain tank.

Provide a fuel gas scrubber, primary and secondary (if required) fuel gas heaters, and a filter/separator for each CTG. The fuel gas scrubber shall be installed upstream of fuel gas heaters. Filter/separator should be installed downstream of the fuel gas heaters. Provide a filter/separator that is designed to satisfy the CTG manufacturer's limits on particulate matter and liquids. Each fuel gas scrubber and filter/separator shall come complete and skid mounted with automatic level control to maintain a safe level of accumulated liquids. Provide 2 X 100 percent station filter/coalescers downstream of the knockout drum. The coalescing filter separator removes any small particles and liquids from the fuel gas. Level sensing and indicating devices shall be located on the side of the coalescing filter separator. These level sensing devices and associated control valves can be used to automatically drain liquid from the coalescing filter separator into the liquid drains tank. A differential pressure sensing device shall be connected across the coalescing filter section of the coalescing filter separator and is used to indicate when the filter is fouled.

Provide 2 X 100 percent drains tanks to collect liquids from the knock-out drum and filter/coalescers. The liquid drains tank collects the liquids removed from the fuel gas stream in the knock-out drum and the coalescing filter separator. Separated liquids shall be drained to collection tanks for subsequent removal. The drain tanks shall have level indication that is provided to the plant DCS. All materials in contract with the clean gas stream inside the filter/separators and downstream of the filter/separators shall be constructed of 300 series stainless steel materials.

Provide dedicated primary performance fuel gas heaters on each CTG unit. The objective of the fuel gas heating system is to heat the fuel gas flow to the Combustion Turbines to increase the efficiency of the power plant. Primary fuel gas heaters shall be shell and tube heat exchangers, utilizing waste heat or low energy heat where possible as a heating medium. Design system to preheat fuel gas to a temperature required by the OEM under all load and ambient conditions prior to supply to the CTG fuel gas skid. Provide a temperature probe in the heated gas stream and temperature control valve in the condensate return line to afford temperature control of the natural gas. Scope of supply for the fuel gas heating system shall include, but not be limited to, heaters, heat exchangers, piping, valves, strainers, controls, drain tanks, expansion tanks, and safety relief valves.

Provide 2 X 50 percent secondary electric fuel gas heaters on the fuel gas stream to each CTG, designed to provide fuel at the temperature required by the CTG manufacturer during startup (dewpoint heating).

Provide DCS controls and all instruments necessary to monitor temperature of fuel gas supply from the primary fuel gas heaters and automatically initiate and control the secondary fuel gas electric heaters to maintain the fuel gas temperature above the minimum allowed by the CTG manufacturer during start-up. Provide an alarm in the DCS for low fuel gas temperature.

Supply regulated gas, at the required CTG inlet supply pressure, to the CTG fuel gas control system. Provide all pressure control equipment required. Include strainers at the inlet of each control valve. Provide an unheated branch line to the HRSG duct burners and auxiliary boiler with pressure reduction control valves to reduce the inlet gas supply pressure to that required by the HRSG duct burners and auxiliary boiler.

Provide flow measurement instruments on each fuel gas supply line to each CTG (meters shall be supplied with the CTGs) and each fuel gas supply line to each HRSG duct burner. Fuel gas metering to each duct burner and to each CTG shall meet the requirements of 40 CFR 75 for reporting. The system shall be sized to meet the design capacity requirement with the gas supply pressures at minimum levels. The system design pressure downstream of control valves shall be at least 550 psig, but shall be selected by Contractor during detailed design based on the maximum gas supply pressure. Pressure safety relief valves shall be included as required to prevent the pressure from exceeding maximum system design pressure (including safety valve accumulation) or as required to protect supplied equipment or systems. Design temperature shall be equal to the maximum operating temperature plus a 10°F margin. Provide an automated emergency vent valve in addition to the safety relief valves. Provide a pressure switch with a set point sufficiently below the relief valve set pressure to close the site pressure control valves and open the emergency vent valve prior to lifting the relief's during a system upset. Locate and direct all vents (emergency and reliefs) away from buildings or occupied areas.

Natural gas supply to the Site will not be odorized. Therefore, provide natural gas detectors throughout the facility as required or recommended by NFPA, applicable codes, and as required by the local fire marshal.

Route all fuel gas piping so that piping is not below any ponds or permanent structures.

Equipment	**Quantity**	**Capacity of each unit**
Station Knock-out Drum	1	1 X 100 percent of Maximum Fuel Demand
Station Filter/Coalescers	2	2 X 100 percent of Maximum Fuel Demand
Collection Tanks	2	2 X 100 percent Collect From Knock-out Drum and Filter/Coalescers
Dewpoint Heater	2	2 X 50 percent of Maximum Fuel Demand (Heat input basis – both CTGs without duct burners)SEE NOTE 1
Station Pressure Control	1	3 Parallel trains, each 50 percent of maximum fuel demand
Duct Burner Metering	2	1 X 100 percent for each HRSG
Duct Burner Pressure Control	2	1 X 100 percent for each HRSG
Auxiliary Boiler Metering	1	1 X 100 percent
Auxiliary Boiler Pressure Control	1	1 X 100 percent
CTG Pressure Control	2	One per CTG

Equipment	Quantity	Capacity of each unit
Primary Performance Fuel Gas Heaters	2	One per CTG
Fuel Gas Knock-out Tanks	2	One per CTG

NOTE 1 – Each dew point heater shall be sized to provide the fuel gas startup temperature (at the minimum operating ambient temperature) at or above the minimum required superheat temperature per the combustion turbine vendors requirements. Each dew point heater shall be sized to provide heating up to the point when the performance heater is capable of maintaining the required fuel preheat requirements plus 5% margin on flow. The dew point requirements shall be based on the combustion turbine manufacturers required superheat above dewpoint assuming the maximum allowable moisture concentration by tariff in the fuel.

5.2.21 Compressed Air System

The compressed air systems shall be designed and constructed to supply filtered, dry, and oil-free compressed air to the plant service air system and to instrumentation and pneumatic control devices via the instrument air system. In addition, the following major equipment shall be provided to supply compressed air when the plant is out of service and during system start-up. Both service air and instrument air shall be provided from a common air receiver. Air receivers shall be located as required by Contractor's design for Currant Creek 2 Equipment.

Equipment	Quantity	Capacity
Air Compressor	2	2 X 100 percent Peak system demand
Air Receiver	2	To level out demand on the Air Dryers and 10 minutes of demand (See Below)
Pre-filters	2	2 X 100 percent peak system demand
Coalescing Filters	2	2 X 100 percent peak system demand
Air Dryer	2	2 X 100 percent peak system demand

The air compressor shall have sufficient capacity to supply the maximum service air and instrument air required during normal operation and maintenance outages including adequate air to clean one of the CTG inlet air filter systems when the CTGs are shut down. The compressor shall provide oil-free (less than 0.05 ppm oil) air at a discharge pressure of 125 psig. Design system to maintain a normal supple header pressure of 115 psig and design all components to operate properly at a minimum supply pressure to each instrument and air user of 80 psig. Service air supply shall be provided with a low pressure cut-off.

System Design Parameters	
Maximum Instrument Air Dew Point	-40 °F at 100 psig
Removal of Particulate ≥ 0.1 microns	99.9 percent

Provide service air hose stations including 100 feet of hose within 100 feet of all areas requiring routine or periodic maintenance with compressed air tools or with compressed air.

Compressed air receivers shall be supplied with a relief valve and shall be ASME Section VIII, Division 1 code stamped and designed for 150 psig. Compressed air receivers shall be provided with sufficient volume to provide 10 minutes of air supply at the design demand rate without the pressure falling below 70 psig with all compressors failed.

The compressor shall be supplied with an inlet filter-silencer and discharged through an aftercooler and moisture separator. The compressor, intercooler, and aftercooler shall be air-cooled. The compressors shall discharge to the common desiccant type air receiver that is sized so that the compressors do not run continuously or in short cycle. The air receiver shall be designed to remove additional moisture.

The air compressors shall operate automatically to maintain the air receiver pressure within an acceptable range. In AUTO mode, the lead compressor shall start on low air receiver pressure and shall stop on high pressure. In the event that the lead compressor cannot maintain the minimum allowable pressure, the standby compressor shall start automatically, and a low-pressure alarm shall be activated in the main control room. A selector switch shall be provided in the DCS to establish the lead compressor and the standby compressors. Remote indication and set point selection capability shall also be provided in the DCS. Air compressor load shall be served off a critical service panel so that the compressor can be operated when the plant is down.

The entire compressed air stream shall be filtered and dried to a dew point of -40°F at 100 psig. A second receiver shall be supplied to level out instantaneous demand on the instrument air dryers. The compressed air piping from the coalescing filters shall be piped to two each 100 percent capacity air dryer skids. Each dryer skid shall consist of a dual-tower, heatless fully automatic regenerating cycle type desiccant dryer with the regeneration cycle controlled by timer with a dew point monitor alarming on high moisture. Re-activation of the moisture-laden desiccant is accomplished by routing dry air from the operating dryer tower outlet through the desiccant in the off-line drying tower. The receiver shall be sized so that the compressors do not run continuously or in short cycle. The instrument air header branches throughout the plant to provide air to the various control loops in the plant.

A pressure-regulating valve shall be provided to shutoff air supply to the service air system when low compressed air system pressure jeopardizes operation of the instrument air system.

5.2.22 Sampling and Analysis System

A sampling and analysis system shall be provided to monitor the performance and operation of the steam, condensate, and feedwater cycles; to monitor the quality of the various process fluids; and to provide sufficient data to operating personnel locally and in the plant control room and to the plant DCS for detection of any deviations from control limits so that corrective action can be taken.

This description is for a sampling system for a 2 X 1 combined cycle configuration.

The sample panel drains shall be collected and routed to the HRSG blowdown tank.

The sampling and analysis system shall be located in a permanent, temperature controlled environment which can either be in a separate room in the Steam Turbine Building or a separate building located between the HRSG's. If the Contractor elects to provide a separate building, it shall be designed and constructed to provide a concrete foundation and floor slab, framed structure, with a finished interior adequate for the operation and maintenance of the system. The location for the Sample Panels is subject to review and approval by the Owner.

The sampling and analysis system shall be designed to condition samples and shall include the following equipment and/or accomplish the following functions:

- Liquid samples shall have a velocity of 6 feet per second. Sample lines between the source and the sample panel shall have a tube size of 3/8".
- Sample lines shall be properly insulated.
- Each sample line shall have an isolation valve.
- Each sample shall be capable of being blown down to the boiler blowdown tank.
- Shall include primary coolers,
- Rod-in-tube pressure reducing valve on each sample,
- Secondary cooler (plus controller) to control sample temperatures at 77 (+/- 1 ^{o} F),
- Thermal cutoff valve on each sample,
- Pressure regulator on each sample,
- Sample flow controllers and indicators on each sample,
- Grab sample capability on each sample.
- Each liquid sample line to each analyzer shall be equipped with an adjustable flowmeter (rotameter)
- The liquid sample line to each analyzer shall be equipped with a 60 micron filter.

The following table gives the analyzers that shall be provided for the various streams. Some analyzers will be shared among streams. When analyzers are shared, three-way manual valves shall be installed to allow selection of which sample is directed to each analyzer. There shall be no automatic sample sequencers.

All equipment and analyzers shall be mounted on the water sampling panels in a way that leaves the panel as open as possible for maintenance. Analyzers shall be mounted at approximately eye-level. Ion exchange columns shall be positioned to be accessible, not at ground level, and shall be connected to sample lines by "quick disconnect" connections. All analyzers' outputs shall be available on the DCS system. Analyzers shall alarm in the water sample panel room during out-of-spec. conditions. All analyzers shall be "hard plumbed" with stainless steel tubing to sample analyzers.

A sink shall be provided that is the length of the portion of the panel where grab sample water discharges. A stainless steel shelf shall be provided that is the length of the sink. At least one power outlet shall be provided in the area of the sink.

Sodium and silica analyzers must be capable of analyzing "grab" samples.

The sample panel shall be logically laid out and clearly labeled with brief source and analyzer descriptions. Samples shall be grouped on the panel as they are grouped in the following table, that is: Common, HRSG 1 and HRSG 2.

Service	**GS**	**SC**	**CC**	**DC**	**DO**	**pH**	**Si**	**Calc pH**
COMMON								
Condensate Pump Discharge	X	X	X	X	X	X	X (S)	X(S)
Main Steam	X		X					X(S)
HRH Steam	X		X					
LP Steam	X		X					
Makeup Demineralizer (Analyzers at DM location?)	X	X					X (S)	
HRSG-A								
LP Drum	X		X					
LP Steam	X		X					
IP Drum	X		X					
IP Steam	X		X					
HP Drum	X		X					
HP Steam	X		X	X(S)			X(S)	
HRSG-B								
LP Drum	X		X					
LP Steam	X		X					
IP Drum	X		X					
IP Steam	X		X					
HP Drum	X		X					
HP Steam	X		X	X(S)			X(S)	

	GS Grab Sample	SC Specific Conductivity
	CC Cation Conductivity	DC Degassed Cat Conductivity
	DO Dissolved Oxygen	pH

Service		GS	SC	CC	DC	DO	pH	Si	Calc pH
	Si Silica				Calc pH (calculated pH)				
	(S) Shared Analyzers								

Two (2) silica analyzers shall be provided. Each HRSG will have its own dedicated silica analyzer as indicated in the table above. The remaining Common (shared) sample points will be split between these two silica analyzers. Each of the Common samples shall have the capability to be routed to the respective silica analyzer via a manual three-way valve. The contractor may select which Common samples are distributed between the two silica analyzers.

Two (2) de-gassed cation conductivity analyzers shall be provided. The condensate pump discharge will have its own de-gassed cation conductivity analyzer. The other de-gassed cation conductivity analyzer will be a shared analyzer that will have capability of analyzing the Common sampling points as indicated in the table above. Each shared sample line shall be routed to the shared analyzer via a manual three-way valve.

Sample lines and valves shall be designed and fabricated in accordance with temperature and pressure requirements of systems from which they originate. The sampling and delivery piping, sample coolers, turbine, valves and the sampling sink shall be of stainless steel construction to minimize corrosion. Sampling and delivery piping shall be routed to prevent pockets or low points. Blowdown from the sample analysis system shall be directed to the boiler blowdown system for disposal. Steam sample connections shall be drawn with isokinetic sample probes.

5.2.23 Fire Protection System

Contractor shall provide two new 300,000 gallon fire water storage tanks and fire pumps for coverage of Currant Creek 2 in accordance with NFPA 850. This is in addition to the specified new raw water storage tank. As an alternative, the Contractor may delete the specified raw water storage tank and substitute for this additional raw water storage capacity in the two fire water storage tanks. In that case the tanks shall be designed with separate suction levels for the two services to ensure that 300,000 gallons per tank is reserved for exclusively fire water service. The Contractor shall provide a complete fire protection system that includes Currant Creek 2 distribution system, CO_2 systems, FM 200 systems, portable fire extinguishers, fire detection, alarm, actuation, and signaling systems. The fire water system capacity shall be based on providing a 2-hour supply at least equal to the greater of the flow rate required for the largest fixed fire suppression system demand or any fixed fire suppression system demands that could be reasonably be expected to operate simultaneously during a single event plus hose stream demand of not less 500-gpm and incidental water usage for non-fire protection purposes. The Contractor shall provide full sized valved piping connections between the new Currant Creek 2 and existing Block 1 distribution systems but shall not be responsible for fire protection performance related to the cross feeding of the new and existing fire protection systems.

All fire protection systems and components shall be designed and supplied in accordance with the appropriate recommendations and requirements of NFPA, UL, FM, and the local Fire Marshall. The systems shall receive the approval of the Owner's insurance carrier.

Fire protection systems provided under these specifications shall be done in accordance with the following codes and standards. Unless otherwise specified, the applicable governing edition and addenda to be used for all references to codes or standards specified herein shall be interpreted to be the latest edition in effect at the date of this document. If a code or standard is not jurisdictionally mandated, then the current edition and addenda in effect at the date of this document shall apply:

Work	In Accordance With
Overall design	NFPA, AHJ, and applicable codes
Fire detection system equipment components	NFPA, FM*, UL*, ANSI, ASME, ASTM, NEMA, IEEE, AWS, AWWA, and DOT
Smoke detection	NFPA 70, 72, 90A, and 850
Heat detection	NFPA 70, 72, and 850
Manual pull stations	NFPA 70, 72, 101, and applicable codes
Indicating devices	NFPA 70, 72, and 850
Sprinkler system	NFPA 13 and 850
Water spray fixed system	NFPA 15 and 850
Control panel initiating and indicating devices	NFPA 70, 72, and 850
Deluge piping	NFPA 1, ASTM A53 or A106
Pipe thread tolerances	NFPA 13 and ANSI B1.20 Pipe Threads
Foam system	NFPA 11, 11A, 11C or 16
Foam pressure proportioner tank	ASME Section VIII
FM-200 system	NFPA 70, 72, 2001; UL; FM

Work	In Accordance With
CO_2 system	NFPA 12, 70, 72 and 850; UL; FM
Water mist system	NFPA 70, 72, and 750; UL; FM
Fire hydrants	NFPA 24, 291, FM, UL Standard 246
Extinguishers	NFPA 10
Hose systems	NFPA 14
Rotating lights and site fire alarm warning horns	UL, NFPA 70 and 72
Fire alarm system wiring (initiating devices, notification appliances, solenoids, signaling line circuits)	NFPA 72, AHJ, and applicable codes
Wiring and installation work	National Electrical Code
*Equipment supplied shall be listed by Underwriters Laboratories Inc. (UL) or shall be included in the Approval Guide as published by Factory Mutual (FM) Engineering. Equipment shall be considered as FM-approved only if it conforms to the characteristics and limitations of the individual component approvals and if those components are used in the service intended by the Approval Guide.	

Any conflict between referenced codes or standards, or between the standards and these specifications, shall be referred immediately to the Owner who shall determine which standard or specification requirements shall govern.

The engineer responsible for the fire protection system shall be a practicing fire protection engineer registered as a Professional Engineer in the State of Utah. All drawings and specifications shall be signed and sealed by the Professional Engineer.

Fire Pumps shall be UL listed/FM approved and designed in compliance with NFPA 20 and 850 recommendations.

The underground fire main shall be a minimum of 12 inches in diameter and shall supply fire water throughout the Currant Creek 2 generation plant area. The fire main shall be looped and shall supply water to fire hydrants, hose stations and fixed water suppression systems installed in buildings and elsewhere around the plant. Provide fire hydrants at a maximum of 250-foot spacing and protective ballasts around all hydrants.

The fire minimum protection and detection systems requirements for specific plant locations are summarized in Table 5-2.

Fire protection during plant construction shall meet the requirements of NFPA 241. All fire protection systems shall be subject to review and approval of the local fire department authorities.

Fire walls, if required in Table 5-2, shall be in accordance with NFPA 221 and NFPA 850. All fire water piping and components that are exposed to freezing conditions shall be freeze protected and all underground fire protection piping shall be below frost depth.

Portable CO_2 and dry chemical fire extinguishers shall be provided in all areas requiring handheld fire protection.

All local alarm, detection and suppression panels shall report status to the main fire alarm panel located in the control room. All alarms shall be indicated in the control room, as well as locally and as required by Code.

In addition to the other requirements, the following minimum fire protection system features are to be incorporated into the design of the plant:

1. Oil Filled Generator Step-up and Auxiliary Transformers
    - A. Transformers shall be provided with oil containment and drainage to the plant oily water separator sized to accommodate the fixed fire suppression system and fire hose demand for 10 minutes plus the oil volume. Drain lines shall be provided with normally closed manual drain valves.
    - B. Transformers less than 50 Ft from buildings and other major equipment shall be provided with fire walls and automatic deluge system.
    - C. Fire walls shall be used between adjacent GSU and auxiliary transformers.
2. Steam Turbine Generator
    - A. Steam turbine lube oil tank/console shall be provided with automatic deluge system.
    - B. Steam turbine lube oil tank/console area shall be provided with oil containment and drainage to the plant oily water separator.
    - C. Steam turbine generator bearings shall be provided with automatic preaction spray system. Preaction spray system shall be designed to spray the bearings and the under deck area below the bearings, all horizontal lube oil piping and the hydraulic oil tank, where oil can accumulate.
    - D. Under deck area below the bearings shall be provided with containment and drainage to the plant oily water separator.

E. Steam turbine underfloor (between ground floor and mezzanine floor and between mezzanine floor and operating floor) provided with automatic sprinkler system.

3. Buildings

A. All electrical rooms shall be provided with automatic FM 200 system.

4. Fuel Gas System

A. Gas detectors shall be provided for areas with non odorized fuel gas.

B. Duct burner management systems shall meet the requirements of NFPA 85 and of the NEC code.

TABLE 5-2

Plant Fire Protection and Detection Systems

Plant Location	Type of Fire Protection	Fire Detection
Water treatment / chemical storage buildings	As required per building code	As required per building code
Chemical Feed Shelters	Handheld extinguishers or as required per building code	As required per building code
Sample analysis / CEM enclosure / PDS	Handheld extinguishers or as required by the local fire marshal.	Smoke/heat detectors
Boiler Feed Pump Enclosure	Handheld Extinguishers or as required by the local fire marshal.	Smoke/heat detectors
Steam Turbine Building		
Steam turbine lube oil tank and lube oil piping Steam turbine and generator bearing housings Hydraulic oil tank Underfloor areas	Fixed, automatic, dry-type, open head, deluge system Preaction Preaction Fixed, automatic, dry-type, open head, deluge system Automatic Sprinklers	Smoke/heat detectors Heat detectors Heat detectors Heat detectors Smoke/heat detectors
Main (Generator Step-up) and station service transformers	Provide fire walls and automatic deluge system if located within 50 feet of other facilities, between adjacent GSU & auxiliary transformers or other major equipment	Fire walls
Gas turbine generator	CO_2 system supplied by the CTG manufacturer	Supplied by the CTG manufacturer
Switchyard control building.	Handheld extinguishers or as required by the local fire marshal.	Smoke/heat detectors
Cable spreading vault/room	FM 200	
Gas Metering Building		Natural Gas Detection

5.2.24 Potable Water System

Contractor shall tie the Currant Creek 2 potable water system to the existing Block 1 water treatment plant. Provide a potable water system for Currant Creek 2 to distribute potable water to various users located around the generation plant. Areas requiring potable water include various chemical storage areas and battery rooms requiring eyewashes and or showers around the plant. The operating pressure shall be controlled between 60 and 90 psig. Drinking fountains shall be included. The maximum potable system demand shall be determined in accordance with the Uniform Plumbing Code for the fixtures and shall include a 30-gpm allowance for eyewash stations and safety showers.

The potable water system shall be designed to provide potable water, both hot and cold as required, at the proper pressure, temperature, and flow rate to all plumbing fixtures and equipment. All instrumentation shall be controlled by the DCS. Potable water piping shall be insulated as required.

Potable water booster pumps shall be provided to supply the Currant Creek 2 potable water system.

Provide back flow preventers on all service water branches off the potable water system.

Provide safety showers and eyewash station at all chemical storage locations, ammonia storage locations, in the battery room, at SCR ammonia injection skids, and otherwise where emergency showers are required per OSHA and where normally installed in a combined cycle power plant. Safety shower system shall be designed and constructed to meet OSHA requirements. Water supplied to the safety showers and eyewash stations shall be tepid per ANSI Z358.1 guidelines. Provide thermal relief valves on all safety showers and eyewash stations. Provide flow switches on all eyewash stations and safety showers. These flow switches shall alarm in the control room when flow is detected.

5.2.25 Raw Water System

Contractor shall provide a raw water system. Raw water to new Raw Water Storage Tank shall be furnished from the Owner's well pumps. Raw water storage tank shall be sized for 5 days of raw water and service water use less usage for cycle makeup water treatment. The system shall include two 100 percent Raw Water Pumps to provide service water. Raw Water Storage Tank shall be provided with level controls. Water level shall be indicated locally and transmitted to the DCS. The system shall be provided with flow meter, backflow prevention, control valves and all controls necessary for satisfactory operation.

5.2.26 Process Bulk Gas Storage and Distribution System

The process bulk gas storage and distribution system described in this section is for use in the plant process systems and is in addition to the CO_2 fire protection system provided with the CTG or any other CO_2 fire protection systems provided at the request of the local fire marshal.

All process bulk storage systems shall be located under cover for sun protection.

The hydrogen storage and distribution system shall be provided to supply hydrogen for generator makeup during normal operation and for initial filling. Hydrogen will be stored in cylinders mounted on a mobile trailer to be provided by Owner's hydrogen supplier. Contractor shall provide a hydrogen storage trailer pad sized for two trailers. Contractor shall coordinate the design of the hydrogen storage system with the Owner's hydrogen supplier, install the complete system, including foundations and utility requirements, ready to receive the hydrogen gas and shall commission the complete system. Location of the hydrogen storage pad shall meet OSHA and NFPA requirements including blast walls installed between the hydrogen trailer and the occupied area of the plant to minimize personnel and/or equipment damage in the event of an explosion.

Contractor shall provide a bottled carbon dioxide distribution system to supply carbon dioxide for purging the generator casing to remove air and hydrogen during outages to prevent an explosive hydrogen mixture. Carbon Dioxide will be stored in cylinders mounted on a mobile trailer to be provided by Owner's carbon dioxide supplier. Contractor shall provide a carbon dioxide storage trailer pad sized for two trailers. Contractor shall coordinate the complete design of the carbon dioxide storage and distribution system with the Owner's carbon dioxide supplier, install the complete system ready to receive the carbon dioxide gas and shall commission the complete system with assistance as required from Owner's carbon dioxide supplier. The bottle storage trailers for Block 2 shall provide sufficient storage for four gas turbine generator purges. The Contractor shall provide a sun shelter over the bottle storage trailers.

Storage racks, manifolds, and pressure regulating stations for nitrogen gas bottles and an on-site nitrogen generator shall be provided and installed at each HRSG for the supply of nitrogen inerting gas. The on-site nitrogen generator shall be sized to fill the gas storage bottles within a 24 hour period. The combined generator and storage system for each HRSG shall have sufficient capacity to adequately blanket a wet HRSG within 4 hours.

Nitrogen may also be supplied to the closed cooling water system head tank for pressurization as necessary for the Contractor's design. If required for other than long-term lay up of equipment, Contractor shall provide permanent facilities for Nitrogen storage.

Pressure control units shall be provided to regulate gas flow to meet system capacity requirements and satisfy minimum inlet pressure requirements at each user. The system design pressures upstream of the pressure control valves shall be equal to the storage systems design pressure. The header pressure of each bulk gas system shall be monitored on the plant DCS. Provide relief valves downstream of the pressure control valve as required to protect the piping from a regulator failure.

5.2.27 Wastewater and Water Discharge Collection and Transfer System

The wastewater and water discharge collection and transfer system shall be provided to collect, treat, and dispose of the facility wastewater and water discharge streams including the following:

1. Sanitary wastewater.
2. Oily water discharge.
3. Gas turbine water wash.
4. Process water discharge.
5. Water discharge and wastewater to holding and evaporation pond(s), respectively.
6. Water discharge to Currant Creek.
7. Chemical wastewater.

All waste and water discharge lift stations shall be open concrete sumps covered with solid dust tight covers. Sump pumps shall be installed in 100 percent capacity pairs.

Sump pumps shall be vertical sump pumps with the motor installed above the sump solid dust tight covers.

Sanitary Wastewater

The sanitary wastewater shall be collected from the various points of origin in the facility and disposed of in the existing drain field septic system. Contractor shall confirm whether existing Block 1 facilities are adequate for the addition of Block 2. The system shall be sized to meet the requirements of local code. A pumped system shall not be used unless a gravity system is impractical. Contractor shall tie into the existing Block 1 system as required.

Oily Water Discharge

Plant water that has the potential for oil contamination shall be collected and routed through an oil/water separator. An oil/water separator shall be provided in accordance with the following paragraph:

Oil/water separator shall be a double-wall vessel in accordance with API 421 standards and UL 58. Separator shall include sufficient corrosion protective coatings or shall be fiberglass and shall be provided with a minimum of two manways for access to the front and back portions of the separator. Extend manways to grade and provide gasketed covers. Design internal components requiring maintenance to be removable from the manways. Provide separator capable of removing entrained oil to a maximum instantaneous concentration of 10 ppm or as required by the plant permits, whichever is more stringent, and hardwired to the DCS if historical data archiving and/or trending is required by the permit. Provide level probe and high level switches and interstitial leak detection devices between the vessel walls. This system shall be designed so that a vacuum truck can remove separated oily waste.

CTG Water Wash

The CTG water wash system shall be provided with two (2) concrete sumps, one for each CTG, sized to contain the wastewater from two complete CTG water wash cycles. The system shall be provided with connections and designed for vacuum truck removal of wastewater.

Process Water Discharge

Process water discharge including blowdown from the water treatment system, RO reject from the cycle makeup treatment system, oil/water separator, and evaporative cooler shall be routed to wastewater and water discharge sumps based on the ability of each stream to meet the site discharge requirements. The sumps containing water that, when discharged from the existing evaporation pond basin, is acceptable for discharge to Currant Creek shall be gravity fed to one of the existing evaporation basins selected by the Owner. This basin shall be modified by addition of a "controlled" overflow, including quality monitoring and emergency shutoff, which shall gravity flow to a Discharge Structure at Currant Creek. The sumps containing water that is not acceptable for discharge to Currant Creek shall be gravity fed to one of the existing evaporation basins selected by the Owner. Contractor shall provide all facilities required for the collection, transfer, control and discharge, including the outfall structure at Currant Creek, for the process water discharge.

The Contractor shall include provisions in the design of this system to drain the process water storage tanks to the existing evaporation basins. Discharge of this water to Currant Creek shall be monitored and controlled in the same manner as all wastewater.

HRSG blowdown shall be drained to a collection sump and recycled to the cycle makeup treatment system. Hot process drains shall be cooled before introduction into the hot drain system. Hot drain piping shall be designed to accommodate temperatures up to 212°F.

The plant water discharge shall be monitored and measured as required by the plant water discharge permits and all applicable federal, state, and local codes. Provisions shall also be made to provide grab samples. Provide sample connections on the water discharge piping to each pond to facilitate the collection of grab samples. All other waste streams shall be directed to the locations indicated above.

Water Discharge

The Contractor shall be responsible for the location, design and construction of the water discharge overflow structure at the existing "Holding Pond", discharge pipe and the Discharge Structure at Currant Creek.

The water discharge pipe, from the existing holding pond, shall be routed to the South on the Owners property until it intersects with the Cow Lane County Road right-of-way. The routing shall cross under Cow Lane County Road and then turn to the East and follow the existing Cow Lane County Road, within the road right-of-way, until it reaches the intersection of Cow Lane Road and Mona Goshen Road. The line shall turn South-East along Mona Goshen Road, follow Mona Goshen Road, within the road right-of-way, until it reaches a point near the existing arch culvert which carries Currant Creek under Mona Goshen Road. Hansen, Allen & Luce Inc. Drawings G-2 and PP-1 thru PP-9 are provided in Appendix "C". These drawings, which were prepared for the installation of an existing raw water line serving the Currant Creek Plant, are provided to show a "general" route for the water discharge pipe, however, the Contractor shall be responsible for development of the final routing.

A discharge structure shall be located at a point where the water discharge can be fed into the Currant Creek stream bed or an existing feeder ditch which will carry the water to the stream bed. The discharge structure and associated appurtenances and improvements shall be located, designed and constructed to meet all permitting requirements.

During the installation of the water discharge line, care shall be taken to avoid all "thrust blocks", air release valves and other pipe line appurtenances associated with the existing raw water line. The Contractor shall be responsible for replacing all fencing, driveways, and/or other existing facilities encountered during the installation of the water discharge pipe.

All pipe materials and installation shall be in accordance with Article 5.3 Plant Piping.

<u>Chemical Wastewater</u>

All chemical tanks and totes shall be provided with containment to prevent contamination due to chemical leakage. All containment areas shall be sloped to drain to a sump. Sumps shall be sized to adequately contain the collected runoff and shall include "duplex" sump pumps for removal of collected wastewater.

HVAC systems shall be designed to maintain the indoor conditions listed in the table shown below based on the maximum ambient temperatures.

Building/Area	Outdoor Ambient Design	Indoor									System Configuration
		HVAC Design Temperature		Humidity Control (percent RH)	Ventilation Rate Based on a 12F rise	Particulate Filtration Efficiency (percent)	Pressuri-zation	Redundancy (Note 4)	Noise Criteria		
		Winter (F)	Summer(F)								
Steam Turbine Building – Below Operating Floor	Note 1	45	104	None	21	None	None	Multiplicity	Backgro und		Heated and Ventilated for Equipment requirements
Steam Turbine building – Above Operating Floor	Note 1	45	104	None	6	None	None	Multiplicity	Backgro und		Heated and Ventilated for Equipment requirements
Aux Boiler Building	Note 1	60	104	None	Minimum 6 ACH	None	None	Multiplicity	85 dba		Heated and Ventilated for Equipment
Electrical Equipment Area, Sample Analysis Shelters	Note 1	72	75	30-65	N/A	High/Low	Positive	2 x 100 percent	NC 45		AC for equipment requirements
Battery Room	Note 1	60	Note 2	N/A	As required For 2 percent hydrogen Dilution	None	Negative	2 x 100 percent	85 dBA		Heated and ventilated for equipment requirements. Explosion-proof construction
Electronics Room	Note 1	72	75	30-65	N/A	High/Low	Positive	2 x 100 percent	NC 45		AC for equipment requirements
Water Treatment Building	Note 1	60	Note 2	N/A	Minimum 5 ACH	None	None	None	85 dBA		Heated and ventilated for equipment.

Building/Area	Outdoor Ambient Design	Indoor								System Configuration
		HVAC Design Temperature		Humidity Control (percent RH)	Ventilation Rate Based on a 12F rise	Particulate Filtration Efficiency (percent)	Pressuri-zation	Redundancy (Note 4)	Noise Criteria	
		Winter (F)	Summer(F)							
Chemical Storage	Note 1	60	Note 2	N/A	Note 2	None	None	None	85 dBA	Heated and ventilated for equipment.
Instrument Shop & Prefabricated Electrical Enclosures	Note 1	72	75	30-65	N/A	Medium	Positive	None	NC 45	AC for personnel comfort and equipment requirements
CEMS Shelters	Note 1	72	75	30-65	N/A	Medium	Positive	2 x 100 percent	NC 45	AC for personnel equipment requirements
Boiler Feed Pumps Building	Note 1	60	Note 2	N/A	Minimum 5 ACH	Medium	None	None	85 dBA	Heated and ventilated for equipment
chemical Feed Shelters	Note 1	60	Note 2	N/A	Minimum 5 ACH	None	None	None	85 dBA	Heated and ventilated for equipment.
Offices (outside of admin area)	Note 1	72	75	30-65	N/A	ASHRAE STD-62	Positive	None	NC 45	AC for personnel comfort and equipment requirements

Notes:

1. 1997 ASHRAE Fundamentals, 1 percent summer/99 percent winter for Salt Lake City, UT.
2. Indoor temperature is the greater of the following: Ambient temperature plus 10F or the equipment temperature limit.
3. Evaporative "swamp" cooler shall be designed for a minimum of 85 percent effectiveness.
4. Redundancy is included to specify the amount of redundancy required (e.g. 2x100 percent requires a primary system with a 100 percent back-up system and None requires only a primary system). Redundancy does not specify the number of units required to accomplish the intended duty. However, unless approved otherwise by the Owner, a maximum of three air-conditioning units shall be used to accomplish any single application for which no redundancy is specified and a maximum of four air-conditioning units shall be used to accomplish any single application for which redundancy is specified. Multiplicity means that more than one partial capacity ventilation device shall be used.

5.2.28 Heating, Ventilating, and Air Conditioning System

The heating, ventilating, and air conditioning (HVAC) systems for the plant shall satisfy the workspace environmental requirements for personnel occupancy and equipment operation. Temperatures shall be maintained well below operating limits so that equipment reliability will not be jeopardized.

The ambient design conditions for the HVAC Systems shall be selected by the Contractor based on ASHRAE data for the plant location.

The design table indicates the level of redundancy for HVAC equipment in the indicated areas. When redundancy is indicated, only the major active components require backup equipment. Static components such as ductwork do not require duplication.

Minimum ventilation rates shall be provided in normally occupied areas in accordance with local codes. In the absence of applicable local codes, ASHRAE Standard 62 requirements will be met.

The air conditioning for control and electrical equipment shall be designed to meet the filtration levels indicated in table shown below. Tabulated filtration levels are indicated as low, medium, or high. These levels are according to the following filtration efficiencies as defined by ASHRAE Standard 52, Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter:

Level	Efficiency (percent)
High	80 to 90
Medium	55 to 65
Low	Less than 20

Noise criteria are indicated in the design table as NC levels, decibels, or as background. Noise criteria (NC) values are as indicated in the ASHRAE Handbook series for acoustical design criteria. Decibels are sound pressure levels, A-weighted, to a reference of 0.0002 microbar (0.00002 Pa), at 5 feet (1,500 mm) from the equipment as measured in a free field with a single reflecting plane. Background indicates that the HVAC equipment will be designed such that the contribution shall be 2 dB or less than the overall room noise at 6 feet (1,800 mm) above the floor with normal plant equipment in operation.

Mechanical equipment rooms containing refrigerants will be designed in accordance with the requirements of ASHRAE Standard 15, Safety Code for Mechanical Refrigeration.

A minimum of five air changes per hour of ventilation or recirculation air will be provided for effective mixing during heat removal ventilation or air conditioning.

Laboratory design ventilation rates shall be based on local codes. If local codes are not available, ASHRAE STD-62 will be used.

Maximum design temperatures represent the average building temperature. Cooler temperatures may occur near the ventilation inlets and higher temperatures may occur at relief and exhaust points.

The indoor temperature design conditions in the control building and electronics enclosures shall be in accordance with equipment operating requirements. The indoor and outdoor design temperatures in non-process areas shall comply with applicable local energy code requirements. As a minimum air-conditioning systems be designed to maintain and indoor temperature of 70 degrees F. Heating systems shall be designed to maintain comfortable space temperatures during normal winter plant operations

Ventilation systems shall be designed to provide adequate ventilation air to dissipate the excess heat developed by the plant equipment and components during plant operations. Ventilation systems for chemical storage areas shall be designed in accordance with Industrial Ventilation Standards to keep chemical concentrations in the air within acceptable limits.

The battery room ventilation system capacity shall be based on limiting the maximum hydrogen concentration to 2 percent or less of the total battery room volume while maintaining an acceptable internal temperature. Battery room air shall be exhausted continuously by a spark-proof exhaust fan (with a spark-resistant fan wheel and explosion-proof motor) to maintain a low level of hydrogen concentration. Provide a hydrogen detector for the battery room and connect to the DCS, either directly or through the fire detection system.

Air velocities in ducts and from louvers and grills shall be sufficiently low so to maintain acceptable noise levels in areas where personnel are normally located. Roof ventilators shall be low noise type to minimize impact of plants overall noise emissions.

Thermal insulation with vapor barrier shall be provided on ductwork surfaces with a temperature below the dew point of the surrounding atmosphere to prevent vapor condensation. All ductwork used for air conditioning purposes shall be insulated: ductwork used for ventilation purposes shall not require insulation.

Exhaust systems shall be provided for toilet and shower areas. Outdoor ventilation air shall be based on normal room occupancy or local codes, whichever is more stringent.

5.3 PLANT PIPING REQUIREMENTS

5.3.1 General Requirements

This criteria covers the requirements for the design, fabrication, installation, and protection of all plant piping. Contractor shall be responsible for the mechanical design of the piping system, pipe stress analysis, and pipe supports. Upon request, all design criteria and calculations shall be provided to Owner for review.

All piping shall be designed, fabricated, installed, examined, and tested in accordance with applicable local codes and the applicable sections of ANSI B31.1 for power piping, B31.3 for fuel piping, and the ASME Boiler and Pressure Vessel Code, Section I for critical boiler related piping

Process pipe sizing shall be based on the following factors:

1. Maximum line velocity as defined in Tables 1 and 2 of Subsection 5.1.2, Piping.
2. Piping layout and configuration.
3. Economic evaluation considering piping material cost and pumping energy costs.
4. Quality of material handled (clean, sedimentation, other).
5. System operation (continuous or intermittent).
6. Minimize flashing, noise, vibration, water hammer, deflection, and erosion over the full range of operation, including startup and shutdown.

7. Minimum pipe size shall be 3/4 inch, except for connections to equipment. Pipe sizes 1-1/4 inch, 3-1/2 inch, 5, 7 and 9 inch shall not be used except for connections to equipment.

All potable water piping shall be sterilized in accordance with AWWA standards for disinfecting purposes prior to filling.

Run all lines parallel to building lines and equipment centerlines. Group parallel lines to the greatest extent possible for support from a common pipe support system.

General service piping shall be installed with north/south runs at one elevation and east/west runs at another elevation. Where change in direction occurs a minimum of 1 foot 6 inches (3 feet on lines above 6-inch NPS) elevation change shall be provided. Exceptions to this requirement will be allowed on the main steam piping (HP steam, Hot Reheat, Cold Reheat, and LP steam.)

Provide sufficient unions and flanged connections to permit dismantling of equipment, automatic valves, and instruments for routine maintenance.

Slope all vent lines and gravity drain lines to provide a minimum of 1/8 inch per foot slope in the direction of liquid flow.

Pump suction and discharge piping shall be at least one pipe size larger than pump connection. Provide spool pieces between pump and isolation valves to permit removal of the pump without removing block valves. Install eccentric reducers with flat side on top at all pump suctions. Do not install pockets in piping on pump suction that would traps liquids. Pump suction piping shall be in accordance with Hydraulic Institute recommendations.

Provide steam drain assemblies at all pocketed low points, at dead ends, and at intervals along main steam lines to be determined by Contractor to ensure adequate condensate removal during system warm-up and compliance with ASME TDP-1.

Provide spare valved instrument air taps on instrument air line a minimum of every 20 feet where instrument air headers are routed through or along equipment. Provide valved taps every 50 feet in general pipe rack runs.

Provide service air and water hose stations within 100 feet of all areas around the plant that may require air or water for maintenance or washdown. Route 1-inch minimum lines to the hose stations. Terminate all hose stations with a quarter turn ball valve and "Chicago type" hose coupling.

Provide plugs or caps in all valved connections open to the atmosphere.

All lines filled with a liquid that could freeze under extended shutdowns which are not freeze protected as required in the Insulation and Jacketing section of these Specifications shall be designed and provided with sufficient drains and vent valves to allow fully draining as a means of freeze protection. Drains and vents on such piping shall be designed to be safely accessible from grade or elevated platforms.

All above ground piping shall be metallic unless specifically approved by the Owner. Above ground pipelines 2-1/2 inches and larger shall be provided with an identification system indicating the pipe contents and direction of flow. The identification system shall be easily visible and readable from floors or platforms. The system used by the contractor shall be approved by the Owner.

The exterior of exposed carbon steel piping that is not insulated or galvanized shall be cleaned and painted.

Piping shall be carried on overhead pipeways, sleeperways, or lined trenches. Space for electrical and instrument conduit runs shall be provided on the pipeways and sleeperways as required. Space for electrical and instrument conduit runs shall be segregated to eliminate electrical interference.

All pipe routing, including field routed pipe and instrument tubing, shall allow for unobstructed maintenance access to all plant equipment including removable access panels and roof covers.

Piping shall not be installed above, or within a horizontal distance of 3 feet (1 m) from, electrical equipment such as switchgear, switchboards, control panels, motor controls, contactors, communication equipment, batteries, battery chargers, and motor generators unless written consent of the Purchaser is obtained. Improperly located piping shall be removed and relocated.

All branch piping shall be provided with shutoff valves at the main headers.

Valves shall be installed in such a manner that they can be operated from the main operating floors or platforms without the use of ladders or special operating devices.

Pipe runs that require condensate drainage shall be installed so that they pitch toward the point of drainage.

Piping subject to freezing shall not be routed in the vicinity of large doors which could be open for the moving of mobile equipment or maintenance.

Where building expansion walls are anticipated, piping shall not be supported from or located on columns or beams on these walls.

Piping indicated on P&IDs or other drawings as having a connection for the future extension of the piping to another unit shall be routed to a convenient point along the column row adjacent to the unit or the location for a future unit.

Underground metallic piping shall be provided with corrosion protection based on the recommendation of a certified corrosion engineer for the piping material and measured soil resistivity. Underground piping shall be routed following designated corridors, rather than the shortest path. The firewater loop piping and potable water piping shall normally be routed underground. All underground piping shall be provided with brightly colored marking tape installed per manufacturer's recommendations along entire length of pipe with colors and markings appropriate for its service. Non-metallic piping shall utilize metal detectable marking tape.

Condensate, feedwater, and steam lines shall not be installed below grade.

5.3.2 Piping Classes

The Contractor shall furnish specifications identifying the piping classes for the major systems. The class description shall include service description, pressure/temperature rating values and materials, descriptions, types, and ASTM specifications for fittings, flanges, branch connections, welding, gaskets, bolting, pipe, and bends.

A general listing of minimum piping materials that shall be used for each service is provided in the following table. To the extent that there is any conflict between the piping materials listed below and any other provision of these Specifications, except code, the piping materials shall have priority. Contractor is responsible for ensuring the materials specified are suitable for the intended service and shall substitute higher quality materials where required to meet the intended service life of the plant. All substitutions shall be approved by the Owner.

PIPING MATERIALS		
Service	**Media**	**Material**
Ammonia	Aqueous Ammonia	ASTM Type 316 SS
Boiler Blowdown	Treated Water	ASTM A53 GR. B or A106 Gr. B or Alloy Piping as required for the application, SMLS
Chemical Treatment Acid Piping	Sulfuric Acid	ASTM B464 UNS N08020, Alloy 20, Fully Annealed, SMLS with a hardness of Rb95 or less.
Closed Cooling Water	Treated Glycol Solution	Above Grade: ASTM A53 GR. B or A106 Gr. B., ERW or SMLS Below Grade: ASTM D1248, D3350, & F714, HDPE per ASTM D3350 class 345434C.
Compressed Air Piping	Air	ASTM A312-TP304, Fully Annealed, Stainless Steel or ASTM B88 Hard Tempered (Soft annealed if used with ferrule tube fittings), Type K, Copper
Compressed Air (Instrument tubing)	Air	ASTM A213, Type 316, Fully Annealed, SMLS, Stainless Steel with a hardness of Rb80 or less or ASTM B75, Soft Annealed, SMLS, Copper Fittings to be flareless type or Victaulic Stainless Steel Pressfit piping system.
Condensate	Water	ASTM A106 Gr.B, SMLS.
Demineralized Water	Water	Above Grade: ASTM A312-TP304L, seamless, Fully Annealed, Stainless Steel Below Grade: ASTM D1248, D3350, & F714, HDPE per ASTM D3350 class 345434C
Drains – Cold	Water	ASTM D1248, D3350, & F714, HDPE per ASTM D3350 class 345434C
Drains – Hot (Below Grade) including services having the potential to be "hot" in the event of a failure	Water	Wrapped Carbon Steel, ASTM A53 Gr. B or A106 Gr. B ERW or SMLS, or Ductile Iron, AWWA C151, Soil Pipe, Mechanical Joints
Feedwater	Water	ASTM A106 Gr.B, SMLS.
Firewater	Water	Above Grade: ASTM A53 GR. B or A106 Gr. B, ERW or SMLS, Galvanized Below Grade: ASTM D1248, D3350, & F714 High Density Polyethylene (HDPE) per ASTM D3350 class 345434C and Factory Mutual Approved for 200 psig W.W.P.

PIPING MATERIALS		
Service	**Media**	**Material**
Lube Oil, seal oil (Supply Piping)	Oil	ASTM A312 GR.B, TP 304 H, SMLS, Stainless Steel
Natural Gas	Natural Gas	Upstream of Filter Separator ASTM A106 Gr.B, SMLS Downstream of Filter Separator ASTM A312-TP 304 L, SMLS, Stainless Steel
Potable Water	Water	Above Grade: ASTM ATP316L - SMLS, or B88 Type K Copper tube. Below Grade: HDPE pipe suitable for potable water. ASTM D1248, D3350, & F714, HDPE per ASTM D3350 class 345434C
Raw Water	Water	Above Grade: ASTM A53 GR. B or A106 Gr. B ERW or SMLS, 2-inch diameter and less to be Galvanized. Below Grade: ASTM D1248, D3350, & F714, HDPE per ASTM D3350 class 345434C.
RO Water/Evap Cooler Makeup	Water	Above Grade: ASTM A312-TP304L, seamless, Fully Annealed, Stainless Steel Below Grade: ASTM D1248, D3350, & F714, HDPE per ASTM D3350 class 345434C
Sample Tubing & General Chemical Tubing	Steam & Condensate Samples and General Chemicals	ASTM A213, Type 316, Fully Annealed, SMLS, Stainless Steel with a hardness of Rb80 or less (Samples over 800F shall use Type 316H stainless steel tubing)
Sanitary Waste	Sanitary Waste	Cast-Iron Soil Pipe, Hub & Spigot or ASTM D1248, D3350, & F714, HDPE per ASTM D3350 class 345434C. ASTM D1785 PVC pipe.
Steam	Steam	Seamless Steel or Seamless Alloy Piping as Required for the Application
Wastewater or Water Discharge	Wastewater or Water Discharge	Above Grade: ASTM A53 GR. B or A106 Gr. B, ERW or SMLS Below Grade: ASTM D1248, D3350, & F714, HDPE per ASTM D3350 class 345434C. C151 A21.51 CL 50 Ductile iron pipe.

All tubing shall be free of scratches and suitable for bending and flaring. ASTM B88 copper tubing used with ferrule type connections shall not be embossed on the exterior. Tubing wall thickness shall meet or exceed the recommendations of Swagelok for use with Swagelok tube fittings.

Carbon steel lines 2 inches and smaller shall be schedule 80 minimum. For 2 inch and smaller alloy steel lines, minimum wall thickness shall be calculated based on design conditions. For 2-½ inch and larger, the minimum wall thickness for carbon steel pipe shall be standard weight.

Design pressure of piping systems shall be a minimum 20 psig above the maximum pressure anticipated during operation or 50 psig, whichever is greater. Where piping is directly or indirectly connected to the discharge of a pump, the maximum operating pressure shall be the maximum pump shut-off head. Design temperature of piping systems shall be a minimum of 15^{o}F above and below the maximum and minimum temperatures anticipated during operation.

Include a 1/16-inch corrosion allowance on all carbon steel piping.

Piping 2-½-inch NPS and larger shall utilize butt-welded construction unless flanges a/.re required. Fire water piping does not require butt-welded construction.

Connections to equipment and instruments may be threaded or flanged. All other piping shall be of welded construction, except small bore service water and potable water. Victaulic couplings are allowed on above grade fire protection systems.

All above ground piping shall be metallic unless specifically approved by the Owner.

5.3.3 Line List

During the project design phase the Contractor shall prepare a piping line list showing line number, originating P&ID number, points of origin (i.e. line or equipment), points of destination, classification, size, insulation symbol and materials, flowing media, operating and design pressure and operating and design temperature.

5.3.4 Clearances

Good design practice shall be followed to assure proper clearance between piping equipment and passageways for operation and maintenance. Proper space shall be provided to service control valves and their operators. Special attention shall be given to provide access for cranes or other equipment handling devices. Clearances shall be provided as specified in the Access and Clearances section of these Specifications.

Provide sufficient clearance between lines to permit access for repair or removal. Clearance between pipe and flanges, fittings, or insulation on adjacent pipe shall not be less than 6 inches. Where pipe is insulated, clearance shall be between insulation and flanges, fitting or insulation on adjacent piping.

5.3.5 Piping Stress Analysis

As a minimum, all piping having a design temperature of 250°F or greater shall be subjected to the piping stress analysis.

Piping analyses shall be performed either by computer or by simplified methods as allowed by piping codes and shall consider:

1. Thermal expansion.
2. Deadweight and hydrotest loads.
3. Steam hammer and relief valve thrust.
4. Equipment manufacturer's allowable nozzle loads.
5. Wind load for piping routed outside.
6. Seismic requirements.

The piping flexibility analysis shall be based on a system's design conditions of pressure and temperature encountered during startup, normal operation, or shutdown. To these operating design conditions, industry accepted conservative margins (safety factors) of temperature and pressure shall be added. Also, the analysis shall consider the maximum temperature differential. The effect of installation temperature and solar temperatures shall be considered in determining the maximum temperature differential.

Computer analysis shall be performed on all piping covered by ASME Boiler and Pressure Vessel Code, Section I and all condensate, feedwater, and steam piping 2-1/2 inches and larger. Other pipe stress analysis methods may be used for the analysis of other plant piping systems. The following industry accepted methods can be used: Grinnell, Tube-Turn, Kellogg, Spielvogel, Flex-Anal Charts, Guided Cantilever.

The piping loads at the equipment nozzles shall be limited to equipment manufacturer's allowable loads. If equipment manufacturer's allowable loads are not available, the piping loads shall be limited to the following levels: Cast connections - 50 pounds per nominal inch; forged connections - 200 pounds per nominal inch (not to exceed 2000 pounds). The actual calculated load shall be forwarded to the manufacturer for concurrence.

5.3.6 Pipe Bending

Pipe bends may be used. Carbon steel pipe may be hot bent or cold bent. Field bending of stainless steel pipe will not be allowed. Bending of carbon steel below 1,300° F is considered cold bending. For hot bending, pipe shall be heated to a temperature not exceeding 2,000°F. No hot bending or forming shall be performed at temperatures below 1,650°F. Bending radius shall not be less than five times nominal pipe size unless approved by Owner. Wall thickness of pipe and metallurgy after bending must meet applicable code requirements for specified design conditions.

5.3.7 Pipe Sleeves

All pipes passing through walls, floors, roofs, decking, and grating shall have sleeves provided. Sleeves shall be sized and have clearances to allow for packing and sealant installation. Sleeves shall be 18-gage carbon steel except that sleeves 8 inch and larger shall have ¼-inch minimum wall thickness. Where pipe movement is anticipated or pipe size is subject to change, larger sleeves shall be used. All floor sleeves shall be anchored with lugs or similar devices. The annular space between the pipe and sleeve at wall and floor penetrations shall be packed with fiberglass. Where penetrations are in walls or floors designed for fire separation, special sealants and packing designed specifically for the application and to meet the fire separation requirements as required by the applicable NFPA codes shall be used. Firestopping materials shall be in accordance with applicable ASTM or UL standards.

5.3.8 Dissimilar Metal Joints

In all cases (except for air systems) when a piping connection is made between steel and aluminum or copper, the mating surfaces shall be electrically isolated. For 2 ½-inch and larger piping, flanges shall be used, and the flanged joint shall be made using an electrically non-conducting gasket and flange bolts fitted with plastic ferrules and plastic washers under the bolt heads. Two-inch and smaller connections may be made using flanges, as stated above, or with dielectric type couplings, bushings, or unions.

Electrically isolated joints shall also be employed at all points where above ground piping meets piping from below ground.

5.3.9 Equipment for Plant Start-up

Temporary piping and supports shall be furnished for chemically cleaning the HRSG and steam blowing. The piping that connects to the steam turbine valves shall be turned over to the Owner for future use.

Silencers shall be used during all steam blowing operations to minimize noise. Silencers are not required to be turned over to the Owner.

All pumps shall be furnished with start-up strainers and with the fittings for their easy installation and removal.

5.3.10 Sewer and Underground Piping

The Contractor shall ensure the entire plant Site is adequately and properly drained. Paved plant operating area shall be sloped from high points and catch basins shall be provided for storm runoff where required.

Vessel and other equipment drains shall interconnect with the plant drainage system and not the storm system. Sewers and drain lines shall run in the general direction of collection or disposal without sharp angles or turns. The minimum size of underground drain lines shall be 4 inches. Buried steel lines shall be coated and wrapped for corrosion protection. Cathodic protection and/or coating and wrapping shall be provided for all underground piping such as vessels and metallic equipment in contact with the earth. Cathodic protection methods shall be recommended by a Corrosion Engineer after reviewing the Geotechnical data for the Site and shall be approved by the Owner

5.3.11 Vents and Drains and Manholes

All piping high points shall be vented and all piping low points shall have drains. The minimum vent and drain line size shall be ½-inch or larger as required. Manholes shall be provided as required by final design.

5.3.12 Root Valves

Root valves shall be of standard gate or globe pattern, mounted with stem upright or horizontal, unless otherwise specified. Root valves shall be positioned as follows:

1. Gate valves – stem upright (preferred), or as nearly upright as conditions permit, but in no case below the horizontal.
2. Y-pattern globe valves – stem upright (preferred), or as nearly upright as conditions permit, but in no case below the horizontal.
3. Special valves – including remotely operated solenoid and control valves, shall be mounted in accordance with manufacturers' recommendations.
4. No valve shall be mounted with the stem below the horizontal centerline.

Root valves shall be double blocked in services greater than 600 psig or 800^{o}F.

5.3.13 Root Connections

Root connections on horizontal or sloping lines shall not be located below the horizontal center of the line. The following rules shall be observed:

1. Root connections for service on steam and condensable vapors or wet gas shall be taken from the top or side of the pipe or from any point between the top and the side.
2. Root connections for service on liquids shall be taken only from the side of the pipe, with the root nipple horizontal.
3. Root connections for service on dry gases shall be taken from the top of the pipe.
4. All root nipples shall be as short as possible, in standard lengths. Room shall be allowed for free manual operation of the valve without the hand or fingers coming into contact with the surface of the pipe or its insulation. Root nipples, longer than 6 inches end-to-end shall not be used.

Welded thermowells shall be installed according to code requirements. Threaded thermowells shall be installed in threaded bosses. Thermowells and piping in which thermowells are installed shall be designed specifically for the application to prevent cycling and fatigue of the thermowells.

5.3.14 Fabrication Requirements

Fabrication shall be in accordance with the specified Codes. All piping materials shall be in accordance with good engineering practice and all piping and fittings shall be new and clean.

Fabrication tolerances shall be in accordance with good engineering practice. Tolerances shall cover general dimensions such as face to face, end to end, or end to center. Tolerances shall not be cumulative.

Weld reinforcements shall be held to a minimum and edges shall merge smoothly with the basic metal without undercutting. All repairs shall be made with matching weld metal and edges shall merge smoothly with the basic metal with no undercutting. The welding procedure shall be established by Contractor and submitted for review to Owner and shall be in conformance with applicable codes.

5.3.15 Shop Cleaning

Cleaning of surfaces, which are not to be painted or coated, shall be done according to the supplier's best recommended practice, and it shall achieve the cleanliness level described by the acceptance criteria and the specific requirements described below.

Parts of subassemblies that may have crevices or inaccessible surfaces after assembly shall be cleaned as well as practicable, prior to assembly.

All cleaning operations shall be conducted so that stainless steel and nickel alloys are not contaminated with lead, copper, mercury, and/or other low melting point metal; chlorides, sulfur, halogens, as well as ferritic steel materials.

Abrasive blasting may be used on raw, unmachined casting, forging, or plate only.

5.3.16 Inspection

Contractor shall be responsible for inspection of all fabricated piping material. Owner reserves the right to inspect fabrication at any time. Contractor shall maintain qualified personnel to inspect shop and field fabrication for material specifications, dimensional accuracy, fabrication techniques, and quality.

5.3.17 Protection for Shipment and Construction

All flange faces, machined surfaces, and threads shall be clean and shall be protected from damage during shipment. Flange faces and machined surfaces shall be protected with wood or metal covers. Couplings and threads shall be protected by steel pipe plugs or by plastic protectors. Pipe shall be cleaned and supplied with end caps prior to shipping. All protective coverings and end caps shall be maintained in place until the component is erected and open ends or faces replaced between installation shifts.

5.3.18 Welding

All welding, welding procedures, and welder qualifications shall be in accordance with all applicable and specified Codes. Contractor shall qualify all welders. Each welding procedure shall include a welding procedure qualification test report.

Welding shall not be performed on materials that are below a minimum temperature of 50°F (at the weld-effected zone) and surfaces to be welded shall be free of moisture prior to welding.

The maximum interpass temperature when welding austenitic stainless steel shall be 350°F.

Field butt weld ends on shop fabricated piping and components shall have end preparations dimensioned in accordance with ANSI B31.1 and B16.25. All welding end preparations made in the field shall be in accordance with the requirements stated above.

Integral attachments welded to piping shall be of the same P-number material groups as the piping material. Attachments, which are shown on the piping Drawing or which require post-weld heat treatment shall be welded in the piping fabricator's shop. All other integral attachments shall be welded in the field. Integral attachment on piping having design temperatures of 600°F or higher shall be attached by full penetration welds except riser clamp shear lugs which may be attached with fillet welds.

Backing rings shall not be used in any service.

All root passes on butt-welded steam, boiler feedwater, condensate, and cycle make-up water shall be made using the gas tungsten arc (GTAW) process.

5.3.19 Field Installation

Piping shall be assembled and installed in accordance with the applicable sections of the specified Codes. Contractor shall take special care that the installed piping is free and clear of all foreign materials, construction debris, etc. All welds shall be clean and free of burrs and slag.

Installation and orientation of all gauge glasses, live controllers, thermometers, thermocouples, pressure gauges, and similar items shall be arranged for convenience of operation and ease of maintenance.

Pipe insulation shoes shall be adjusted so that they are centered over pipe supports in the hot position after the line is completely installed and brought into operation.

5.3.20 Pipe Supports, Guides, Restraints, and Anchors

The following requirements shall govern the installation of pipe supports for large bore and small bore piping systems.

General Requirements

All pipe supports shall be installed in accordance with MSS-SP58, MSS-SP69, ANSI B31.1 and B31.3, AISC, and AWS D1.1.

Pipe supports shall be constructed of ASTM A36, ASTM A992, Grade 50, or ASTM A500 carbon steel, or alloy steel components as required by pipe materials or process conditions.

Surfaces to be welded and surfaces up to 1 inch from the edge of the weld shall be clean and free from oil, rust, scale, paint, and other deleterious materials.

Installation of the permanent hangers at the time of pipe installation is required. Hangers shall be installed so that their nameplates are visible and accessible.

All hanger components shall be given a 3-mil prime coat of inorganic zinc paint.

The spacing of hangers and supports for steel piping shall not exceed the values recommended by ANSI B31.1.

All hanger components shall support the piping in the normal operating position and during hydrostatic test, shall allow for the expected expansion or contraction except where anchored and guided, and shall not cause excessive stresses in the piping or excessive loads on the connected equipment.

Standard stock or production parts shall be used where possible. The recommended load ratings and limitations in manufacturer's hanger catalogs shall not be exceeded.

For critical systems accurate weight balance and thermal movement calculations shall be made to determine the required supporting force of each hanger and the limits imposed upon each equipment connection. The weight balance for all hangers shall include the weight of the pipe, fittings, valves, the medium transported, the insulation used, and the suspended portion of hanger assemblies and pipe attachments. Spring hanger assemblies shall be designed to support the piping under normal operating conditions. All hangers and components, however, shall be designed to supporting the piping system during hydrostatic test.

No support shall utilize other piping systems for attachment. Hangers shall not be attached to flange, valve, or equipment bolts or to equipment. Hangers shall be a minimum of 6 inches away (in either a hot or cold position) from any flange and shop or field pipe welds.

Adjustable type pipe supports shall be used at all pump suctions and discharges.

Supports installed on concrete slabs or pads shall be installed on a minimum of 1 inch of grout. Use shims to bring supports to elevation. Jack nuts shall not be used.

Attachments to Piping

Integral attachments shall be used only where non-integral attachments are impractical at Owner's discretion. Where necessary, symmetrically loaded clamps with shear lugs welded to the pipe 90 degrees apart shall be used. Localized stresses, induced by external forces into the pipe wall, shall be analyzed in combination with all existing pipe stresses to ensure that total stress levels are within code allowable values.

Integral attachments shall be of the same P-number material group as the piping.

Non-integral attachments to piping shall be of design and materials suitable for the entire range of operating temperatures of the piping system.

Clamps used as the attachment to piping components in a strut assembly shall have a minimum spring rating equal or greater than five times the strut spring rating.

For insulated lines at 750°F and below, pipe clamp MSS Type 3 or clevis hanger MSS Type 1 with an MSS Type 39 insulation protection saddle shall be used. All voids in the pipe covering protection saddles shall be filled with insulation. Supports on insulated piping shall not penetrate the insulation lagging. For lines with no insulation, pipe clamp MSS Type 3 or 4 or clevis hanger, MSS Type 1 may be used. Riser clamp MSS Type 8 shall be used on all risers.

For lines that are heat-traced and lines that have an operating temperature below 70°F, the use of clamps or attachments in direct contact with the pipe shall be minimized to the greatest extent possible. Except for unusual situations, which require attachments in direct contact with the pipe, the attachments or clamps shall be outside the thermal insulation. For horizontal pipe, the thermal insulation shall be protected by means of pipe covering protection saddles, MSS Type 39, and pipe clamps or clevis hangers sized to fit on the insulation OD. All voids in the pipe covering protection saddles shall be filled with insulation.

Attachments to Structure

Reduction of the effective strength of any structural member shall not be permitted. Structural attachments to steel shall be designed to support the maximum calculated loads. For attachments to the supporting steel on hangers for pipe sizes 2 ½-inches and larger, beam attachments MSS Type 22 shall be used within the limitations of loads. For piping 2 inches in diameter and less, where relatively small movements are expected and where hangers are normally not engineered, MSS Type 23 may be used. Where sliding supports or other integral base attachments are supported on a concrete floor, an anchored or fixed steel base shall be provided as a sliding surface.

Structural attachments should be made to steel whenever possible, whether to structural steel or to steel embedment plates or inserts in structural concrete. When necessary to use drilled-in-place bolts in concrete, only wedge type anchor bolts such as HILTI Kwik-Bolts, or equal shall be used, and the connection shall be carefully designed using the allowable loads including the effect of combined tension and shear loads, spacing, and embedment depths.

No attachments should be made to anything but structures.

Anchors, supports, restraints, and guides shall be designed to prevent the transmission of temperatures in excess of 300°F to building steel and 150°F to concrete. This determination may be made by using a reduction factor of 100°F/inch from the outside surface of the uninsulated pipe for all parts in direct contact with or welded to the pipe.

Spacing

Support points shall be selected on the basis of proper location and spacing for optimum load distribution and weight balance, taking into consideration the available building structure and load distribution from which hangers can be suspended.

The spacing of hangers and supports for steel piping operating at temperature above 750°F shall not exceed the values given in ANSI B31.1. The above maximum spacing figures are applicable to straight piping runs. Additional supports shall be provided for concentrated loads such as valves, strainers, or other in-line items. At changes in piping direction, supports shall be located at, or immediately adjacent to, the change in direction to the greatest extent feasible, and the spacing to the next support beyond the change in direction shall be appropriately less than the maximum spacing of supports permitted for straight piping runs.

Vertical pipe should be supported directly with riser type hangers rather than having the weight of the riser supported by adjoining horizontal pipe.

The maximum support spacing recommendations of the nonmetallic or nonferrous pipe manufacturer shall not be exceeded.

Pipe Support Identification

The Contractor shall submit the pipe support identification system to the Owner for its approval.

Anchors, Restraints, and Sliding Supports

Anchors, guides, and restraints shall be capable of supporting the pipe and resisting dead loads plus any expansion or contraction thrusts that may be imposed by the piping.

Anchors required for expansion joints shall withstand the longitudinal pressure force plus the joint-spring force and sliding friction force. The longitudinal pressure force shall be calculated as the product of the hydrostatic test pressure and the maximum internal transverse area of the joint. Guides for expansion joints shall direct piping movement into the joint within the joint manufacturer's allowable lateral and angular misalignment limits.

Sliding supports and guides shall be designed to withstand the induced friction force in addition to other loads on the support. Dry lubricant surfaces (i.e., Teflon or UHMW) may be used to reduce the friction force. Preformed graphite or carbon shall not be used.

Corners and edges of metal slides and guides in sliding supports shall be rounded or chamfered, and guide parts shall be designed with sufficient length so that binding within the necessary clearance will not occur.

Hanger Rods

Hanger rods shall be sized in accordance with ANSI B31.1. Hanger rod diameters shall be 3/8-inches minimum on 2-inch and smaller pipe and ½-inch minimum on piping 2-½-inch and larger and shall be compatible with the other component parts of the hanger assembly and subjected to tension stresses only. Where horizontal movement is anticipated, the rod shall be fitted with eyes, links, or swivels to permit unrestrained swinging of the rod. Un-welded eye rods shall not be used. Where anticipated piping movement would cause hanger rods to be more than four degrees out of plumb, the hangers shall be offset in the erected position to provide vertical alignment when the piping system is in operation. Hanger rod lengths shall be calculated to provide for at least plus or minus 3 inches of rod adjustment subsequent to hanger erection.

Maximum length of rods shall be 20 feet. Minimum rod length shall be 15 inches for each inch of horizontal movement.

Variable Spring Hangers

All variable spring hangers shall be selected for operation at or about the mid-load range. The length of spring and the spring scale shall be selected so that variation in the supported load due to temperature differences does not exceed 25 percent of the dead load; otherwise, constant support hangers shall be used.

The working range of variable spring hangers shall account for all load movements as well as for thermal movement. A minimum of ½-inch additional travel beyond the maximum and minimum values at the working range shall be provided after final field adjustments.

Variable spring hangers shall be of the enclosed helical, pre-compressed type with the end coils ground flat and square with the spring axis. Travel stops shall be factory installed, so that the piston cap is set at the "cold" position. The travel stop shall be easily identified and removable but shall act as a "rigid" hanger during erection and hydrostatic testing. To avoid misplacement of a travel stop, it shall be attached to the spring unit by means of a cotter pin and chain or equivalent. Variable spring hangers shall be calibrated by a dynamometer and the load affixed to the housing. The unit shall then be adjusted to the proper ambient position to suit the travel it is to accommodate and the position plates locked. The locked unit shall be capable of supporting at least two times the normal operating load. When the loads induced by hydrostatic testing exceed the spring capability, temporary supports shall be installed. Each variable spring hanger shall have a travel and load scale plate, red and white markers to indicate the design hot and cold positions, respectively, and a travel indicator. The red and white markers and the travel indicator shall be easily visible at a distance of not less than 30 feet and visible from the ground or platform. The hanger type, mark numbers, and calibrated load shall be die-stamped on each hanger nameplate.

Adjustment and Locking Devices

All supports shall have screw adjustments accessible and workable when fully loaded. Threaded members shall have a true and complete depth of thread. Nuts, clevises, sleeves, turnbuckles, and related items, shall have their full length of thread in complete service while in use and the amount of male thread available for adjustment plainly visible; sight holes shall be provided for visibility in parts where necessary. Eight pitch series threads will be permitted only when the supplier furnishes both mating parts. All bolts on hangers shall be double-nutted. Hanger rods shall have a locking nut on each end of the turnbuckle.

<u>Inspection</u>

When the piping is being put into service, the hangers shall be inspected by Contractor's qualified inspectors to insure the pipe is moving as intended and is not causing the hangers to deflect against travel stops or exceed load or travel scale.

When the system has reached maximum normal operating temperature, the spring hangers shall be inspected and, if necessary, adjusted to the hot or calibrated position indicated on the hanger. If a hanger is deflected to its stop, it shall be adjusted immediately so that it will carry load on the spring and not on the stop. In making such adjustments, care shall be exercised to avoid adjustments which will result in a hanger deflecting against stops or off-the-load or travel scale as the pipe cools during a shutdown. If such a condition is unavoidable, the hanger must be replaced with one of proper size.

5.3.21 Painting

Un-insulated, above grade, structural and miscellaneous carbon surfaces shall be shop blasted and primed in accordance with Section 7. Surfaces shall also be finish painted and color coded with colors selected by the Owner.

Carbon steel piping which is installed underground shall be coated with one of the following:

1. Prime with Type B primer and coat with coal tar enamel and non-asbestos felt wraps per AWWA C203. Finish with one coat of water resistant whitewash.
2. 12-inch and smaller: Coat with 16 to 24 mill applied polyethylene plastic coating, Entec or X-Tru-Coat, or owner approved equal.
3. Shop applied tape wrap. Tape shall consist of butyl-based adhesive with polyethylene backing (similar to Polyken 930, Protecto Wrap 310, or Tapecoat CT)

Consult the services of a corrosion engineer to recommend further corrosion protection based upon the soils condition. Submit the corrosion engineer's recommendations to the Owner for information and acceptance of the recommendations. Provide cathodic protection for underground piping as recommended by the corrosion engineer and as approved by Owner.

The Contractor shall provide labeling of all piping and valving per ANSI Standards and as approved by the Owner (Reference Appendix G – "Piping, Equipment and Valve Labeling Standard – CUR-OPS-ADMIN-002".

5.3.22 Testing

Hydrostatic testing shall be performed after piping is completely installed. Test pressure shall be in accordance with the specified codes. Care shall be exercised by the Contractor to protect vessels, equipment, and instrumentation which can be damaged during pipe pressure testing through the use of slip blinds or other suitable means.

5.4 VALVES

This section details the technical requirements for furnishing, delivering, and installing butterfly, globe, gate, check, plug, and ball valves. The Contractor will complete valve data sheets and specify all valves in accordance with the requirements of this section.

5.4.1 General Requirements

All hand operated valves 2-inch and smaller for throttling service shall be globe valves unless service requires other specific types.

All control valves shall have a bypass valve and isolation block valves. Bypasses installed around liquid service equipment shall use globe type.

Isolation valves shall be provided for all piping connections to equipment.

Isolation valves for pump suctions and discharges shall be located in the larger piping sections.

Manually operated valves shall be located to be accessible from grade or elevated platforms such that operation can readily be performed or, where this is impossible, chainwheel operators shall be provided on manual valves. Valves shall be provided with a minimum of one handle length or handwheel diameter clearance between handle or handwheel in all positions and the nearest obstruction.

Install valves with stems vertical, wherever practical. Where not practical, stems shall be horizontal or above.

Install valves with indicators visible from accessways or elevated platforms wherever possible.

Valve operators shall not extend through floors or platforms so as to create a tripping hazard.

All instruments and gauges that are not in-line, except flow switches and temperature elements, shall be supplied with root valves for isolation during maintenance.

All temperature elements and gauges shall be provided with thermowells constructed of materials suitable for the service.

5.4.2 Valve Materials

All valves and valve materials shall be chosen as to be suitable for the intended service fluid, temperatures, pressure, and flows. Good engineering judgment shall be used at all times. The yoke or intervening structural member(s) between the valve and operator shall be of an ASTM material.

A graphite packing system (e.g., Grafoil ribbon pack with corrosion inhibitor, using end rings of braided graphite filament) is preferred. Alternate asbestos-free packing systems compatible with the intended service, shall be submitted to the Owner for approval.

5.4.3 Valve Shop Painting

Corrosion-resistant valve surfaces shall not be painted or treated with a rust preventative.

Exposed external ferritic steel surfaces of the valve assembly shall be painted with one coat of the manufacturer's' standard primer, except for machined working surfaces or adjusting nuts, bolts, or studs which shall be coated with a rust preventative, suitable for providing up to 1-year corrosion protection under outdoor storage conditions.

5.4.4 Lubricant Materials

Replacement lubricants, where required, shall be in accordance with manufacturer's requirements.

5.4.5 Design Requirements

Butterfly valve design shall be to, and meet the requirements of, MSS SP67, Type I, for tight shutoff.

Steel gate, globe, and check valves 2-½ inch and larger shall be designed and constructed in accordance with ANSI B16.10 and B16.34.

Steel gate, globe and check valves 2 inches and smaller shall have their pressure ratings in accordance with ANSI B16.34 and shall be of forged material.

Gate and globe valves shall have bolted packing gland and a fixed backseat.

Bronze valves shall be designed, manufactured, and inspected in accordance with MSS-SP80.

The stem finish in the area which will contact the packing shall be 32 rms or better. The stuffing box wall shall have a 125 rms or better finish. When required, seals shall be provided to retain grease and keep dirt and moisture out of bearings. Alemite lubricating fittings shall be furnished to lubricate bearings, yoke nuts, or bushings.

All forgings shall be clean and free from unacceptable defects. Repair of unacceptable defects is not allowed on forgings.

Valves of the same size, type, material, and pressure/temperature rating shall have interchangeable parts in order to reduce spare parts inventory.

Ball valves shall be in accordance with MSS SP72, and ANSI B31.8.

Ball, plug, and butterfly valves shall have blowout proof stems whose retention shall comply with ANSI B16.34, Paragraph 6.5.

Preferably, all ball valves shall be of top entry type so that the ball and seals can be replaced in the body without removing the valve from piping during maintenance. However, alternate types will be considered, provided the design does into require cutting piping to remove the ball and seals. Submit alternates for Owner's approval.

Plug valves shall be designed to the requirements of the API-6D. Plug valves shall be wrench or gear-operated, and of the tapered plug, self-lubricating sleeve, or reinforced seat type.

Flanged and weld-end valves shall conform to the face-to-face and end-to-end dimensions of ANSI B16.10 for each respective pressure class.

The valve and operator assemblies shall be designed and assembled so critical parts cannot become disengaged due to vibration and/or assemble orientation. Particular attention should be given to drive keys to assure that they are locked or "captured" by means other than press fits or the use of adhesives.

5.4.6 Valve Operators

Select valve operator and install valve to allow operation of valve without interference with adjacent piping or equipment without valve operator disassembly.

Provide gear operators for ball, plug, and butterfly valves 6 inches and larger.

If smaller valves require more than 60 lb of force applied to the manufacturer's standard lever, the Owner shall be advised as to the force required to operate and options available (e.g., lever length), so it can be determined whether a gear actuation is required.

Gate and globe valves shall be provided with the manufacturer's standard operator or handwheel for seating the valve.

Valves with gear operators shall be provided with a protective pipe and/or pipe plug on the operator, as appropriate, to protect the stem/stem nut from dirt, debris, and other matter. Operating valves installed at an elevation of more than 6 feet 9 inches between the bottom of the handwheel and grade or an elevated platform shall be furnished with a chain operator for operation from grade or elevated platforms. Install chain operators such that chain hangs within 2 feet of the operating level and can be "tied off" on a nearby structure so as to keep the chain out of the operating aisles.

Block valves used only for isolation in shut downs or repairs that are accessible by portable ladder need only be supplied with chain operators if installed at an elevation of more than fifteen feet between the bottom of the handwheel and grade.

Operating valves installed with handwheels under platforms shall be supplied with extensions for operation above the platform. Handwheels shall extend upward beside the platform and not through the platform

Supply quarter turn valves with locking devices on the handles.

Provide valve handle extensions of extended bonnets on valves installed in pipelines designated to be insulated. Handle extensions shall be suitable to provide a minimum of 2 inches clearance between the handle and the outside of the insulation jacket.

5.4.7 Valve Identification

Contractor shall provide a tagging system for all valves. The Contractor shall submit the proposed tagging system to the Owner for review and approval.

5.5 INSULATION AND JACKETING

5.5.1 General Requirements

This section covers the requirements for the selection and application of insulation systems for plant equipment and piping. Contractor shall be responsible for determining the economical insulation thickness and selecting the appropriate insulation material.

Provide illustrations and instructions for field installation of insulation for piping, valves, vessels, and equipment that is not pre-insulated by the supplier.

Provide removable insulation and jacketing sections at all flanged joints in insulated piping. Install removable sections to allow entire flange studs to be removed from either side of joint.

Insulation on valves shall be extended to include the valve bonnet.

Insulation

Minimum insulation thickness shall be 1 inch.

Provide an insulation specification thickness table and specification summary sheet indicating materials, manufacturer, material thermal properties, and application requirements for each insulation system proposed. Table shall indicate required heat conservation insulation thickness for each nominal size of piping and duct and for equipment for each 100^{o}F temperature increment in the range of 200^{o}F to 1100^{o}F. Table shall also include insulation thickness for burn protection for each NPS and equipment component in the same temperature range and for anti-sweat insulation for each NPS and for equipment.

All outdoor piping shall be insulated and freeze protected unless the piping is self draining. Use removable insulated jackets on control valves and large isolation valves. Freeze protection should be extended at least 12" below the frost line for the site.

All piping or equipment filled with a liquid that could freeze under normal operation and/or during a shutdown, when the outside ambient temperature is between +32 F and -30 F, shall be heat traced and insulated as required to prevent freezing under such conditions. Such lines shall include, but not be limited to instrument tubing, chemical tubing, sample analysis piping, boiler trim piping, boiler and steam line drain piping, fuel gas header flex couplings to burners on duct burners, and service water piping to utility stations. Heat tracing shall be installed completely to delivery point, such as blowdown tanks. All heat traced tubing shall be integrally heat trace tubing / heat tracing bundles.

Provide heat conservation insulation on all piping and equipment operating above 200^{o}F for which heat loss is not desirable. Insulation thickness shall be determined by an economic analysis of the cost vs. energy savings for the ambient conditions. Provide insulation to maintain an average surface temperature of any insulated lines below 140^{o}F with an ambient temperature of 80^{o}F, an emissivity of 0.09, no incident solar heating, and a 5 mph wind. Components requiring insulation shall include, but not be limited to, the following:

1. All steam piping.

2. Boiler feedwater pumps and piping.
3. Condensate piping (after condensate enters the preheaters).
4. Natural gas pre-heater gas side piping downstream of the heater.
5. Feedwater piping feeding and returning from natural gas pre-heater.
6. HRSG steam drums and trim.
7. HRSG casing including all transitions.
8. HRSG exhaust stack.
9. All other lines with an operating temperature above 140°F.

Provide anti-sweat insulation on piping installed in areas where the ambient dew point could be below the surface temperature of the piping at any conditions within the operating range of the plant.

Provide personnel protection insulation on all surfaces operating above the OSHA limit which are accessible from grade, ladders, or elevated platforms. Personnel protection insulation shall extend to a level of 7 feet (minimum) above grade or platforms and 3 feet (minimum) beyond any handrail.

Insulation materials shall have a flame spread rating of 25 or less, when tested in accordance with ASTM E84. Where installed inside building, insulation shall have a smoke density of 50 or less, when tested in accordance with ASTM E84. Select insulation materials to be suitable for the intended service in accordance with the National Insulation Association standards. Ceramic fiber insulation should be used where temperatures exceed the allowable limits of calcium silicate. Use elastomeric rubber, polyethylene, or polyisocyanurate foam insulation on cold service piping for anti-sweat applications. Anti-sweat applications shall include a continuous, unbroken, vapor seal. Outdoor anti-sweat insulation not provided with a jacket, shall be painted in accordance with insulation manufacturer's recommendations.

Use cellular glass insulation on all hot piping requiring insulation, which is installed in an area prone to flooding (either due to rainfall or from process upsets).

Insulation installed on stainless steel shall be limited in chloride content and shall meet the latest revision of military specification, Mil-1-24244B. Certification test is not required; however, manufacturer shall guarantee that insulation meets this standard.

Provide removable blanket insulation on all manways, removable covers, control valves, automated valves, engineered valves, and instrumentation installed in insulated piping systems. Transmitters and other remote mounted instrument shall be supplied with O-Brien, pre-fabricated, insulated instrument enclosures with quick opening latches. Removable blankets insulation shall maintain an average surface temperature below 140^{o}F with an ambient temperature of 80^{o}F, an emissivity of 0.09, no incident solar heating, and a 5 mph wind. Use stainless steel speed lacing hooks or stainless steel D-rings with fabric straps.

Insulation application including mastics and coatings shall be in accordance with insulation manufacturer's recommendations and the National Insulation Association standards.

Insulation installed in areas subject to foot traffic shall be designed to prevent collapse of the insulation.

Provide insulation support rings on vertical piping 6 inches and larger with spans greater than 10 feet. Maximum spacing between support rings shall be 10 feet.

Acoustic insulation shall be designed and applied to piping and equipment where required to meet the noise limits specified in Section 1.

<u>Jacketing</u>

Provide jacketing systems on all insulated equipment and piping, except those insulated with elastomeric rubber or polyethylene. Install jacketing to prevent the entry of moisture. Jacketing materials shall be as follows:

Equipment:	0.036 inch thick (minimum), corrugated, embossed, Aluminum with vapor barrier
Piping and valves:	0.02 inch thick (minimum), corrugated, embossed, Aluminum with vapor barrier

Use stainless steel or aluminum bands with wing seals to hold jacketing in place.

Seal all penetrations in jacketing with mastic cement and weather tight flashing.

Seal all breaks in insulation that would be exposed upon removal of flange insulation, equipment insulation, instrument insulation, or removable jacket insulation. Seal end caps using aluminum flashing and mastic.

Apply jacketing in accordance with insulation and jacketing manufacturer's installation instruction.

SECTION 6.0
CIVIL SCOPE

6.1 GENERAL REQUIREMENTS

This section covers the minimum scope and quality for the plant civil design and construction.

Contractor is responsible to inspect the Site, obtain all necessary Site data, perform all required additional geotechnical investigations, and determine all Site data for the design and construction of the power plant. This shall include determination of local code requirements for seismic and wind design loads. It is Contractor's sole responsibility to ensure that the building foundations and Site work comply with all federal, state, and local code requirements and all industry codes and standards.

All waste material removed from the Site shall be properly disposed of by Contractor.

The scope shall include, but not be limited to the following:

1. Clearing and grubbing.
2. All subgrade facilities and preparation.
3. Site drainage during construction.
4. Permanent drainage system.
5. Construction wastewater disposal.
6. Site grading including rough grading of the switchyard area.
7. Construction of all foundations and structures.
8. Permanent and temporary roads.
9. Modifications to existing Evaporation Ponds.
10. Site Security.
11. Off-site Road Improvements and repair (if required to transport or receive equipment or if required as a result of construction work).

The Project design shall take into account existing Site conditions with respect to soil characteristics, Site clearing, grading, and drainage. The Contractor shall be responsible for all Site preparation including any demolition, soil stabilization, grading, drainage, fencing, roadways, and parking areas.

6.2 SITE PREPARATION AND MAINTENANCE

Contractor is responsible for all Site preparation, backfill, and excavation. Cut and fill for the entire site, including the ponds and switchyard, shall be managed by Contractor.

6.2.1 Site Preparation

The Site shall be properly leveled with no construction debris or dirt piles. Contractor can store native material on Site that is suitable for use as backfill. Consideration shall be given to drainage to ensure no low lying areas are left, which would accumulate water. Installation of Site construction utilities shall be planned and constructed by Contractor. Location shall be approved by Owner.

6.2.2 Site Clearing and Grubbing

Selectively clear the Site of all trees, debris, rubbish, shrubs and vegetation as required for construction of new facilities. Effort shall be taken to ensure that as much as possible existing vegetation remains undisturbed. All debris from clearing and grubbing shall be removed from the Site. All root mats and stumps shall be completely removed and holes refilled with select material and compacted adequately for the ultimate expected loading for the material used.

6.2.3 Drainage

The working areas of the Site shall be well drained during and after construction. The Site drainage plan and discharge of drainage from the Site shall conform to federal, state, and local laws and regulations. All drainage shall be away from the buildings at a minimum of 1/4-inch per foot for the first ten feet. Design storm for culverts and storm sewer shall be for the peak flow rate for the 25-year 24-hour duration storm and shall be checked for flooding for a 100-year 24-hour duration storm.

6.2.4 Erosion

Contractor shall provide for erosion control during and after construction in accordance with Project permits, local and state laws and regulations, and local practice. Best management practices such as check dams and sedimentation basins shall be used during construction to minimize erosion. Drainage facilities shall be designed and constructed in a manner to minimize erosion.

6.2.5 Debris

All construction-related debris and unsuitable material shall become the immediate property of Contractor and shall be removed from the premises and lawfully disposed of off-Site by Contractor.

6.2.6 Road Maintenance

All temporary access roadways used by Contractor shall be maintained in serviceable condition. Contractor shall keep the surfaces of those roadways free from spills, mounds, depressions, and obstructions which might present a hazard or annoyance to traffic. Block 1 and Block 2 roads shall be tied together.

6.2.7 Excavation, Filling, and Backfilling

Excavated native material may be used on the construction Site for embankment, if suitable. All rock, concrete, wood, metal, and other materials from the excavation shall be removed from the Site by Contractor. To the extent possible, backfill and subgrade fill will utilize excavated materials. Under-slab and bedding material, topsoil, and other materials from off Site borrow areas shall be the responsibility of Contractor. Site dewatering during construction is the responsibility of Contractor.

6.2.8 Site Grading

Grades shall be established to minimize the amount of earthwork required to construct the facilities. All areas disturbed during construction shall be graded to a smooth surface and (covered with appropriate material as conditions require). Finish grading will be performed to conform to the finished design elevations for surface drainage and to prepare the areas to receive the specified surface finishes.

6.3 SITE IMPROVEMENTS

Paving and fencing improvements shall be in accordance with the Site plan and detail drawings included in the Appendices. Final design shall be shown in detail on Contractor's final plot plan. Paving design criteria shall be:

1. Subgrades shall be constructed of material with CBR of 4 or better, if available.

2. Design life shall be 35 years.
3. The construction period will produce 70 to 80 percent of the maximum wheel loads for the design life.
4. Structures supporting pavement shall be designed to support H-20 standard highway loads.
5. Pavement design shall be in accordance with AASHTO or other Owner approved procedures.

6.3.1 Storm Water Drainage System

A storm water drainage system shall be used to collect all rain water from the Site that is not potentially contaminated by oil and or other chemicals (non-active areas). Building roof drains will drain into this system. The storm water drainage system shall drain into the local drainage system. Provide suitable facilities and access for sampling of the storm water leaving the Site.

All rain water collected from active areas that can be contaminated by oil shall be contained and routed through an oil/water separator as described in the Mechanical Scope Section before release to evaporation/retention ponds.

6.3.2 Sanitary System

If a new sanitary sewer system is required, the system shall consist of drain piping, septic tank, and leaching fields on the Owner's property. Contractor shall confirm whether existing Block 1 facilities are adequate for the addition of Block 2.

6.3.3 Fencing and Gates

Security fences and gates, as required, will be in accordance with Company Specification – See Appendix F.

6.3.4 Crushed Stone Surfacing

All general plant areas, that do not require paving or landscaping, shall be surfaced with compacted aggregate.

6.3.5 Buildings and Equipment Foundation

Building and equipment foundations shall be of reinforced concrete including all formwork, rebar, waterstop, and related items.

6.3.6 Tank Foundation

Tank foundations shall be either reinforced concrete slabs or reinforced concrete ring wall foundations with a compacted sand bottom within the ring walls.

6.3.7 Manholes

Manholes shall be provided as required by final design.

6.3.8 Duct Banks

Underground banks of power and instrument conduit shall be encased in concrete. Encasements shall be reinforced when ducts pass under roadways, traffic, or heavy maintenance areas. The top of the duct banks shall be color marked.

6.3.9 Landscaping

Areas to be disturbed but does not contain foundations, paving, or other surfacing shall be stabilized and protected from erosion by topsoil and seed or other erosion control measures. Seed mixture shall be suitable for local conditions.

6.3.10 Roads and Parking

Subgrade preparation and compaction shall be in accordance with Sound Geotechnical Engineering Practice. Geogrid and limestone may be used for subgrade improvements. Paved roads and surfaces shall be paved as described below, unless state or local codes and standards specify more stringent requirements.

Roadways and paved areas shall be designed for AASHTO HS20 loading as a minimum. Paving may be either reinforced concrete or asphalt concrete and shall be designed based on the value of the modulus of subgrade reaction (k) determined for the site. Concrete paving shall be used in maintenance areas and for roadways subject to heavy maintenance cranes, parked trailers, or delivery trucks. Asphalt paving will be acceptable for roadways not subject to heavy load traffic. The laydown areas shall also be designed with consideration for concentrated loading due to handling of loads such as turbine rotor removal. Temporary construction roadways shall be designed and surfaced to meet the heavy loads of moving the turbine and generators on steel wheeled dollies.

In general, roads shall have a minimum one way lane width of 12 feet, and a two-way total width of 20 feet. All roads shall have 3 feet wide shoulders. Minimum radius of curvature shall be 45 feet. All roads shall have a 2 percent slope from the crown with shoulders sloped at 2 percent. All other paved areas shall pitch a minimum of 2 percent to drains.

Roads

Roads on-site shall conform to the following:

Description	**No. Lanes**	**Lane Width**	**Shoulder Width**	**Surface**
Access Road	2	10 ft	3 ft.	Paved
Plant Island Perimeter	2	10 ft.	3 ft.	Paved
Building Driveways	1	Width of Door Plus 2'	-	Paved
Equipment Access	1	12 ft.	-	Paved

Applicable Specifications:

Utah Department of Transportation's Standard Specifications for Road and Bridge Construction

Subgrade Preparation:

Subgrade shall be proof rolled five (5) passes of a 10-ton vibratory roller (minimum), or as required by additional geotechnical analysis.

Pavement:

Road pavement shall be in accordance with the State of Utah Department of Transportation's Standard Specifications for Road and Bridge Construction, and final geotechnical report.

Design Traffic Number, DTN = 50
Design Vehicle = HS20-44
Construction Loading

Horizontal and Vertical Curves:

Horizontal and vertical curves shall meet the Federal Highway Administration and AASHTO standards.

The inside edge of paved surfaces at intersections shall have a minimum radius of 45 feet inside the plant.

Vertical curves shall be as flat as practicable.

Parking Areas

Parking facilities shall be provided for plant personnel and visitors. Parking facilities shall include 25 parking spaces. Parking shall meet requirements for the physically handicapped as required by federal regulations such as the American with Disabilities Act. Car stops, parking lines, and lighting shall be provided. Contractor shall provide additional parking stalls as directed by Owner.

Provision shall be made within the fenced areas for parking in accordance with the local zoning ordinances.

Paved Walkways

Contractor shall provide paved access walkways to all buildings and major equipment. Walkways shall be a minimum of 5 feet wide. Walkways shall be incorporated into the roadway system such that the Owner will have a paved access between all buildings and major equipment which can be kept clear of snow and ice in the winter months.

Plant Area Surfacing

Asphalt Paving –	Roads and Parking Areas
Crushed stone Base (minimum 6"), Crushed stone shall be clean, uniform with a minimum of 95 percent of stone greater than ¾"	Area inside loop road, air cooled condenser and transformer area, and other equipment areas as required
Rip Rap – As a minimum, stone shall have an average of weight of 120lbs/cubic feet and average size of 6" diameter.	At Storm Drain inlets and outlets and as required for erosion protection

Bollards

Above ground piping, valves, fire hydrants, and accessories adjacent to traffic areas shall be protected with minimum 6" diameter steel pipe guard posts painted yellow, minimum height of 42" above ground and 36" below ground. Post shall be set in 12" diameter hole filled with concrete. Post shall be filled with concrete with a dome shaped top.

6.3.11 Oil/Water Separation

Work areas, equipment area, unloading areas, roads, and other areas subject to oil spills, shall drain to an oil/water separator(s) system designed to prevent oil-contaminated runoff from leaving the site or contaminating the site. Other areas will be designed to drain out through the natural site drainage system. Treated water from the oil/water separator(s) shall be routed to collection sumps and combined with other wastewater and/or water discharge streams in accordance with the Wastewater and Water Discharge Collection and Transfer System described in Article 5.2.28.

6.3.12 Unloading Areas

All oil, diesel, fuel and chemical tank loading/unloading areas shall be designed to provide for secondary containment of 110 percent of the largest single compartment of the relevant delivery truck. All diesel fuel oil and oil loading/unloading areas shall be designed and constructed in compliance with the EPA Spill Prevention, Control, and Countermeasure (SPCC) requirements.

SECTION 7.0
STRUCTURAL AND ARCHITECTURAL SCOPE

This section covers the minimum scope and quality standards for the plant structural and architectural facilities.

7.1 MATERIALS
7.1.1 Steel

Design of structural and miscellaneous steel shall be in accordance with the 1989 American Institute of Steel Construction (AISC) Manual of Steel Construction – Allowable Stress Design.

Materials for structural steel and miscellaneous steel shall conform to the following requirements of the American Society for Testing and Materials:

1. Wide Flange (WF) Shapes and Tees cut from WF: ASTM A992, Grade 50
2. M shapes, S shapes, Hp (Bearing Piles), Channels, and Angles: ASTM A36
3. Structural Plates and Bars: ASTM A36

Metal decking shall comply with SDI "Design Manual for Floor Decks and Roof Decks."

Structural steel grating shall be welded and galvanized and shall conform to ASTM A569. Grating shall be banded at edges and openings with bars of the same size as the bearing bars. It is recommended that one size grating be used throughout the Project. Grating for exterior use shall be serrated.

Minimum stair tread width shall be uniform for full length of stairs. Rise and run of stairs shall be in accordance with local building codes, state requirements, the International Building Code (IBC), and OSHA requirements.

High strength bolts, nuts, and washers shall conform to ASTM A325. Galvanize bolts, nuts, and washers when connecting galvanized steel members.

Anchor bolts shall conform to ASTM F1554, Grade 36. Anchor bolt sleeves shall conform to ASTM A501.

Anchor bolts shall be used for all structural and building columns, all major equipment, and all vibrating equipment. Galvanize all anchor bolts exposed to the weather.

Steel pipe for handrail shall conform to ASTM A53, Type E or S, Grade B. Handrails for exterior use shall be galvanized.

All structural welding shall conform to the requirements of AWS D1.1.

Galvanizing, as specified herein, shall conform to the requirements of ASTM A123 or ASTM A153, as applicable.

Structural framing using structural tube and/or box beams shall have "end closure" plate or screen to prevent entrance of birds.

7.1.2 Concrete

Design of structural concrete shall be in accordance with the American Concrete Institute (ACI) - "Building Code Requirements for Reinforced Concrete," ACI 318.

An independent testing laboratory shall be retained by the Contractor to perform acceptance sampling and testing of the concrete in the field. Sampling and Testing shall be in accordance with ACI 301 and applicable ASTM procedures. Make at least one strength test for each 100 cu yd, or fraction thereof, of each concrete mix placed in any single day. Determine the concrete slump for each strength test sample and whenever consistency of the concrete appears to vary. Determine air content of each strength test sample. Record the ambient temperature and the concrete temperature for each sample.

Minimum concrete strength classes for various structures shall be as follows:

Item	Minimum Ultimate Compressive Strength,(psi) (at 28 Days)
Subgrade leveling slab	2,000
Water retaining structures with aggressive exposures, i.e. cooling towers	5,000
All other construction	4,000

Reinforcing bars shall be deformed bars conforming to ASTM A615, Grade 60. Welded wire fabric shall conform to ASTM A185.

Cement shall be Portland cement conforming to ASTM C150, Type I or Type II, or Type V, as necessary to comply with ACI 318 recommendations in Section 4.3 regarding sulfate exposures.

The minimum cement content for 4000 psi mixes shall be 564 lbs per cubic yard and the maximum water cement ratio shall be 0.45 unless noted otherwise. Maximum water cement ratio for 5000 psi mixes shall be 0.40. Concrete shall be homogeneous, readily placeable, uniformly workable and finishable, and shall be proportioned to conform to ACI 211.1. Mix proportions shall be selected in accordance with ACI 318.

Provide air entrainment for concrete permanently exposed to the weather. Total air content shall be based on ACI recommendations for the type and size of aggregate used in the concrete.

Aggregates for normal weight concrete shall conform to ASTM C33.

Provide a housekeeping pad under all pumps and heat exchangers. Pad shall extend a minimum of 6 inches above grade or slab, whichever is higher.

Provide a minimum of 1 inch of grout under all equipment, support structures, platform supports, pipe supports and other structural supports that are mounted on concrete foundations or concrete slabs. Apply grout in accordance with grout manufacturer's instructions.

All concrete trucks shall be rinsed out on site. Rinse material shall be properly disposed of as spoils in road base.

7.2 STRUCTURAL LOADING

7.2.1 Dead Loads

Dead loads shall include all vertical loads due to weight of permanent structural and nonstructural components, including permanent hung loads.

7.2.2 Live Loads

Live loads shall be in accordance with local codes, the 2006 International Building Code (IBC) and the provisions of the Utah Uniform Building Standard Act Rules (R156-56), and the 2006 ASCE Standard American Society of Civil Engineers Minimum Design Loads for Building and other Structures, ANSI/ASCE 7 (latest edition) unless local governing code is more severe.

7.2.3 Wind Loads

Wind loads shall be in accordance with local codes, the 2006 International Building Code (IBC) and the provisions of the Utah Building Standards Act Rules (R156-56). Basic wind speed shall be 90 miles per hour.

7.2.4 Seismic Loads

Seismic loads shall be in accordance with local codes, the 2009 International Building Code (IBC), ASCE Standard No. 7-05 – Minimum Design Loads for Buildings and Other Structures, and the provisions of the Utah Building Standards Act Rules (R156-56).

The soil profile type shall be determined by the Contractor based on the results of a subsurface investigation, which shall be performed by the Contractor.

7.2.5 Thermal Loads

Buildings and structures shall be designed for forces and/or movements resulting from a change in temperature. Induced thermal loads (i.e., thermal loads induced by equipment operating temperatures) shall be considered in design of applicable structural elements.

7.2.6 Crane Loads

Crane loads shall be in accordance with the 1989 AISC Specification for Structural Steel Buildings – Allowable Stress Design (ASD) and Plastic Design and Code of Standard Practice for Steel Buildings and Bridges. Additional requirements for the turbine room crane are listed under Section 7.5, BUILDINGS / STRUCTURES.

7.2.7 Vehicle Loads

Design loading, for areas accessible to trucks, shall be (AASHTO) HS20-44.

Floors in buildings accessible to a forklift truck shall be designed for the forklift truck wheel loads.

7.2.8 Pipe and Equipment Anchor Loads

Supporting structures shall be adequate to resist all pipe and equipment anchor loading under all design conditions, including seismic.

7.3 STRUCTURAL FOUNDATIONS

Type and depth of foundations required shall be as recommended by Contractor's Geotechnical Engineer based on the existing subsurface conditions and the geotechnical studies. The foundation system used shall be piling, drilled shaft, spread footing, or mat as recommended by the subsurface investigation report.

Foundations supporting rotating machinery shall be checked for resonant frequency and isolated from other foundations using expansion joints.

The combustion turbine generator foundations shall be isolated from surrounding building foundation mats and shall be designed such that no adverse dynamic response or settlement occurs. The foundation shall satisfy the settlement, deflection, and dynamic response criteria supplied by the equipment manufacturer.

The steam turbine generator foundation shall be designed for the following:

1. Static loading per Manufacturer's loading diagram.
2. Vertical impact load as specified by Manufacturer.
3. Torque, vacuum, horizontal impact, thermal and alignment loads per Manufacturer's load diagrams.
4. Deflection shall be limited to values specified by Manufacturer under loading conditions as specified.

Gas turbine foundations and steam turbine foundations shall include foundation imbeds for anchoring and aligning the turbine generators. Gas turbine foundations shall include fixators to facilitate alignments.

Electrical transformer foundations shall include fire walls as recommended by NFPA and the Owners Insurance.

Foundations for hydraulic equipment and oil-filled transformers shall include concrete slabs and curbs for containment of the largest spill plus fire water or precipitation from the 10-year recurrence interval.

7.4 ARCHITECTURAL

The architectural design of the buildings, sound attenuation, and all associated facilities shall seek to optimize functional, aesthetic, and economic considerations; and minimize the visual impact on the surrounding area. Safety and construction requirements shall be in accordance with the requirements of applicable state and local codes.

7.4.1 Siding/Panels

Exterior siding shall be steel wall panels. Insulation shall be installed between the exterior surface panel and the interior surface panel. In areas susceptible to damage, an interior liner panel shall be installed to 8' 0" above the walking surface.

Wall panels shall be designed to withstand the specified wind loading with practical/economical support girt spacing.

Exterior face of wall panels shall be finished with an epoxy prime coat and a urethane or polyurethane finish coat.

Interior liner panels shall be ceiling height and finished with siliconized polyester.

Owner to approve exterior and interior color selection.

7.4.2 Roofing

Roofing shall be designed to withstand specified snow loading and wind loading, including appropriate uplift. Roofing shall be sloped metal.

Roofing shall be pitched not less than 1-¼ inch per foot and shall drain to a roof drain system. Pitch shall be governed by local codes and standards.

All roof drain systems, including gutters and downspouts, which are subject to freezing during cold temperatures shall be "heat traced" in accordance with Sections 8 & 9 of these specifications.

7.4.3 Interior Construction Materials

In general, architectural finishes for each area shall be per the following table:

Room Name	Floor	Wall	Ceiling
Steam Turbine Generator Building	mc	Mwlp	ex
Water Treatment Equipment Building	mc	Mwlp	ex
PDC's, Electrical Equipment Room	mfg std	mfg std	mfg std
CEMS Shelters	mfg Std	mfg Std	mfg Std
Chemical Feed Enclosures	mfg std	mfg std	mfg std
Sample Panel Enclosure	mc	Mwlp	ex

Floor Finishes:

cmc – sealed, cast-in-place concrete coated with coating resistant to battery acid attack

mc - sealed, cast-in-place concrete

vct – reinforced vinyl composition tile

cft - unglazed ceramic tile

rcp – special raised composite panel floor

- Specialty coatings shall be applied in areas subject to acid or chemical spills

** Vinyl tile in Control Room shall be static dissipative type.

Wall Finishes:

gbp –painted gypsum board on metal studs

mwlp - metal wall liner panel at pre-engineered building exterior walls

cmup - filled, painted concrete masonry

cwt - glazed ceramic tile over masonry or gypsum board

Ceiling Finishes:

sap – lay-in grid, grid type, suspended acoustical panel (use moisture resistant type in lockers and toilet areas)

ex - exposed to structure

Except where concrete unit masonry partitions are required, ceiling high interior partitions shall be of metal stud and gypsum board construction. Where applicable, metal stud partitions shall be insulated to reduce sound transmission.

Hollow load bearing or non-load bearing lightweight concrete unit masonry or metal stud/gypsum board partitions shall be provided in stairwells and electrical rooms where required by Building Codes.

7.4.4 Platforms

Platforms, other than those within the scope of major equipment suppliers shall be provided by the EPC Contractor. All platforms shall be designed and supplied with handrail and toe-plate in accordance with OSHA standards. Ladders and stairs shall be in accordance with local Building Codes, the IBC, and OSHA standards. See Mechanical Scope, General Requirements, for the types of platforms required.

Provide self-closing, OSHA approved safety gates on all platform ladder openings. Chain type safety gates shall not be used.

All grating shall be fastened to support steel with a minimum of two fasteners at each support. Fasteners shall be either Saddle Clips with Nelson, Erico or KSM welded studs or Hilti Grating Disk System.

7.4.5 Stairs

Stair construction shall be open riser stair treads. Stair treads and platforms shall have non-slip nosings.

Cross brace all stringers where the horizontal run exceeds 12 feet to provide lateral stability.

Fasten stair tread to stringer with a minimum of two 3/8-inch bolts.

7.4.6 Handrail

Railings shall be 1-1/2-inch standard weight steel pipe, and posts shall be 1-1/2-inch extra strong steel pipe, with welded joints, and ground smooth. Handrail and Guardrail shall be in accordance with the requirements of IBC 2006.

7.4.7 Windows, Window Walls, Entrance Doors, and Louvers

Windows and Window Walls – Window and window wall systems shall be anodized finished aluminum unitized framing systems with tinted, heat-treated, factory-fabricated, double pane insulating low "E" glass. Color of anodizing shall be selected to match the plant color system. Windows to areas which have possible explosive equipment failures shall be wire safety type.

1. Louvers – Louvers shall be drainable, fixed-blade, manual or gravity operating, weatherproof-type louvers, and shall include bird screens and be finished in a color to match adjacent wall panels.
2. Exterior Doors
   - A. Personnel Doors – Exterior doors shall be flush panel type insulated steel doors in pressed steel frames with weather stripping, weatherproof saddles, closures, and kick armor plates.
   - B. Coiling Steel Doors – Coiling steel doors shall be insulated standard type, motor operated, with manual chain-operated override, hood baffle, weather stripping, and bottom seal.

3. Interior Doors – With the exception of acoustical, fire rated, and coiling steel doors, all other interior doors shall be 1-3/4-inch thick, hollow metal flush panel-type in pressed steel frames. Vision panels shall be provided where appropriate. Interior doors to process areas shall have windows with wired safety glass.
4. All personnel access doors, in exterior walls at grade level, shall be provided with a 5' by 5' concrete landing pad with the top-of-concrete elevation a minimum of 2" and a maximum of 4" below the finish floor elevation. These doors shall also be provided with an "awning/eyebrow" constructed of a steel frame and metal roof panels which protects the landing pad from snow and ice. The awning roof shall be sloped such as to drain to the sides of the landing pad away from the normal means of access.

7.4.8 Painting

In general, all exterior and interior surfaces, except items furnished in manufacturer's finish or finish coat, shall be painted, including:

1. All structural steel, piping, and miscellaneous steel (except surfaces to be enclosed by concrete).
2. Surfaces of all ferrous metal.
3. All gypsum board. Gypsum board shall be painted in a semi-gloss acrylic enamel latex coating system.
4. All concrete unit masonry. Concrete unit masonry shall be painted in an acrylic latex system, unless a special coating is specified.

Stainless steel and galvanized steel shall not be painted.

ACC and auxiliary ACC structural steel shall be galvanized to match Block 1. All other structural steel to be painted.

Protective Coatings

Component	Surface Prep.	Primer	Finish Coat
Interior Structural Steel Building Framing, including Framing for Hangers and Equipment (Except for ACC)	SSPC-SP6	Organic Zinc/epoxy, 3 to 4 mils DFT	Acrylic Polyurethane, 3 to 5 mils DFT

Component	Surface Prep.	Primer	Finish Coat
Misc. Steel, Interior or Exterior (handrail, stair stringers, ladders, toeplate) (Except for ACC)	SSPC-SP6	Organic Zinc/epoxy, 3 to 4 mils DFT	Acrylic Polyurethane, 3 to 5 mils DFT
Exterior Structural Steel Supports & Framing for Equipment (Except for ACC)	SSPC-SP6	Organic Zinc/epoxy, 3 to 4 mils DFT	Acrylic Polyurethane, 3 to 5 mils
Platform Grating, Stair Treads, Checkered Plate, Composite Plates, Concrete Embeds, Anchor Bolts	Per the American Hot Dip Galvanizers Assoc. recommendations	Hot Dipped Galvanized	
Structural Steel Framing for the Air Cooled Condenser (ACC), including platforms, handrail, toeplates,	Per the American Hot Dip Galvanizers Assoc. Recommendations	Hot Dipped Galvanized	
Interior Above Grade Uninsulated Piping (Not requiring color coding)	SSPC-SP6	High Build Epoxy Primer or Galvanized	None.
Interior Above Grade Uninsulated Piping (Requiring color coding)	SSPC-SP6	High Build Epoxy Primer or Galvanized	None
Exterior Above Grade Uninsulated Piping	SSPC-SP6	Inorganic Zinc Rich Primer	Polyurethane, 3 to 5 mills
Exterior and Interior Insulated Piping	None	None	None.
Equipment, Motors, Valves, Instruments, and other manufactured components	Manufacturer's Standard	Manufacturer's Standard	Manufacturer's Standard
Stainless Steel, Galvanized, or Nonferrous pipe or Materials	None	None	None
Stacks and other hot surfaces	SSPC-SP6	Inorganic Zinc rich ethyl silicate, 2 to 3 mils, DFT	Hi-temp silicon, 3 to 5 mils

7.4.8.1 Surface Preparation

The exterior surface of structural and miscellaneous steel and tanks shall be abrasive blasted in accordance with the Society for Protective Coatings, SSPC-SP6, Gray Commercial Blast, or SSPC-SP10, Near White Blast for submerged items.

Tank interiors to be lined shall receive an abrasive blast in accordance with SSPC-SP5, White Blast, with a 3.0 mils maximum anchor pattern.

Small miscellaneous field fabrications shall be given not less than SSPC-SP3, Power Tool Cleaning.

All masonry surfaces to be coated shall receive a light brush-off blast or an acid etch prior to coating.

Piping shall be field-cleaned to a minimum of SSPC-SP3, Power Tool Cleaning.

7.4.8.2 Prime Protective Coating for Steel

All structural and miscellaneous steel shall be primed within 8 hours after the surface preparation is completed to a full 2.5 mils. The primer shall be as specified in the Protective Coatings Table, this Section. Open web joists may be primed with a red iron oxide primer.

7.4.8.3 Finish Coating

Structural and miscellaneous steel shall be finish coated as specified in the Protective Coatings Table, this Section.

Above grade piping designated to be painted, shall be color coded to coordinate piping service. Provide a color code chart to Owner for approval indicating piping color for each piping system included in the Project.

Before painter's finish work is begun, the surfaces to be painted shall be carefully inspected to assure that they are in proper condition to receive the finish coating. Surfaces, which are in poor condition, so that a proper finish cannot be produced, shall receive such special treatment or additional coats as necessary to produce a smooth, durable, satisfactory finish. Contractor shall supply color samples to Owner for approval.

7.5 BUILDINGS/STRUCTURES

7.5.1 Minimum Requirements

Drawings showing floor plans, equipment arrangements and other building and architectural features shall be submitted by the Contractor for Owner's review, comments and approval. Building framing may be Pre-Engineered or designed of standard rolled shapes. The use of shipping containers retrofitted for packaging of systems shall not be allowed.

Design all building roofs, platforms, and structures for a minimum collateral load of 15 psf, in addition to the Code required and specified live loads. Increase the minimum collateral load in routing corridors for piping, electrical conduit, and cable tray, and determine the design collateral load by consideration of actual weights and by calculations.

Buildings shall be provided as follows:

Building	Min number of external doors / windows	Minimum Size	Special Notes
Steam Turbine Generator Building	Exit doors in accordance with Building Code. Minimum of two roll-up doors.	See Note 1	One of the roll-up doors shall be sized to allow removal of the largest piece of equipment.
Water Treatment Equipment Building	2 roll-up, 2 doors, no windows	See Note 2	
CEMS Shelters	1 door	8-foot x 10-foot (if 1 per CTG) or 10-foot x 12-foot (if 1 per 2 CTGs) Minimum of 1 per 2 CTGs	
Boiler Feed Pumps Building	Per Building Code requirements.	As required for access of equipment	Include monorail for maintenance of pumps and motors.
Other Buildings	Per Building Code requirements.	As required for access of equipment	

Building	Min number of external doors / windows	Minimum Size	Special Notes
Note 1 – The Steam Turbine/Generator Building shall be a totally enclosed building sized to house all of the equipment associated with the Steam Turbine/Generator and accessories. The building shall include an operating floor at the turbine/generator support level for access and laydown of materials during maintenance, access platforms for operation and maintenance of equipment housed in the building, access isles for removal of equipment, hoists and monorails required for maintenance of equipment and an overhead crane for maintenance of the turbine/generator. The crane lifting height, and building roof, elevations shall be set such that the heavy turbine parts requiring removal and reinstallation during maintenance can be lifted, stored on the operating deck or moved to an access "drop bay" for lowering to the ground floor and removal from the building. The building drain system shall include oily waste, chemical and area drains routed as appropriate for treatment and discharge.			
Note 2 – The Water Treatment Equipment Building shall be a totally enclosed, heated and ventilated building sized to house all of the equipment associated with the Cycle Makeup Treatment System, including filters, RO's, EDI, chemical dosing skids, chemical storage, raw water pumps, service water pumps and cycle makeup pumps. The building shall include access isles for operation and removal of equipment. Hoists and monorails, or other lifting devices, shall be provided as required for maintenance of the equipment. The equipment layout in the building shall include provisions for accessing any equipment which requires periodic "charging" with consumables delivered in bulk. The building shall include an environmentally controlled room to contain electrical and control equipment requiring a conditioned environment. The building drains shall include oily waste and chemical drains as appropriate.			

7.5.1.1 Maintenance Access and Lifting devices

As a minimum, the Contractor shall provide access to and/or lifting devices, such as cranes, hoists, trolleys and monorails for operation and maintenance of the following installations:

Steam Turbine Building: An overhead crane shall be provided for maintenance of the stream turbine/generator and other "major" equipment, excluding electrical equipment such as Motor Control Centers, Secondary Unit Substations, IO Cabinets, VFD Controllers, etc., in the steam turbine building. Arrangement of equipment shall include access provisions, where possible, for use of the overhead crane during maintenance activities. Where possible, removable covers and/or openings shall be provided in suspended floors for access by the turbine room crane lifting hooks.

Steam Turbine Building: Arrangement of "major" equipment in the building, not accessible by the turbine room crane for maintenance, shall include provisions for access by Owner furnished portable lifting mechanisms or shall be provided with monorails with hoists and trolleys for maintenance. For "minor" equipment (such as small pumps, motors, fans, compressors, etc.) maintenance aisles shall be provided for access by Owner furnished mobile lifting equipment or the building support structure shall be designed such that the Owner can temporarily "rig" lifting devices from the structure.

Boiler Feed Pumps: Monorails with hoists and trolleys shall be provided for disassembly and assembly of the Boiler Feed Pumps and drive motors.

HRSG: A lifting device shall be provided, at the top of the HRSG's, for transferring maintenance tools and small equipment from the grade level to the HRSG Drum Level. This device shall include monorail, hoist and trolley.

HRSG Exhaust Stacks: A lifting device shall be provided at the top access platform of the exhaust stacks. The device shall include lifting beam, hoist and trolley (if required) for delivery of maintenance tools and monitoring equipment from grade level to the access platform.

SCR Catalyst Removal and Placement: Monorails, hoists and trolleys shall be provided for removal and placement of catalyst baskets. The lifting device shall be designed to transfer baskets from grade level to the openings provided for installation of the baskets.

Combustion Turbine/Generator: The manufacturers standard lifting devices shall be provided for maintenance of the equipment furnished for the Combustion Turbine/Generator. Layout of the plant equipment shall include areas for setting Owner furnished mobile equipment (cranes) to maintain the large Turbine/Generator parts.

Air Cooled Condenser: The manufacturers standard lifting devices shall be provided for maintenance of the equipment furnished for the Air Cooled Condenser.

General Outlying Equipment: Where "major" equipment is located in an "isolated" area, away from buildings and structures, access provisions shall be provided for maintenance by Owner furnished mobile lifting devices.

7.5.2 Steam Turbine Generator Building

Column Bases shall be designed as pinned.

The turbine room roof design shall utilize horizontal bracing.

Floor and roof live loads shall be as follows:

1.	Turbine room roof	30 psf
2.	Operating floor, turbine room area	500 psf
3.	Operating floor, other areas	250 psf
4.	Ground floor	300 psf plus HS20 loading

Building footprint shall be adequately sized to allow laydown of all turbine generator components during maintenance or refurbishment.

7.5.3 Other Structures

Contractor shall provide sun shade covers for all CO_2 and bulk gas storage systems.

7.5.4 HRSG Equipment Enclosure

Provide steel frame equipment enclosure with weather-tight metal siding and roof deck at the top of the two HRSG Units. Include doors with hardware, ventilation, and interior lighting.

7.5.5 Turbine Room Crane

An overhead crane shall be provided for maintaining the steam turbine/generator equipment as well as other "major" equipment located in the steam turbine building. The turbine room crane shall have a "main" hook capacity of 85 Ton, or 110 percent of the heaviest piece of the steam turbine/generator (including the turbine rotor and generator field) to be lifted during maintenance, whichever is largest. The turbine room crane shall have an "auxiliary" hook with a capacity of 25 Ton.

The turbine room crane shall be designed such that the main and auxiliary hooks can lift equipment from the operating floor elevation and lower to the grade level for maintenance and/or storage.

Operation shall be by remote radio control and by control pendant suspended from trolley. Include a platform with stair or ladder to provide access to the crane bridge service platform from the Turbine Operating Floor.

7.5.6 Monorails, Hoists and Trolleys

Where monorails are provided for maintenance of equipment, they shall be located so that excessive "drifting" of the load is not required.

Hoists and trolleys shall be electric driven, pendant controlled, festoon cable fed unless otherwise approved by the Owner.

SECTION 8.0
ELECTRICAL SCOPE

8.1 GENERAL REQUIREMENTS

This section covers the minimum scope and quality standards for the major electrical equipment, systems, and interfaces with other plant systems and facilities and with off-Site facilities. Contractor shall provide all material and labor for the engineering, design, procurement, installation, construction, startup, inspection, and testing of all electrical systems specified herein and necessary for a complete, functional power generating facility and in conformance with generally accepted utility practices for generating facilities.

The conceptual design is shown on the one line diagram that is included in Appendix E. Contractor shall develop a detailed plant design based on Owner's conceptual design. Alternative designs may be acceptable if they meet the functional requirements of this specification. Any changes in plant arrangement or design must be approved by the Owner. Arrangement and design of the auxiliary power system equipment shall provide for unobstructed vertical clearance on the access road between units for bringing in cranes and other heavy equipment for maintenance.

The design and specification of all work shall be in accordance with all applicable laws and regulations of the Federal government and the State of Utah, and applicable local codes and ordinances. A listing of the codes and industry standards to be used in design and construction is found in Section 3.0. All equipment furnished under these specifications shall conform to applicable standards of IEEE, NEMA and ANSI. All materials and devices shall be in accordance with the applicable requirement of the Federal "Occupational Safety and Health Standards". The latest editions of the referenced codes and standards shall apply. Equipment ratings and capacities are generally referenced to 40° C maximum ambient and less than 3300 feet. Contractor shall revise ratings accordingly for equipment and materials as required for Project maximum ambient conditions and elevation.

Other recognized standards may be utilized when required in Contractor's opinion and when not in conflict with the standards listed in Section 3.0. Contractor shall notify and obtain Owner approval prior to any changes.

8.1.1 Plant System Studies

Contractor shall perform a set of system studies to demonstrate the adequacy of the proposed electrical system design, including ac and dc distribution systems, by performing the following studies as a minimum. The design and construction of the electrical systems shall reflect the findings and conclusions of these studies. Prior to starting studies, provide Owner with cases to be analyzed. Owner will identify other cases if required to meet the criteria established in the following. These system studies shall be subject to review and comment by Owner.

1. Load flow and voltage regulation

   A series of studies shall be undertaken over a range of operating conditions, including pre-synchronizing, post-synchronizing, variation in grid voltage, auxiliary transformer failure, etc., to demonstrate that the plant electrical equipment operates within its manufacturer's rating and the voltage at all buses is maintained in the required range. For the studies, cable impedance shall be included and transformer and generator impedance shall include the maximum positive tolerances.

   Transformer impedance shall be determined to optimize the through-fault withstand current of the transformer and the interrupting duty of the switchgear and switchyard breakers and to ensure that the voltage will not fall below allowable limits when the largest motor will be started.

   The studies shall include motor starting studies to show that, when starting any motor, the distribution voltage at all levels does not fall below 90 percent of motor nameplate rating except for motors designed for lower terminal voltage. This requirement shall apply for all the contingencies given above and include motors of the largest starting current at each voltage level. Motors subject to the low starting voltage will be rated for 80 percent starting voltage.

Evaluate generator step-up transformer reactive power flow study to verify that transformer does not reduce generator reactive power flow through all operating conditions. Reactive power flow shall be evaluated in accordance with IEEE C57.116 to meet a power factor of 95 percent lagging and 95 percent leading for each unit at the 345 kV side of the generator step-up transformer.

System design shall provide for transmission voltage deviation of plus or minus 5 percent and short term (one minute or less) voltage excursions of plus 10 percent to minus 10 percent. During normal operation system bus voltage shall be within plus or minus 5 percent of nominal voltage. Auxiliary equipment shall be designed for continuous operation for a plus or minus 10 percent voltage variation.

2. Fault level

   Studies shall be undertaken to ensure that the prospective fault current is within the rating of the switchgear and cables. For these studies: cable impedance shall be ignored, full motor contribution shall be included, and transformer impedance shall be at the maximum negative tolerance. Fault study criteria shall be minimum of 1.05 p.u. prefault voltage for each bus analyzed.

3. DC System Studies

   A load profile shall be developed for all DC loads to size the batteries and chargers, and to verify minimum voltages are maintained as specified and required by equipment vendors.

4. Grounding Studies

   Perform grounding system studies using a minimum of a 2 layer model to limit touch and step potentials to safe values as specified using the MALZ module of CDEGS software. The calculation of the ground resistance and associated minimum grid conductor spacing shall include the 345kV switchyard area and plant. The grounding system shall be designed to provide personnel safety and to provide protection to electrical equipment considering the maximum available single line to ground fault current and the longest fault clearing time. The grounding system study shall be in accordance with the latest version of IEEE 80, 81, and 665, NESC and the NEC. Soil resistivity measurement shall be made using the Wenner four point test method and shall conform with the latest version of IEEE 80. A fall of potential test must be performed to verify the soil model. After construction of the ground grid, another fall of potential test shall be performed to verify the site ground grid resistance matches the model.

5. Arc-Flash Study

An arc flash study shall be performed using SKM Power Tools based on IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations. The study shall include all applicable voltages and equipment as detailed in IEEE 1584. A report shall be furnished along with electronic files. Contractor shall furnish Arc-resistant 3-cycle breakers for medium voltage busses. Incident energy shall be limited to a maximum of 25 cal/sq-cm for all busses rated 480V and above. Contractor shall not include resistance equipment for 480 VAC and lower busses. If the study results indicate the incident energy levels are greater than 25 cal/sq-cm, Contractor shall provide recommendations for implementation including available vendor switchgear alternatives, optical relays, remote racking mechanisms, and rapid tripping schemes to minimize incident energy and the associated pricing. In addition, process redundancy which allows equipment to be maintained while de-energized can be considered as remedial approaches. See Company Specification referenced in Appendix Q for additional details.

6. Protective Relay Coordination Study

A protective relay coordination study and relay setting report shall be prepared. This study will serve as the basis for relay protection for the plant electrical distribution systems. Relay settings are required for all protective relays furnished by Contractor. Recommended settings for combustion and steam turbine relays will be provided by equipment supplier. Contractor shall provide settings for relays requiring system information. Contractor shall request any information from Owner to provide relay settings. Contractor shall provide a hardbound report including settings, calculations, system data, one lines, and coordination curves. In addition a CD shall be furnished including all documents in the report, relay setting files, relay communication software, instruction manuals, and application manuals where applicable. Contractor shall coordinate with the local utility company to implement any special protection or system requirements. See Company Specification regarding Protective Relays referenced in Appendix G.

7. Cable De-Rating Analysis

   All power feeders in duct banks shall be analyzed for current carrying capability based on heating effects of other circuits, the duct bank, and surrounding earth. Study shall include transient analysis of feeder cables to combustion turbine start system where the main generator is backfed as a motor.

8.1.2 Interface Requirements

8.1.2.1 Utility System Interface

1. The interconnection of the plant will be through the new 345kV plant switchyard and associated high voltage transmission lines to the Mona Substation. The Contractor shall be responsible for intergrating the work performed in the design and construction of the plant proper, switchyard and transmission lines up to the Mona Substation. Specifications for the switchyard are covered in Appendices F, R and S.

A generator fault on a combustion turbine shall trip only its associated generator excitation and low side generator circuit breaker. This scheme should allow the auxiliary loads to continue receiving the power supply from the switchyard through the corresponding station auxiliary transformer. A fault on a step-up transformer shall trip its high side circuit breakers and associated generator breaker. A fault on the steam turbine generator shall trip its associated high voltage breakers.

Contractor shall coordinate routing of circuits to the 345kV plant switchyard control building. Contractor shall provide the required raceways to interface with the 345kV plant switchyard raceway system. Wiring to the interface point will be provided and tested by Contractor. In addition to the required raceways, Contractor shall provide two spare 4" conduits from administration building to the 345kV plant switchyard. The Contractor shall interface with Owner company for interconnection of the power plant at least but not limited to the following technical areas:

1. Basic System Design
2. Protective Relays of the generation system.
3. Engineering Studies
4. Metering
5. Telemetering
6. Generator synchronizing
7. Reactive Power Requirements
8. RTU Dispatch Control
9. Backup power supply
10. Dead end structure line termination

Interfaces to an RTU (remote terminal unit) located in the switchyard control building will be provided as follows for each of the three generating units:

1. Gross megawatts (by Contractor)
2. Net megawatts (by others)
3. Auxiliary megawatts (by Contractor)
4. Station net megawatts (by others)
5. Gross megavars (by Contractor)
6. Net megavars (by others)
7. Auxiliary megavars (by Contractor)
8. Generator voltage (by Contractor)
9. Upper operating limit (by Contractor)
10. Lower operating limit (by Contractor)
11. AGC control status (by Contractor)
12. Power system stabilizer status (by Contractor)
13. Voltage regulator status (by Contractor)

Final point list shall be developed during Contract execution, and shall include additional points typical of this type of installation.

Furnish and install plant side revenue metering system consisting of Maxsys Elite2510 revenue meters for each generator and auxiliary transformer, current transformers, and potential transformers for combustion turbine generator gross (low side for each unit), combustion turbine auxiliary load (each unit) and steam turbine gross (low side). Meters shall be furnished with 7760 firmware, peer to peer networking capability, bi-directional metering capability, DNP 3.0 communications protocol, 4 KYZ outputs, and 4 analog outputs. Meters shall be connected to allow internal calculation of unit and net station power. Meters shall be connected to dedicated revenue class .3 quality current and potential transformers. Provisions shall be included to accumulate auxiliary power when the CT units are off line in separate registers or other methodology as approved by Owner. Owner will supply meter catalog number. Hardwired analog, pulse, and communication outputs shall be made to switchyard RTU. Metering to have remote dial up capability.

Provide rack space, 48V 150 A-H battery and charger system for the Owner provided DMXplore and Channel bank communications equipment. Furnish conduits and fiber cable between the new 345 kV switchyard and the communications equipment.

Contractor shall include all technical and operational requirements within the plant to design to meet the requirements of the LGIA and associated documents included in Appendix H.

Contractor shall include all technical and operational requirements within the plant design to meet the requirements of the LGIA and associated documents.

8.1.2.2 Plant Synchronizing and Switching Scheme Interface

Contractor shall design a synchronizing scheme in coordination with the turbine supplier. Combustion turbines will be synchronized across low side generator breakers. The steam turbine will be synchronized across the switchyard breakers. Design shall be based on a single high side breaker connected to a collector bus.

As required to ensure proper synchronization operation, phase matching potential transformers shall be provided to compensate for any phase angle and potential differences (caused by step-up transformer phase-shift) on the derived voltage sources from the 345kV switchyard and generator systems. Potential selection relays and selection logic shall be included as part of the synchronizing scheme.

8.1.3 Auxiliary Power Supply Equipment

The auxiliary power supply equipment includes the unit auxiliary transformers, 4160-volt switchgear, 4160-volt motor control centers, 480-volt secondary unit substations, 480-volt motor control centers, 480/277-volt distribution panelboards, and 208/120-volt power panels. All 4160 volt switchgear and 4160 volt motor control centers shall be arc-resistant. The auxiliary power equipment shall distribute electrical power to the plant auxiliary equipment. Electrical equipment with the exception of transformers shall be installed in rooms with a controlled environment including redundant air conditioning, except as approved by the Owner. Each class of primary distribution equipment (4160-volt switchgear, 4160-volt MCC, 480-volt switchgear, 480-volt MCC's) shall be of the same type and manufacture (i.e. all 4160-volt switchgear shall be of the same type and manufacture, but not necessarily the same manufacture as the 480-volt switchgear).

Critical loads for each block will be configured in such a manner that critical loads can be easily and quickly isolated from the normal source and transferred to the backup source (emergency diesel generator). Included in the critical loads are the loads to keep the combustion turbines in a ready to start condition, steam turbine critical loads, DC system, HVAC, communications and other loads as selected by Owner. Loads shall be selected up to the capacity limit of the emergency diesel.

Each 4160 and 480 volt bus shall be provided with metering functions to include, 3-phase bus voltage, 3-phase current, kW, kVAR, kWh (meter functions may be provided through protective relay data to DCS). Summary metering shall be configured to provide total kW, kVAR, kWh for the station and the auxiliary power system. The station service power shall be supplied from the utility system during plant startup, shut down, and maintenance periods. Power shall be supplied from the generated power during normal operation. Primary control for medium and low voltage switchgear, mains, ties, and feeders shall be from the distributed control system. Backup control shall be provided near the switchgear to allow buses to be energized if the DCS is out of service. DCS shall display feeder and bus metering information in addition to switchyard voltage.

The quantity and size of 480 volt panel boards shall be selected such that the capacity is adequate for total running load under all operating conditions, plus a 20 percent design allowance, plus 10 percent allowance for future use. The continuous current ratings and interrupting ratings of the feeder breakers shall be based on the available fault current and the characteristics of the connected load. Each distribution panel board shall include the feeder breakers required to supply the connected load, plus two three-pole and two single-pole feeder breakers for future use.

Welding receptacles shall be provided for portable 480 volt, 3-phase welding equipment. Sixteen receptacles will be placed in strategic locations as directed by the Owner.

All 208 volt loads and all single-phase 120 volt loads shall be supplied from the 208/120-volt power panels. The continuous current rating of the main bus and the 480-208/120-volt transformer shall be as required plus a 20 percent design allowance. The continuous current ratings and interrupting ratings of the feeder breakers shall be based on the available fault current and the characteristics of the connected load. Distribution transformers shall be dry type, U.L. listed, class H insulation (based on a 115 degrees C rise) with 4 – 2½ percent FCBN and 2 –2 ½ percent FCAN taps in primary winding with suitable enclosure. Motor space heaters, equipment space heaters, equipment lights and receptacles and equipment miscellaneous power feeds shall be from power panels. Each power panel shall include the feeder breakers required to supply the connected load, plus 6 single-pole feeder breakers for future use.

8.1.4 Classification of Hazardous Areas

Areas where flammable and combustible liquids and gases are handled and stored shall be classified for the purpose of determining the minimum criteria for design and installation of electrical equipment to minimize the possibility of ignition. The criteria for determining the appropriate classification are specified in Article 500 of the National Electric Code (NFPA/ANSI C1). The application of these criteria to specific areas at generating stations is provided in Article 127 of the National Electrical Safety Code (ANSI C2) and applicable NFPA standards.

8.1.5 Lighting

A lighting system shall be furnished for all structures and new equipment. The lighting system shall provide personnel with illumination for plant operation under normal conditions, means of egress under emergency conditions, and emergency lighting to perform manual operations during a power outage of the normal power source. Provide aviation lighting system for stacks, if required. The power supply for the lighting system shall be from 120/208 or 277/480 volt, 3-phase, 4-wire lighting panelboards. Emergency lighting shall be powered from a 120 volt AC normal source with local battery backup.

The lighting system shall be designed in accordance with the Illuminating Engineering Society (IES) to provide illumination levels recommended by the following standards and organizations:

1. ANSI IIES RP-7, 1979, Industrial Lighting.
2. ANSI IIES RP-8, 1977, Roadway Lighting.
3. Federal Aviation Administration (FAA).
4. Occupational Safety and Health Act (OSHA).

In addition to the above, the lighting design shall meet all local codes and regulations.

Lighting sources and fixture selections shall be based on the applicability of the luminaries for the area under consideration.

Four types of lamps shall be used for the light sources in the lighting system including fluorescent, high-pressure sodium, metal halide, and incandescent. Generally, fluorescent lamps shall be used in indoor, low-bay enclosed areas; high-pressure sodium lamps shall be used outdoors, metal halide in high-bay enclosed areas, and incandescent lamps shall be used for emergency lighting. Exterior lighting shall include all roadways, HRSG platforms, combustion turbine platforms, and CEMS equipment platform areas. Lighting levels shall be designed to at least the following minimum foot-candle levels:

Platforms, stairs, & walkways	10
Maintenance areas	50
Toilets and locker rooms	40
Warehouses/mechanical rooms	20-30
Water treatment	30
General outside areas	1
Roadway and parking areas	1
Electrical rooms	50

In general outside areas shall be controlled by photocell. Outside areas such as HRSG platforms shall have auto/manual stations to selectively turn-off lights when plant is not operating. Lighting should be down shaded to minimize offsite view impact.

Lighting fixtures shall be located and positioned such that maintenance of fixtures can be carried out with minimal use of ladders or lifts.

8.1.6 Telephone and Data Systems

Contractor shall expand the existing telephone/data network to include Currant Creek 2 equipment. As a minimum voice/data lines shall be installed to the areas tabulated below. The telephone / data system design including all equipment shall be approved by the Owner. Provide dedicated raceway system from the control room building to the plant terminal point for telephone cable. Owner will supply and install the telephone and data switching equipment.

Contractor shall include a raceway system, racks, VoIP equipment, wiring, fiber, jacks, and switches as required for the telephone and communications system indicated below. Listing is per building when multiple buildings are included:

Facility	Voice	Data	Analog
Admin Building	4	4	2
Boiler Feed Pump Enclosure	1	1	1
Chemical Treatment Building	1	1	1
Power Distribution Building(s)	1	1	2
CEMS Enclosures	1 Each	1 Each	1 Each
CT Electrical building	1 Each	1 Each	2 Each
ST& CT Excitation Building	1	1	2
Gas Regulating station		1 (fiber)	2
CT Outdoor Burner Fronts	1 Each		
Steam Turbine Building	1 @ Each Elevation		
Emergency Shower Locations	1 Each		

Final locations will be determined by Owner during detailed design.

Provide data ports for at locations near the phone outlets. Data ports in other buildings remote from the Control/Administration building will be connected through fiber optic cable unless otherwise approved.

8.1.7 Construction Power

Contractor shall contact local utility and make arrangements for construction power services. Contractor shall pay all fees and operating costs associated with the installation, operation, and maintenance of the service including removal at project completion. Construction power shall be available through the duration of the project up to commercial operation unless approved by Owner. Owner will furnish power for commissioning and startup through back-feed of the auxiliary transformers. This power source will not be available for construction.

8.1.8 Freeze Protection

A freeze protection system shall be provided for piping, instrument impulse lines (integral tubing bundles), gauges, pressure switches, and other devices subject to freezing. See Division 5 and 9 for additional requirements. All transmitters, remote gauges and switches located outdoors shall be located in a heated instrument enclosure complete with a thermostat and space heater which will automatically turn on when the ambient temperature falls below 40 F. The enclosures shall be designed such that the heater cable circuit for the integral tubing bundle connecting the instrument to the process is terminated inside the enclosure.

On pipes that operate below 300°F, parallel circuit type heating cable shall be directly applied to the pipe. These heating cable circuits can be assembled and installed in the field using the appropriate connection kits.

For pipes which operate at 300°F and above, parallel circuit-type heating cable shall be sandwiched between layers of insulation or heat tracing of suitable temperature rating shall be used. These heating cable circuits can be assembled and installed in the field using appropriate connector kits.

Power distribution panelboards, each fed from 480-120/208 volt transformers shall furnish power to the freeze protection circuits. Power to the freeze protection circuits shall be controlled by ambient thermostats through a central control panel which shall provide control and alarm/monitoring functions for the freeze protection system. In addition, thermostats that sense actual pipe temperature may be required to prevent overheating of critical process or chemical piping. Remote alarms for the overall system and local monitoring of each freeze protection circuit shall be provided. Panels shall include provisions for checking amp loadings without opening the panel.

High temperature cables and self-regulated cables shall not be interconnected.

8.1.9 Cathodic Protection System

Cathodic protection and other corrosion control measures shall be provided to protect metal tank bottom and underground piping and shall be designed and installed according to soil survey results. A study shall be prepared by a corrosion control specialist (member of NACE) to provide recommendations as to the requirements for, and methods of, preventing corrosion of metallic elements due to galvanic action. This study shall be submitted for review by the Owner. The study shall include a conceptual design, including comparison of active versus passive corrosion control methods, and a bill of material for implementation of any recommended corrosion control system.

8.1.10 Lightning Protection

Lightning protection system shall be provided for building structures, transformers, the GT packages (including HRSG and stacks (regardless of stack thickness), the air-cooled condenser, and tanks.

Lightning protection for the building structures shall consist of air terminals installed at the highest points. The air terminals shall be connected together with copper cable and connected to the plant ground grid with copper down conductors. Protection system will be certified with a Master Label.

8.2 ELECTRICAL PROTECTIVE SYSTEMS

This Contract shall furnish and install a coordinated protective relay system to detect faults and trip the appropriate equipment. Owner will review and approve all protective relay equipment, logic, nomenclature and settings to verify consistency with the specifications and Owner's standards. Contractor will coordinate with switchyard supplier to ensure a proper interface.

In general protective relays are to be based on the Schweitzer relay products unless specifically approved by Owner. Any grouping of relays shall be provided with an SEL-2030 for remote modem access. Contractor to include communication lines to allow remote dial up capability. All protective relays shall be time synchronized using a station IRIG-B time signal. All relay currents, potentials, and trips shall be wired through test switches. When required relay outputs shall trip ElectroSwitch type LOR lockout relays with a minimum of 10 decks. Owner shall provide assignment of relay output contacts. All current, potential, and lockout trip contacts shall be wired through clear cover test switches.

8.2.1 Generator Protective Relays

The generator protection system shall be based on redundant SEL-300G multifunction relays. Relays shall include the following protective functions: 21 backup impedance; 24 volts/hertz; 32 Multi-step reverse power; 27TN/59N 100 percent stator ground fault; 46 Phase unbalance; 50/27 inadvertent energization; 50BF breaker failure (combustion turbines); 59 over voltage elements; 59N bus ground fault; 60 loss of potential detection; 78 out-of-step protection; 87 differential protection. In addition to protective functions relay shall have extensive metering capability, oscillography, self-diagnostics, and communication capability.

Each SEL-300G will be provided a lockout relay for turbine tripping and a lockout relay for generator tripping. Tripping, blocking, and initiate logic shall be consistent with Owner's operating requirements and coordinated with the switchyard protection.

8.2.2 Generator Step-up Transformer Relays

The primary protection shall be an SEL-387E that only includes the transformer windings in the protective zone. Relay shall trip dedicated lockout relay. Backup relaying shall be dual SEL-387's connected in unit differential configuration. Backup relays shall trip dedicated lockout relays. The protection zone shall include the 345 kV breaker, generator and auxiliary transformer tap (steam turbine does not have auxiliary transformer.) Dual sudden pressure contacts and dual neutral current transformers shall be provided as inputs to the protective relays.

8.2.3 Unit Auxiliary Transformer Relays

Protection for auxiliary transformers shall include an SEL-387E with a protective zone including the auxiliary transformer and switchgear main breaker. Provide lockout relay for status, blocking, and tripping functions.

8.2.4 Medium Voltage Switchgear and Motor Controllers

Provide SEL-351A multifunction protective relays for mains, ties, and non-motor feeder breakers. SEL-701 shall be used for protection for motor feeders. Relays will be configured to detect faults or abnormal operating conditions and trip appropriate breaker or alarm operator and coordinated with other protective devices. Any trip operations will include lockout functions to block closing of breakers without operator intervention.

8.2.5 Torsional Stress Monitoring and Protection

The Contractor shall provide a GE Turbine-Generator Torsional Stress Relay (TSR) to protect the turbine and generator from damaging torsional stresses. The system shall include a GE RC2000 digital transducer and control assembly. The Contractor shall provide and install all associated control wiring including shaft speed from toothed wheel transducer inputs and trips to generator and turbine outputs. The toothed wheel assembly shall be included as an integral part of the turbine package. The TSR shall also include a Torsional Stress Analyzer (TSA). One system shall be provided to protect all three units (both combustion turbine generators and the steam generator).

8.3 SWITCHYARD AND TRANSMISSION LINE TO MONA SUBSTATION

The Contractor shall design and install the new 345kV Currant Creek 2I switchyard and transmission line to the existing Mona Substation. Appendix "F", Appendix "R", Sections 1 and 2, and Appendix "S" include specification documents for the new Currant Creek switchyard and transmission line. This work also includes the relocation of the existing Block 1 transmission line near Mona Substation. Appendix "C" includes "reference drawings" which show the details of the Block 1 switchyard, the relocated Block 1 transmission line at Mona Substation, and the new Currant Creek 2 electric transmission line to Mona Substation.

Generated Electrical Power Interface: Contractor shall provide all facilities from the GSU high voltage bushings and including the generator step-up transformer, including 345 kV dead-end structure as required to generate electricity and transform it to 345 kV.

Switchyard Control, Relaying and Metering Interface: Contractor shall provide terminal cabinets located inside the switchyard control building for control, relaying and metering interface between the 345 kV switchyard and the power plant. Contractor shall provide all facilities required for control, relaying and metering interface on the power plant side of the switchyard junction box, including but not limited to, duct bank, wiring, programming, controls, and relaying and metering equipment.

RTU Communications Interface: Contractor shall provide an RTU (remote terminal unit) located in the Currant Creek 2 switchyard control building. Fiber connections shall be made directly to the RTU from the Currant Creek 2 DCS. Points not available in the DCS shall be hardwired directly to RTU. Contractor shall provide all facilities required for RTU communications on the power plant side, including but not limited to, duct bank, wiring, programming, and remote input/output interface equipment.

Ground Grid Interface: Contractor shall connect the plant-grounding system at two locations per generator step-up transformer for connection to the switchyard grounding system. Contractor shall connect fence grounding at all interfaces with the switchyard fence. Contractor shall extend ground system at a minimum of four locations to connect to any existing ground system.

Fence Interface: Contractor shall provide all fencing and gates for the switchyard. Fencing shall be installed in compliance with "PacifiCorp Standard 6B.5-Fence Application and Construction" dated September 2007" as provided in Appendix L.

Utility Communication Interface: On the Currant Creek 2 transmission line deadend structure located immediately outside the Mona 345kV Substation, Contractor shall provide a termination cabinet for Others to utilize for terminating fiber optic communication cable. Contractor shall install OPGW communication cable from the Currant Creek 2 switchyard to the deadend structure immediately outside the Mona 345kV Substation. Others shall install fiber optic communication cable from the Currant Creek 2 transmission line deadend structure in to the Mona 345kV Substation.

The Contractor shall provide two separate 480 V AC feeds to the switchyard to provide redundant AC power sources for the switchyard. Contractor shall also provide one 125 V

DC feed to the switchyard to provide redundant DC power source. Contractor shall provide one 1 kVA (to be validated) 120 V AC UPS supply to the switchyard control building interface cabinet.

8.3.1 GSU Deadend Structures

Contractor shall provide engineering, procurement and installation of GSU deadend structures including all supporting systems. These systems include but are not limited to all low and high voltage cable, conductor and connectors, raceway, foundations, grounding, and monitoring controls and protection. All high voltage systems shall be coordinated with plant switchyard design and installation. Owner reserves the right to approve final design and arrangement of the deadend structures.

Deadend structures shall have a conductor height of 45 feet, a shield wire height of 65 feet, mast height of 20 feet, phase spacing of 20 feet and a line angle from 0 to 20 degrees. Design conditions shall be NESC heavy loading. The structures shall be designed using the ultimate stress method. The following are maximum loads:

Conductor Loading – 3000 lb per conductor
Shield Wire Loading – 2500 lb per wire

8.3.2 Generator Step-up Transformers

This section covers power transformer equipment, material, and accessories. The power transformers furnished shall have all standard and normally supplied accessories ready for installation, connection, and immediate service. The following requirements are to be used in conjunction with the applicable sections of the Owner's specifications for transformers ‘Material Specification ZS 101, Power Plant Equipment – Generator Step-up Transformer, All Ratings included in Appendix F.

Transformers shall be generator unit step-up transformers (GSU), and shall be rated a minimum 5 percent over generator capability throughout the full ambient operating range with a temperature rise limited to 65°C. The method of cooling shall be ONAN/ONAF/ONAF. Step up transformers for the combustion turbines shall be designed for a minimum guaranteed efficiency of 99.7 percent and the steam turbine 99.75 percent at the top ONAF rating.

Transformer size, impedance and high side tap shall be selected to allow full range of generator reactive capability at the system nominal voltage. Transformer impedance shall be selected to limit fault current below generator breaker interrupting level, and allow starting of largest plant motor without exceeding NEMA starting criteria.

Transformers shall be provided with oil containment and drainage to the plant oil water separator. Drain lines shall be provided with normally closed manual drain valves.

Transformers shall be provided as a minimum with the following accessories and capabilities:

1. 4 (four) full capacity 21/2 percent taps, 2 (two) above and 2 (two) below nominal voltage rating for manual "no-load" operation.
2. Standard angular displacement of voltages to match existing Unit 1 GSU transformers.
3. Sound level not to exceed 85 dBA at 3 feet at top ONAF rating (or less if required to meet project sound limitations).
4. Manholes located in cover.
5. Lockable tap changer handle accessible from ground level.
6. Short circuit capability with only transformer impedance limiting fault current.
7. Accessible core ground bushing and well for core ground.
8. Detachable radiators with lifting eyes and upper and lower isolation valves.
9. Upper and lower filter connections with sample valves.
10. Qualitrol temperature monitor with a minimum of 8 output contacts, diagnostic alarm, communications capability, and analog outputs.
11. Oil temperature and level gauges.
12. Conservator or sealed tank with inert-gas pressure oil preservation system.
13. Pressure relief device with a semaphore visible from ground level.
14. NEMA 3R control cabinet with latchable doors.
15. Adequate number of current transformers with relay accuracy of C800 and metering accuracy of 0.3B1.8 (or as required by interconnect standards) for plant metering and relaying including any relaying interface with substation. Current transformers shall have a minimum thermal

rating factor of 2.0. A minimum of three current transformers on high side with at least one with metering accuracy and two on the low side.

16. Dual neutral current transformers.
17. Station Class surge arresters (internal surge protection not acceptable) with an MCOV of not less than 110 percent of line to ground voltage.
18. Discharge counters.
19. Sudden pressure relay device with dual outputs.
20. Fall protection device mounting provisions.
21. Serveron on-line gas analysis monitor with communications capability to the plant DCS, alarm and configurable analog outputs.
22. Copper windings with EHV-Weidmann insulation and materials suitable for 120° C continuous operation.
23. Local annunciator with common alarm or adequate alarms in DCS to quickly identify alarm source.
24. Maximum core flux density of 1.7 Tesla at no load and 100 percent rated tap voltage.
25. High temperature gasket material (Viton).

Factory Tests:

1. Notify Owner not less than six weeks prior to the starting date of the factory tests to permit observers to be present during the factory tests.
2. Procedures for factory tests shall conform to ANSI C57.12.90, unless otherwise specified. Except where a specific test method is specified, the factory test report shall state the test method used. Perform the following factory tests on each transformer unless otherwise stated:
    A. Winding ratio on rated voltage connections and on all tap positions.
    B. Winding polarity and phase relation on the rated voltage connections.
    C. Excitation loss at 100 percent and 110 percent of rated voltages on the rated voltage connections.
    D. Excitation current at rated voltages and at 110 percent rated voltages, on the rated voltage connections.
    E. Impedance and load loss at the maximum $65^{o}C$ rise rating.
    F. Temperature rise at the maximum $65^{o}C$ rise rating for the transformer supplied under this contract. Records of temperature

tests performed on duplicate or essentially transformers will not be acceptable.

G. Temperature indicator accuracy test.

H. Applied potential test.

I. Induced potential test with the transformer connected at rated voltage, with the transformer's own bushings in place, accompanied by partial discharge monitoring (to conform to ANSI C57.12.90) with transformers own bushings in place.

J. Switching surge tests on the high-voltage winding, with the transformer's own bushings in place.

K. Test all control wiring for continuity, grounds, and correct connections; and test operation of all relays, indicators, switches, lights, and interlocks.

L. Resistance measurements of all windings on the rated voltage connection and all load tap connections. Test results shall be reported in ohms at 75°C

M. Doble insulation power factor tests conforming to Method II in Table 4 of Article 10.10 of ANSI C57.12.90. The power factor shall be equal to or less than 0.5 percent at 20°C.

N. Lightning impulse tests on all winding terminals, with transformer's own bushings in place.

3. Perform the manufacturer's standard tests on each surge arrester.

8.4 PLANT AUXILIARY TRANSFORMERS

Transformer shall be suitable for operation throughout the full ambient temperature operating range. The method of cooling shall be ONAN/ONAF. Transformers shall have a minimum efficiency of 99.5 percent at the top rating. Transformer spare capacity at the top ONAF rating may drop below 20 percent when one auxiliary transformer is out of service. The following requirements are to be used in conjunction with the applicable sections of the Owner's specifications for transformers ‘Material Specification ZS 101, Power Plant Equipment – Generator Step-up Transformer All Ratings' included in Appendix F.

The continuous rating of the unit auxiliary transformers shall be as required to supply electrical power to the total plant (two combustion turbines and one steam turbine) auxiliary load under all operating conditions but not to exceed 4160 volt switchgear capability. Transformers shall be 100 percent redundant. The transformer impedance shall be selected to provide adequate voltage regulation and motor starting capability under all operating conditions.

Transformers shall be provided as a minimum with the following accessories and capabilities:

1. 4 (four) full capacity 21/2 percent taps, 2 (two) above and 2 (two) below nominal voltage rating for manual "no-load" operation.
2. Standard angular displacement of voltages.
3. Sound level not to exceed 85 dBA at 3 feet at the top ONAF rating.
4. Continuous over excitation capability of 110 percent at full load and 125 percent for 30 seconds.
5. Manholes located in cover.
6. Lockable tap changer handle accessible from ground level.
7. Short circuit capability with only transformer impedance limiting fault current.
8. Accessible core ground bushing and well for core ground.
9. Detachable radiators with lifting eyes and upper and lower isolation valves.
10. Upper and lower filter connections with sample valves.
11. Qualitrol temperature monitor with a minimum of 8 output contacts, diagnostic alarm, communications capability, and analog outputs.
12. Oil temperature and level gauges.
13. Pressure relief device with a semaphore visible from ground level.
14. Control cabinet with latchable doors.
15. Adequate number of current transformers with relay accuracy of C800 and metering accuracy of 0.3B1.8 (or as required by interconnect standards) for plant metering and relaying. At least one set of CT's on primary shall have metering accuracy. Current transformers shall have a minimum thermal rating factor of 2.0.
16. Sudden pressure relay device.
17. Serveron on-line gas analysis monitor with communications capability to the plant DCS, alarm and configurable analog outputs.

18. Copper windings with EHV-Weidmann insulation and materials suitable for 120° C continuous operation.
19. Maximum core flux density of 1.7 Tesla at no load and 100 percent rated tap voltage.
20. Fall protection device mounting provisions.
21. Grounding resistor.
22. Local annunciator with common alarm.
23. High temperature gasket material (Viton).

Factory Tests:

1. Notify Owner not less than two weeks prior to the starting date of the factory tests to permit observers to be present during the factory tests.
2. Procedures for factory tests shall conform to ANSI C57.12.90, unless otherwise specified. Except where a specific test method is specified, the factory test report shall state the test method used. Perform the following factory tests on each transformer unless otherwise stated:
    A. Winding ratio on rated voltage connections and on all tap positions.
    B. Winding polarity and phase relation on the rated voltage connections.
    C. Excitation loss at 100 percent and 110 percent of rated voltages on the rated voltage connections.
    D. Excitation current at rated voltages, and at 110 percent rated voltages, on the rated voltage connections.
    E. Impedance and load loss at the maximum 65^{o}C rating.
    F. Temperature rise at the maximum 65^{o}C rating for the transformer supplied under this contract. Records of temperature tests performed on duplicate or essentially transformers will not be acceptable.
    G. Temperature indicator accuracy test.
    H. Applied potential test.
    I. Induced potential test with the transformer connected at rated voltage, with the transformer's own bushings in place, accompanied by partial discharge monitoring (to conform to ANSI C57.12.90).
    J. Lightning impulse tests on all winding terminals, with the transformer's own bushings in place.

K. Switching surge tests on the high-voltage winding, with the transformer's own bushings in place.

L. Test all control wiring for continuity, grounds, and correct connections; and test operation of all relays, indicators, switches, lights, and interlocks.

M. Resistance measurements of all windings on the rated voltage connection and all load tap connections. Test results shall be reported in ohms at 75°C

N. Doble insulation power factor tests conforming to Method II in Table 4 of Article 10.10 of ANSI C57.12.90. The power factor shall be equal to or less than 0.5 percent at 20°C.

3. Perform the manufacturer's standard tests on each surge arrester.

8.5 4160 VOLT METAL-CLAD SWITCHGEAR

8.5.1 General

This section covers the furnishing of 4160 volt vacuum metal-clad indoor switchgear equipment, material, and accessories. Equipment shall be provided in accordance the conceptual one-line diagram. Switchgear will have continuous ratings as required and minimum short circuit duty of 50kA (symmetrical) with a K factor equal to 1. Ratings shall be confirmed during detailed design. Switchgear shall be draw-out type, with provisions for locking in the drawn-out position. Switchgear shall be arc-resistant. Switchgear will be of the same type and manufacture. Bus and breaker ratings of 4160V switchgear shall not exceed a maximum of 3000A. Lifting mechanism shall be provided for stacked breakers.

The continuous current rating, short-circuit interrupting capability, and short time current carrying capability of the 4160 volt switchgear and 4160 volt motor control center shall be coordinated with the ratings of the unit auxiliary transformer and the characteristics of the connected loads. All motors rated 4000 volts and all 480 volt secondary unit substations shall be supplied directly from the 4160 volt switchgear or 4160 volt motor control center. The 4160 volt switchgear shall be furnished with potential transformers and current transformers as required for protective relaying, metering, and control. Provide surge arresters on mains and feeder breakers.

Switchgear main bus shall be fully insulated copper. Control power shall be 125 VDC with mains, tie, and feeders controlled from the plant DCS.

Relays will be configured to detect faults or abnormal operating conditions and trip appropriate breaker or alarm operator and coordinated with other protective devices. Any trip operations will include lockout functions to block closing of breakers without operator intervention. Motor feeders 2500 hp or larger shall be provided with differential protection.

Provisions and space for future expansion of each line-up shall be provided.

8.6 4160 VOLT MOTOR CONTROL CENTERS

8.6.1 General

These specifications cover 4160 volt, general purpose, indoor motor control centers. The continuous current rating, short-circuit interrupting capability, and short time current carrying capability of the 4160 volt motor control center shall be coordinated with the ratings of the unit auxiliary and the characteristics of the connected loads. Motor control centers shall be arc-resistant.

The motor control centers shall be designed and fabricated with all normally supplied accessories for use on a 4160 volt, 3-phase, 60-hertz, 60 kV BIL, resistance grounded system, and shall be coordinated to protect motors over the complete range of overload and fault conditions. Construction of Motor Control Centers shall allow either one-high or two-high arrangements. Motor control centers shall be of the draw-out type, with provisions for locking in the drawn-out position. Lifting apparatus shall be provided for the two-high arrangements. Provisions shall be made, including space, so that the Motor Control Centers can be extended to include additional sections in the future. . Motor control centers shall be furnished with necessary ground connections, properly sized for interface with field ground cables.

8.6.1.1 <u>Codes and Standards</u>

All motor starters and motor control center components shall be designed and fabricated to conform to the requirements of NEMA standards for Class E-2 Industrial Control Equipment and to the requirements of applicable IEEE and ANSI standards. All materials and devices shall be in accordance with the applicable requirements of the

Federal "Occupational Safety and Health Standards". The latest edition of these codes and standards shall be applied to the manufacture of the equipment

8.7 480 VOLT SECONDARY UNIT SUBSTATIONS

8.7.1 General

Secondary unit substations shall be main-tie-main configuration, with coordinated pairs of switchgear that are normally fed from separate sources (normally open tie breaker), and with transformers, main breakers and tie breaker sized such that the entire double-ended pair of unit substations can be fed from a single source. Bus and breaker ratings for 480V switchgear shall not exceed a maximum of 4000A.

Each power transformer included with each secondary unit substation shall be rated to supply the total 480 volt auxiliary load plus 30 percent under all operating conditions and 110 percent of the auxiliary load when the tie breaker is closed and one transformer is out of service. The transformer impedance shall be selected to provide adequate voltage regulation and motor starting capability under all operating conditions. The continuous current ratings and interrupting ratings of the main breakers, tie breakers, feeder breakers, and main bus shall be coordinated with the ratings of the power transformers and the connected loads. Breakers shall be drawout air magnetic units. The secondary unit substations shall include feeder breakers required to supply the connected load, plus one additional equipped space for future use on each bus.

Overload and fault protection for loads connected to the 480 volt secondary unit substations shall be provided by solid-state trip devices which are an integral part of the drawout type air circuit breakers or separately mounted panel devices. Integral trip devices shall include long time, short time, instantaneous, and ground functions as required for a coordinated system. Trip units shall display metering information. If required, auxiliary power shall be provided for trip unit display at low loads.

General arrangement of unit substation shall be as indicated on the conceptual one-line diagram. This Contract shall provide substations of quantity and sizes to support the plant loads. One spare breaker of each frame rating (except for mains) shall be included for future use. Main and tie breakers shall have same rating and be electrically operated. MCC feeder breakers shall be manually operated.

Transformers for 480-volt secondary substations may be oil filled or cast coil for outdoor applications, or vacuum pressure impregnated (VPI) dry type for indoor applications. If dry type, they shall be indoor close coupled to 480-volt switchgear. Oil transformers shall have a maximum of 65° C rise, cast coil 80°C rise, and VPI 115°C rise. Oil filled units shall have high side BIL of 60 kV and low side BIL of 30 kV, ventilated dry type shall have BIL of 45 and 10 kV respectively, and cast coil 75 and 30 kV respectively. Transformers shall be low loss units and have a minimum efficiency of 99 percent. Transformers shall have the following accessories:

1. Externally operated no load tap changer (for oil type), bolted taps on dry type.
2. Lower drain valve and liquid sampling device (for oil type).
3. Dial-type thermometer with contacts for cooling control and high-temperature alarm.
4. Magnetic liquid level gauge with alarm contact for low level (for oil type).
5. Pressure/vacuum gauge (for oil type).
6. Lifting lugs and jacking pads.
7. Pressure relief device (for oil type).
8. Two ground pads, on diagonally opposite corners.
9. All other standard accessories.

8.7.1.1 Codes and Standards

Unit substation components furnished under these specifications shall be in accordance with the requirements of applicable IEEE, NEMA and ANSI standards. All materials and devices shall be in accordance with the applicable requirements of the Federal "Occupational Safety and Health Standards". The latest edition of these codes and standards shall be applied to the manufacture of the equipment

8.8 480V MOTOR CONTROL CENTERS

8.8.1 General

The Contractor shall furnish and install motor control center equipment, materials, and accessories as specified herein. The motor control centers shall be designed and constructed for use on a 480 volt, 3-phase, 60-hertz, 3-wire, solidly grounded system.

Except as specified otherwise, all equipment shall be designed for service with an ambient temperature of 40°C.

All equipment furnished under these Specifications shall conform to applicable standards of IEEE, ANSI, and NEMA. Motor control centers shall conform to UL 845, NEMA ICS1, NEMA ICS2, NEMA ICS4, and NEMA ICS6. All materials and devices shall be in accordance with the applicable requirements of OSHA standards. The latest edition of these codes and standards shall be applied to the manufacture of the equipment.

The continuous current rating of the motor control center main bus shall be as required to supply the total running load under all operating conditions, plus a 20 percent design allowance. The bus bracing and the interrupting ratings and continuous current ratings of the combination starters and feeder breakers shall be based on the available fault current and the characteristics of the connected loads. Each motor control center shall include the combination starters and feeder breakers required to supply the connected load, plus 10 percent spare units for each type size 3 and smaller. Motor control centers main breakers shall be protected by an adjustable long-time and short-time solid state trip device element for phase protection.

Each magnetic starter within an MCC which supplies power to a motor shall be equipped with a magnetic-only molded case circuit breaker and a microprocessor based overload system. Starters shall be supplied with control power transformers.

Certain loads will be fed from MCC feeder circuit breakers. The breakers shall be thermal magnetic molded case breakers sized to protect supply cable and individual loads.

All starter units and feeder tap units shall be readily interchangeable with units of the same type and size. At least one spare starter unit of each type and size used in that MCC shall be provided for future use in each motor control center. MCC's shall have provisions and space to expand at least one vertical section.

All units, except Size 5 starter units and 400 ampere frame or larger feeder tap units, shall be automatically disconnected and connected to the bus as the units are removed or replaced in the motor control centers. Size 5 starter units and 400 ampere frame or larger feeder tap units shall have fixed mounting within the motor control centers.

8.8.2 Circuit Breakers

Each combination starter unit and each feeder tap unit shall include one 3-pole, single-throw, 600 volt, molded case air circuit breaker with the appropriate amperes symmetrical interrupting rating at 480 volts. All breakers shall be manually operated with quick-made, quick-break, trip-free mechanisms of the toggle type. The breakers shall be equipped with suitable arc quenching devices. Main current carrying contacts shall be silver-plated and shall be capable of carrying their rated current without exceeding the Underwriters' Laboratories specified temperature rise. All circuit breakers shall be of the same manufacture.

Manual operating handles shall be furnished on the access doors of starter units and feeder tap units to operate the circuit breakers. Provisions shall be made for padlocking each handle in the open position. Each operating handle shall indicate when the breaker has tripped automatically.

The access doors shall be interlocked with the operating handles to prevent opening the doors normally when the circuit breakers are in the closed position. Provisions shall be made for overriding this interlock.

8.8.3 Combination Starter Units

All combination magnetic full voltage starter units shall include disconnecting and branch circuit over-current protective devices; 480 to 120 volt dry-type control transformers; 480 volt, 3-phase, 60 hertz contactors with microprocessor based overload relays. Control transformer leads, starter overload relay contacts, contactor operating coils, and starter auxiliary contacts shall be wired to marked unit terminal blocks. A minimum of 2 spare normally open and 2 spare normally closed contacts wired out to terminal blocks shall be provided on each starter. In addition, local indicating lights shall be included on each combination starter.

Low Voltage Variable Frequency Drive (VFD) equipment shall in a motor control arrangement and shall include the following:

- NEMA 12 Enclosure
- 110V AC Control Power
- 5% Maximum Harmonic Control

- Incoming breaker protection including phase loss, over frequency, line surge, over temperature, status and fault indicator displays.
- Ventilation/cooling system energized by separate power supply.

Disconnected and branch circuit over-current protection devices shall be magnetic instantaneous trip-only type circuit breakers as previously specified under Circuit Breakers.

8.9 GENERATOR TERMINAL EQUIPMENT/ISOLATED PHASE BUS DUCT

The generator terminal equipment includes the isolated phase bus duct, the generator circuit breakers, the generator transformer, and associated auxiliary equipment. The generator terminal equipment shall provide the interface between the steam turbine generator, combustion turbine generator, and the generator step-up transformers and neutral connections of steam turbine generator. Bus duct shall be selected with suitable continuous, momentary, and BIL ratings for this application and consistent with the applicable standards and considering operating and environmental conditions. Bus shall be provided with pressurized air system or heaters to prevent condensation. Bus shall include appropriate seals for connection to hydrogen cooled generators. System shall include adequate gauges, alarms, and controls for automatic operation.

8.9.1 GT Generator Bus Duct/Auxiliary Power Connections

Generator bus duct shall connect generator line terminal unit to the generator breaker and then to the generator step-up transformer with taps to the auxiliary transformers as depicted on the conceptual single-line drawing. Bus duct shall be self cooled with suitable continuous, momentary, and BIL ratings for this application and consistent with the applicable standards and considering operating and environmental conditions. The bus shall be a low loss design. The bus shall include seals at the generator terminals.

Tap bus shall be provided for connection to the auxiliary transformers. Tap bus shall have suitable momentary and continuous ratings.

Bus duct shall be provided with wall bushings / vapor barriers at transitions from indoor to outdoor sections.

8.9.2 Low Side Generator Breakers

A generator breaker shall be provided between the combustion turbine and generator step-up transformer. Each generator circuit breaker shall have a continuous current rating at least 125 percent of generator rating to transmit the generator output under all normally expected loading conditions. Each breaker shall have a short-circuit interrupting capability and short-time current carrying capability which is equal to or greater than the fault current available under any operating conditions. The potential transformers and current transformers shall be furnished as required for protective relaying, metering, and synchronizing of the generator to the grid.

The surge protection equipment shall include surge arresters and capacitors. The surge protection equipment shall be coordinated with the characteristics of each generator to provide protection for each generator insulation system. Generator breaker shall be provided with dual tripping coils, transformer side surge protection, generator side surge capacitor, isolation switch, grounding switch and generator side grounding switch. The generator breaker shall include all material required for termination of the isolated phase bus duct. Breaker shall be provided with adequate number of current and potential transformers to implement protective relaying as specified or required. At least one PT shall be a broken delta configuration with ferro-resonant loading resistor.

Access platforms shall be provided for the normal maintenance and operation of the units.

8.9.3 ST Generator Bus Duct

Generator bus duct shall connect the steam turbine generator directly to its step-up transformer. Provide PT and surge cubicle, and steam turbine bushing terminal enclosure**.** The isolated phase bus duct and tap bus shall have a continuous current rating as required under all normally expected loading and ambient conditions and suitable momentary ratings. The bus shall include seals at the generator terminals.

All medium voltage, isolated phase bus duct and accessories shall be designed, fabricated, and tested to the latest applicable standards of NEMA, IEEE, and ANSI. The latest editions of these codes and standards shall apply.

8.10 NON-SEGREGATED PHASE BUS DUCT

8.10.1 General

Non-segregated phase bus duct shall be utilized on all transformer secondary to main switchgear connections (other than main generator and close coupled SUS transformers) that are rated 1000A or higher. Bus duct shall have continuous and short circuit ratings equal or exceeding all equipment connected to the bus. Bus shall be non-ventilated and include all hot-dipped after fabrication support structures. Flexible connections shall be provided at each termination point to allow for differential settlement. Appropriate sealing method shall be provided for wall penetrations.

8.10.2 Bus Enclosures

Bus enclosures, fitting enclosures, and termination enclosures shall be ventilated-type for indoor locations and totally enclosed non-ventilated type for outdoor locations. Enclosures shall be fabricated from heavy gauge steel or aluminum with removable covers for access to splice points and heaters. All covers or access points shall be gasketed. Welded or riveted connection means shall be used for non-removable construction. Top covers shall be solid, removable, and gasketed. Removable bottom covers shall be provided where required for splice access. Bottom pan shall have filtered breathers for outdoor section. All steel framing and panels shall be chemically cleaned and phosphatized prior to painting. All outdoor and indoor sections shall be painted. Bus enclosure shall be such that mating parts with termination boxes, elbows, wall seal sections, and tees shall fit properly without warping, gaping, or distortion of the enclosure or accessories. Connections between joining sections of enclosures or accessories shall be bonded by the enclosure design or by jumpers to ensure electrical continuity of the enclosure. The enclosure shall be designed to be hung from overhead (indoors) or supported from below (outdoors). The bus duct manufacturer shall supply all support hardware, hangers, and pedestals.

8.10.3 Bus Conductors

Bus conductors shall be multiple flat bar copper with silver plating at connections with flame-retardant, track-resistant insulation, mounted on insulated supports. Bar size and quantity per phase shall be such that the continuous current rating specified shall not cause bar temperature rise exceeding 65°C above a 40°C ambient. Bars shall be insulated with "Noryl" sleeving or dipped with a fluidized bed epoxy coating. Bars shall be mounted within the housing with flame retardant, molded, reinforced fiberglass supports. Bars shall be braced to withstand the available fault currents specified. Splice points shall use bolted connections that are accessible after installation for inspection. Splices shall be fully insulated after installation with flame retardant PVC boots or flame retardant insulating tape and jacketing tape.

8.11 BATTERY/UPS SYSTEM

This section covers furnishing a generating station unit battery complete with charging system. Additionally, this section covers the furnishing of power conversion switching and distribution equipment for continuous supply of electric power to critical AC loads.

8.11.1 Codes and Standards

All equipment furnished under these specifications shall conform to applicable standards of IEEE, ANSI, and NEMA. All materials and devices shall be in accordance with the applicable requirements of the Federal "Occupational Safety and Health Standards." The latest edition of each code and standard shall apply.

8.11.2 Design and Construction

Each battery cell shall be wet cell, lead-acid pasted plate-type with lead-calcium alloy plate grids or sealed type with 20-year expected life. Cell containers shall be sealed, clear, shock absorbing, heat resistant plastic, with electrolyte high and low-level markers and spray-proof vents. Batteries shall be manufactured for full float service with a high discharge rate, low deterioration rate, and low maintenance. Batteries shall be supplied complete with all accessories (e.g. battery rack, inter-cell connectors). Racks shall be a 2 step configuration. Battery shall be installed in protected room ventilated with conditioned air. Battery shall have a final discharge voltage of 1.75 volts per cell and a design temperature of 25° C.

The DC power supply equipment shall include batteries (number of batteries and number of cells as required) of required voltage to provide 125-volt DC power for plant switchgear control power, protective relaying, steam turbine loads, and to the essential service AC system; two redundant ferro-resonant battery chargers for each battery; DC switchboard, and DC panelboards as required. The equipment shall supply DC power in emergencies to protect power plant equipment (UPS) and to ensure the safety of operating personnel. The equipment shall provide power to trip circuit breakers, to energize emergency bearing oil pumps, emergency lighting, continuous AC power supply equipment, and critical control and protection systems.

Each CTG shall be supplied with its own dedicated DC power system for combustion turbine DC loads.

The DC switchboard and panelboards shall have a main bus current rating as required to supply the connected load. Battery leads to switchboard shall be run in individual raceways for each pole. The continuous current ratings and interrupting ratings of the feeder breakers shall be based on the available fault current and the characteristics of the connected loads or the battery chargers. Each panelboard shall include the feeder breakers required to supply the connected loads plus six two-pole feeder breakers for future use. Switchboard shall include bus voltmeter, battery ammeter with shunt, ground detection and alarm, and low voltage alarm.

8.11.3 Rating

The Contractor, in accordance with IEEE 485 and these Specifications, shall determine the capacity of each battery. With the actual discharge capacity of the battery at 80 percent of rated discharge capacity, with the battery initially fully charged at the floating voltage specified, and with the battery chargers disconnected, the battery shall be capable of supplying the duty cycle specified. The ambient temperature during the duty cycle shall be 30° C. An aging factor of 25 percent and design margin of 20 percent shall be used. Contractor shall submit battery calculations for approval.

8.11.4 Duty Cycle

The batteries shall be sized to safely shut down the plant under emergency conditions without a source of auxiliary power or station service power. The station battery shall also have adequate capacity to supply emergency lighting, continuous AC power supply equipment, and critical control and protection systems for a period of three-hours following an emergency shutdown.

8.11.5 Battery Charger Requirements

Each battery charger-eliminator furnished shall be self-regulating, natural cooled, solid-state silicon controlled full wave rectifier type designed for single and parallel operation with the batteries specified under these Specifications. The parallel operation features of the battery chargers shall include cross-compensation providing for equal sharing of the charger loads. Chargers shall be able to provide the DC load requirements in the event that batteries are disconnected.

The chargers will be served from a 480 volt, 3-phase, 60 hertz system.

The battery chargers shall maintain output voltage within plus or minus ½ percent from no load to full load, with an input power supply deviation in voltage level of plus or minus 10 percent and an input power supply deviation in frequency of plus or minus 5 percent.

Solid-state electronic circuits shall have AC and DC transient voltage protection and shall be designed to recharge a totally discharged battery without overloading and without causing interrupting operation of AC or DC circuit breakers.

Redundant chargers shall be provided for each battery. Charger shall be a full capacity charger. Each charger shall have the capacity to carry the continuous load and recharge the battery in 8 hours following complete discharge. Battery chargers shall also have an equalizing charge mode. Battery chargers will be self-regulating after charging levels are manually selected. Battery chargers shall be manufactured in NEMA 1 enclosures suitable for placement in an indoor, environmentally controlled atmosphere. The battery chargers shall require only front access, and will allow either top or bottom conduit/cable entry.

8.11.6 UPS Equipment Requirements

The continuous AC power supply equipment includes a voltage regulator, inverter, static transfer switch, a manual bypass switch, and distribution panelboard. The equipment shall provide 120-volt AC power to essential plant control, safety, and information systems.

The equipment shall supply all plant essential loads that would be affected by a loss of power of more than 1/4 cycle and excessive voltage and frequency deviations. The equipment shall be rated so that one inverter can supply the total plant essential loads plus 10 percent for future expansion. The distribution panelboard shall have a main bus current rating as required to supply the connected loads plus six single-pole switches for future use. The ratings of the fuses shall be coordinated with the characteristics of the loads and the capabilities of the inverter. In addition to the plant loads furnished by this Contract, Contractor shall include critical AC loads for the combustion and steam turbine including HMI's, hydrogen control panel, fuel gas control station, communication equipment, SCADA RTU's, and other critical loads determined during design.

The following equipment shall be designed and assembled to provide 120 volt, single-phase, 60 hertz power to a 2-wire uninterruptible AC power system;

1	Static Inverter
1	Full Capacity Static Switch
1	120 Volt AC Distribution Panelboard
1	Manual Bypass Switch
1	Voltage Regulating Transformer

All equipment, enclosures, and accessories shall be designed, arranged, assembled, and connected in accordance with the requirements of these Specifications.

8.11.6.1 Static Inverter

The static inverter shall be solid-state type employing silicon controlled rectifiers and other required solid-state devices to convert direct current power to essentially sinusoidal alternating current power, and shall conform to the following characteristics and requirements:

Voltage	
Output	120 volts, single-phase, 60 hertz
Input (battery)	105 to 140 volts DC
Harmonic Distortion	Not more than 5 percent, 0 to 100 percent load
Voltage Regulation	Not more than plus or minus 2 percent at 0 to 100 percent load, 1 .0 to 0.8 power factor, 105 to 140 volts DC Input
Output, Self-Regulated	Automatic, not more than plus or minus 0.5 percent 0 to 100 percent load

Efficiency	Not less than 80 percent at rated load and 1.0 power factor
Duty	Continuous
Cooling	Natural convection or forced air cooling
Ambient Temperature	0-50°C maximum, 35°C normal
Minimum SCR De-rating	50 percent from peak voltage and peak current ratings

8.11.6.2 Inverter Capacity

The static inverter shall have the following minimum capabilities:

Continuous Full Load Rating	The inverter shall be sized to supply power for 110 percent of the Plant's critical 120-volt AC loads with 125 percent overload capability for 10 minutes.
Step Load Pickup	Upon transfer of full load, the inverter output voltage shall not drop below 75 percent of nominal voltage during the first half cycle after transfer and 90 percent of nominal voltage subsequently.
Fuse Clearing	Upon a fault in any branch circuit lateral feeder, the inverter shall have the capacity to carry a load equal to one-half of its full load rating and clear a 30-ampere, fast-acting fuse in 4 milliseconds (1 /4 cycle) or less. This requirement shall be met if the static switch fails to transfer from the inverter to the alternate source.

8.11.6.3 Static Transfer Switch

The static transfer switch shall use silicon-controlled rectifiers and other static devices required to automatically transfer loads from the "Normal" source to the "Alternate" source. The static transfer switch shall conform to the following requirements:

Capacity, continuous	Equal to the continuous full load capacity of the inverter
Capacity, peak	1,000 percent of continuous rating for 5 cycles
Voltage	120 volts, single-phase
Frequency	60 hertz

Transfer time sensing,	Including 1/4 cycle maximum. Transition shall be "make before break." Voltage failure shall be sensed on the output of the static switch. Failure shall cause the static switch to transfer. The static switch shall also transfer on over-current prior to the inverter reaching a current limit mode.
Voltage transfer to "Alternate" source	Automatic transfer to alternate source When output voltage of inverter deviates plus or minus 10 percent from nominal
Over-current transfer to "Alternate" source	Continuously adjustable from inverter Continuous rating to inverter current limit rating
Retransfer to "Normal"	Return to normal shall be automatic for all source externally caused transfers such as overload or clearing of a branch circuit fuse, but shall be manual for all internally caused transfers such as inverter, filter, or normal patch failure.
Overload	125 percent for 2 minutes
Line voltage transient	170-volt peak above normal line voltage tolerance
Ambient temperature	0-50°C maximum, 35°C normal
Cooling	Natural convection or forced air cooling
Duty rating	125 percent Continuous

The static switch shall be provided with protective fuses in both "Normal" and "Alternate" power sources. The static transfer switch shall be furnished mounted in enclosures described later in these Specifications.

8.11.6.4 Manual Bypass Switch

A manual bypass switch shall be used to isolate a static switch from its load and alternate power supply and to take it out of service without power interruption to the load. In so doing, it will connect the load bus to the alternate source. It shall have make-before-break contacts, so that power supply to the loads is continuous during switch operations. It shall be rated 600 volts, single-phase, 60-hertz, and shall have a continuous rating 125 percent of output rating.

8.11.7 Distribution Panelboards

Panelboards for distribution of continuous AC power to essential loads shall be dead-front type panelboards rated 120 volts AC. The hinged panelboard front shall cover the fuses and wiring gutter, but not the switch handles. The enclosure door shall cover the hinged front and switch handles.

Each panelboard shall be constructed for a 2-wire, single-phase distribution with a solid neutral bar. Phase and neutral bars shall be copper. Rating of the main lugs shall be equal to the rated continuous full-load current of the inverter.

Each panelboard shall have sufficient quantity single-pole, branch circuit protective devices to serve all loads plus 25 percent spare. Circuit protective device sizes required will be determined by Contractor.

Circuit identification labels or tags shall be provided on the panelboard front.

8.11.8 Construction Details

Details of construction shall conform to the requirements of the following paragraphs.

Enclosures shall be ventilated switchboard type, fabricated from not less than 14 USS gage sheet steel. Enclosures shall be designed to permit easy access to all components for maintenance or replacement. The enclosures shall be reinforced with formed steel members as required to form a rigid self-supporting structure. Doors shall have three-point latches.

Adequate ventilating louvers and openings and enclosure top panels shall be included. All vent openings shall be covered with corrosion resistant fine screen coverings.

If the equipment supplied requires forced air cooling, the cooling system furnished shall meet the following requirements.

1. Reserve cooling equipment shall be furnished for each switchboard assembly. Reserve fan capacity shall be equal to 100 percent of cooling fan requirements for full-load operation at the specified maximum ambient temperature.

2. Completely independent duplicate wiring and control systems shall be provided for the normal cooling fan system and the reserve cooling fan system.
3. Each cooling fan shall normally run continuously and shall be powered from the output of the inverter. Each cooling fan supply circuit shall be separately fused.
4. Each cooling fan shall be equipped with an airflow switch having an alarm contact that closes upon failure of airflow.

8.12 EMERGENCY DIESEL GENERATOR

8.12.1 General

Furnish and install an outdoor self-contained integrally assembled low-emission emergency diesel generator system with auto-start capability. An automatic transfer switch shall be provided for energizing critical loads. Critical loads include loads to keep the combustion turbines in the ready to start condition, battery chargers, turning gear, seal oil pumps, lube oil pumps, emergency lighting, and other loads as developed during the design phase. It is anticipated that the emergency diesel generator will be a 480V, 3 phase, 60Hz, 600kW, 0.85pf unit, however, the Contractor shall be responsible for the sizing of the unit.

Design of diesel generator with relation to air emissions shall be consistent with the Air Permit.

8.12.2 Design and Operation

Unit shall be designed for No. 2 fuel oil with an integral day tank for 18 hours operation before filling. Heaters shall be provided to maintain water temperature to allow unit to be brought to full load within 30 seconds of starting. Provide day tank fuel oil heaters. Provide local panel for control and monitoring of unit. Unit shall be capable of remote control from the plant distributed control system. Unit shall include an exercise clock. Unit alarms and fuel level information shall be displayed on the DCS. Unit shall be capable of automatic starting and synchronizing to hot or dead bus. Include any required fire protection equipment. The diesel generator shall have adequate controls to allow full load testing during plant operation by paralleling with plant auxiliary loads.

8.13 ELECTRIC MOTORS

Except for valve motor operators (specified elsewhere), these motor specifications are applicable to all electric motors furnished under these Specifications. Special requirements for individual motors and specifications for special application motors are included in the equipment technical sections, as required. All motors shall be Premium Efficiency.

All motors shall conform to applicable standards of ANSI, IEEE, NEMA, and AFBMA, except where modified or supplemented by these specifications. All equipment and materials shall be in accordance with the applicable requirements of the Federal "Occupational Safety and Health Standards." The latest edition of these codes and standards shall apply.

The motor nameplate horsepower multiplied by the motor nameplate service factor shall be at least 15 percent greater than the driven equipment operating range maximum brake horsepower. Motor ratings shall be based on site maximum design ambient temperature. Any motors used in variable frequency applications, such as air-cooled condenser fans, shall be rated for the application and type of drive.

Motors shall be designed for full voltage starting and frequent starting where required, and shall be suitable for continuous duty in the specified ambient. Intermittent duty motors may be furnished where recognized and defined as standard by the equipment codes and standards. Motors shall be sized for the altitude and temperature range at which the equipment will be installed.

Except as specified otherwise in the individual paragraphs or technical sections, the torque characteristics of all induction motors at any voltage from 90 percent rated voltage to 110 percent rated voltage shall be as required to accelerate the inertia loads of the motor and driven equipment to full speed without damage to the motor or the equipment.

8.13.1 4000 and 460 Volt Integral Horsepower Motors

Motors ¾- hp to 200-hp shall be rated 460-volt, 3-phase, 60-hertz. Motors 250-hp and greater shall be rated 4000 volt, 3-phase, 60-hertz. Design and construction of each 460-volt integral horsepower motor shall be coordinated with the driven equipment requirements and shall be as specified herein. Any exceptions shall be approved by Owner.

The following nameplate data shall be included:

1. Starting limitations, if any.
2. AFBMA bearing identification number for motors furnished with rolling element bearings.
3. Weight

For motors designed for service in hazardous areas:

1. Location class and group design.
2. Maximum operating temperature value or operating temperature code number.
3. All other motor data such as horsepower, FLA, service factor and related items.
4. All motor nameplates and attachment pins shall be corrosion-resistant metal.

All motors shall be self-ventilated unless required otherwise. Medium voltage self-ventilated motors shall have minimum WPII type enclosure. Low voltage self-ventilated motors shall have minimum TEFC type enclosure.

Enclosure parts for all motors (e.g., frames, bearing brackets, external fan covers) shall be made of cast iron, cast steel, sheet steel, or steel plates. Aluminum enclosure parts are not acceptable. All open-type motors and the fan covers of totally enclosed fan-cooled motors shall meet NEMA MG 1 requirements for a fully guarded machine.

Totally enclosed motors shall be furnished with drain holes and rotating shaft seals. Drain holes shall be provided with Crouse-Hinds Type ECD "Universal" combination water drain-breather plugs, or approved equal. Motors for outdoor service shall have all exposed metal surfaces protected with a corrosion-resistant polyester paint or coating.

In addition to the preceding requirements for outdoor service motors, totally enclosed motors with NEMA waterproof features shall have enclosure interior surfaces and the stator and rotor air gap surfaces protected with corrosion-resistant alkyd enamel or with polyester or epoxy paint or coating. Bolts, nuts, screws, and other hardware items shall be corrosion-resistant or heavy cadmium-plated metal. A rotating labyrinth shaft seal shall be furnished on the shaft extension end of the motor.

Motors specified for Class I, Group D locations shall be UL approved and labeled.

Except as specified in the following paragraph, all insulated windings shall have Class F Non-hygroscopic insulation systems limited to class B rise. Motors larger than 250 hp shall be provided with sealed insulation systems and be abrasion resistant for any open motors.

All insulated winding conductors shall be copper. The winding temperature rise for all motors, when operating at the nameplate horsepower multiplied by the service factor shall not exceed NEMA MG-1 class B insulation temperature rise (Table 12.43 for LV Motors and Table 20.7.2 for MV Motors), determined by resistance method, and adjusted for site altitude and ambient temperature. Motors larger than 250 hp shall have 2 embedded RTD's per phase.

Space heaters are required on all motors 25 hp and above. Space heaters shall be rated a 120 volts, single-phase, 60 hertz. Space heaters shall be sized as required to maintain the motor internal temperature above the dew point when the motor is idle. The space heaters shall not cause winding temperatures to exceed rated limiting values, nor cause thermal protective device "over temperature" indication when the motor is not energized.

Terminal housings for totally enclosed motors shall be cast iron. Terminal housings for all other motors shall be cast iron, pressed steel, or fabricated steel. Housings shall be diagonally or longitudinally split with a gasket between the split halves of the housing. Each housing shall have a threaded opening to provide a watertight, rigid connection with the conduit, and shall be designed for rotation in 90-degree increments, or have other provisions to receive conduit from any of four directions

All leads shall be wired into the motor terminal housing. All leads and their terminals shall be permanently marked in accordance with the requirements of NEMA MG 1, Part 2. Cable-type leads shall be provided with compression-type terminal connectors.

Motors 2500 hp and larger shall be provided with surge protection and current transformers (both installed in motor terminal box) for motor differential protection.

Each motor shall be furnished with a grounding connector attached to the motor frame inside the motor terminal housing. The grounding connector may be a lug or terminal or other acceptable grounding connector. Motors larger than 250 hp shall have grounding pad on frame for connection to plant ground grid.

Antifriction radial and thrust bearings shall be designed and fabricated in accordance with AFBMA standards to have a minimum: L_{10} rating life of not less than 130,000 hours for direct coupled service, and not less than 42,500 hours for belt or chain connected service. Grease lubricated radial bearings shall be double-shielded.

Oil ring lubricated-type sleeve bearings shall be provided with oil level sight glasses marked for required oil level at motor running and motor standstill. The oil ring shall be one-piece construction; split-type construction will not be acceptable. Stationary labyrinth seals shall be bronze material.

Sleeve bearings, end bells, and bearing housings for horizontal motors shall be split-type when available for the frame and the enclosure specified. Air gap measurement holes or other acceptable means will be provided in each motor end enclosure for checking air gap of sleeve bearing motors.

Sleeve bearings on horizontal motors shall be designed and located centrally, with respect to the running magnetic center, to prevent the rotor axial thrust from being continuously applied against either end of the bearings. The motors shall be capable of withstanding without abnormal damage the axial thrusts that are developed when the motor is energized.

Motors furnished with spherical roller thrust bearings shall also be furnished with deep groove radial guide bearings. One guide bearing shall be locked to the shaft so that the guide bearing will take upward thrust and to assure that the thrust bearing is always loaded. If spring loading is furnished, the guide bearing shall not be preloaded during normal operation.

Thrust bearings for vertical motors shall be capable of operating for extended periods of time at any of the thrust loading imposed by the specific piece of driven equipment during starting and normal operation without damage to the bearing, the motor frame, or other motor parts.

Stacked antifriction bearings will not be acceptable, except as vertical thrust bearings in frame sizes up through NEMA 360 Series open-type enclosures and up through NEMA 680 Series open-type enclosures. Where stacked bearings are furnished, matched pair precision tolerance bearings with flush ground sides shall be provided. Bearing seats on the shaft and in the bearing housing shall have accuracy equal to that of the bearing.

Grease lubricated bearings shall be self-lubrication and re-greaseable. Bearings and bearing housings shall be designed to permit disassembly in the field for inspection of the bearings or removal of the rotor.

Bearing lubricants shall contain a corrosion inhibitor. The Contractor shall furnish all lubrication information required to assure proper equipment startup and subsequent bearing maintenance.

All induction motors shall have squirrel-cage rotors.

Where shipment permits, motor output shafts shall be complete with motor half-coupling mounted, connected to the driven equipment, and adjusted ready for operation. Where motor size prevents shipment with motor connected to driven equipment, the motor half-coupling shall be factory-mounted for field connection to the driven equipment.

Motors shall have torque and locked rotor current in accordance with NEMA MG 1, Part 12 and sufficient to meet starting requirements of loads.

The maximum motor sound level shall be 85 dBA.

8.13.2 Fractional Horsepower Motors

Motors rated less than ¾-hp shall be rated 115-volt, single-phase, 60-hertz except for valve or damper operators. Motor rating, service factor, and nameplate data shall conform to the requirements of NEMA MG 1 standards.

Motor nameplate horsepower ratings shall not be exceeded when the equipment is operating within the limits of the design conditions specified. The motor loading shall not exceed the motor service factor rating on startup conditions or at the equipment maximum load point.

All motors shall be self-ventilated. Fully guarded enclosures shall be furnished on all motor enclosure types having accessible moving parts other than shafts. All insulated winding conductors shall be copper. Shafts of motors shall be furnished with corrosion-resistant treatment or shall be of corrosion-resistant metal.

Capacitors, as required, shall be furnished in removable metal enclosures mounted on the motor frame. Lock washers shall be provided under the heads of the enclosure hold-down bolts.

Manual reset thermal protection, for both stalled rotor and overload protection, shall be furnished on all motors where available unless specified otherwise in the individual technical sections. All motors shall be completely assembled with the driven equipment, lubricated, and ready for operation.

8.14 RACEWAY

This section covers furnishing and field installation of a complete raceway system in accordance with these specifications.

The raceway system is defined to include conduit, flexible conduit, continuous rigid cable supports called "cable tray" herein, underground duct, wireway, cabinets and boxes, and all materials and devices required to install, support, secure, and provide a complete system for support and protection of electrical conductors.

The design and specifications for the raceway system used in supporting and protecting electrical cable shall be in accordance with the provisions of the NEC. Fire stops shall be provided wherever raceways penetrate floors or fire rated walls.

Individual raceway systems shall be established for the following services:

1. 4160 volt power.
2. 480 volt and 125 Vdc power.
3. 600 volt control cable.
4. Special electrical noise-sensitive circuits or instrumentation cable.
5. Lighting

6. Fiber optical

Lighting branch circuits, telephone circuits, fiber optic cables, and intercommunication circuits shall be routed in separate conduit systems. Lighting circuits shall be routed in electrical metallic tubing (EMT) for indoor concealed areas, rigid conduit for hazardous exposed and outdoor areas, and polyethylene (PVC) tubing or Schedule 40 PVC conduit for underground.

Hot dipped galvanized conduit (after fabrication) shall be used for above ground power control wiring. Fiberglass or aluminum tray and conduit shall be used for corrosive areas.

Rigid galvanized steel conduit shall be used for routing individual circuits from the cable tray system to individual devices and pieces of equipment. Liquid-tight flexible conduits shall be used on all motor connections and all other connections subject to vibration.

All underground duct banks shall consist of Schedule 40 PVC conduit encased in concrete. Duct banks shall be reinforced at road crossings and areas subject to heavy loads. Duct banks shall have colored dye incorporated in the top two inches of concrete. Galvanized steel conduit shall also be installed for digital and analog low level circuits to provide noise immunity from adjacent power circuits if required. Risers shall be concrete encased conduit. Spare ducts shall be provided in each duct bank run equal to 20 percent of the total number of ducts with the size of the spare ducts equal to the largest size duct in the duct bank. Duct banks shall be sloped to provide proper drainage.

Duct banks shall be assembled using non-magnetic saddles, spacers and separators as recommended by the duct manufacturer. Separators shall provide 3 inches minimum concrete between the outer surfaces of the conduits.

All conduit shall have a maximum fill capacity not to exceed thirty (30) percent of the conduit's inside cross sectional area.

8.14.1 Routing of Above Grade Raceway and Conduit

The Contractor shall route raceway and conduit and shall coordinate conduit locations with other equipment and structures. Raceway and conduit shall be routed so that, except where they are being lowered to enter equipment, the lowest part of the raceway or conduit, including its associated supports and appurtenances, is at least 6'-8" above the closest floor or walking surface beneath it. Raceway and conduit may be routed a reasonable distance away from the supporting wall, ceiling, or structural member so long as the specified support is provided, interference with other equipment and structures is avoided, and the routing is acceptable to the Owner. Raceway and conduit, including their associated supports and appurtenances, which must be routed closer than 6'-8" above the closest walking surface beneath it, shall be routed as close as possible to surfaces of walls, columns, and the equipment served. Conduit supports shall be spaced no longer than 10 feet. All junction, terminal, and pull boxes shall have construction suitable for the environment and area classification. Expansion couplings are required for every 100 foot.

All raceway and conduit shall be installed in a neat, rectangular form. Special attention shall be given to securing a neat appearance. All raceway and conduit shall be installed perpendicular or parallel to the major equipment, building structure, and floor levels, except in special cases consented to by the Owner. All cable tray and conduits, including field routed, shall allow for unobstructed maintenance access to all plant equipment including removable access panels and roof covers.

8.14.2 Electrical Cable Tray System

An electrical cable tray system shall be furnished and installed in accordance with these Specifications. The electrical cable tray shall be in accordance with the requirements of NEMA VE 1 except that, in case of conflict between the requirements of these Specifications and the requirements of NEMA VE1, the requirements of the latter shall govern to the extent of such conflict. Tray shall be installed in a continuous system. In addition to and concurrent with the load specified in this section, the tray shall be designed to withstand a concentrated load of 200 pounds at the mid-span, at the center of the rung or on either side rail.

Cable trays shall be of ladder-type construction with a rung spacing of 6 to 9 inches, nominal depths of 4 to 6 inches, and various widths as required. Cable trays shall be supported in accordance with NEMA VE-1 standards.

Cable trays and fittings shall be the standardized products of a single manufacturer designed to permit easy assembly in the field. The parts shall consist of the manufacturer's standard straight sections, crosses, tees, reducers, flat and riser elbows, as required to suit the layout. Coupling between the members shall be manufacturer's standard. All fittings shall be designed and constructed so that (1) the assembled system will be free of sharp edges or projections on surfaces which contact the cables, and (2) the cables will not be bent, either during installation or in the final position to radii less than allowable for each respective size and type. Dropout fittings shall be provided where required to maintain the minimum cable-bending radius. Where warranted, Contractor may use tray dividers for different class cables. The fill of each of the respective sections shall not exceed NEC limits.

Solid bottom trays shall be provided for all special noise-sensitive circuits and analog instrumentation circuits. Instrumentation trays shall be of steel solid bottom trough tray, galvanized after fabrication. All instrumentation trays shall have complete coverage with solid tray covers. Standard ladder type tray without tray covers may be utilized for instrumentation circuits if this installation method and separation criteria is acceptable to equipment vendors. In any case, shielded, twisted pairs shall be utilized for all low level signals.

All trays shall be of steel or aluminum construction, width and depth as required for application. All trays shall be designed with a safety factor of 2.0. Cable tray shall be labeled with the tray type and node designations shown on the Contractor's drawings. Labels shall be of the adhesive type and shall be applied to both sides of each tray at the locations shown on the Contractor's Drawings. Letters and numbers on the labels shall be a minimum of two inches in height and shall be colored as follows:

Power Tray: Black characters on red background
Control Tray: Black characters on yellow background
Instrumentation Tray: Black characters on green background

8.14.3 Covers

Except as specified otherwise herein, all indoor vertical trough and ladder-type trays shall be furnished with ventilated covers to provide mechanical protection to cables which are exposed to traffic. All indoor horizontal trays located under grating floor or insulated pipe shall be furnished with covers which, on trough and ladder-type trays, extend at least two feet beyond that part of the trays directly exposed beneath the grating floor or insulated pipe. Indoors, covers may be omitted on those lower trays of stacked trough and ladder-type trays where a covered tray at a higher elevation in the stack provides complete vertical shielding to the lower tray. The top level of outdoor tray runs shall be furnished with covers. Tray covers and the cover attachments, for outdoor tray, shall be designed to withstand high wind conditions. Trays which are specified to have solid bottoms shall also have solid covers throughout including all horizontal runs, all fittings, and all vertical runs.

8.14.4 Tray Supports

Tray supports shall be furnished and installed in accordance with these Specifications. The Contractor shall be responsible for designing the cable tray support system within the allowable limits specified by the manufacturer of the support hardware.

Each support shall be capable of supporting the uniform weight of the trays, plus their nominal uniform cable loads, plus a 200-pound concentrated load without exceeding the allowable limit of any element of the support system. The safety factor of support hardware shall not be considered in determining the suitability of any element, except that the safety factor shall not be less than 2.0 for any support element.

Hanger rods shall not be smaller than 1/2-inch diameter electro-galvanized threaded steel rods.

8.14.5 Material

Underground duct system materials furnished under these Specifications shall be new and undamaged and shall conform to the following requirements:

Duct	Polyvinyl chloride, Schedule 40 PVC in accordance with NEMA TC-2.
Couplings	Plastic, for use with duct previously specified and "Duct-to-steel" adapters as required, including joint cement.
Spacers	Plastic high impact, interlocking, base and intermediate type
Factory bends and sweeps	Schedule 40 PVC, 36 inch minimum radius
End bells	Plastic
Plugs	Plastic, high impact, tapered to fit end bell provided
Duct binder	Hemp or sisal twine coupling
Riser termination	Rigid hot-dip galvanized mild steel coupling
Riser bends	Rigid steel conduit elbows, factory or field made, 36-inch minimum radius, 90 degree, entirely concrete encased below grade; hot-dip galvanized rigid mild steel in accordance with ANSI C80.1 and UL 6; the conduit interior and exterior surfaces having a continuous zinc coating with an overcoat of transparent enamel or transparent lacquer.

8.15 CONDUCTORS

In general, conductors shall be insulated on the basis of a normal maximum conductor temperature of 90°C in 40°C ambient air with a maximum emergency overload temperature of 130°C and a short-circuit temperature of 250°C for medium voltage cables and 75°C for 600 volt cables. Power conductor size and ampacity shall be coordinated with circuit protection devices. Conductor minimum size shall be the largest conductor of the following:

1. Applicable standards
2. Maximum ambient temperature
3. 125 percent of connected load
4. For bus feeders 100 percent of connected load plus 25 percent of running load.
5. 90 percent minimum motor terminal voltage on starting (except if motor is designed for lower terminal voltage)
6. Voltage drop from no load to full load for switchgear and MCC's excluding transformer drop per NEC.
7. Computerized thermal model of cable position in duct bank (85°F average soil temperature).
8. Cable temperature rise due to short circuit.
9. Worst environmental condition when routed through multiple areas.

Insulated cable, conductors, and conductor accessories shall be furnished and installed in accordance with the requirements of this section of these Specifications. Insulated cable, conductors, and conductor accessories shall be furnished in quantities sufficient for a complete installation as indicated in these Specifications.

Installation shall be defined to include placement, splicing, terminating conductors; coiling and taping of spare conductors; identification, testing, and verification of each circuit, cable, and conductor. Installation of cable in trays shall also include removal and replacement of cable tray covers. Installation shall be in accordance with manufacturer's requirements. Manufacturer's pulling or side wall tension shall never be exceeded. Contractor shall submit recorded cable tension reports. Cable shall be supported by conduits or tray for any cable routed over tray side wall. Any bottom exit cables shall be shall have suitable fittings. Cable in vertical tray risers shall be supported every 2 feet or less to prevent stress on cable.

Terminating a conductor shall include installing cable termination kits for shielded cable, attaching the conductor at its designated location, and insulating the entire connection where specified or required by the application.

8.15.1 Cable Specifications

The cable furnished shall be flame retardant construction meeting IEEE 1202 and UL 1581 and manufactured in accordance with the applicable ICEA standards and suitable for wet or dry locations. All cable installed in trays shall be rated for tray use. All cable shall have surface printing showing manufacture's name, insulation type, jacket type, conductor size, conductor type, voltage rating, and numbered footage markers. Control and instrument cables shall be terminated with ring tongue connectors. Compression type terminals may be utilized if this is the manufacturer's only offering. Special construction cables as required to meet equipment supplier requirements (turbine-generator) shall meet the following requirements to the extent possible in addition to meeting supplier requirements. Control, metering, and relaying cables routed to the switchyard shall have construction as follows except cable is to be shielded

The cable furnished shall conform to the cable descriptions included below:

Cable Type	Description
Medium Voltage Power	25,000 and 5,000 volts, single-conductor and three conductor with ground, Class B stranded copper, ethylene propylene rubber (EPR) 133 percent insulation, conductor, insulation and tape shield; and chlorosulfonated polyethylene (CSP), polyvinyl chloride (PVC), or chlorinated polyethylene (CPE) jacketed. Where specified by OEM unshielded cables are to be used.
Low Voltage Power	600 volts, single-conductor, Class B stranded copper; EPR or XLP insulated; CPS, PVC, or CPE jacketed.
Low Voltage Power	600 volts, three-conductor; concentric lay, stranded copper with a ground wire in the interstices; FRXLPE or FREPR insulation; CSP, PVC, or CPE jacketed overall.
Control	Control cable, 600 volt, multiple-conductor, as required, stranded copper, 10 AWG, 12 AWG, 14 AWG; multiple-conductor, XLP insulation; CSP, PVC, or CPE jacketed overall.

Cable Type	Description
Thermocouple	Thermocouple extension cable, one, four, six, and eight twisted pairs, solid alloy conductor with the same material as the thermocouples, with shield over each pair (except for one-pair construction) and with an overall shield, 16 AWG single pair; 20 AWG multi pair; FRXLPE or FREPR insulation; aluminum mylar tape shield with drain wire; CSP or CPE jacketed overall.
High Temperature Thermocouple	High temperature thermocouple extension cable, single-twisted pair thermocouple extension cable; solid alloy conductor with the same material as the thermocouples; 20 AWG; with normal maximum operating temperature of 200° C; Teflon insulation; aluminum mylar tape shield with drain wire; Teflon jacketed overall.
Instrumentation	Instrumentation cable, 300 V minimum, flame retardant single-and multiple-twisted pairs and triads, shielded instrument cable with individually shielded pairs, overall shield, and overall jacket; FRXLPE or FREPR insulation; CSP, PVC, or CPE jacketed overall. (Single pair or triad 16AWG, multi-pair or triad 18AWG).
High Temperature Instrumentation	Same as instrumentation able above 200°C Teflon insulation and jacket.
High Temperature Fixture Wire	High temperature control and fixture wire, single-conductor control cable; stranded copper; 12 AWG; stranded copper, with normal maximum operating temperature of 200°C; silicone rubber insulation; braided glass jacket.
Lighting & Receptacles	Lighting circuit runs totally enclosed in conduit, NEC Type RHH-RHW-USE with XLPE insulation for use in outdoor or unheated areas.

8.16 GROUNDING

This section covers the furnishing and installation of grounding materials complete as specified herein.

The station grounding system shall be an interconnected continuous network of bare copper conductor and copper-clad ground rods (ground wells maybe used instead of ground rods if dictated by the soil analysis). The system shall be designed to protect plant personnel and equipment from the hazards that can occur during power system faults and lightning strikes. Contractor shall perform ground resistivity testing prior to final design to determine ground analysis parameters. Ground system design will include switchyard and incoming lines in the development of the ground model. The grounding system shall be designed to ANSI/IEEE standard 80, 142, and 665 and NEC Sec. 96A.

Contractor shall not locate and route any ground "stingers" across walkways which can become tripping hazards. This includes ground floor slabs and concrete foundations where Owners employees will be working during the operation and maintenance of the plant.

8.17 PLANT SECURITY SYSTEM

Contractor shall install raceway, power cable, and fiber optic cable to each of the plant fence corners, main entrance gate, contractor turnstile gate, and other areas as shown in Appendix P Security Conduit Termination Locations Drawing. The cables shall be routed to an area designated by Owner in the control room for connection to Owner furnished security system

8.18 ELECTRICAL TESTING

Contractor shall perform detailed testing for all equipment, materials, and systems furnished under this Contract. Equipment shall be tested in accordance with manufactures instructions and NETA (National Electrical Testing Association - Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems) requirements. In addition to equipment tests, Contractor shall perform functional tests to verify proper operation and interlocks of equipment. Any procedures that may affect the existing plant shall be coordinated with Owner.

Contractor shall prepare detailed written step-by-step procedures for major electrical functional tests such as back-feed and synchronization. Procedures shall include predicted values as well as actual measured values. These procedures shall be submitted to Owner for review and comment. Prior to the start of any of these major tests, all associated parties shall sign-off on the procedure.

Contractor shall prepare a hardbound notebook with copies of the testing reports. In addition CD's shall be prepared with electronic copies of the reports plus any manuals, software, or reference material used in the plant testing. Owner may choose to witness some tests. Prior to start of the testing program coordinate with Owner to identify tests they may witness.

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SECTION 9.0
INSTRUMENTATION AND CONTROLS

9.1 GENERAL REQUIREMENTS

This section covers the minimum scope, technical requirements and quality standards for the combine cycle power block instrumentation, control systems, Equipment and interfaces with other plant systems and facilities. The Contractor shall provide all Materials and labor for the engineering, design, procurement, delivery, staging, installation, construction, inspection, factory testing, startup, and commissioning of all instrumentation and controls systems specified herein and necessary for a complete, functional combine cycle power generating facility and in conformance with generally accepted practices for generating facilities. All control and instrumentation design will be performed under the supervision of a Professional Engineer. In addition, all Work shall comply with applicable codes and standards identified in Section 3.0 including all State and local codes, laws, ordinances, rules and regulations.

Provide instrumentation and controls for the plant to keep the number of plant operators to a minimum while providing sufficient monitoring and control capabilities, ensuring continued safe and reliable operation of the plant, and alerting the operators to any abnormal conditions or situations requiring manual intervention in a timely manner. The facility shall be capable of operating at all normal and abnormal conditions, including hot startup with one control room operator and one outside operator. During cold startup, the plant shall be capable of operating with one control room operator and two outside operators.

The integrated control of all plant systems shall be accomplished using the Emerson Ovation Distributed Control Systems (DCS) as described in this Specification.

Provide discrete, independent, and dedicated I/O racks, DCS controllers, and operator interfaces. Controllers and operator interfaces shall be networked together to provide an integrated control system. The controllers, I/O racks, raceways, and conduit shall be completely physically independent of other system. DCS, controller, communication modules, I/O racks shall be partitioned to logical arrangements.

In general, modulating controls shall be backed up by interlocks and/or safety systems which cause pre-planned actions in cases where unsafe conditions develop faster than the modulating controls or the operator can be expected to respond.

Skid mounted Programmable Logic Controllers (PLC) shall be interfaced with the DCS to provide full remote control and monitoring capabilities to the operator. Specific control and monitoring requirements for major systems are described in the Specification sections covering the systems.

All instrumentation and control equipment shall be of proven design and shall be selected to achieve the highest level of plant availability and ease of equipment maintenance. Control and instrumentation provided shall be complete in all respects, requiring no further additions. Standardization of instrumentation and controls hardware shall be observed throughout the Project. All instruments, control valves, PLC controllers, and other control devices of a common nature shall be of the same manufacture, and wherever practical, shall be of identical model. DCS controllers shall be of identical manufacture and model. All electronic field devices shall be Smart, Highway Addressable Remote Transducer (HART) compatible.

All PLC controllers shall be Allen Bradley (Control Logix) and shall be located in air conditioned rooms or enclosures.

In general, local single closed loop control may be utilized for the control of systems that do not require optimization such as, for example, blowdown tank level. Individual sensors with integral or local controls, for example, direct level controllers shall be utilized for these types of loops.

Redundant components, as required by code, shall be installed as completely separate devices with individual sensing taps and individual isolation capability.

All critical sensors for continuous controls and protection shall be redundant. No control I/O signals shall be multiplexed. Indication signals may be multiplexed at the Contractor's option.

Mechanical equipment shall be provided with safety interlocks incorporated into the system controls to prevent damage to the equipment. Mechanical systems shall incorporate in their control the necessary equipment recommended by the manufacturer to assure that operational Contract conditions, as set forth by Owner, have been complied with.

Mechanical equipment on standby status shall automatically start when system conditions are beyond the parameters set for normal operation. Annunciation shall be provided whenever a "standby" piece of equipment is placed into service.

9.2 OPERATING PHILOSOPHY

This is a fast start and cycling plant. As such its equipment and systems will be exposed to frequent transients during startup and shutdown. It is the intent of this specification that the plant shall be operated at all times and during all transients within the design basis and limitations specified by suppliers of all equipment and systems so that all components are capable of completing the specified design fatigue life without premature failures or replacement and expected equipment durability will be obtained from all equipment. The CTG, HRSG and Steam Turbine Suppliers, or Power Island Suppliers (if applicable) shall each provide necessary information related to equipment they are supplying to permit the other key equipment suppliers and themselves to provide to the EPC Contractor the information he needs to develop a set of total-plant integrated detailed operating procedures for the lead and lag CTG/HRSG for each of cold-ambient, cold, warm and hot starts and for detailed normal shutdown procedures of the lead and lag CTG/HRSG from full pressure 100 percent load to about 75 percent pressure at the start of hot standby. The EPC Contractor shall document these procedures via written descriptions and plots of event sequenced steps from critical point to critical point in the startup, their timing, and expected operating parameters (temperatures, pressures, ramp rates, emissions rates etc) developed to comply with the critical equipment acceptance targets and limitations set by CTG, HRSG and Steam Turbine Suppliers. The procedures and plots shall take into consideration all plant equipment design and operating limitations during both steady state and dynamic operating conditions during loading at startups when CTG exhaust gas temperature and flow is increasing and HP superheater and reheater outlet steam temperatures, pressures and flows are changing. The startup and shutdown procedures must also observe all regulatory permit requirements and limitations. The procedures designed by the EPC Contractor for startups and shutdowns shall be utilized by the EPC Contractor prior to first fire for initial set-up and tuning of the Plant Control System and for operating the plant during startups and shutdowns performed during commissioning and initial operation of the plant.

The Plant Control System shall be designed by the EPC contractor to execute those steps in the foregoing startup and shutdown procedures that are amenable to automation. The Plant Control System shall provide fully automated shutdown of the plant from the time when HP superheater and reheater outlet steam temperatures fall below their rated design temperature and HP and hot reheat steam is diverted from the steam turbine to the HP bypass and hot reheat dump systems down to CTG shutdown and prompt preparation of the HRSG for hot standby with all steam, feedwater, continuous blowdown, vent and drain isolation valves closed.

During startups, both the "lead" and "lag" CTG exhaust gas temperatures shall be controlled so that critical HRSG pressure parts and critical steam turbine components are heated at rates within their design limitations for target fatigue life. Examples of critical pressure parts and steam turbine components include steam drums, superheater headers and outlet pipe manifolds, HP first stage metal, etc.

During startups and shutdowns, the HP turbine bypass and IP/LP turbine bypass systems shall maintain stable upstream pressures without fluctuations to adjustable inlet pressure setpoints established though the DCS. During normal on-load operation with the HP turbine and IP/LP turbine bypasses shut, their inlet pressure control setpoints shall continuously shadow by a predetermined additional small differential pressure the prevailing HP steam and hot reheat steam pressures such that the HP turbine and IP/LP turbine bypasses will open when their inlet pressure rises to the respective prevailing setpoint pressure following a steam turbine trip from any load and the HP turbine and IP/LP turbine bypasses shall then maintain stable upstream pressure without fluctuation.

The EPC Contractor shall develop control logic and operating procedures such that during all controlled shutdowns of either the "lead" or "lag" CTG, or of both CTGs simultaneously, the CTG exhaust gas temperatures shall be controlled so that HRSG superheater headers are cooled to as close as possible to 50°F (28°K) above saturation temperature at a predetermined rate of reduction in HP superheater outlet steam temperature. This rate of reduction shall be compatible with the specified design lifetime numbers of shutdown-startup cycles and within the design limitations to maximize fatigue life of the HP superheater headers. During the shutdown the HP superheater outlet steam pressure shall be maintained by the steam turbine and HP bypass inlet pressure control systems at 75 percent of the design maximum operating pressure. This shall be accomplished by operating the combustion turbine in an exhaust gas temperature control mode with the setpoint for exhaust gas temperature continuously adjusted downwards during unloading of the CTG from some point below 50 percent load in accordance with exhaust gas temperature versus time algorithm(s) established in the DCS. The EPC Contractor shall include logic in the DCS to accomplish this requirement. If the combustion turbine has an exhaust gas temperature versus CTG output characteristic that causes the exhaust gas temperature to continuously reduce from some temperature above 1050°F (566°C) as CTG output is lowered the Contractor shall develop logic that reduces the CTG output to a characteristic versus time that obtains the exhaust gas temperature and consequent target superheater outlet steam temperature versus time characteristics desired. During the shutdown extended to obtain an acceptable steam-cooling rate for the thick superheater outlet headers the CTG will have to operate longer at loads between the lowest load at which the CTG can operate in emissions compliance and minimum CTG load. Time limits for out-of-emissions compliance shall accommodate the additional out-of-compliance operation during normal cycling operation shutdowns.

9.3 DISTRIBUTED CONTROL SYSTEM (DCS)

The DCS shall be designed for automatic supervisory control of the combined cycle generation plant as well as to initiate manual commands and shall provide safe, reliable, and efficient operation of the plant. The EPC Contractor shall ensure that all processor based equipment is up to date with the manufacturer's latest firmware. The Owner's DCS system standard is Emerson Ovation.

The DCS shall include supervisory controls, plant process operation monitoring, plant operating condition indication, and display to advise operating personnel of the current operating status of the plant. During normal operation or in the event of an abnormal plant upset condition(s), the DCS shall enable the operator to take over and manually control the plant.

The DCS shall contain sufficient built-in hardware and software redundancy to include but not limited to redundant control processors, redundant data highway and power supplies with automatic changeover to the standby unit upon detection of a fault of the operating units. The failure of any single element shall not affect the operations or monitoring of the plant.

The DCS shall be utilized to the maximum extent possible for control, monitor, logging, alarm annunciation of plant equipment and the process. Features of the DCS shall include redundancy of controllers, redundancy of power supplies, operator stations, printers, and redundant communications. In addition to control capabilities, the system shall include all features required for historical data recording, data processing, and minor calculations for report generation and billing purposes. Consolidation of files shall be selectable. A minimum of 250 days data storage capacity shall be provided with system to allow for downloading to a CD/DVD drive or DAT-tape drive. Data storage should be configured using RAID.

Where process equipment is furnished with its own packaged controls and instruments, these devices shall be interfaced with the DCS as required to provide full data for monitoring, logging, to annunciate, and acknowledge alarm conditions, and to fully communicate DCS commands and responses to and from the packaged controls as required via redundant gateway interfaces.

A control room operator using the DCS shall be capable of supervisory control including starting, stopping, normal operation, and monitoring and acknowledging of alarms for the gas turbine generator(s) and steam turbine without physically needing to go to the CTG or STG control interfaces.

Provide first-out indication, annunciation, alarming, and sequence of event (SOE) monitoring, time stamp to 1 millisecond for each CTG and STG. Provide a GPS time stamping synchronization system or Owner approved equal for the synchronization of all system clocks.

Installation of the DCS shall be in accordance with the manufacturer's recommendations and guidelines. Installation shall take into account noise and grounding considerations. A complete power-up and grounding check shall be performed subsequent to cabinet installation and prior to beginning terminations. The Contractor shall be responsible for the application loading and debugging of all software, and for testing, calibration, startup and commissioning of the DCS and communication links with other plant systems.

Coordination of all electrical and steam generating systems with respect to one another shall be maintained and designed into the DCS controls so that a change in plant load demand shall be translated into a smooth, characterized change in demand to each affected system. The coordinated control shall recognize all limitations exhibited in these systems and shall take appropriate action.

The DCS shall be supplied with all process signals required to perform calculations and comparisons by the operator.

The plant consumption and generation of energy shall be monitored and logged in the DCS. Metering requirements are provided in Section 8. Reports shall be generated for each billing period documenting gross and net generation. These reports will be used to confirm the utility furnished metering system and may be relied on for billing in the event of a utility metering system malfunction.

Provisions shall be made for the prevention of unauthorized or accidental changes to system configuration. System data logging and recovery capability shall be provided so that control system configuration and database can be quickly restored in the event of an operator error or system failure.

The DCS shall include the necessary equipment and software to interface with the Owner supplied PI data storage system.

The DCS shall be designed to be capable of complying with NERC CIPS requirements

The DCS shall also include the following capabilities for monitoring and controlling electrical systems within the facility, displayed on operator console graphic screen(s):

1. Control, status, and alarm indications of all high voltage circuit breaker on electrical one-line diagram.
2. Analog Input and output signals as indicated on electrical one-line diagram.
3. Control, status, and alarm indications of the emergency AC system transfer switches.
4. Status and alarm indications of uninterruptible power supply (UPS) and DC system.

5. Other analog, status, and alarm indications for complete monitoring of electrical systems and subsystems.

DCS system shall have the following as a minimum:

1. Four operator workstations for plant monitoring and control each equipped with an operator keyboard, mouse, and dual 22" CRT Flat Panel or LCD graphic displays. Operator work stations should be equipped with quad graphics cards.
2. One dedicated engineering workstation for programming modifications equipped with keyboard, mouse, and dual 22" CRT Flat Panel or LCD graphic displays.
3. Two printers, one for periodic reports and operator logging, the other for an alarm printer.
4. One color laser printer for hardcopy documentation of system configuration and color graphics.
5. 100 custom interactive P&ID graphics shall be included in the design. In addition to these displays, all control loops, indicator, and alarms will be shown on group displays depicting H/A stations and push button stations.
6. Control Loops and logic shall be designed and configured in accordance with manufacturer's (Emerson Ovation) standards and PacifiCorp standards.
7. Two (2) 50” LCD or LED monitors that can be tied to the operator work stations.

Provide the capability to allow all graphics and controls interface to be monitored and manipulated from any of the operator interfaces and the engineering workstation.

All software and operating systems provided shall be manufacturer's latest offering and shall comply with the design requirements, features, and capabilities specified herein.

All control room furniture and consoles provided for the Project shall be of identical manufacture and configuration. Consoles shall be provided for the operator stations, engineering station, CTG and STG Remote HMI's, CEMS stations, 5 printers, and trip panel containing CTG, STG, HRSG MFT Trip pushbuttons. The existing Block 1 combined cycle plant control room shall be expanded by Owner to incorporate the new Block 2 combined cycle plant consoles, and plant control workstations. In addition, the existing DCS room adjacent to the Central Control Room shall be utilized for DCS processors for the Block 2 DCS. Block 2 DCS I/O cabinets shall be installed within the boundaries of the Block 2 equipment. A layout for existing Block 1 Central Control Room detailing Block 2 layout is attached in Appendix C.

9.4 DCS CONTROLLERS AND I/O

DCS Controllers shall be loaded to no more than 60-percent upon completion of Factory Acceptance Testing and 75-percent upon completion of commissioning. Controller cabinets shall be located throughout the plant, as required, to enhance reliability and to reduce wiring requirements.

The DCS shall be sized such that there shall be 20-percent spare's of each I/O type at each location at time of shipment to the site and 10-percent spares of each I/O type at each location at Substantial Completion, as a minimum. In addition, cabinets will be furnished with at least 10-percent spare card slots in every card cage and 20-percent extra space in each cabinet for future use.

The system will be capable of scanning, processing and storing any inputs and outputs at the rate of at least four times per second and at 1 millisecond for SOE points. Peer-to-peer communications between controllers will communicate all points at the rate of once per second. Actual scan times will meet the hardware requirements for the controller loop processing time. Overall system scan rate shall not exceed 250 milliseconds.

To permit removal of I/O modules without removing field wiring, all I/O field terminations shall be terminated on separate field termination blocks in I/O cabinets.

Analog input signals to the system will be isolated and either current limited or fused from the internal circuitry so that shorting, grounding or opening the circuit at the transmitting Equipment will not affect control system performance. Analog inputs shall not exceed 8 per card. The system shall provide quality checks for all analog inputs. Data will be automatically tagged as bad on all displays or logs if the input value is out of range. System accuracy shall be 0.1-percent of calibrated range, (excluding transmitters).

Analog output signals from the system will be isolated and either current limited or fused from the internal circuitry so that shorting, grounding or opening the circuit at the receiving Equipment will not affect control system performance. Analog outputs will not exceed eight per card. System accuracy will be less than 0.5-percent of output signal range (excluding final element).

Digital (contact) outputs will be individually fused in the control system. Digital outputs will not exceed 16 per card. Interposing relays will be used for all applications where the current and/or voltage requirements exceed the capability of the DCS outputs. The system will be capable of assigning each digital output as momentary or maintained. Momentary outputs will be present for at least 100 milliseconds but not more than two seconds. The system will be capable of providing normally open and normally closed contact outputs.

Digital (contact) inputs will be individually current limited. Digital inputs will not exceed 16 per card. Contact inputs will be scanned at the controller level for status change. Normal state for a contact will be definable as either open or closed. In general, digital inputs shall be failsafe or closed for normal state. The system software will have the ability to apply digital filtering or time delay to all contact inputs.

The DCS shall be capable of resolving at least 100 inputs for Sequence of Events (SOE) monitoring at a resolution of 1 millisecond. Control shall provide a preliminary SOE list for Owner review and approval. System shall be able to assign any digital point in the control system for SOE service. Grouping of these points is acceptable, but the points or groups may be distributed in all I/O locations including remote I/O. The provided GPS time stamping synchronization system shall be used for the synchronization of all system clocks and for the SOE time stamp.

The processing for thermocouple and RTD inputs is the same as that described for analog inputs above. The system will also check for open thermocouple and provide alarm. Thermocouple readings will be linearized.

All analog I/O shall be HART capable.

9.5 RACK MOUNT HMI PC's

Rack mount PC's shall be suitable for the environmental conditions in which they will be installed. In extreme cases rack mount electronic processor based equipment to be installed in high traffic, dust prone areas, such as DCS I/O equipment rooms, shall be installed in filtered enclosures or instrument air pressurized cabinets

9.6 INTERFACES AND NETWORKS

The DCS shall be interfaced to a number of systems throughout the plant and remotely to include, but not limited to the following:

1. CTG
2. STG
3. HRSG Duct Burner PLC's
4. RTU for Dispatch Control
5. CEMS
6. Plant Skids/systems implementing PLC's

The DCS control system components shall incorporate a 100mbps fiber optic communications network. The network shall be provided for control and monitoring from the operator, engineering servers and client workstations.

Data communication link interfaces shall be provided with watchdog timers and communications alarms.

All communications cabling running exterior to plant buildings shall utilize multimode fiber optic cabling with fiber patch panels, fiber to Ethernet media converters as specified in Section 8.0.

9.7 REMOTE TERMINAL UNIT (RTU) DISPATCH

An RTU to implement Dispatch Automatic Generation Control (AGC) will be furnished and installed in the switchyard control building by others. The Contractor will provide a fiber optic connection from the switchyard RTU located in the switchyard control building to the plant DCS. Provide all facilities required for RTU communications between the power plant and Switchyard control building. Any I/O points required at RTU but not available in the DCS shall be hardwired to the RTU. Facilities shall include but not be limited to, ductbank, fiber, wiring, programming, and interface equipment. The Contractor shall provide all required Fiber Patch Panels at the substation and control room and/or other location to allow for the complete termination of all fibers into and out of each location. The Contractor shall work with the Owner Dispatch Center and personnel and to test and commission the DCS to Dispatch link for control, monitoring and alarming functions as specified in Section 8.

9.8 DCS FACTORY ACCEPTANCE TEST (FAT)

The Contractor and DCS manufacturer shall completely configure, load, and debug the DCS control system components and database at the factory or Contractor's facilities prior to FAT. A hardcopy printout and electronic copy of the I/O database, graphic screens, logic diagrams and detailed hardware configuration and FAT plan itemizing FAT activities shall be supplied to the Owner in advance for review and comment prior to finalization of system configuration and FAT. FAT plan and schedule shall be agreed to by Contractor and Owner early in the Project cycle. The DCS manufacturer shall provide 3 weeks for the FAT of the hardware, logic and software design and data communication interfaces. The FAT Logic shall be verified by simulation. Data communication links to the CTG, STG, and HRSG Duct Burner PLC shall be verified using a test simulator per the manufacturer's recommended practices. Owner shall witness FAT. DCS manufacturer shall provide problem or variance report sheets to document any and all problems encountered with hardware, software, graphic screens or control logic implementation. All problems found during the FAT shall be reconciled prior to shipment to the field. Owner reserves the right to require additional FAT, at Contractor's and/or DCS manufacturer's expense, if original testing proves the system design to be incomplete or substantial revisions are required.

9.9 HARD PANEL CONTROL BOARD

Hardwired, redundant, emergency trip, mushroom-style push buttons one pair for each CTG, STG, and HRSG MFT one for the entire block, and one for closing the emergency fuel gas shutoff for Block 2 shall be provided as a part of the emergency shutdown protection panel as required by the system per Section 5.

9.10 INSTRUMENTATION AND CONTROL DEVICES

9.10.1 General

Signals for analog control system inputs and outputs shall be provided from process transmitters at 4-20 mA signal level, or direct-wired RTDs and thermocouples. Pneumatic signals shall be 3-15 psi.

Instrument primary sensing devices shall be nominally ranged at 150 percent of the systems normal operating pressures and temperatures.

Instrument calibration shall be verified by Contractor and documented for submittal to Owner.

Instrumentation and sensing lines shall be freeze protected where appropriate for instrumentation supplied by Contractor and by equipment manufacturer as required.

Gauges and indicators, including position indicators on valves, shall be installed to be visible from normal operating platforms or accessways without the need for ladders, mirrors, or other devices. All termination lugs shall be applied with a ratchet type crimping tool to insure an equal pressure connection between lug and signal cable core.

All analog transmitters shall be HART Smart type transmitters.

9.10.2 Thermocouples and Resistance Temperature Detectors

Temperature measurement shall in most cases be performed using thermocouples. Thermocouples and extension wire shall comply with the standard limits of error according to ANSI MC96.1-1975 and shall be Type E.

Resistance temperature detectors (RTDs) of the three-wire platinum type shall be used in certain cases such as motor winding temperature measurements. The nominal resistance of the platinum detectors shall be 100 ohms at 0°C. All resistance temperature detectors shall be metal sheathed, and ceramic packed.

Thermocouples and RTDs shall have stainless steel sheathed elements and spring-loaded to provide good thermal contact with the thermowell. All connection heads shall be weatherproof equivalent to NEMA 4, with chain-connected screwed covers, and supported from the well by lagging extension long enough to clear the head of the temperature element above the process pipe lagging.

9.10.3 Thermowells

Temperature sensors shall be equipped with thermowells made of one piece, solid bored Type 316 stainless steel (or higher alloy if required for the application) of step-less tapered design. Maximum bore internal diameter shall be 0.385 inch.

Test wells shall be provided on main steam, feedwater, condensate, and other piping as required to meet ASME test requirements. Test wells shall be provided with screw cap and chain.

9.10.4 Flow Elements

Flow elements shall be provided in accordance with appropriate applications and in accordance with requirements contained in Section 5. Weld-in type Factory Certified Flow Nozzles shall be used for Main Steam, Hot Reheat and Cold Reheat flow measurements. Flow Nozzle shall be provided with two (2) sets of pipe wall pressure taps. All FEs required for performance testing shall be PTC6 certified to include but not limited to: HP and IP Feedwater, LP Steam, Condensate, and Cold Reheat.

9.10.5 Transmitters

Transmitters shall be used to provide the required 4-20 mA DC signals to the DCS. Transmitters shall be of the smart electronic two-wire type, HART compatible and capable of driving a load of at least 500 ohms with non-interacting zero and span adjustments and remote recalibration features.

9.10.5.1 Static Pressure and Differential Pressure Transmitters

Differential pressure transmitters shall be HART compatible with transmitter sensor specified to withstand 150 percent of design pressure. DP transmitters shall be provided with remote seals and filled capillaries where required, static pressure protection limit and any other applicable options required to accommodate specific applications.

9.10.5.2 Level Transmitters

Sensing elements for level transmitters shall be as follows:

1. Gauge pressure transmitters for vessels exposed to atmospheric pressure.
2. Enclosed, pressurized vessel level shall be measured using radio frequency or Differential Pressure transmitters with filled capillaries and remote seals.
3. Differential Pressure element with constant head chamber for high pressure and temperature applications where installation of float cage becomes impractical (level transmitters of this type are the same as differential pressure transmitters).

9.10.5.3 Flow Transmitters

Flow transmitters, in general, shall be differential pressure types. Square root extraction shall generally be performed electronically in the control system.

9.10.6 Gas Meters

Contractor shall tie into the existing gas metering station. A check meter shall also be provided on the main gas supply to Currant Creek2. Meters used for fuel gas flow measurement shall be complete with temperature and pressure compensation capability using design pressure and temperature as its base conditions. Total gas flow shall be indicated locally, and gas flow rate shall be transmitted to, and monitored and totalized in, the DCS. Gas flow meters shall be provided for each CTG, each HRSG duct burner system and the auxiliary boiler. Flow meters shall meet the requirement of the EPA and Currant Creek Air Quality Permit. Manufacturer's calibration certificate shall be provided that shows that flow meter meets the accuracy requirements of the EPA and Currant Creek Air Quality Permit.

9.10.7 Temperature, Pressure, Level, and Flow Switches

Temperature, pressure level, and flow switches shall generally have two Form C contacts for each actuation point and shall be equipped with screw type terminal connections on a terminal block for field wiring. Switch set point and deadband shall be adjustable with a calibrated scale. Contacts shall be snap acting type. Switch enclosures shall be NEMA 4 for non-hazardous locations, and NEMA 7 or 9 for hazardous locations. All termination lugs shall be applied with a ratchet type crimping tool to insure an equal pressure connection between lug and signal cable core.

9.10.8 Local Indicators

9.10.8.1 Thermometers

Thermometers shall be the bimetallic adjustable, every-angle types with minimum 4-½ inch dials. Where view is obstructed or unavailable, thermometers shall be provided for remote mounting including filled capillaries.

9.10.8.2 Pressure Gauges

Pressure gauges shall be the bourdon tube type with solid front cases with blowout back, 4-½ inch dials, stainless steel movements and nylon bearings. Gauges shall have ½-inch NPT bottom connections. Gauges shall be provided with pigtail siphons for steam service, snubbers for pulsating flow, and diaphragm seals for corrosive or severe service. Gauges located on process lines exposed to ambient temperature shall be freeze protected.

9.10.8.3 Local Level Indicators (Gauge Glasses)

Magnetic flipper style level indicators shall be used for local level indication applications. All wetted parts shall be stainless steel. The float chamber shall be 2 ½" pipe with RF slip on blind drain flange designed for process conditions. The indicator tube shall be polycarbonate with bi-colored flag flippers. The gauges shall have a continuous scale in feet and inches with ¼" resolution.

9.10.9 Control Valves

Control valves shall be used in modulating service throughout various processes within the facility and as specified in Section 5. Globe valves shall be used extensively in water, steam, gas, and oil service with butterfly and ball valves used in limited applications, typically low pressure and temperature water service.

Pressure retaining component and valve trim materials shall be selected based on process conditions such as type of fluid, static and differential pressures, and temperature. In general, control valves in water and steam service shall be provided with hardened stainless steel trim.

Modulating control valves shall be sized to pass design flow at 60 to 80 percent of valve capacity. Multiple service conditions should be specified when a control valve is expected to operate over a wide range of travel, i.e., feedwater flow and drum level control valves. When the calculated Cv is less than the manufacturer's recommended minimum Cv, two valves with split range control shall be provided, unless otherwise approved by Owner.

Minimum control valve body size shall be not less than 50 percent of the upstream pipe size. When a calculated Cv requires a smaller valve, reduced trim shall be used in order to maintain the body size requirement. Reduced trim shall not be less than 40 percent of valve capacity.

Pneumatic actuators of the diaphragm or piston/cylinder type shall be Smart, Hart compatible, with the ability to provide position feedback and diagnostic information on each valve. All critical valves shall be equipped with hardwired position feedback modules. Careful consideration should be given to the fail-safe position of control valves. Where practicable, actuators with integral springs shall be specified. All control valves shall be capable of operating with a 60 psig air header pressure.

In general, all control valves shall have ANSI class IV leakage ratings. Valve failure philosophy shall be developed with Owner participation.

Control valves shall be designed to operate from a control signal range of 3 to15 psi.

Each control valve shall be provided with accessories such as handwheels, filter regulators, solenoid pilot valves, limit switches, and position indicators as applicable.

9.10.10 Instrument Racks

Where possible, field instruments other than local indicators shall be grouped together on instrument racks. Maximum tubing run from the sensing point to the rack shall be 50 feet, unless approved otherwise by Owner. Interior instrument racks shall be open structures with frames constructed of angle or structural tubing. The frames shall be reinforced as required to provide adequate support for instruments and equipment. Equipment supports shall be horizontal members, which provide a place for the attachment of mounting brackets and clamps for piping and tubing.

Instruments shall be installed indoors wherever possible. Instruments exposed to ambient temperatures shall be housed in heated instrument enclosures with heat traced impulse lines with integral tubing bundle. Integral tubing bundle shall be O'Brien or Owner approved equal. Heated enclosures shall be diagonal, clam-shell style to provide easy access to process instruments from the front, top or either side. No flexible insulation (soft-case) is acceptable. Enclosures shall have a maximum of three (3) instruments each and shall be large enough to house all required blowdown valves inside enclosure. Heat trace system shall be designed to activate enclosure heaters when ambient temperature is below 40 degrees Fahrenheit.

9.10.11 Tubing Systems

Instrument, control, and sampling tubing systems shall be designed, fabricated, and tested in accordance with ANSI ISA RP 7.1.

Primary process instrument and sampling tubing for steam and water systems shall be ASME SA213 grade TP316H SS 3/8 inch .049 standard wall or 1/2 inch .065 standard wall, respectively (Note: On high pressure, high temperature applications, tubing shall be 316H minimum wall per ANSI B31.1 specifications).

Fittings shall be manufactured of the same material as the tubing, wherever practical. Where not practical, fittings shall be manufactured of a harder material than the tubing and at minimum of Rockwell 80B.

Pressure type instruments shall have associated isolation and test valves or combination two-valve isolation/test manifolds. Differential pressure type instruments shall have associated pairs of isolation and test valves plus an equalizing valve or combination three-valve isolation/test/equalizing manifolds.

Blowdown valves shall be provided for each remote device as required. Tandem blowdown valves shall be provided on high pressure, high temperature applications (pressure greater than 600 PSIG and/or temperature greater than 450 degrees Fahrenheit). Blowdown valves are not required for vacuum, gas, or dry air service.

Sample tubing systems carrying high temperature samples shall be insulated or guarded in areas which require personnel protection.

9.11 CONTROL SYSTEM LOOP COMPONENT DESIGN

The major plant systems to be controlled and monitored are described and presented in Section 5. They include the following:

1. Gas Turbine/Generator Systems.
2. Steam Turbine/Generator Systems.
3. Heat Recovery Steam Generator Systems.
4. Feedwater Systems.
5. Air Cooled Condenser (ACC) System
6. Water Treatment System
7. Fuel Gas Metering and Conditioning System.
8. Plant systems to include tie-in to Block 1 Raw Water System.
9. Plant Monitoring System.

9.11.1 Gas Turbine Generator (CTG)

The DCS shall be implemented to provide supervisory control, monitoring, alarming and historical functions for each CTG and shall interface to each CTG control system through hardwired and data link interfaces. The DCS interface to each CTG control system shall be in accordance with the turbine manufacturer's recommended configuration. The DCS, through a combination of hardwired and data link interfaces, shall be able to perform all actions necessary to start and stop the unit, raise and lower load, monitor status, log operating data, and annunciate and acknowledge alarms. Critical control functions, status and alarms for essential gas turbine operation will be hardwired to the DCS control system. Remaining control functions, status, and alarms shall be interfaced with each CTG control system through a high speed 100 Mbps, fiber data link per manufacturer's recommended configuration. The link will provide all data on the manufacturer's standard interface list, as required. Final determination of I/O will be subject to Owner approval. Key CTG system control, alarm, and status graphics shall be integrated with the DCS to provide the identified supervisory control. A common CTG

Remote HMI shall be provided in the main control room for detailed controlling, alarming, and monitoring of the Gas Turbine system. The main control room shall serve as the primary operator interface. Runbacks, rather than trips, will be utilized whenever possible.

All critical control trips and interlocks shall be hardwired between the DCS and the CTG control system. Remote manual tripping of the CTG shall be possible using the auxiliary console-mounted, hard-wired emergency stop pushbuttons located in the control room.

9.11.2 Steam Turbine Generator

The DCS shall provide supervisory control, monitoring and alarming for the STG and shall interface to the STG control system and governor through hardwired and data link interfaces. The DCS interfaces to the STG control system shall be in accordance with the turbine manufacturer's recommended configuration. The DCS, through a combination of hardwired and data link interfaces, shall be able to perform all actions necessary to start and stop the unit, raise and lower load, monitor status, log operating data, and annunciate and acknowledge alarms. Critical control functions, status and alarms for essential steam turbine operation will be hardwired to the DCS control system. Remaining control functions, status, and alarms shall be interfaced with each STG control systems through a high speed 100 Mbps fiber data link per manufacturer's recommended configuration. The link will provide all data on the manufacturer's standard interface list, as required. Final determination of I/O will be subject to Owner approval. Key STG system control, alarm, and status graphics shall be integrated with the DCS to provide the identified supervisory control. A STG Remote HMI shall be provided in the main control room for detailed controlling, alarming, and monitoring of the steam turbine system. The main control room shall serve as the primary operator interface.

All critical control trips and interlocks shall be hardwired between the DCS and the STG control system. Remote manual tripping of the STG shall be possible using the auxiliary console-mounted, hard-wired pushbuttons located in the control room.

9.11.3 Heat Recovery Steam Generator (HRSG)

Control of the HRSG shall consist of the following loops under control of the DCS to safely and efficiently maintain steam header pressure and feedwater to match turbine-generator requirements during start-up, normal operation, upsets, and shutdown.

Duplicate controls shall be supplied for each HRSG, as required. Consult Section 5 for further requirements.

Control of each HRSG shall include the following subsystems:

1. Drum Level Control System
2. Duct Burner Safety System
3. Ammonia Injection Control System
4. Steam Temperature Controls.
5. LP Drum Level Control System

9.11.3.1 HRSG Drum Level Control System

The HRSG drum level control system shall be conventional three-element control using main steam flow as the feed-forward signal, drum level, and feedwater flow as the feedback signals. Based on demand, the system controls the feedwater control valve to adjust feedwater flow to the HRSG. The system will be designed to operate on single-element control using drum level only during start-up. Transfer from single-element to three-element and back to single-element shall be automatic based on steam flow.

9.11.3.2 Duct Burner Safety System

The duct burner control system shall be fully integrated with the plant DCS.

The duct burner safety system shall be a self-contained PLC and shall be designed to safely shut down the HRSG auxiliary burner system on abnormal and emergency conditions. The system shall be interlocked to shut down the fuel gas to the HRSG as recommended by the HRSG manufacturer. The duct burner safety system shall comply with NFPA 8506 and the NEC code. The duct burner safety system shall incorporate hardwired and softlink status, alarms, controls signal for control and monitor from the DCS.

9.11.3.3 Ammonia Injection Control System

The ammonia injection control system shall be designed to control stack emissions to meet permit requirements.

9.11.3.4 Steam Temperature Control System

The purpose of this system is to maintain the final superheater and reheater outlet temperatures at a set value with minimum fluctuation. This shall be a single station, cascade-type control system in which the final superheater and reheater outlet control units serve as the master or primary control units, and the desuperheater outlet control units serve as the slave or secondary control units.

9.11.3.5 LP Drum Level Control System

The LP Drum levels shall be controlled by the DCS. Level switches shall be provided to alarm high and low levels and to trip the feedwater pumps on low-low level.

9.11.4 Feedwater System

Feedwater systems will be comprised of the following subsystems:

9.11.4.1 Condensate Receiver Tank Level Control

The level shall be controlled from the DCS. Cycle water make-up flow shall be regulated through a control valve to maintain condensate tank level. If the level is low, make-up will be admitted from the demineralized water storage tank. If the level is high, a fraction of the condensate flow will be routed to the demineralized water storage tank to prevent condenser flooding. Level switches shall be provided to alarm high and low levels. Pump run indicators shall be provided to alarm pump cutout. Condensate tank shall also be provided with local level indication.

9.11.4.2 Boiler Feed Pump Minimum Flow Control

Feedwater pump minimum flow control consisting of a recirculation valve which circulates water back to the LP drum during periods of low HRSG feedwater demand shall be provided. This may be in the form of a flow control valve.

9.11.4.3 Boiler Feed Pump Existing Vibration Monitoring

BFPs shall be equipped with Bentley Nevada Vibration Monitoring Control monitoring systems. This system shall be tie to Block 1 main Bentley Nevada Vibration Monitoring System.

9.11.5 Air Cooled Condenser (ACC) System

The ACC system controls shall be implemented through the DCS. The ACC system components, performance and requirements are identified in Section 5. ACC fans shall be controlled automatically from the DCS as required to maintain the steam turbine condenser backpressure at operator selected values associated with acceptable steam quality in the steam turbine and maximum plant net output. In addition, the implemented controls shall protect system from freezing, include no sub-cooling, and minimize parasitic power consumption.

9.11.6 Water Treatment Systems

The water treatment systems shall be prepackaged units with self-contained PLC controls. All data from the water sample panels shall be provided for control, monitoring and alarming in the DCS.

9.11.7 Fuel Gas Metering and Conditioning System

The Fuel Gas Metering and conditioning system shall be prepackaged units with self-contained PLC controls. Data from this system shall be provided via communication link and/or hardwired interface for monitoring and alarming in the DCS. See Section 5 for system requirements.

9.11.8 Plant Systems – Raw Water

Block 1 Raw Water Supply System shall be modified to support the new Currant Creek 2 combine cycle plant. Block 1 Raw Water System includes two (2) existing Well pumps, and an existing Raw Water Storage Tank. A second Raw Water Storage Tank shall be added for Currant Creek 2. Modification of existing Block 1 Raw water system and controls may be required to enable Currant Creek 2 to control existing well water pumps, and to monitor the level in Block 1 Raw Water Tank.

9.11.9 Plant Monitoring System

Plant parameters shall be monitored and indicated, alarmed and/or recorded in the DCS to facilitate the plant operator with control of the plant. The gas turbine and steam turbines shall be interfaced to the DCS for monitoring, trending, and control from the

DCS. All local controllers shall be interfaced with the DCS for monitoring, trending, and control from the DCS.

9.12 HISTORICAL DATA STORAGE AND RETRIEVAL

Provide historical trending of all DCS data points including data provided from the combustion turbine and steam turbine control systems. Provide enough on-line memory to support a 250-day recall of all data points taken at the following periods:

Temperature:	5 min.
Levels:	1 min.
Pressures:	1 min.
Flows:	15 sec.

The historical data storage and retrieval system shall be fully compatible with current market Emerson Ovation DCS systems. Provide a CD/DVD writer in the control system to facilitate downloading and archiving of the trended data.

9.13 CONTINUOUS EMISSIONS MONITORING SYSTEMS

Dedicated extractive continuous emissions monitoring systems (CEMS) complete in all respects including analyzers, sample extraction system, sample lines, flue gas flow equipment, data acquisition system, controllers, printer, monitor display, keyboard, mouse, software, controls, modem link, and other system specific accessories shall be installed in the HRSG stacks to measure the NO_X, CO, and O_2 concentrations at the HRSG stacks. The CEMS shall be housed in a shelter located at the base of the HRSG stacks.

Additional NO_X monitors shall be installed in HRSG upstream of SCR catalyst to monitor ammonia injection and CTG emission rates.

Each CEMS shall meet all the requirements of the plant air quality permit and state and local regulations. The CEMS shall be designed to comply to the requirements of the Environmental Protection Agency as stated in 40 CFR Part 60 "Standards of Performance for New Stationary Sources," specifically Paragraph 40 CFR 60 Subpart GG; 40 CFR Part 60.13; 40 CFR 50 Appendices B and F; and 40 CFR Part 75.

Each CEMS must be capable of completing a minimum of one cycle of operation (sampling, analyzing and data reading) for each successive 15-minute interval and shall display the following air pollution control parameters:

1. Exhaust unit flow.
2. NOx, CO, and O_2 in ppmv at actual stack conditions.
3. NOx in ppmv and lb/hr upstream of SCR catalyst.
4. NOx, CO, and O_2 in ppmv corrected to 15 percent oxygen on a dry basis.
5. NOx and CO in lb/hr.
6. Temperature at the SCR.
7. NO_X at SCR inlet.
8. Fuel consumption.

Each CEMS shall be designed with a stand-alone personal computer, with an emissions software package which includes emissions warning, archiving, and report generation, as required under CFR 40, Part 60, Appendix F; 40 CFR PART 75; and the air quality permit. Daily calibration error test cannot exceed 5.0 percent of span value (or exceed 10 ppm). Linearity – No quarterly linearity test required. RATA shall be </= 0.015 lb/MMBtu mean difference.

The CEMS personal computers shall be networked together with a supervisory station located in the control room. The DCS/PI Data Historian shall interface with the CEMS supervisory station through a communication link. The link shall provide up to 50 analog data points and 75 digital data points.

Equipment standards shall be per PacifiCorp CEMS Currant Creek Requirements document to be provided at Contractors request. The dedicated extractive CEMS shall be supplied with the following analyzers and systems:

1. NOx Analyzer shall be Thermo-Fisher Scientific 42i-LS Dual Range (Low 0 – 10 ppm, High 0 – 200 ppm) Note: Readings obtained during typical unit operation shall be kept between 20.0 and 80.0 percent of full-scale range of the instrument (1 - 4 ppm).
2. CO Analyzer shall be Thermo-Fisher Scientific 48i CO Dual Range (Low 0 - 10 ppm, High 0 – 1,200 ppm).
3. Oxygen Analyzer shall be Servomex 1440 with Range: 0 – 25 percent.

4. The data acquisition system shall be an Environmental Systems Corporation (ESC) 8832 data system controller with ESC software.
5. Sulfur dioxide (SO_2) will not be measured but shall be calculated utilizing the methodology outlined in 40 CFR 75 (Part 75) Appendix D titled "Optional SO_2 Emissions Data Protocol for Gas-Fired and Oil-Fired Units."
6. Exhaust gas flow and carbon dioxide (CO_2) will not be measured but shall be calculated utilizing the methodology in 40 CFR 60 (Part 60) Appendix A Method 19.
7. As required by Utah DAQ, the CEMS shall either have the capability to measure NH_3 or to calculate NH_3 based on other instrument data.
8. Extractive Sample Probe shall be M&C SP-2020 extractive w/ heated stack filter.

Other design requirements include the following:

1. Sample Line shall be heat traced with a temperature controller capable of maintaining 240 degrees F at minus 20 degrees F ambient. Each sample line shall consist of three (3) 3/8" Teflon tubes (sample line, blow back, spare) and two (2) 1/4" Teflon Tubes (calibration gas, spare).
2. Sample Conditioner shall be M&C ECM-2 (5 liters/minute) and shall utilize the peltier effect for condensing moisture from the gas sample. The condensate shall be removed with a Masterflex dual head peristaltic pump. The sample system must include an inline 2.0 micron particulate filter and a moisture conductivity sensor.
3. Contractor provided Fuel Flow meter shall be Yokogawa vortex flowmeter. The flowmeter must be certified for Part 75 using the applicable procedure found in 40 CFR Part 75, Appendix D, section 2.1.5. The certification results must accompany the flowmeter.
4. Initial certification testing of the CEMS including development of a test plan (protocol) and preparation of a test report of the results will be provided.
5. Assistance with completing the Part 75 Monitoring and QA/QC Plans shall be provided.
6. Contractor shall provide the initial set of gasses for daily calibration and initial certification (RATA) testing of the CEMS. Supply of gasses after

initial certification and up to Substantial Completion will be to the Contractor's account. Use of Block 1 gas combinations and concentrations is recommended.

7. The Part 75 monitoring and QA/QC Plans shall be initiated by the Contractor and shall incorporate Contractor supplied and Owner supplied information.
8. The CEMS shall be housed in a climate-controlled "walk-in" shelter. A HVAC system shall be designated to maintain a suitable temperature environment inside the shelter. Other features include lighting, internally mounted bottle racks and a secure lockable entrance.
9. The DAS server shall be located in the plant's central control room. The client computer shall be located in the CEMS shelter.

SECTION 10.0
TRAINING PROGRAM

The purpose of the training program is to provide specific information about the power plant to qualified operator trainees. The overall intent is to provide a comprehensive program that will increase the competence level of the plant operating personnel to ensure that the plant can be safely operated.

The training shall consist of basic theory, as well as specific technical training on major equipment and systems functions. The basic theory shall provide an effective base for those who have had no formal training and a refresher for those who have experience. This shall prepare everyone to a common level for specific technical training on major equipment and systems.

The training program shall include, at a minimum:

1. Classroom instruction with active instructor-trainee interaction and utilize a full range of training materials and professionally produced training tapes.
2. In-plant, hands-on training by various instructors and major equipment suppliers.
3. Exercises to familiarize trainees with all the different systems in the plant.

Training shall include use of the Plant Manual.

Skill testing and progress monitoring shall be used throughout the training program to gauge the effectiveness of the training and the knowledge of the trainees. All training shall be reviewed with Owner on an ongoing basis.

Training program shall include the scope as defined in Appendix V ("Contractor Provided On-Site Training Program") a minimum of 100 hours of overall plant training by Contractor. Training program shall also include major equipment training, both classroom and hands-on, to be conducted by the equipment vendors. Vendor training for equipment purchased by Owner shall be coordinated and managed by Contractor. As a minimum, vendor training shall be provided for the following equipment:

1. Gas turbine generators.
2. Steam turbine generator.
3. Transformers.
4. Heat recovery steam generators including duct burners and SCR ammonia injection systems.
5. Boiler feedwater pumps.
6. Distributed control system.
7. Continuous emissions monitoring system.
8. Air Cooled Condenser System.
9. Auxiliary Boiler
10. Emergency Diesel Generator
11. Water Treatment Systems
12. Fire Protection Systems

As part of the training program the contractor shall include operator trainees in commissioning of the DCS. The Contractor shall maintain a DCS technician for follow-on training on site for 6 months after acceptance. DCS technician selection shall be subject to Owner's approval.

SECTION 11.0
START-UP AND INITIAL OPERATION GENERAL

11.1.1 SUMMARY:

1. Contractor shall prepare all Equipment and systems installed under this Contract for initial operation in accordance with the manufacturer's instructions, these Specifications. Contractor shall use latest technology to carry out the plant start-up, initial operation, and performance testing process in the shortest time possible.
2. Contractor shall provide all labor and materials to perform cleaning, flushing, sterilization, steam line blowdown, operational checks and adjustments, and preparation for initial operation.
3. Contractor shall cooperate with Owner and manufacturer's service personnel during the start-up period.
4. Contractor shall provide all supervision and labor as required for initial operation of all piping systems, equipment and appurtenances installed under this Contract until the Project is turned over to the Owner.
5. Owner shall provide to Contractor all reasonable and necessary support during the commissioning and startup of the Plant.
6. Owner shall provides operations and maintenance staff personnel to participate in the commissioning activities. This support shall be provided during normal working hours or other times as may be requested by Contrator with advance notice.
7. General Requirements:
   A. Perform specified inspections and tests and report all deficiencies in Equipment and Materials to Owner immediately upon becoming aware of them. Where applicable, perform Work under the direction of equipment manufacturer's field service representatives.
   B. Contractor shall be responsible for any damage to Equipment or Material due to improper test procedures or test apparatus handling, and replace or restore to original condition at the Owner's option, any damaged Equipment or Material.
   C. Furnish miscellaneous hand tools, ladders, or scaffolding, as required, to allow access to equipment, boxes, cabinets, or devices.

D. Furnish updated P&ID's prior to start of commissioning.

E. Certain inspections and tests specified to be performed by this Contract may also be performed by others. This overlapping and duplication is necessary and intentional. Contractor will be notified of tests by others prior to test to assure proper safety procedures are followed.

F. Owner will review and approve the testing schedule of all plant testing and inspections. Contractor shall cooperate and work closely with Owner during all phases of construction, especially with respect to the following:

G. Sequence and priorities of construction and start-up.

H. Testing and testing methods.

I. Equpment checkout and procedures.

J. Equipment start-up.

K. Testing records.

L. Tagging procedures for personnel and equipment safety.

11.1.2 QUALITY ASSURANCE:

1. Perform all work to meet the quality specified hereinafter and the quality assurance requirements of the Equipment manufacturers, including, but not limited to, the following standards:
   American National Standards Institute (ANSI).
   American Society of Mechanical Engineers (ASME).

11.1.3 SUBMITTALS:

1. Submit as specified in SECTION 4 of this Specification.
2. Submittals required shall include the following:

   A. Contractor shall submit a detailed flushing and cleaning procedure 90 days prior to performance of the activity. This will include, but not be limited to, calculations, demineralized water source, disposal procedure, pipe routings, auxiliary requirements, equipment source, schedules, etc.

   B. Contractor shall submit a detailed steam blow procedure 90 days prior to performance of the activity. This shall include, but not be limited to, calculations, pipe routings, steam requirements, support designs, schedules, etc.

C. Contractor shall submit a detailed gas blow procedure 90 days prior to performance of the activity. This shall include, but not be limited to, calculations, pipe routings, support designs, schedules, etc.

D. Contractor shall submit a detailed acceptance and performance test procedure as part of the Turnover Package 90 days prior to starting the testing.

11.1.4 ACCEPTANCE AND PERFORMANCE TESTS:

1. After a period of initial operation, acceptance and performance tests will be conducted by Contractor on the complete power plant per Appendix M.
2. If operation and performance of the power plant is unsatisfactory due to any deficiency in Contractor's Work, Contractor shall make repairs and redo his Work to obtain satisfactory operation and performance.

11.1.5 EXECUTION

1. <u>FLUSHING AND CLEANING</u>:

A. General:

1) Flush, hydro-blast, chemical clean, or blow out all piping systems and Equipment to remove all dirt, scale, chips, and other foreign material.
2) Furnish and install all necessary equipment and materials required for flushing and cleaning including pumps, temporary blank-off plates, steam sources and supply lines, special fittings, temporary piping systems, gaskets, supports, anchors, and bracing required for the flushing and cleaning operations.
3) Provide temporary water supplies for filling and flushing and provide temporary drain lines and hoses for disposal of water without flooding.
4) Furnish labor and materials to dismantle Equipment and open handholes and manholes as required to inspect and clean piping and Equipment.
5) Furnish labor, materials, portable pumps, and equipment to clean out and inspect existing sumps and tanks.

6) Remove orifice plates and flow element from pipelines before cleaning and flushing and reinstall after cleaning and flushing.

7) Remove control valve internals before cleaning and flushing and reinstall after cleaning and flushing.

8) Remove, clean and replace pump suction strainers as necessary during cleaning and flushing operations.

9) Protect all equipment during cleaning and flushing.

10) Protect instruments and appurtenances during cleaning and flushing.

11) Remove all temporary piping, supports, anchors, bracing, fittings, and blank-off plates after flushing.

12) Reassemble all Equipment ready for operation. Furnish and install new gaskets as required to reassemble Equipment.

B. Heat Recovery Steam Generator (HRSG) cleaning:

1) Perform a hot alkaline detergent degreasing and acid cleaning of the HRSG in accordance with OEM recommended cleaning procedures. Alternative cleaning measures may be proposed by Contractor for Owner consideration, acceptance of which is in Owner's sole discretion.

2) Cleaning shall be performed by a firm specializing in such services.

3) Provide all required chemicals and equipment including heat source necessary to heat cleaning solution to proper temperature. Provide all piping, hoses, and drain lines required to deliver water and chemicals to the unit for cleaning. Dispose of waste offsite after cleaning is completed.

4) Install orifice plates in HRSG downcomers to obtain 0.5 – 1.0 ft/sec flow rate during alkaline degrease cleaning.

5) After cleaning, open the unit, wash down, and inspect. Replace gaskets, gauge glasses, and other parts damaged by cleaning with new parts and material.

C. Condensate System:

1) Thoroughly chemically clean (degrease and acid) the condensate system from the condensate pumps discharge to the Heat Recovery Steam Generator (HRSG) preheater inlet in conjunction with the HRSG chemical cleaning.

2) Install blanking plates on the following:

   a. Discharge of the condensate pumps.

   b. Inlet and outlet of the Inter/After condenser and gland steam condenser.

3) Clean any dead legs not cleaned during the HRSG chemical cleaning by hydro-blasting as specified.

4) When cleaning and hydro-blasting is completed remove blanking plates from Inter/After condenser and gland steam condenser and flush the main header from the condensate pump discharge cleaning connection to the HRSG preheater inlet connection with condensate. Then flush each branch line in the condensate system with condensate. Flush until system is clean as determined by Owner.

D. Feedwater System:

1) Thoroughly chemically clean the boiler feed pump suction and discharge piping from the LP drum to the HP economizer inlet during the HRSG chemical cleaning.

2) Hydro-blast clean any dead legs not included in the chemical cleaning circuit as specified.

   a. When chemical cleaning and hydro-blasting is complete flush each branch line in the feedwater system with condensate from the boiler feed discharge cleaning connection throughout the system. Flush until system is clean as determined by Owner.

E. Steam Systems:

1) Thoroughly clean the following steam system main lines by hydro-blasting:

   a. Main high pressure steam lines from the main steam turbine stop valves to the HRSGs superheater outlet.

b. Main high pressure steam bypasses to cold reheat line.

c. Main high pressure steam reverse flow discharge valve to condenser (if applicable).

d. Hot reheat steam lines from the hot reheat stop valve to the HRSG reheater outlet.

e. Hot reheat steam line bypasses to the condenser.

f. Cold reheat steam lines from the stream turbine cold reheat check valve to the HRSG reheater inlet.

g. Low pressure steam lines from the LP inlet butterfly isolation valves at steam turbine o the HRSG LP superheater outlet.

h. Low pressure steam line bypasses to condenser.

i. All common steam lines as listed above.

2) Install blanking plates where required.

3) Perform steam blow cleaning as specified below.

F. Hydro-blasting requirements:

1) Hydro-blasting equipment minimum requirements shall be as follows:

a. Shall be high pressure water nozzle cleaning designed to be self propeller and revolve.

b. Cleaning nozzle shall be supplied with a minimum pressure of 13,000 psig and a minimum flow of 50 gpm.

c. Nozzle rotation speed and feed rate shall be as required to blast clean 100 percent of the interior pipe surface.

d. Nozzle withdraw rate shall not exceed 3 feet per minute and be as required to flush clean pipe.

e. Feed and withdraw shall provide two pass cleaning/flushing.

2) Remove items from Equipment and pipelines that might be damaged during hydro-blasting, including, but not limited to, flow elements, control valves, instruments, etc.

3) Do not hydro-blast expansion joints.

4) Blast in segments as required to achieve complete cleaning.

5) Hydro-blast in a manner that allows water to wash debris to be flushed from system high points in the system to low points.

6) Direct hydro-blast discharge to plant floor drains. Install temporary pumps in the oil/water separator and discharge cleaning/flush water to plant collection sump and evaporation pond. Contractor shall confirm that wastewater and water discharge is suitable for discharge to the evaporation pond.

G. Water Flush Other Liquid Systems:

1) Flush all other systems until clean as determined by Owner.

2) Remove items from, blank off or bypass Equipment and pipeline items that might be damaged during flushing, including, but not limited to, flow elements, control valves, instruments, etc

3) Discharge flush water to plant collection sump and evaporation pond. Contractor shall confirm that wastewater and water discharge is suitable for discharge to the evaporation pond.

4) Permanent plant pumps may be used for flushing. Turn all system pumps on when flushing.

5) Flush the main headers and each branch line.

6) Flush the raw water system from the well pumps to the raw water storage tank. Flush the connection piping between Blocks 1 and 2.

a. Flush from each well.

b. Flush to include underground piping, above ground piping and branch lines.

c. Install temporary drainage pipe from tank inlet to equipment drains.

7) Flush the potable water system from the Block 1 supply to the potable water skid inlet and throughout the potable water system as it applies to the system extension.

a. Flush from the water treatment plant.

b. Flush to include underground piping, above ground piping and branch lines.

c. Install temporary drainage pipe from the potable water skid inlet to equipment drains.

d. Flush from the potable system to each eye wash and shower and each fixture.

8) Flush the service water system as it applies to the system extension.

a. From the raw water tank to the service water pumps.

b. From the service water pumps to the RO/Demineralizer system, blowdown tanks and miscellaneous drains tank.

c. From the service water pumps to hose bibs.

d. The inter-tie between Blocks 1 and 2

e. All other branch lines.

9) Flush the demineralized water system as it applies to the system extension.

a. Flush through all demineralized water system piping and evaporative cooler make-up system.

b. Install blanking plates on all equipment connections. Disconnect piping at equipment and direct flush water to equipment drains.

c. All other branch lines.

10) Flush the condensate makeup water system.

a. From demineralized water tank to condensate receiver tank and condensate system.

b. All other branch lines.

11) Flush the closed cooling water system.

a. From the closed cooling water pump to each heat exchanger and the return line back to the pump.

b. Install a temporary bypass around the closed cooling water heat exchanger.

c. Install temporary bypasses around each heat exchanger.

d. All other branch lines.

12) Chemical feed, ammonia and sample lines. (These lines may be air blown at Contractor option.)

a. Flush with temporary pumps.

b. Disconnect piping at process connections and flush water to equipment drains.

13) Boiler blowdown and steam turbine drains.

a. Flush to respective blowdown and miscellaneous drains sumps.

14) General drains.

a. Flush with general drains pumps.

b. Flush to the collection sump.

15) Combustion Turbine drains.

a. Flush with temporary pumps to the wash water sumps.

b. Install temporary pumps in the wash water and discharge cleaning/flush water to plant evaporative pond in a manner which does not cause erosion. Contractor shall confirm that wastewater and water discharge is suitable for discharge to the evaporation pond.

16) Open up Equipment and clean and flush.

17) Provide all temporary pump, pipe, and Equipment as required

H. Air blow the following systems:

(1) Contractor shall provide source of compressed air for air blowing purposes.

(2) Blow piping at a minimum velocity of 200 fps until air is free of grit and foreign material as determined by Owner.

(3) Air blow the following systems:

a. Instrument air.

b. Compressed gas carbon dioxide.

c. Compressed gas hydrogen.

d. Compressed gas nitrogen.

e. Compressed generator gas.

f. Combustion turbine bleed heat lines.

g. All 2 inch and small Combustion Turbine Generator system lines.

h. All lube oil lines.

I. Equipment:

1) Open all Equipment installed by this Contract including, but not limited to, the following for inspection, swab, blow out, flush, and clean.

a. Air Cooled Condenser and condensate receiver tank.

b. Blowdown and miscellaneous drains tanks.

c. Closed cooling water expansion tank.

d. Wastewater and water discharge tanks.

e. Compressed air receivers.

f. Ammonia Storage Tank.

g. Raw Water Storage Tank.

h. Oil/water separator.

2) Thoroughly inspect, clean, and flush any other Equipment affected by the flushing operations.

3) Furnish and install new manhole gaskets as required.

4) Contractor shall submit manufacturers recommended cleaning procedures for the Air Cooled Condenser System for Owner review and approval.

J. Lubricating and Hydraulic Oil Systems:

1) Thoroughly clean and flush steam turbine and boiler feed pump lubricating and hydraulic oil systems until clean and

in accordance with manufacturer recommendations and instructions.

2) Provide a separate flushing pump for the steam turbine lube oil flush.

3) Heat oil, circulate oil, vibrate lines, clean strainers, and replace filters in accordance with Equipment manufacturer's instructions. Contractor shall furnish all flushing oils. Flushing oils shall meet the requirements the equipment manufacturers.

4) Contractor shall be responsible for all costs and equipment associated with flushing oil testing required to confirm if the oil system flushing operations has satisfied the manufacturer's requirements and recommendations.

5) Drain systems, dispose flushing oil off site, wipe out reservoirs, and clean as required.

6) After flushing dispose flushing oil offsite. Fill lubricating systems with oil and lubricate Equipment.

K. Initial Turbine Operation:

1) After turbine stretch-out or when directed by Owner, dump the Condensate Receiver Tank to waste for proper disposal off-site by Contractor.

2) Clean and flush condensate receiver tank and LP drum.

3) Furnish and install new manhole gaskets as required.

4) Repack valves, retighten flanges, tighten valve bonnets, and make repairs and adjustments for all piping systems, equipment, and appurtenances installed under this Contract at least once during initial operation.

2. <u>WATER LINE STERILIZATION:</u>

A. General:

1) Sterilize entire potable water system installed under this Contract. Sterilize the system from the potable water treatment system connection throughout all potable water pipe lines up to and including fixtures.

2) Provide all required materials including the following:

a. High test hypochlorite (HTH) with 65 percent available chlorine.

b. Sterilized pipe, valves, fittings, and accessories.

B. Sterilization:

1) Perform sterilization as follows:

a. Flush lines with clean water.

b. Make slurry of HTH in separate container.

c. Simultaneously add slurry and water to obtain a uniform concentration of 40 ppm of available chlorine throughout the system.

d. Maintain system full for 6 hours during which time all valves and faucets shall be operated several times.

e. Drain and flush system with potable water until residual chlorine content is not greater than 0.2 ppm.

f. Allow system to stand full for 24 hours.

g. Draw sample under direction of Owner and designated officials.

h. Test sample in approved laboratory for bacterial count, and as directed by health authorities.

2) After sterilization make connections to system with sterilized fittings only.

3. <u>STEAM LINE BLOWDOWN</u>:

A. General:

1) Clean each Heat Recovery Steam Generator (HRSG) and steam lines with steam with low pressure, high velocity continuous blows to completely clean the lines to the satisfaction of Owner.

a. Provisions shall be made to thermally shock the steam lines without affecting the steam drums.

b. Blowdown steam lines in accordance with a schedule approved by Owner. Owner will notify the proper authorities of the time and duration of the blows.

c. Contractor shall design the temporary steam blow system and shall furnish and install all temporary piping, silencers test targets (coupons), valves, thermocouples, pressure gauges, anchors, and supports required for blowing steam lines as indicated on the drawings and as required.

d. Discharge of steam blows shall not enter the condensate system.

B. Furnish all labor and attendance, and pay all expense for overtime work required to blow steam lines and install or remove temporary pipe, valves, and related items between blowing sequences. Blow steam lines around the clock including weekends and holidays if so directed by Owner. Contractor shall be responsible for obtaining permitting for such work, as required.

C. Steam line blowdown shall be performed by a firm specializing in such services.

D. System Design:

1) The temporary pipe and silencer shall be sized to provide a cleaning mass ratio of 1.5 through the steam system. The cleaning mass ratio is defined as:

$$C.R. = \frac{M_B^2 V_B}{M_D^2 V_D}$$

where M_B is the main steam flow during steam blow, V_B is the steam specific volume measured at the superheater outlet, M_D is the design operating main steam flow, and V_D is the design operating specific volume.

2) Steam line conditions for determining the cleaning mass ratio shall be provided by Contractor for Owner review.

3) Contractor shall submit calculations verifying the cleaning mass ratio at the superheater outlet and at the highest velocity on the main steam line, attemperation water flow rates required, and condensate makeup water flow rates required.

4) System shall be designed to inject water in the temporary vent piping and the vent silencer to reduce the steam velocity and temperature. Contractor to provide temporary piping from the construction water system to the injection points. All valves, piping and fittings shall be furnished by the Contractor.

5) Additional attemperation water will be supplied through temporary feedwater attemperation lines installed by this Contract to shock the steam lines through steam attemperation. Contractor shall provide any temporary piping hose fittings, or equipment required to supply attemperation water to the steam line connections required for thermal shocking.

6) Steam blow test coupons shall be installed in the temporary piping upstream of final quenching water. Test coupon shall be designed for quick and easy removal and inspection and insertion into the temporary piping.

7) Steam line blowdown test coupon acceptance criteria shall be as follows:

    a. No raised impacts shall be visible.

    b. No greater than three visible impacts for two consecutive steam line blowdown cycles.

    c. In accordance with steam turbine manufacturer's requirements.

8) All temporary piping hanger to supports shall be designed in compliance with SECTION 5 of this Specification.

9) Test coupons shall be made available to Owner 30 days prior to conducting the steam line blowdown.

10) A temporary silencer shall be utilized and shall be designed for a maximum steam velocity of 50 ft/min. Silencer shall be capable of limiting the steam discharge sound pressure level to 85 dBA at 100 feet from the silencer. Silencer location shall be such that the silencer exhaust plume will not impact existing structures or electrical lines. Silencer location shall be located a

significant distance from the steam turbine building (minimum of 75 feet) and shall be subject to the approval of Owner.

11) Contractor shall supply mobile demineralizer as required to provide demineralized water for steam blows. Contractor shall supply temporary hose from the mobile demineralizer to the demineralized water storage tank and/or condensate receiver tank.

12) Demineralized water quality shall be as follows:

a.	Conductivity, micromhos/cm at 25^{o}C,	< 0.15
b.	Sodium, mg/l as Na	< 0.003
c.	Silica, mg/l as SiO_2	< 0.010
d.	Chloride, mg/l as Cl	< 0.003
e.	Sulfate, mg/l as SO_4	< 0.003
f.	Total Organic Carbon, mg/l as C	< 0.100

13) Existing site construction water source is well water. Raw water quality shall be as indicated in Appendix I.

14) Wastewater from the Contractors temporary mobile demineralizer shall be disposed of offsite by the Contractor.

15) Use test coupons installed in the exhaust lines to indicate when lines are clean. Test coupons shall be 1 inch wide and extend the full diameter of the line being blown. Test coupons shall be made from AISI 1030 brass keystock and shall be ground and polished so that the root mean square surface irregularities does not exceed 16 micro-inches. Lines will be considered clean when test coupons are acceptable to Owner.

E. Owner will operate combustion turbine and heat recovery steam generator to generate steam at Contractor specified conditions for steam blows.

F. After Owner acceptance of test coupons, remove all temporary piping, supports, and associated material. Reassemble valves under Owner supervision. The Owner will inspect the existing main steam/hot reheat/cold reheat tie-ins for cleanliness prior to making the final fit-up.

G. At no time is it acceptable for Contractor to make any temporary weld to any critical piping system or associated equipment for support or any other reason, without approval from Owner.

4. STEAM BLOWING SEQUENCE:

A. General:

Portions of the cold reheat and the low pressure steam line may not be included in the steam blow (at the turbine connections). For sections of piping, which will not be in steam blow, piping shall be received from fabricator clean, shop blasted, and sealed. Contractor shall assume all responsibility in assuring piping is protected against any contamination. Immediately before installation, and upon completion of steam blows, Contractor shall provide means for Owner to perform visual inspection of the piping. Final piping welds shall not be performed until Owner has signed off on all piping inspections.

Furnish and install temporary steam blow piping, blow valves and silencers.

Install stop valve blow kits.

B. First Blow

1) Steam blowdown will begin after all temporary piping, silencers and demineralized water makeup systems are installed.
2) Owner will operate the combustion turbine to provide a heat source to generate steam from the HRSG. Steam drum pressure will be held constant during the steam line blowdown.
3) Install blow kits in the main steam stop valves.
4) Furnish and install temporary blow piping from the stop valve to a safe discharge point outdoors. Piping shall include blow valve and silencer.

5) Blow from the HP drum through the HP steam piping and the steam turbine HP stop valves, through temporary piping and blowdown valve to exhaust silencer.

6) After a period of blowdown, the attemperation water flow shall be increased to shock the main steam line. Steam line shock will be repeated as directed by Owner to enhance cleaning.

7) Install test coupons after a period of steam line blowdown.

8) The initial blow shall clean from the HRSG through main steam piping and out temporary piping to a silencer. The first stage blow shall be completed only after Owner acceptance of test coupon insertion test result.

9) Blow through HRSG, main steam piping, stop valve, temporary piping, and blowdown valve to atmosphere until clean.

C. Second Blow:

1) Furnish and install bypass piping and temporary blowdown valve from main steam outlet to cold reheat connection at the steam turbine.

2) A temporary connection shall be made to the cold reheat piping at the steam turbine and shall be performed by this Contract.

3) Contractor shall provide temporary attemperation line in the temporary piping between the main steam and cold reheat line to limit the temperature of the steam entering the cold reheat line to the cold reheat design temperature limit.

4) Install blow kits in the hot reheat steam stop valves.

5) Furnish and install temporary blow piping from the stop valve to a safe discharge point outdoors. Piping shall include blow valve and silencer.

6) Contractor shall provide temporary attemperation line in the temporary piping between the main steam and cold reheat line to limit the temperature of the steam entering

the cold reheat line to the cold reheat design temperature limit.

7) Blow from the main steam piping, through the main steam bypass to hot reheat piping, hot reheat stop valves and temporary piping to atmosphere until clean.

8) Blow from the IP drum to the cold reheat inlet connection and then blow through the reheater, hot reheat piping, hot reheat stop valves and temporary piping to atmosphere until clean.

9) Blow through main steam piping, through main steam to cold reheat bypass piping, cold reheat piping, to the reheater, hot reheat piping, hot reheat stop valves and temporary piping to atmosphere until clean

10) Blow through main steam piping, stop valve, bypass piping, cold reheat piping, to the reheater, hot reheat piping, hot reheat stop valves and temporary piping to atmosphere until clean.

11) After a period of blowdown, the attemperation water flow shall be increased to shock the reheat steam line. Steam line shock will be repeated as directed by Owner to enhance cleaning

12) Third stage blow shall be completed only after Owner acceptance of test coupon

D. Third Blow (may occur concurrently with other blows):

1) LP steam blowdown will begin after all temporary piping, silencers and condensate makeup systems are installed.

2) Furnish and install temporary blow piping from the strainer upstream of the turbine to a safe discharge point outdoors. Piping shall include blow valve and silencer.

3) Install test coupons after a period of steam line blowdown.

4) The LP steam blow shall clean from the HRSG LP drum through low pressure steam piping and out temporary piping to a silencer. The fourth stage blow shall be completed only after Owner's acceptance of test coupon insertion test result.

5) Blow through LP steam piping, stop valve, temporary piping, and blowdown valve to atmosphere until clean.

6) Additional Steam Blows:

7) Contractor shall blow remaining lines as required for service blows, which shall include at least:

   a. Main Steam to Combustion Turbine Hot Reheat Bypass to Condenser

   b. LP Steam Bypass to the Condenser

   c. Steam cold reheat lines through the Turbine Gland Steam System

   d. Auxiliary Boiler steam lines through the Turbine Gland Steam System, steam jet air ejectors, condenser sparger, HRSG spargers.

   e. Other steam system lines as designated by the Owner.

   f. No steam blow discharge shall pass into the condenser and/or condensate system.

5. FUEL GAS LINE BLOWDOWN AND CLEANING:

A. General:

1) Fuel gas line shall be cleaned in accordance with gas turbine manufacturer's gas cleaning procedure or as defined herein, whichever is more stringent.

2) Clean the fuel gas system by blowing down the main line from the gas metering station to each combustion turbine main inlet with enough blows to completely clean the lines of all foreign matter and to the satisfaction of the Owner and Engineer.

3) Blowdown fuel gas lines in accordance with a schedule approved by Owner. Owner will notify the proper authorities of the time and duration of the blows.

4) No welding, grinding or other activities that could generate a spark shall be conducted during the blowing operation.

5) Perform blowing and line cleaning operations in accordance with Equipment manufacturer's cleaning procedures and as specified herein.

6) Blowing procedure shall be developed by Contractor and submitted to Owner for review and approval. Procedure shall blow clean all fuel gas piping from the fuel gas yard to inlet of the filter separators. After this segment is clean, blow from the filter/separators to the combustion turbine accessory modules.

7) Blow down piping with at least 4 short duration blows (approx. 15 seconds), then blow with at least 4 medium duration blows (approx. 60 seconds), then blow with long duration blows (approx. 2 minutes) until clean

8) Furnish and install all temporary piping, blanking flanges and plates, valves, thermocouples, pressure gauges, anchors, and supports required for blowing fuel gas lines as indicated on the drawings and as required. Remove valve internals and inline flow elements during blowing.

9) Install temporary piping to bypass the heat exchangers, knock out tank and filter separator during the initial blows. Remove temporary piping during the final blows and blow through the heat exchangers, knock out tank and filter separator.

10) Remove filter separator internals during blowing operations. Inspect and remove all foreign matter from filter separator after blowing operations. Reinstall internals when blowing is completed.

11) Furnish and install all required temporary blowdown piping and valves as required to discharge blow gas in a safe location. The temporary blowdown valves shall be equipped with a pneumatic operator with an opening and closing time under pressure not exceeding 10 seconds.

12) Gas line blowdown test target acceptance criteria shall be as follows: No visible impacts, pits, dings or holes shall be visible.

13) Use test targets installed at the exhaust lines to indicate when lines are clean. Test targets shall be made from 2 foot by 2 foot plywood painted white. Position test target at

a 30 or 45 degree angle to the exhaust pipe and position the centerline of the target 2 foot from the exhaust pipe exit.

14) Lines will be considered clean when test targets are acceptable to Owner.

15) Furnish all labor and attendance, and pay all expense for overtime work required to blow fuel gas lines. Blow fuel gas around the clock and on weekends and holidays if so directed by Owner.

16) Fuel gas blowdown shall be performed by a firm specializing in such services.

17) The temporary pipe and silencer shall be sized to provide a cleaning mass ratio of 2.0 through the fuel gas system. The cleaning mass ratio is defined as:

$$C.R. = \frac{M_B^2\ V_B}{M_D^2\ V_D}$$

where M_B is the fuel gas flow during gas blow, V_B is the fuel gas specific volume measured at the fuel gas meter yard, M_D is the design operating fuel gas flow upstream of the combustion, and V_D is the design operating main fuel gas specific volume.

18) Fuel gas blow test targets shall be installed at the temporary piping exhaust at a safe location as approved by Owner. Test target shall be designed for quick and easy removal and inspection and reinstallation at the exhaust of the temporary piping.

19) All temporary piping hanger to supports shall be designed in compliance with this Specification.

20) Test targets shall be made available to Owner 15 days prior to conducting the gas line blowdown.

21) Owner will furnish the fuel gas for the gas blows.

22) After Owner acceptance of test targets, remove all temporary piping, supports, and associated material.

Reinstall the filter/separator internals. Reconnection Combustion Turbine Accessory Module. Owner will inspect the tie-ins for cleanliness prior to making the final fit-up.

23) After completing blow procedure clean gas piping in accessory module and downstream to combustion turbine injection nozzles. After cleanliness verification by Owner, restore the system when complete.

B. Gas Blowing Sequence:

1) First Blow:

a. Bypass the gas fired heat exchangers and hot water heated fuel gas heaters.

b. Furnish and install temporary blow piping including blow valve and silencer and which discharges to a safe point.

c. Blow from the gas yard to the filter/separator inlets until clean.

d. The first stage blow shall be completed only after Owner acceptance of test coupon insertion test result.

2) Second Blow:

a. Close Bypass and open flow through the gas fired heat exchangers and hot water heated fuel gas heaters.

b. Blow from the gas yard to the filter/separators inlet until clean.

c. The first stage blow shall be completed only after Owner acceptance of test coupon insertion test result.

3) Third Blow:

a. Install blanking plate at accessory modules.

b. Furnish and install temporary blow piping including blow valve and silencer and which discharges to a safe point.

c. Blow from the gas yard to the accessory module inlets until clean.

d. The third stage blow shall be completed only after Owner's acceptance of test coupon insertion test result

6. INITIAL OPERATION:

A. General:

1) As soon as Contractor's equipment, system or a portion of a system is completed in accordance with Owners defined turnover packages (to be provided after Contract award) and ready for turnover, Owner will perform a walk down of the equipment, system or a portion of a system as follows:

a. Contractor shall notify Owner as soon as a system is ready for initial operation.

b. Owner will inspect the system to ensure that all work required preparing it for initial operation has been completed.

c. As soon as Owner is satisfied that a system has been properly prepared for initial operation, Owner will give Contractor written notice that it is accepted for initial operation. Owner will furnish Contractor an exceptions list for system completion and correcting.

d. After acceptance for initial operation, Owner will assume all operational and maintenance duties as defined. All other Contractor's personnel are specifically prohibited from starting or stopping any equipment in the system, opening or closing any valve in the system, operating any switches, breakers or controls in the system, or performing any other operational and maintenance duties whatsoever.

2) When the Owner accepts a system or a portion of a system for operation it will be so marked in accordance with the Project standard marking system (to be provided after Contract Award).

3) After acceptance for operation, Contractor shall continue to provide all specialized personnel and attendance required to correct defective material and workmanship and to perform the Work specified within.

4) Acceptance by Owner of a system or a portion of a system for initial operation does not constitute final acceptance for making final payment nor does it constitute that the system is properly constructed and/or adjusted for proper operation.

5) Contractor shall follow instructions given in manuals supplied by the manufacturer of equipment and materials for erection, installation, cleaning, testing, checkout and start-up.

6) Contractor shall follow instructions of service representative of equipment and materials.

7) Contractor shall cooperate with Owner and manufacturer's service personnel during the start-up period.

8) Contractor shall strictly enforce his own and Owner's safety measures for the protection of equipment and personnel. Owner's tagging procedure shall be strictly complied with.

B. Equipment and System Turnover Packages:

1) The Acceptance for Initial Operation Turnover Package shall contain the following items, and shall be documented in the manner indicated:

a. Agreement for Acceptance for Initial Operation form signed by the responsible personnel.

b. Table of Contents sheet listing the documents contained in the Turnover Package.

c. A copy of the Construction Exceptions List and the Deficiency List with a status of items noted.

d. Performance Test data sheets signed and dated by designated personnel.

e. Lubrication and alignment data sheets signed and dated by designated personnel.

f. Marked-up P&ID drawings, electrical schematics and any other drawings necessary to define the system boundaries. All drawings shall be current with all known corrections made prior to Acceptance for Initial Operation.

g. List of instruments by instrument number that are within the scope of the system boundaries.

h. A list of equipment that is within the scope of the system boundaries.

2) System Turnover boundaries shall be established by Owner to reflect functional systems. Each system shall be assigned a system designator by Owner, and Owner will prepare a system turnover schedule. Every reasonable effort shall be made on the part of all responsible parties to turnover systems within the boundaries described on the scheduled date.

3) Approximately six (6) to eight (8) weeks prior to the scheduled turnover date, Contractor shall conduct an informal walkdown of the system with his subcontractors and Owner. This early informal walkdown will define the system boundaries. The informal walkdown shall mark the beginning of the Construction Exception and Start-up Deficiency listing process. One (1) to two (2) weeks prior to the scheduled turnover date, Contractor shall perform a final pre-turnover walkdown. An official Exception List and a Deficiency List shall be prepared at this time. These Lists are to be agreed upon by all parties as exceptions to the system turnover. Those items that Owner indicates must be completed prior to turnover shall be so noted on the Construction Exception List.

4) Once the proper signatures have been affixed, the package will be transmitted to Owner for review and acceptance. Owner will also review the turnover package. If accepted by Owner, Contractor shall release all Construction safety tagging within the boundaries of the

turnover and Owner shall affix tags/labels where necessary to signify jurisdictional transfer to Owner. If necessary, the Turnover Package shall be returned for completion to Contractor with a written description of outstanding items.

5) When performing the final walkdown between Owner and Contractor, all known exceptions shall be clearly identified and documented. All exceptions shall be noted on the up Deficiency List or on the Construction Exception List. Control of the Exception List shall be as follows:

   a. Exception List shall be numbered in accordance with the turnover schedule.
   b. Owner shall maintain control of the both Exception and Deficiency Lists until completed.
   c. The Construction Exception List and the Deficiency List with estimated completion dates for open exceptions shall be transmitted to Owner with the Turnover Package.
   d. Contractor shall meet scheduled completion dates for turnover exceptions and notify Owner of each item completed.
   e. Contractor shall contact Owner to obtain safety tag clearance as required for completion of turnover exception items.
   f. Contractor shall document the completion of each exception on the list.
   g. Contractor shall, as required, transmit copies of updated Exception Lists to Owner.

6) Once Owner accepts the Turnover Package, Owner will place Owner tags or labels on all major valves, boundary valves, breaker panels and breaker panel control switches, various control switches, instrument and instrument panels and other components as necessary to identify boundaries and equipment within boundaries. Once tags are hung, no Contractor personnel shall be permitted to operate or otherwise work on the equipment under tags unless

clearance is obtained from Owner. All boundary valves or breakers shall be safety tagged to prevent Owner from interfering with construction activities. Turnover from Contractor is not complete until tagging is complete. Tags or labels indicate jurisdictional transfer only. These are not to indicate safety protection for personnel or protect equipment from accidental damage. If protection for personnel or against equipment damage is deemed necessary by Contractor or Owner, the appropriate safety tags will be hung in accordance with a Safety Tagging Procedure.

7. PERFORMANCE AND ACCEPTANCE TESTS:

   A. Performance and acceptance tests shall be in accordance with procedures outlined in Appendix M.

8. EMISSIONS TESTING

   A. Emissions testing shall be in accordance with procedures outlined in Appendix M.

9. NOISE TESTING:

   A. After the Facility is placed into successful operation and before Substantial Completion, Contractor shall perform a Noise Level Test on the Facility, Materials and Equipment as specified in Appendix M to verify compliance with the requirements of Appendix M.

   B. Appropriate corrections, in accordance with recognized industry standards, shall be made to the operating plant sound level measurements.

Performance Test Completion Certificate

Contractor, under the Contract dated _______,, 20___, between Contractor and Owner for the Facility hereby certifies that on the __ Day of_______, 20___ the Contractor has completed a Performance Test [run or rerun]. A copy of these Performance Test results is attached hereto as Attachment A. The Performance Test [run or rerun, is or is not] the final such Performance Test to demonstrate Facility performance. [Additional or No additional] Performance Testing shall be performed.

Contractor has/has not achieved the Performance Guarantees.

Contractor has/has not achieved the Minimum Performance Standards.

IN WITNESS WHEREOF, Contractor has executed and delivered this certificate through its duly authorized representative as of the _____ Day of ________ , 20__

By: ___________________________

Title: ___________________________

Performance Test Completion Certificate

ACCEPTANCE OF PERFORMANCE TEST COMPLETION CERTIFICATE

Owner hereby accepts the foregoing certificate and confirms that acceptance of this certificate constitutes acknowledgment by the Owner of the level of performance achieved by the Facility.

Owner's Representative hereby accepts the foregoing certificate and confirms that acceptance of this certificate constitutes acknowledgment by the Owner of the level of performance achieved by the Facility.

Consultant hereby accepts the foregoing certificate and confirms that acceptance of this certificate constitutes acknowledgment by the Owner of the level of performance achieved by the Facility.

IN WITNESS WHEREOF, Owner, Owner's Representative and Consultant have caused this Acceptance of Performance Test Certificate to be executed by their duly authorized representative as of the ____ Day of _______________, 20___

OWNER'S REPRESENTATIVE	OWNER
By: ________________________________	By: ________________________________
Title: ________________________________	Title: ________________________________

CONSULTANT

By: ________________________________

Title: ________________________________

APPENDIX A

ABBREVIATIONS

ABBREVIATIONS

ac	alternating current
AGC	automatic generation control
ARMA	Air and Radiation Management Administration
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
Btu	British thermal unit
°C	degree Centigrade
CEMS	continuous emissions monitoring system
CO	carbon monoxide
CO_2	carbon dioxide
CPCN	Certificate of Public Convenience and Necessity
CRT	cathode ray tube
GT	gas turbine
CTG	gas turbine-generator
dBA	decibel
dc	direct current
DCS	distributed control system
DNR	Department of Natural Resources
EAF	equivalent availability factor
EPC	engineering/procurement/construction
EPA	Environmental Protection Agency (U.S. unless noted)
°F	degree Fahrenheit
FAA	Federal Aviation Administration
FERC	Federal Energy Regulatory Commission
gal	gallon
GNP	Gross National Product

gpd	gallons per day
gpm	gallons per minute
Hga	mercury absolute
HHV	higher heating value
HP	high pressure
hp	horsepower
hr	hour(s)
HRSG	heat recovery steam generator
HVAC	heating, ventilating and air conditioning
Hz	hertz
I&C	instrumentation and control
in	inch(es)
IP	intermediate pressure
ISO	International Standards Organization
kV	kilovolt(s)
kVA	kilovoltampere(s)
kW	kilowatt(s)
kWh	kilowatt-hour(s)
lb	pound(s)
lb/hr	pounds per hour
LHV	lower heating value
LNG	liquid natural gas
LP	low pressure
mA	milliampere(s)
MCC	motor control center
MCR	maximum continuous rating
mgd	million gallons per day
MMBtu	million British thermal units
MVA	megavoltampere
MW	megawatt(s)
MWa	megawatt(s)

MWe	megawatt(s) electrical
MWh	megawatt-hour
NO_2	nitrogen dioxide
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NO_x	oxides of nitrogen
NSPS	new source performance standards
O_2	oxygen
O&M	operation and maintenance
PCS	Parallel Condensing System
pf	power factor
PM	particulate matter
PM-10	particulate matter below 10 microns
ppm	parts per million
ppmvd	parts per million by volume, dry
PPRP	Power Plant Research Program
PSC	Public Service Commission
PSD	Prevention of Significant Deterioration
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gauge
PURPA	Public Utility Regulatory Policy Act
QF	qualifying facility
RH	relative humidity
rpm	revolutions per minute
scf	standard cubic feet
SCR	selective catalytic reduction
sf	square foot
SO_2	sulfur dioxide
STG	steam turbine-generator

TSP	total suspended particulates
UL	Underwriters Laboratory
UPS	uninterruptible power supply
V	volt
VAR	volt ampere reactive
VOC	volatile organic compounds

APPENDIX B

APPROVED VENDORS LIST

APPENDIX B

APPROVED VENDORS LIST

The following document provides a list of approved Vendors for plant materials and equipment. In many categories, a Vendor has been identified as “Preferred” in order to maintain the same Vendors of equipment as Currant Creek 2 or because PacifiCorp has utilized the equipment supplier for its generating fleet and has had favorable experiences.

The basis for the plant design should generally be the “Preferred” Vendors in areas where common operating procedures, routine maintenance or spare parts can be affected.

In other areas, the Owner shall be notified and shall have the option to select an identified equipment “Preferred” Vendor via a Change Order if the “Preferred” Vendor is not the Contractor’s evaluated equipment bidder. The Owner would not expect to see a request for change order however unless there are significant cost delta’s from the “Preferred” Vendor.

Approved Vendors List

Equipment / Construction Package	Approved Subcontractors / Equipment Suppliers
Combustion Turbines	General Electric 7FA.05 (Existing combustion turbines are GE7241FA), Siemens SGT6-5000F Mitsubishi M501GAC
Steam Turbine	Toshiba GE Mitsubishi Siemens Alstom
Generator for Steam Turbine	Toshiba General Electric Mitsubishi Siemens Alstom
Turbine Supervisory Instrumentation Unit	**Bently Nevada – PacifiCorp Standard**
Position Switch	Namco Co.
Position Transmitter	M-System **Fisher-Rosemount - Preferred** Foxboro Yokogawa Dresser Measurement & Control ABB
Flow Indicator	Yokogawa Electric Co.
Purity Analyser	**Yokogawa - PacifiCorp Standard**
Solenoid Valve	Asco, Co.
Positioner	Fisher Co.
Instrument Valve	**Swagelok, Co. - Preferred** **Whitey Co. – Preferred Valves**
Instrument Fittings	**Swagelok, Co. - Preferred** Whitiey Co.
Control Valve	**CCI (Feedwater) – Preferred** Fisher Co. Valtek Masoneilan ABB
I/P Converter	Yokogawa
Generator Condition Monitor	**E-One, GCMX – PacifiCorp Standard**
Instrument Rack / Generator	**E-One – PacifiCorp Standard**
Seal Oil Gauge Panel	**E-One – PacifiCorp Standard**
Hydrogen Gas Measuring Rack	**E-One – PacifiCorp Standard**
H2 Gas Dryer	LectroDryer
Combined Main Stop and Control Valve / Actuator	Rexroth
Combined Reheat Valve Actuator	Rexroth

Equipment / Construction Package	**Approved Subcontractors / Equipment Suppliers**
Gland Steam Condenser	Southern Heat Exchanger ITT Industries Struthers Industries Krueger Engineering & Mfg. Co. Thermal Engineering International Yuba GEA SPX
Gland Steam Exhauster	Gardner Denver The New York Blower Co. Chicago Blower Co. or Equivalent Toshiba
Main Oil Cooler	Tranter PHE Southern Heat Exchanger ITT Industries GEA Ecoflex **Alfa Laval (Plate & Frame) - Preferred**
Oil Conditioner	**Kaydon - Preferred** TORE Alfa Laval
Oil Mist Eliminator	Burgess-Miura Co. Koch-Otto York
HRSGs	Nooter/Ericksen Vogt Power Alstom NEM CMI
HRSG Duct Burners	**Forney – Preferred** Coen John Zink
SCR and CO Systems	Peerless Mfg. Hitachi Vector MHI
SCR Catalyst	Cormetech Argillon (formerly Siemens) Haldor Topsoe
HRSG Stack Damper Actuator	**Limitorque – Preferred** Rotork Siemens
CO Catalyst	**BASF Catalysts - Preferred** EmeraChem

Equipment / Construction Package	Approved Subcontractors / Equipment Suppliers
Auxiliary Boiler	**Nebraska - Preferred** Babcock & Wilcox Cleaver Brooks Indeck Rentech Victory Energy
Boiler Feed Pumps and Motors	Ebara Flowserve **KSB, Inc. – Preferred** Sulzer Pumps
Condensate Pumps and Motors	Ebara Flowserve ITT Goulds Pumps Johnston Pump Company KSB Sulzer Pumps Weir Pump Company
Component Cooling Water Heat Exchanger (fin fan)	GEA Rainey SPX
Condenser, Air Cooled (ACC)	SPX (Marley) GEA
Heat Exchangers, Plate & Frame	**Alfa Laval– Preferred** APV Graham ITT Standard Paul Mueller Tranter
Water Treatment Systems (Demin)	Hungerford & Terry, Inc. Ecodyne GE Water Technologies Graver Water Co. Infilco Degremont US Filter Water and Power Technologies (Degremont) Ovivo
Condensate Filter	**Cuno - Preferred**
Oil Water Separators	**PS International – Preferred** Anderson Great Lakes Environmental Highland Tank

Equipment / Construction Package	Approved Subcontractors / Equipment Suppliers
Air Compressors	**Gardner Denver - Preferred** Atlas Copco Cameron Cooper/Joy Industries Dresser Elliot Ingersoll Rand Sullair UE Compression
Air Dryers	**Atlas Copco – Preferred** Deltech Gardner Denver Hankison Ingersoll Rand Kemp Pneumatic Productions corporation Sullair Van Air Systems
Fuel Gas Treatment	Anderson Separator/Clark Reliance/National Burgess Manning Exterran Filtration Flowtronex Gas Packagers GTS Energy Hanover Smith Oil & Gas Systems PECO Peerless Pipeline Equipment Texas Systems Total Energy Resources Tran-Am System International Universal Compressors
Miscellaneous Horizontal Pumps	**ITT Goulds Pumps - Preferred** Aurora Pumps Flowserve Johnston KSB Peerless Sulzer
Pumps, Vertical	Aurora Pumps ITT Goulds Pumps Flowserve **Johnston -Preferred**

Equipment / Construction Package	Approved Subcontractors / Equipment Suppliers
Vacuum Pumps	**Nash - Preferred** Gardner Denver Graham Manufacturing Nitech
Sump Pumps (Submersible)	Aurora Pumps Flowserve ITT Flygt ITT Goulds Johnston Pumps KSB Nagle Warman
Pumps, Fire Water	**Fairbanks Morse – Preferred** Aurora Pumps ITT A-C Pump Peerless
Steam Conditioning Valves (attemporators)	CCI Drag Emerson Process Management Flowserve Copes Vulcan
Fire Protection System	**Delta Fire Protection – Salt Lake City - Preferred** American Fire Technologies Dooley Tackaberry F.E. Moran International Fire Protection McDaniel Fire System S&S Sprinkler Securiplex Shambaugh & Son Simplex Grinnell VFP Fire Systems

Equipment / Construction Package	Approved Subcontractors / Equipment Suppliers
GSU Transformers and Unit Auxiliary Transformers	ABB all voltages – Ludvika, Sweden ABB all voltages – Cordoba, Spain ABB all voltages – Varennes, Quebec – Canada ABB up to 230 kV – StLouis, Missouri ABB 14 MVA and below – South Boston, Virginia ABB-Kulman up to 138 kV – Crystal Springs (near Jackson), Missippi EFESEC all voltages – Porto, Portugal General Electric-Prolec all voltages – Monterrey, Mexico HICO all voltages – Changwon, South Korea HYUNDAI all voltages – Ulsan, South Korea MEPPI -Mitsubshi Electric all voltages – Ako City, Japan Pennsylvania Transformer up to 345 kV – Canonburg, Pennsylvania Siemens all voltages – Weiz, Austria Siemens all voltages – Jundiai', Brazil Siemens all voltages – Nuremberg, Germany Siemens up to 230 kV – Guanajuato, Mexico Smit all voltages – Nijmegen, Netherlands TBEA all voltages – Shenyang, China Toshiba up to 230 kV – Belo Horizonte, Brazil Waukesha up to 230 kV – Waukesha, Wisconsin
Switchgear	**GE – Preferred 4160V** **Square D – Preferred 480V** Eaton/Cutler-Hammer – 4160V and 480V Powell (Only if part of package) Siemens ABB Alstom Mitsubishi Hitachi
Motor Control Centers	**Allen Bradley – Preferred for 480V MCC, 4160V MCC** **Eaton/Cutler-Hammer – Preferred for 480V MCC, 4160V MCC** ABB Alstom GE Powell (Only if part of package) Siemens Square D

Equipment / Construction Package	Approved Subcontractors / Equipment Suppliers
Medium Voltage Motors	ABB Inc. General Electric Hitachi Hyundai Marathon Motors Reliance Siemens TECO-Westinghouse WEG
Low Voltage Induction Motors	ABB Baldor/Reliance General Electric Siemens TECO-Westinghouse Toshiba U.S. Motors
Variable Frequency Drives	ABB Allen-Bradley Cutler-Hammer Danfoss General Electric Mitsubishi Saftronics Siemens
Isolated Phase Bus Duct	**Delta-Unibus – Preferred** **GE Canada - Preferred** ABB Calvert Emform Hitachi JES Engineering Simelectro
Non Segregated Phase Duct	**Delta-Unibus – Preferred** **Powell - Preferred** ABB Calvert Square D Technibus

Equipment / Construction Package	Approved Subcontractors / Equipment Suppliers
Power Control and Instrumentation Cables	**Belden – Communication Cable - Preferred** **Okonite - Preferred** **Southwire - Preferred** Anixter BICC Dekoron Draka Cableteq Furon/Dekoron Kerite Pirelli Rockbestos Supernaut Rome Southwire Tamaqua
High and Medium Voltage Cable	**Okonite - Preferred** Anixton Kerite Pirelli Rome Southwire
Distributed Control System	**Emerson Ovation – PacifiCorp Standard for Currant Creek Plant**
Continuous Emissions Monitoring System	**Environmental Systems Corporation (ECS) DAHS Software; and PacifiCorp specified instruments – PacifiCorp Standard** Thermo-Fisher Scientific 42i-NOx Thermo-Fisher Scientific 48i-CO Servomex 1440-Oxygen
UPS-DC Inverters/Chargers	**Ametek - Preferred**
Station Batteries (VRLA)	GNB East Penn (DEKA) Douglas
Chemical Feed Systems	**Milton Roy/(Not LMI product line) – Preferred** GE . Nalco Neptune Prominent Pulsafeeder Sentry Equipment
Water Sample Panel	Delphi Control Systems Sentry Equipment Corp. Waters Equipment Co. Johnson March

Equipment / Construction Package	Approved Subcontractors / Equipment Suppliers
Instrumentation Analytical Measurements	
Chromatographs	ABB Daniel (Natural Gas) EG&G Emerson Process Management Rosemount
Conductivity	**Yokogawa – PacifiCorp Standard**
Oxygen	Orbisphere Hach Swan Analytical Yokogawa
Silica	**Hach – PacifiCorp Standard**
pH Probe	**Yokogawa – PacifiCorp Standard**
Vibration	**Bentley Nevada – PacifiCorp Standard**
Computers (Flow)	**Daniel - Preferred** Omni Fisher
Controllers, Field Mounted, Pneumatic	Fisher Masoneilan
Flame Supervisory Systems	Fireye Forney Honeywell Allen Bradley Iris
Indicating Manometers	**Dwyer – preferred** Meriam
Indicators Press/Receiver Gauge	**Ashcroft – preferred** Weksler Wika
Programmable Logic Controllers	**Allen Bradley - PacifiCorp Standard Control Logix, Micrologix or SLC 500 (Ethernet Version)**
Transmitters, Electronic	
Differential Pressure	**Rosemount Model 3051 (or approved equivalent) - PacifiCorp Standard** ABB Dresser Measurement & Control Foxboro Yokogawa
Level Measurement	
Capacitance, Etc.	AMETEK Drexelbrook Fisher
Displacement	Fisher Magnetrol
Process Radar	**Rosemount - Preferred** Ohmart-Vega

Equipment / Construction Package	**Approved Subcontractors / Equipment Suppliers**
Custody Transfer/Radar/Displacement	Enraf Saab
Radioactive	Kay-Ray Ohmart-Vega Texas Nuclear
Ultrasonic	**Milltronics – preferred** Endress & Hauser Inc. Kistler Morse Magnetrol Panametrics
TDR	**Rosemount – preferred** Magnetrol
Magnetic Flow	**Rosemount – preferred** Endress & Hauser
Mass Flow	**Rosemount – preferred** Fisher ABB/Bailey
Pressure	**Rosemount Model 3501 (or approved equal)– preferred** Foxboro Honeywell Yokogawa
Target Meter	**Hersey Measurement – preferred** Foxboro
Temperature	**Fisher-Rosemount – preferred** Foxboro Honeywell Moore Industries Yokogawa
Turbine	Daniel Foxboro
Transmitters, Pneumatic	
Differential Pressure	**Fisher – preferred**
Level Displacement	Fisher Magnetrol
Pressure	Fisher Foxboro
Target Meter	Foxboro
Temperature	Fisher-Rosemount Foxboro
UPS	Best SCI
Valves and Regulators	
Actuators, Diaphragm	**Fisher – PacifiCorp Standard** Masoneilan Valtek

Equipment / Construction Package	Approved Subcontractors / Equipment Suppliers
Actuators, Piston	Contromatics Emerson Bettis Flowserve Automax Flowserve Valtek George-Fischer Hills-MC Canna Jamesbury Vanton Whitey XACT
Control Valves – ON/OFF or Throttling Ball	**Fisher – preferred** ABB Atwood & Morrill (E) Cameron WKM Flowserve Jamesbury Masoneilan SPX Copes Vulcan TYCO (E) Valtek Valve Technologies Velan Watts
Positioners, Electric	**Limitorque, MX – Preferred** Fisher-Rosemount
Butterfly/ECC Disk	AMRI Continental Fisher-Rosemount Flowserve Durco Masoneilan Neles-Jamesbury Valtek
Valves, Butterfly <24-inch	Bray Valves & Controls Dezurik Flowseal Henry Pratt Co. Jamesbury Keystone Valve KSB-AMRI

Equipment / Construction Package	Approved Subcontractors / Equipment Suppliers
Valves, Butterfly >24-inch	**Dezurik - Preferred** Atwood & Morrill Centerline Crane Flowseal Grinnell Corp. Henry Pratt Co. Keystone Valve \ Posiseal Vanessa (Tyco) Watts
Valves, Globe	Atwood & Morrill Edwards Newco Valves Pacific Valves Whitey Yarway
Valves, Cast Steel	Atwood & Morrill Crane Edwards Pacific Valves Tyco Velan Valve Co. WM Powell Co.
Control Valves, Severe Duty, (Bypass, Recirculation, Drum level control, ACC spargers)	**CCI Drag – PacifiCorp Standard (Steam bypass valves shall be CCI Drag technology valves, not BTG)** Copes-Vulcan
Control Valves, Severe Duty, Boiler Feed Pump Recirculation Control Valve	**Copes-Vulcan Multi-stage HUSH**
Valves, Forged Steel	Bonney Forge Conbraco Conval, Inc. Crane Dresser Industrial Valve Edwards Valves, Inc. Flowserve VogtNewco Velan Valve Corp Wm. Powell Company Yarway

Equipment / Construction Package	Approved Subcontractors / Equipment Suppliers
Valves, High Pressure	Atwood & Morrill Crane Edwards Pacific Valves Tyco Velan Valve Co. Wm. Powell Company Newco Tong Yung Valve technologies
Valves, Knifegate	Clarkson Dezurik Newcon Warman
Valves, Check	APCO Crane Edward Valves Pacific Valves Stockham Valves & Fittings Yarway/Tyco
Globe / Cage (No Split Body) 300#	**Fisher - Preferred** Collins Instrument (Plastic) Control Component, Inc. (CCI) Masoneilan Samson Valke
Miniature / Special	Collins Instrument Research Controls Whitey
Solenoid Valves	ASCO
Pinch, Weir, Diaphragm	**Fisher-Rosemount - Preferred** ASAHI Emerson Grinnell Red Valve RKL
Plug	Durco Tufline
Regulators	**Emerson Fisher-Rosemount - Preferred** Air Service Cashco Emerson Process Service
Strainers, Automatic Flushing	Fluid Engineering Hayward Strainers Hellan SP Kinney Engineers

Equipment / Construction Package	Approved Subcontractors / Equipment Suppliers
Valves, Ball	Apollo Cooper Cameron Dresser ITT Engineered Valves Mogas Neles Jamesbury NIBCO, Inc Stockham Valves & Fittings Valve Technologies Whitey
Relief or Safety Valves	**Dresser Consolidated – PacifiCorp Standard for Steam Service** Anderson Greenwood/Crosby (Tyco) Ferris
Installation Hardware	
Boxes or Cabinets – Instrument and Junctions Metal	**Hoffman – preferred** Appleton
Boxes or Cabinets – Instrument and Junctions Fiberglass or Plastic	**Hoffman – preferred** Stahlin
Cable Tray and Tubing Support Tray Metal	B-Line OBO Betterman PW James C. White Co., Inc.
Cable Tray and Tubing Support Tray Nonmetallic	Enduro Fibergrate Seagate Stahlin Channel Way James C. White Co., Inc.
Instrument Manifolds and Valving Assemblies	**Rosemount – Preferred** Anderson Greenwood/Crosby (Tyco) PGI
Tubing Metal	Dekoron Thermoelectric
Tubing NonMetallic	Dekoron Thermoelectric
Fittings (Compression) Metal	**Swagelok – Preferred** Gyrolok
Fittings (Compression) Non-metallic	JACO (Kynar)
Fittings (Compression) Valves, Metal	**Whitey – Preferred** Anderson Greenwood/Crosby Hoke PGI
Wire Signal	Alpha Belden Dekoron
Wire Thermocouple	Dekoron
Other	

Equipment / Construction Package	Approved Subcontractors / Equipment Suppliers
Expansion Joints	Bachmann Industries Effox Pathway Wahlco Engineered Products KE Burgmann
Fluid Couplings	Voith
Pipe, Fabricated LP	Bendtec McAbee Construction Scott Process Team Industries Turner (International Piping Systems)
Pipe, Supports	Lisega Bergen PTP Froneck
Tanks, Field Erected	Advance Tank and Construction American Tank & Vessel, Inc. Brown-MN CBI Chatanooga Tank Columbian Tank Fisher Tank HMT, Inc Matrix Mountain States Paso Robles Tank, Inc Pittsburgh Tank PSF Industries Rocky Mtn. Fab Salt Creek Welding
Tanks, Shop Fabricated	Arrow Tanks Brown-MN CBI Chatanooga Tank Dixie Southern Eaton Highland Tanks Modern Welding Palmer Paso Robles Tank, Inc PSF Industries Rocky Mtn. Fab Salt Creek Welding
Protective Relaying Devices and Systems	**Schweitzer Engineering Labs, Inc.300 Series – PacifiCorp Standard**
Lockout Relays	**Electroswitch – PacifiCorp Standard**
Test Switches	**ABB – Preferred** States

Equipment / Construction Package	Approved Subcontractors / Equipment Suppliers
Revenue Meters	**Landis & Gyr Elite – (or most recent Landis & Gyr replacement – Advanced approval required) - PacifiCorp Standard**
Revenue Current Transformer/Voltage Transformer	**Alstom Model KOTEF 362-ER- Preferred**
Switchyard Work **Approved Engineering Companies**	Power Engineeers Contact: Don Evans Tel: 503-244-9321 E-Mail – devans@powereng.com Burns & McDonnell Contact: Justin Sherman Tel: 303-474-2235 E-Mail – jsherman@burnsmcd.com Dashiell Contact: Adam Brown Tel: 713-558-6732 E-Mail – adam.brown@dashiell.com Stanley Contact: Ken Moriarty Tel: 303-925-8248 E-Mail – moriartyken@stanleygroup.com ECI Contact: Bruce LaMeres Tel: 801-292-9954 E-Mail – bruce.lameres@ecislc.com HDR Contact: Paul Campell Tel: 503-423-3879 E-Mail – paul.capell@hdrinc.com
Switchyard Equipment	
Air Switches, Group Operated, Spec ZS 050	Pascor/Pascor Atlantic Royal Switchgear Southern States Turner Electric Areva USCO
Air Switches, Hookstick Operated	Royal Switchgear Southern States Turner Electric S&C Electric USCO
Air Switches, SF6 Bottles	Southern States

Equipment / Construction Package	Approved Subcontractors / Equipment Suppliers
Air Switches, regulator Bypass 1200 A or less	Bridges Electric Kearney Morpak Royal Switchgear S&C Electric Southern States USCO Turner Electric
Air Switches, Regulator Bypass, 2000A	Cleveland Price Morpak
Air Switches, Vacuum Bottles	Turner Electric Joslyn Royal Switchgear
Batteries, ZS 018	Alcad C&D Enersys
Breakers, 345kV and above, ZS 013	ABB T&D HVB Mitsubishi HICO
Control Buildings	CellXion Buildings Parkline Trachte
Switchyard Steel	Continental Steel – Magna Great basin Steel – Riverton MD Henry – Birmingham Pioneer Trailer - Portland

APPENDIX C

CONCEPTUAL SITE ARRANGEMENTS AND REFERENCE DRAWINGS

APPENDIX C

Conceptual Site Arrangements and Reference Drawings

Conceptual Site Arrangements

The following drawings are included to assist the Contractor in development of the Scope of Work. The Contractor shall be responsible for providing construction drawings for the Currant Creek Block 2 Facility in accordance with Exhibit A of these documents.

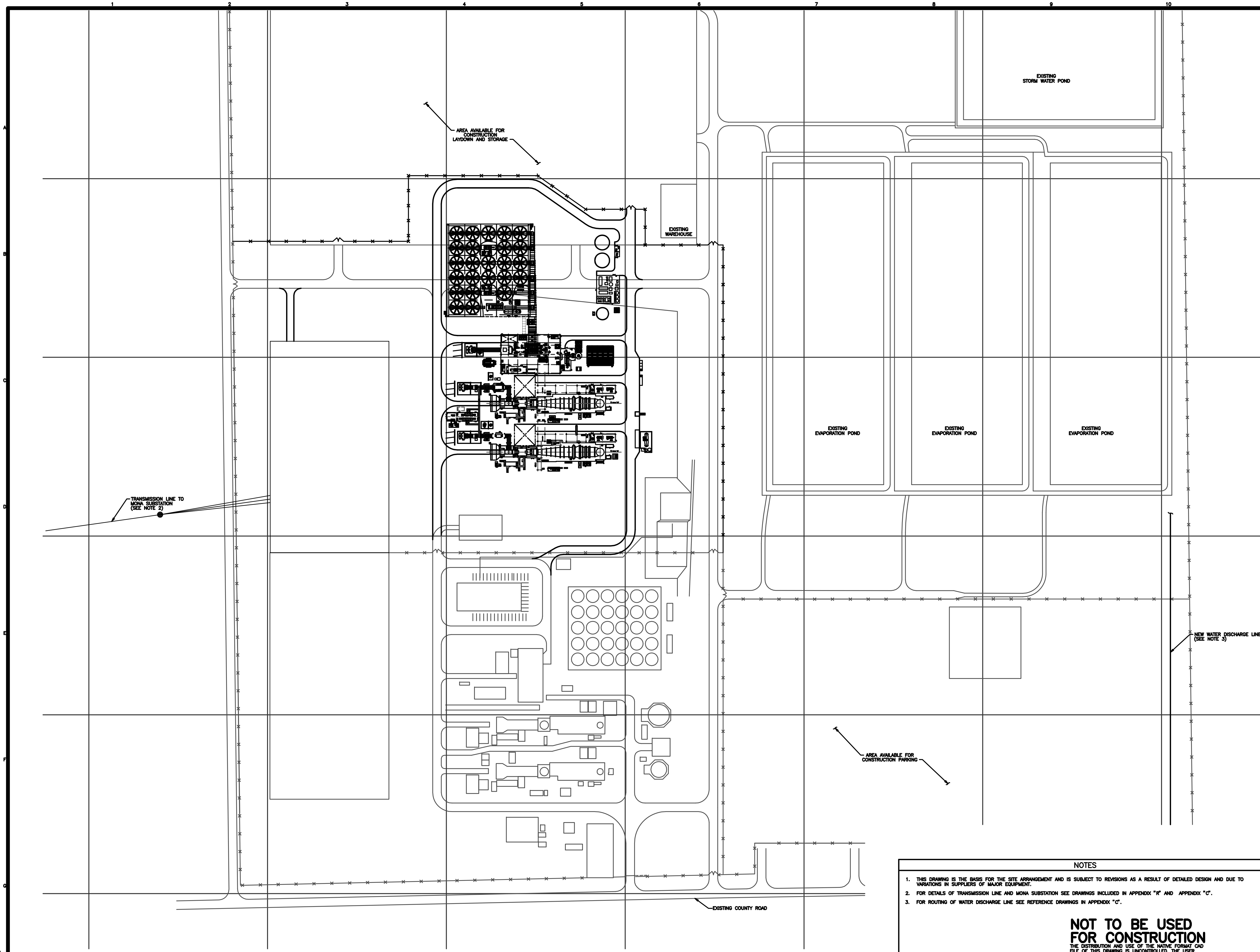
Drawing	**Drawing Title**
B&V 173604-2STA-G1000, Rev. A	Plot Plan – GE F Class 2 X 1 Combined Cycle
B&V 173604-2STA-G1001, Rev. A	Site Plan – GE F Class 2 X 1 Combined Cycle
B&V 173604-2STA-G1100 Rev. A	Plot Plan – MHI G Class 2 X 1 Combined Cycle
B&V 173606-2STA-G1101 Rev. A	Site Plan –MHI G Class 2 X 1 Combined Cycle
B&V 173604-2STA-G1200 Rev. A	Plot Plan – Siemens 5000 F Class 2 X 1 Combined Cycle
B&V 173606-2STA-G1201 Rev. A	Site Plan –Siemens 5000 F Class 2 X 1 Combined Cycle
B&V 162628-2PPA-E8100, Rev. C	Currant Creek II – Electrical Plan

Reference Drawings

The following listed reference drawings are included to aid the Contractor in determining the necessary details and scope of work associated with interfacing with existing facilities and routing of the Water Discharge Line to Currant Creek. The Contractor shall be responsible for development of construction drawings relating to the work in accordance with Exhibit A of these documents.

Drawing	**Drawing Title**
Rocky Mountain Power – USGS Map	Map Currant Creek Plant
Electric Consultants, Inc Sheet 1 of 2	Currant Creek - ALTA Survey
Electric Consultants, Inc Sheet 2 of 2	Currant Creek - ALTA Survey
Hansen, Allen & Luce Inc.	Mona Wells & Pipeline – February 2004
	Cover Sheet

Drawing	**Drawing Title**
Hansen, Allen & Luce Inc. Sheet G-2, Rev. 3	Mona Wells & Pipeline Plan & Profile – Sheet Index & Locator
Hansen, Allen & Luce Inc. Sheet PP-4, Rev. 3	Mona Wells & Pipeline Plan & Profile – Sta. 0+00 to Sta. 13+50
Hansen, Allen & Luce Inc. Sheet PP-5, Rev. 3	Mona Wells & Pipeline Plan & Profile - Sta. 13+50 to Sta. 27+50
Hansen, Allen & Luce Inc. Sheet PP-6, Rev. 3	Mona Wells & Pipeline Plan & Profile – Sta. 27+50 to Sta. 41+50
Hansen, Allen & Luce Inc. Sheet PP-7, Rev. 3	Mona Wells & Pipeline Plan & Profile – Sta. 41+50 to Sta. 55+50
Hansen, Allen & Luce Inc. Sheet PP-8, Rev. 3	Mona Wells & Pipeline Plan & Profile - Sta. 55+50 to Sta. 69+50
Hansen, Allen & Luce Inc. Sheet PP-9, Rev. 3	Mona Wells & Pipeline Plan & Profile – Sta. 69+50 to Sta. 83+50
PacifiCorp 70456R01	Mona Substation – One Line Diagram Key Sketch Plan
PacifiCorp 120334.002	Mona Substation – General Plan Future Development Sketch
PacifiCorp Sketch 113910.001,	345kV Current Creek Switchyard Plan & Profile
PacifiCorp 100545-DE-590-01, Rev. 2	Underground Raceway Plan - Area 90



NOTES

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2. FOR DETAILS OF TRANSMISSION LINE AND MONA SUBSTATION SEE DRAWINGS INCLUDED IN APPENDIX "R" AND APPENDIX "C".
3. FOR ROUTING OF WATER DISCHARGE LINE SEE REFERENCE DRAWINGS IN APPENDIX "C".

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A	07/21/2011	ISSUED FOR CLIENT REVIEW	MWS	LEK		LEK	

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DATE ______ REG NO. ______

BLACK & VEATCH Building a world of difference

PACIFICORP
CURRANT CREEK POWER PROJECT – BLOCK 2

PROJECT / DRAWING NUMBER: 173604–2STA–G1000 REV B

DESIGNER LEK DRAWN MWS
CHECKED DATE

PLOT PLAN
GE F CLASS 2X1 COMBINED CYCLE

CODE
AREA

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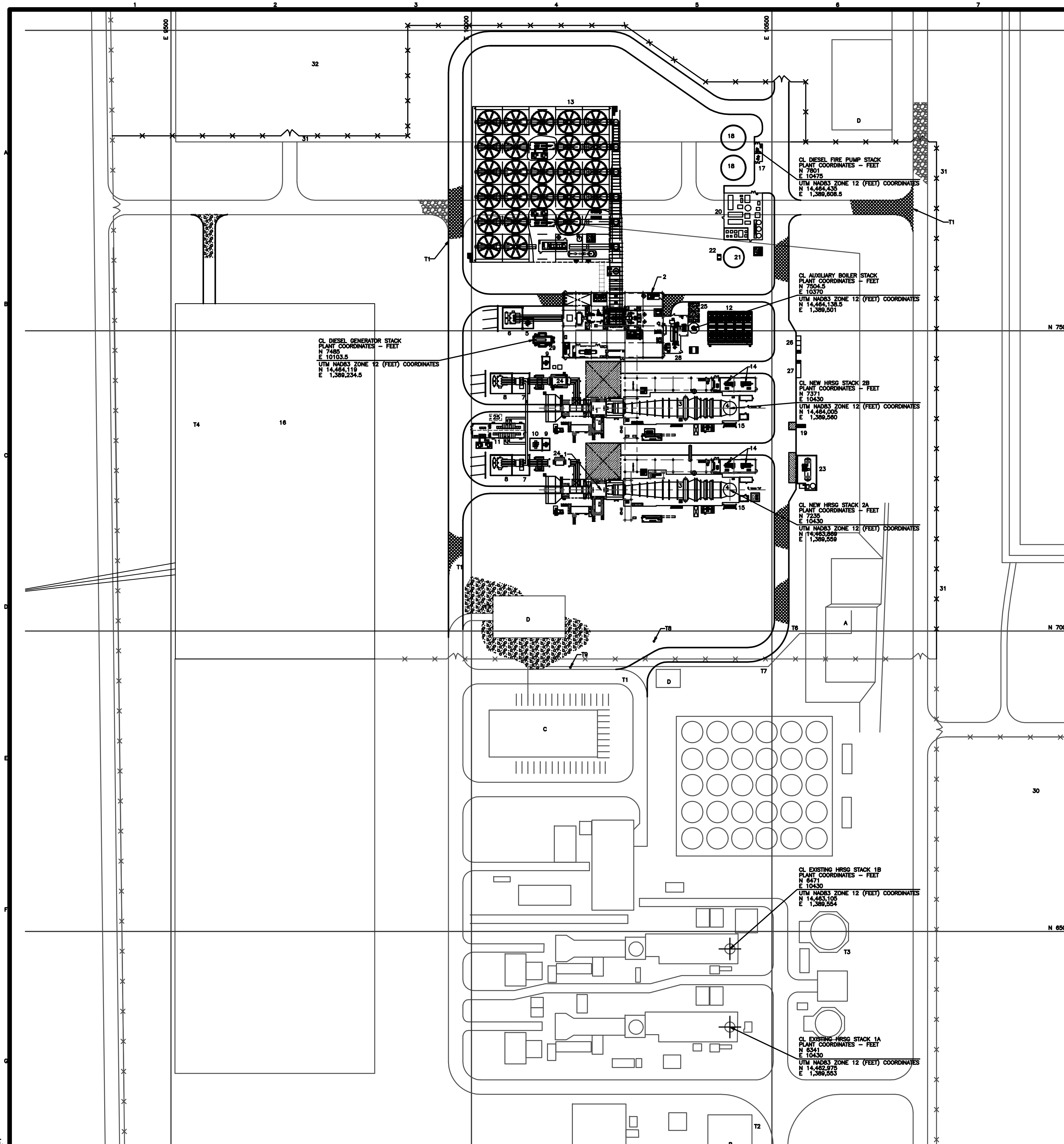

FACILITIES LEGEND

ID	FACILITY	FOUNDATION	TIEDOWN LOCATION NORTH	TIEDOWN LOCATION EAST	REMARKS
1	COMBUSTION TURBINE	–	–	–	
2	STEAM TURBINE BUILDING	–	–	–	
3	HEAT RECOVERY STEAM GENERATOR	–	–	–	
4	HEAT RECOVERY STEAM EXHAUST STACK	–	–	–	
5	ST EXCITATION TRANSFORMER	–	–	–	
6	ST GENERATOR STEP-UP TRANSFORMER	–	–	–	
7	UNIT AUXILIARY TRANSFORMER	–	–	–	
8	CT GENERATOR STEP-UP TRANSFORMER	–	–	–	
9	CT EXCITATION TRANSFORMER	–	–	–	
10	STATIC START ISOLATION TRANSFORMER	–	–	–	
11	MAIN ELECTRICAL CONTROL ENCLOSURE	–	–	–	
12	AIR COOLED HEAT EXCHANGER	–	–	–	
13	AIR COOLED CONDENSER	–	–	–	
14	BOILER FEED PUMPS	–	–	–	
15	CONTINUOUS EMISSIONS MONITORING EQUIPMENT	–	–	–	
16	EXPANDED SWITCHYARD	–	–	–	
17	FIRE WATER PUMP ENCLOSURE	–	–	–	
18	FIRE WATER STORAGE TANK	–	–	–	
19	HYDROGEN STORAGE AREA	–	–	–	
20	WATER TREATMENT BUILDING	–	–	–	
21	DEMIN STORAGE TANK	–	–	–	
22	DEMIN WATER PUMPS	–	–	–	
23	AMMONIA STORAGE AREA	–	–	–	
24	CT EXCITATION COMPARTMENT	–	–	–	
25	OIL/WATER SEPARATOR	–	–	–	
26	CARBON DIOXIDE STORAGE AREA	–	–	–	
27	NITROGEN STORAGE AREA	–	–	–	
28	AUXILIARY BOILER	–	–	–	
29	DIESEL GENERATOR	–	–	–	
30	CONSTRUCTION PARKING	–	–	–	
31	SECURITY FENCE	–	–	–	
32	CONSTRUCTION LAYDOWN	–	–	–	
33	X	–	–	–	
34	X	–	–	–	
35	X	–	–	–	
36	X	–	–	–	
37	X	–	–	–	
38	X	–	–	–	
39	X	–	–	–	
40	X	–	–	–	
41	X	–	–	–	
42	X	–	–	–	
43	X	–	–	–	
44	X	–	–	–	
45	X	–	–	–	
46	X	–	–	–	
47	X	–	–	–	
48	X	–	–	–	
49	X	–	–	–	
50	X	–	–	–	
51	X	–	–	–	
52	X	–	–	–	
53	X	–	–	–	
54	X	–	–	–	
55	X	–	–	–	
56	X	–	–	–	
57	X	–	–	–	
58					
59					
60					

EXISTING FACILITIES LEGEND

ID	FACILITY	FOUNDATION	TIEDOWN LOCATION NORTH	TIEDOWN LOCATION EAST	REMARKS
A	SANITARY SEWER SYSTEM	–	–	–	
B	FUEL GAS METERING STATION	–	–	–	
C	ADMIN/CONTROL BUILDING & WAREHOUSE	–	–	–	
D	WAREHOUSE	–	–	–	
E	X	–	–	–	

TERMINAL POINTS

T1 ACCESS ROAD
T2 NATURAL GAS
T3 SERVICE WATER (RAW WATER)
T4 ELECTRICAL TRANSMISSION
T5 NOT USED
T6 POTABLE WATER
T7 FIRE PROTECTION
T8 SERVICE AIR
T9 CONTROL/COMMUNICATIONS/PHONE (DUCTBANK)

GENERAL LEGEND

ASPHALT SURFACING
AGGREGATE SURFACING
CONCRETE SURFACING
EXISTING AGGREGATE SURFACING
NEW FENCE
EXISTING FENCE

NOTES

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SIGNED ____ DATE ____ REG NO. ____

SCALE: 1"=60'

BLACK & VEATCH
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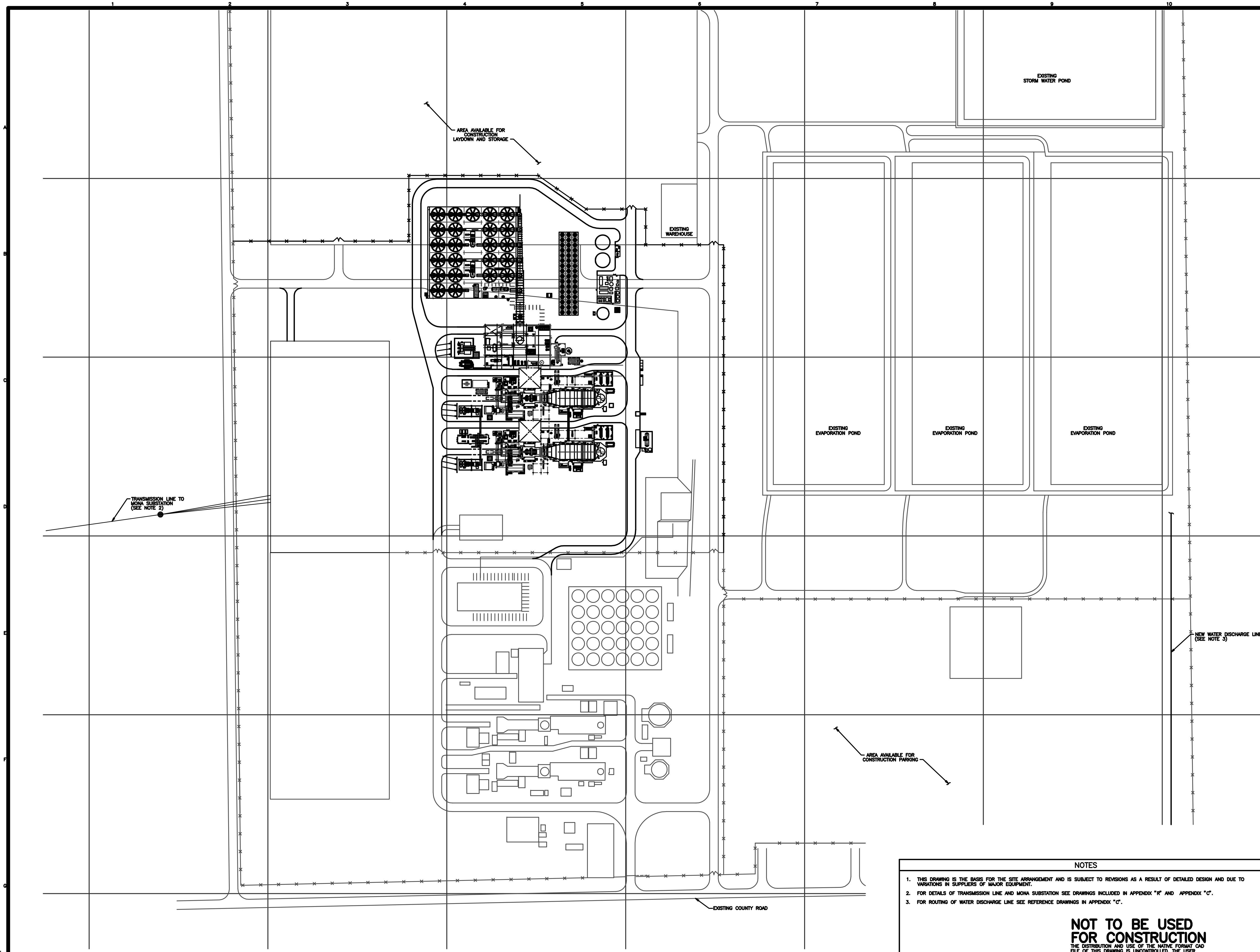
DESIGNER LEK DRAWN MWS
CHECKED DATE

PACIFICORP
CURRANT CREEK POWER PROJECT – BLOCK 2
SITE PLAN
GE F CLASS 2X1 COMBINED CYCLE

PROJECT DRAWING NUMBER 173604–2STA–G1001 REV B
CODE
AREA



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N

100' 50' 0 100' 200'
SCALE: 1"=100'

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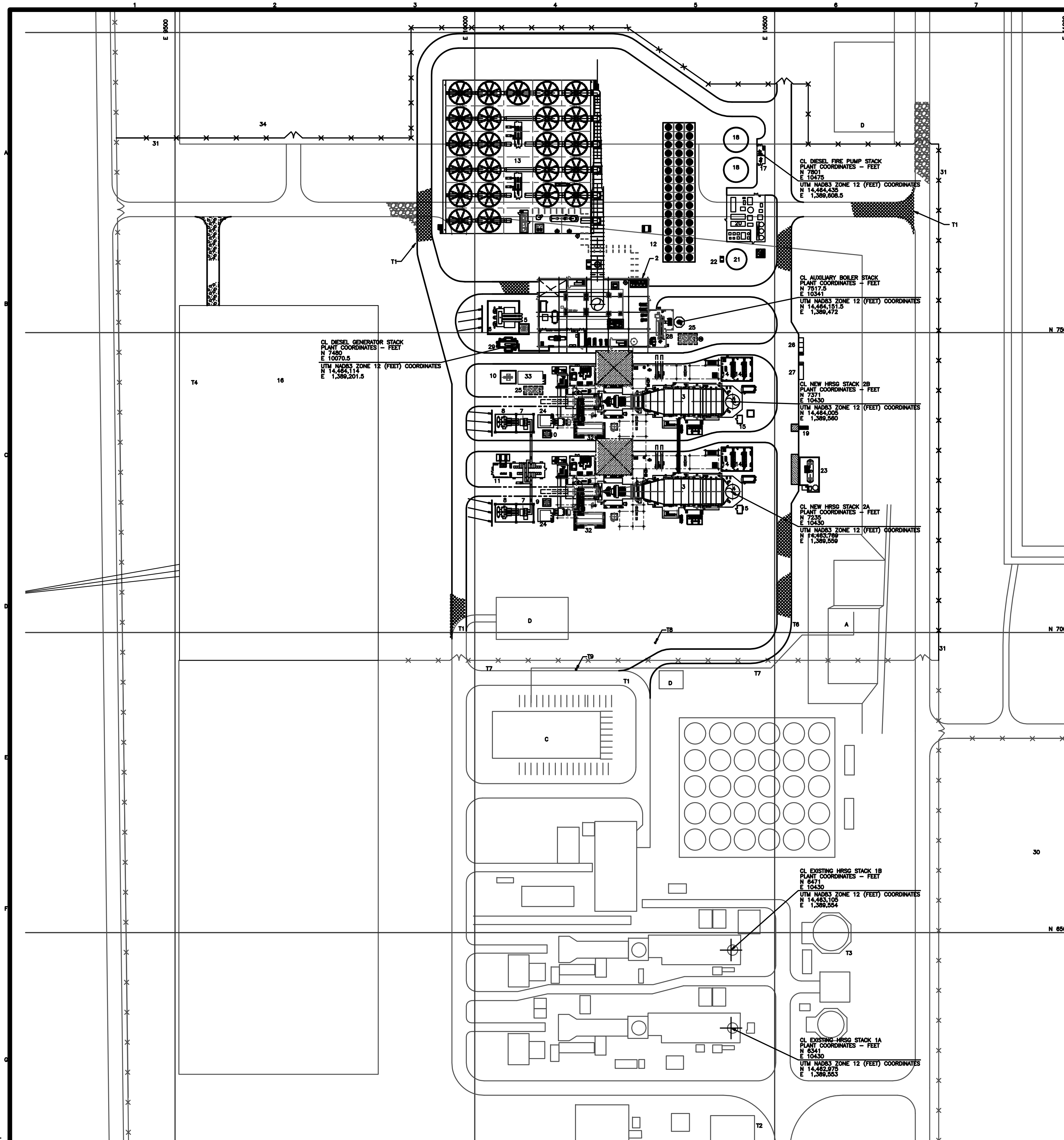
PACIFICORP
CURRANT CREEK POWER PROJECT – BLOCK 2

PLOT PLAN
MHI G CLASS 2X1 COMBINED CYCLE

PROJECT DRAWING NUMBER 173604–2STA–G1100
REV B
CODE
AREA



FACILITIES LEGEND

ID	FACILITY	FOUNDATION	TIEDOWN LOCATION NORTH	TIEDOWN LOCATION EAST	REMARKS
1	COMBUSTION TURBINE	–	–	–	
2	STEAM TURBINE BUILDING	–	–	–	
3	HEAT RECOVERY STEAM GENERATOR	–	–	–	
4	HEAT RECOVERY STEAM EXHAUST STACK	–	–	–	
5	ST EXCITATION TRANSFORMER	–	–	–	
6	ST GENERATOR STEP-UP TRANSFORMER	–	–	–	
7	UNIT AUXILIARY TRANSFORMER	–	–	–	
8	CT GENERATOR STEP-UP TRANSFORMER	–	–	–	
9	CT SEE TRANSFORMER	–	–	–	
10	CT SFC TRANSFORMER	–	–	–	
11	MAIN ELECTRICAL CONTROL ENCLOSURE	–	–	–	
12	AIR COOLED HEAT EXCHANGER	–	–	–	
13	AIR COOLED CONDENSER	–	–	–	
14	BOILER FEED PUMPS	–	–	–	
15	CONTINUOUS EMISSIONS MONITORING EQUIPMENT	–	–	–	
16	EXPANDED SWITCHYARD	–	–	–	
17	FIRE WATER PUMP ENCLOSURE	–	–	–	
18	FIRE WATER STORAGE TANK	–	–	–	
19	HYDROGEN STORAGE AREA	–	–	–	
20	WATER TREATMENT BUILDING	–	–	–	
21	DEMIN STORAGE TANK	–	–	–	
22	DEMIN WATER PUMPS	–	–	–	
23	AMMONIA STORAGE AREA	–	–	–	
24	CT SEE ENCLOSURE	–	–	–	
25	OIL/WATER SEPARATOR	–	–	–	
26	CARBON DIOXIDE STORAGE AREA	–	–	–	
27	NITROGEN STORAGE AREA	–	–	–	
28	AUXILIARY BOILER	–	–	–	
29	DIESEL GENERATOR	–	–	–	
30	CONSTRUCTION PARKING	–	–	–	
31	SECURITY FENCE	–	–	–	
32	CT GEN ELECTRICAL AND CONTROL CABINET	–	–	–	
33	CT GEN SFC COMPARTMENT	–	–	–	
34	CONSTRUCTION LAYDOWN	–	–	–	
35	X	–	–	–	
36	X	–	–	–	
37	X	–	–	–	
38	X	–	–	–	
39	X	–	–	–	
40	X	–	–	–	
41	X	–	–	–	
42	X	–	–	–	
43	X	–	–	–	
44	X	–	–	–	
45	X	–	–	–	
46	X	–	–	–	
47	X	–	–	–	
48	X	–	–	–	
49	X	–	–	–	
50	X	–	–	–	
51	X	–	–	–	
52	X	–	–	–	
53	X	–	–	–	
54	X	–	–	–	
55	X	–	–	–	
56	X	–	–	–	
57	X	–	–	–	
58					
59					
60					

EXISTING FACILITIES LEGEND

ID	FACILITY	FOUNDATION	TIEDOWN LOCATION NORTH	TIEDOWN LOCATION EAST	REMARKS
A	SANITARY SEWER SYSTEM	–	–	–	
B	FUEL GAS METERING STATION	–	–	–	
C	ADMIN/CONTROL BUILDING & WAREHOUSE	–	–	–	
D	WAREHOUSE	–	–	–	
E	X	–	–	–	

TERMINAL POINTS

- T1 ACCESS ROAD
- T2 NATURAL GAS
- T3 SERVICE WATER (RAW WATER)
- T4 ELECTRICAL TRANSMISSION
- T5 NOT USED
- T6 POTABLE WATER
- T7 FIRE PROTECTION
- T8 SERVICE AIR
- T9 CONTROL/COMMUNICATIONS/PHONE (DUCTBANK)

GENERAL LEGEND

ASPHALT SURFACING

AGGREGATE SURFACING

CONCRETE SURFACING

EXISTING AGGREGATE SURFACING

NEW FENCE

EXISTING FENCE

NOTES

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DESIGNER LEK DRAWN MWS

CHECKED DATE

PACIFICORP
CURRANT CREEK POWER PROJECT – BLOCK 2

SITE PLAN
MHI G CLASS 2X1 COMBINED CYCLE

PROJECT / DRAWING NUMBER: 173604-2STA-G1101 REV B

CODE

AREA

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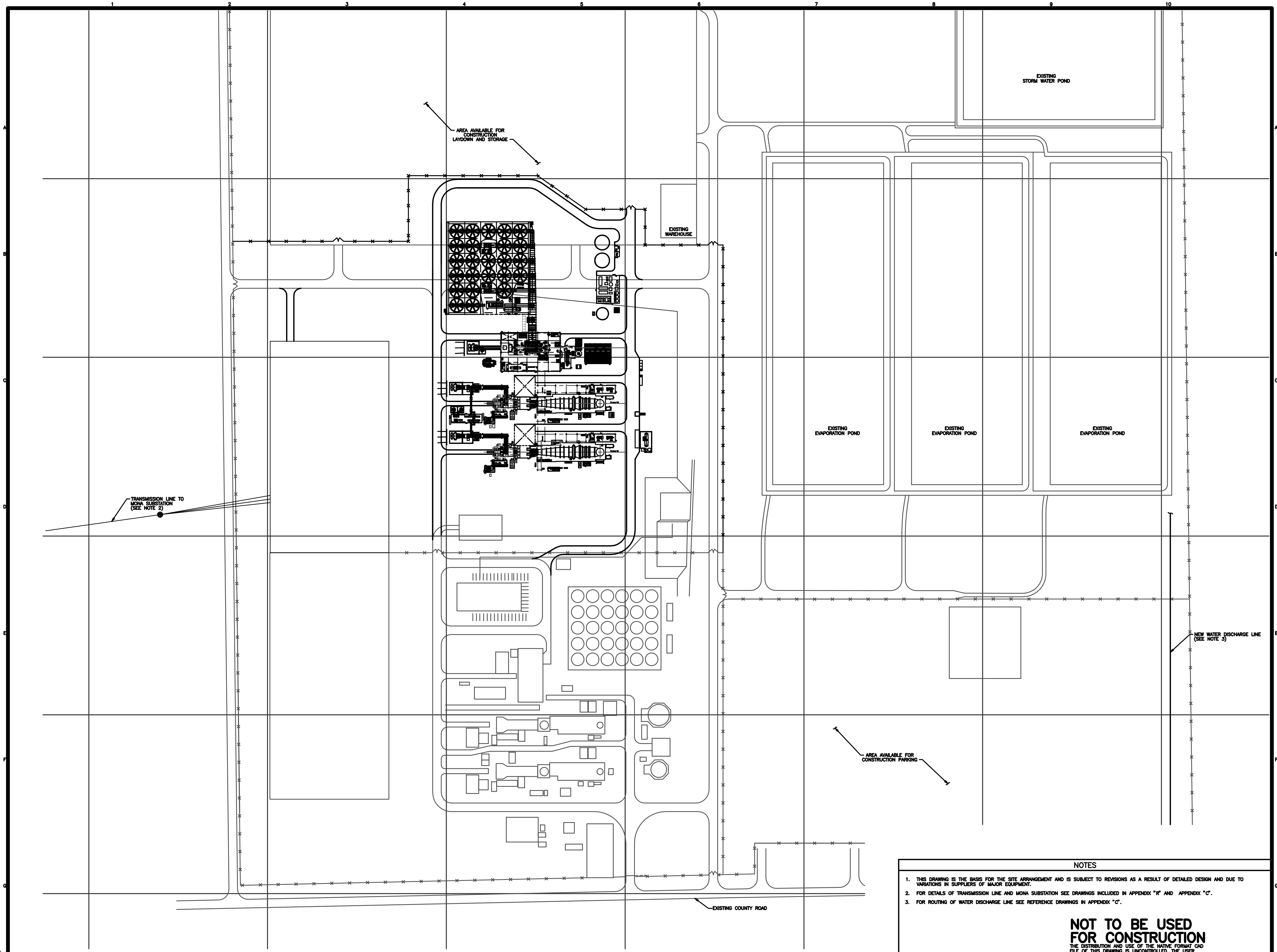

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100' 50' 0 100' 200'
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DATE ____ REG NO. ____

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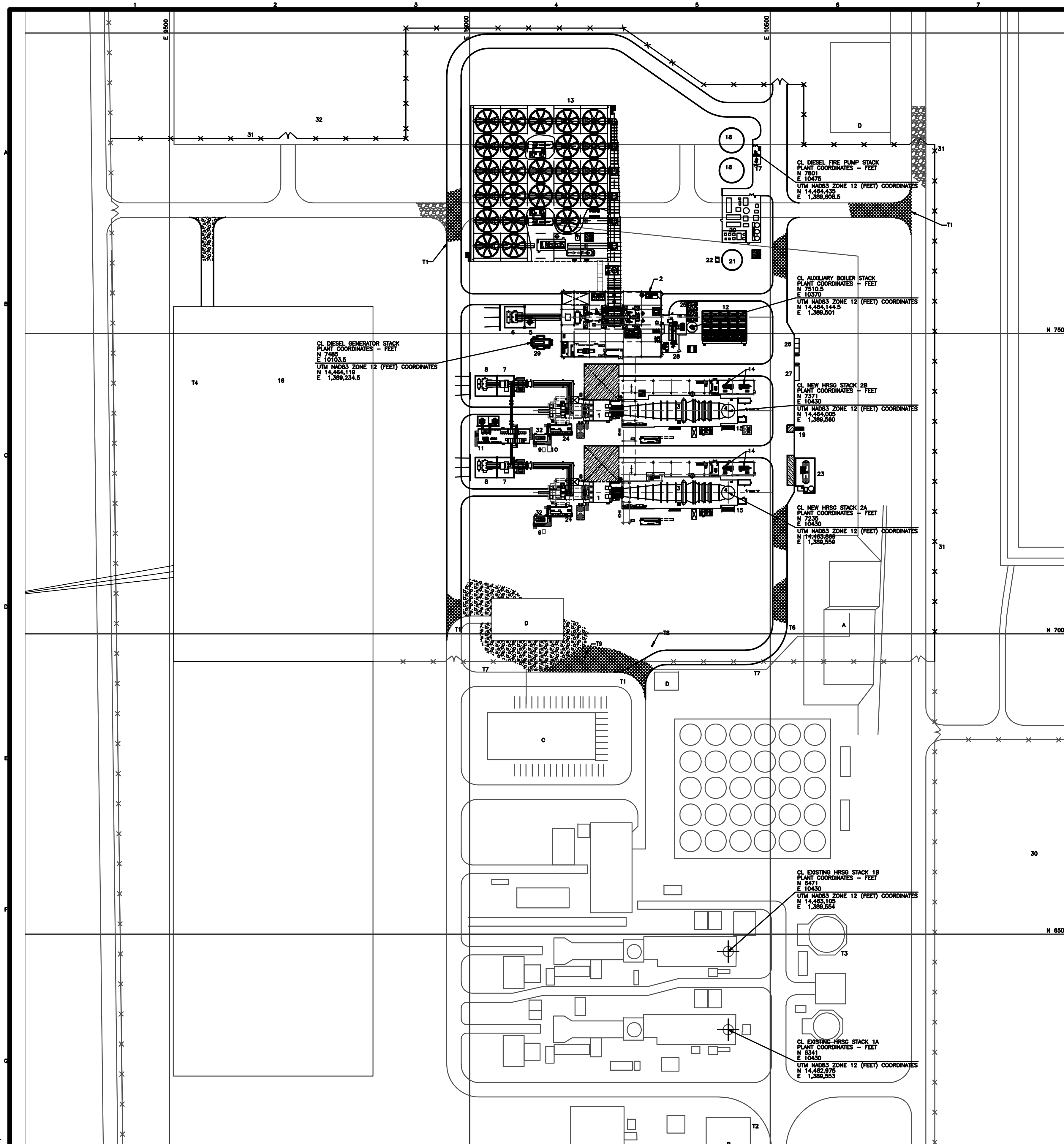
DESIGNER LEK
DRAWN MWS
CHECKED
DATE

PACIFICORP
CURRANT CREEK POWER PROJECT – BLOCK 2

PLOT PLAN
SIEMENS 5000F CLASS 2X1 COMBINED CYCLE

PROJECT DRAWING NUMBER: 173604–2STA–G1200
REV: B
CODE
AREA



FACILITIES LEGEND

ID	FACILITY	FOUNDATION	TIEDOWN LOCATION NORTH	TIEDOWN LOCATION EAST	REMARKS
1	COMBUSTION TURBINE	–	–	–	
2	STEAM TURBINE BUILDING	–	–	–	
3	HEAT RECOVERY STEAM GENERATOR	–	–	–	
4	HEAT RECOVERY STEAM EXHAUST STACK	–	–	–	
5	ST EXCITATION TRANSFORMER	–	–	–	
6	ST GENERATOR STEP–UP TRANSFORMER	–	–	–	
7	UNIT AUXILIARY TRANSFORMER	–	–	–	
8	CT GENERATOR STEP–UP TRANSFORMER	–	–	–	
9	CT SEE TRANSFORMER	–	–	–	
10	CT SFC TRANSFORMER	–	–	–	
11	MAIN ELECTRICAL CONTROL ENCLOSURE	–	–	–	
12	AIR COOLED HEAT EXCHANGER	–	–	–	
13	AIR COOLED CONDENSER	–	–	–	
14	BOILER FEED PUMPS	–	–	–	
15	CONTINUOUS EMISSIONS MONITORING EQUIPMENT	–	–	–	
16	EXPANDED SWITCHYARD	–	–	–	
17	FIRE WATER PUMP ENCLOSURE	–	–	–	
18	FIRE WATER STORAGE TANK	–	–	–	
19	HYDROGEN STORAGE AREA	–	–	–	
20	WATER TREATMENT BUILDING	–	–	–	
21	DEMIN STORAGE TANK	–	–	–	
22	DEMIN WATER PUMPS	–	–	–	
23	AMMONIA STORAGE AREA	–	–	–	
24	ELECTRICAL ENCLOSURE	–	–	–	
25	OIL/WATER SEPARATOR	–	–	–	
26	CARBON DIOXIDE STORAGE AREA	–	–	–	
27	NITROGEN STORAGE AREA	–	–	–	
28	AUXILIARY BOILER	–	–	–	
29	DIESEL GENERATOR	–	–	–	
30	EVAPORATION POND EXTENTION	–	–	–	
31	SECURITY FENCE	–	–	–	
32	CT SEE/SFC ENCLOSURE	–	–	–	
33	X	–	–	–	
34	X	–	–	–	
35	X	–	–	–	
36	X	–	–	–	
37	X	–	–	–	
38	X	–	–	–	
39	X	–	–	–	
40	X	–	–	–	
41	X	–	–	–	
42	X	–	–	–	
43	X	–	–	–	
44	X	–	–	–	
45	X	–	–	–	
46	X	–	–	–	
47	X	–	–	–	
48	X	–	–	–	
49	X	–	–	–	
50	X	–	–	–	
51	X	–	–	–	
52	X	–	–	–	
53	X	–	–	–	
54	X	–	–	–	
55	X	–	–	–	
56	X	–	–	–	
57	X	–	–	–	
58					
59					
60					

EXISTING FACILITIES LEGEND

ID	FACILITY	FOUNDATION	TIEDOWN LOCATION NORTH	TIEDOWN LOCATION EAST	REMARKS
A	SANITARY SEWER SYSTEM	–	–	–	
B	FUEL GAS METERING STATION	–	–	–	
C	ADMIN/CONTROL BUILDING & WAREHOUSE	–	–	–	
D	WAREHOUSE	–	–	–	
E	X	–	–	–	

TERMINAL POINTS

T1 ACCESS ROAD
T2 NATURAL GAS
T3 SERVICE WATER (RAW WATER)
T4 ELECTRICAL TRANSMISSION
T5 NOT USED
T6 POTABLE WATER
T7 FIRE PROTECTION
T8 SERVICE AIR
T9 CONTROL/COMMUNICATIONS/PHONE (DUCTBANK)

GENERAL LEGEND

ASPHALT SURFACING
AGGREGATE SURFACING
CONCRETE SURFACING
EXISTING AGGREGATE SURFACING
NEW FENCE
EXISTING FENCE

NOTES

1. THIS DRAWING IS THE BASIS FOR THE SITE ARRANGEMENT AND IS SUBJECT TO REVISIONS AS A RESULT OF DETAILED DESIGN AND DUE TO VARIATIONS IN SUPPLIERS OF MAJOR EQUIPMENT.

NOT TO BE USED FOR CONSTRUCTION

THE DISTRIBUTION AND USE OF THE NATIVE FORMAT CAD FILE OF THIS DRAWING IS UNCONTROLLED. THE USER SHALL VERIFY TRACEABILITY OF THIS DRAWING TO THE LATEST CONTROLLED VERSION.

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
B	09/14/2011	ISSUED FOR CLIENT REVIEW	DAK	LEK		LEK	
A	07/21/2011	ISSUED FOR CLIENT REVIEW	MWS	LEK		LEK	

SCALE: 1"=60'
60' 30' 0 60' 120'

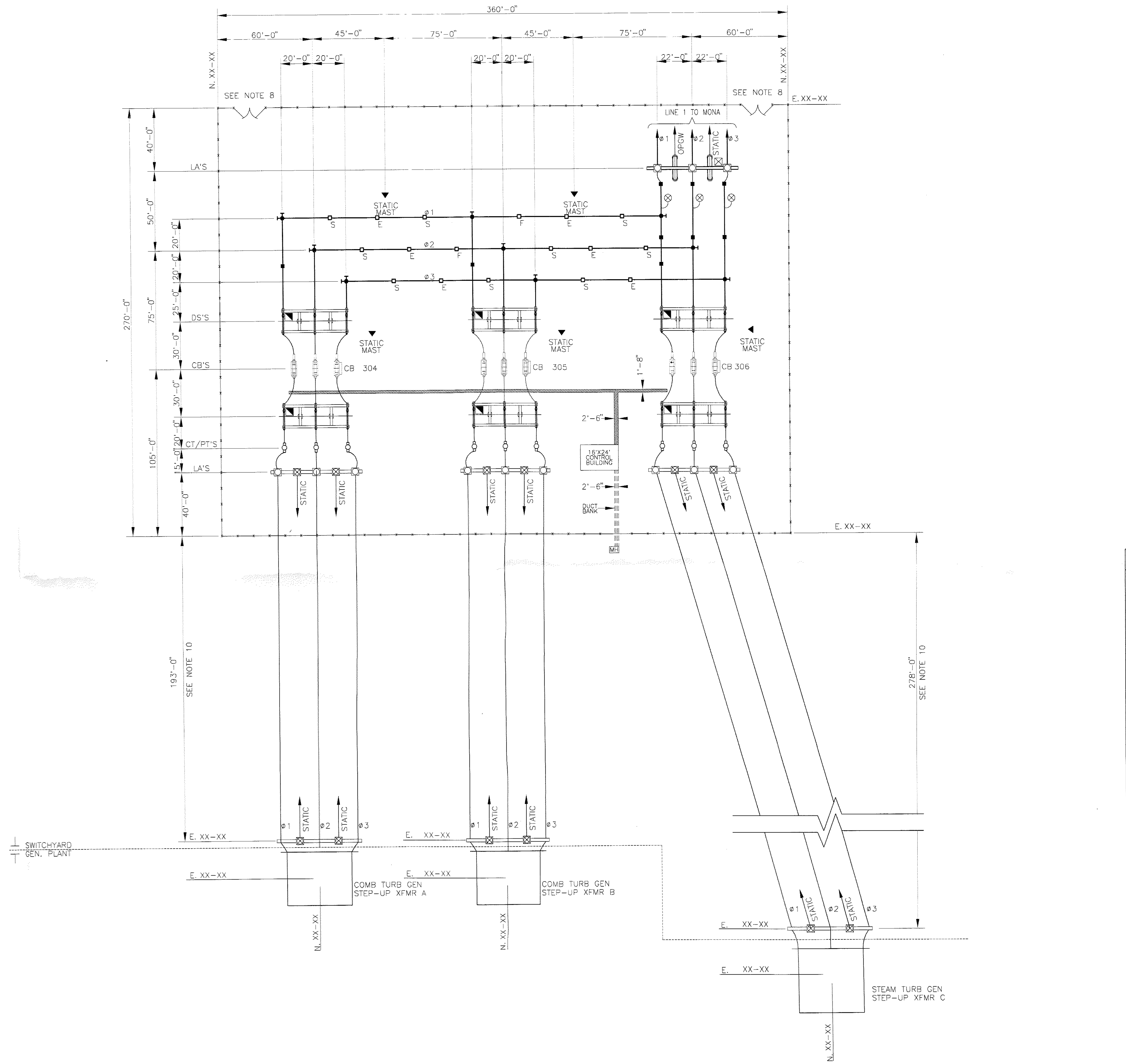
I HEREBY CERTIFY THAT THIS DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF
SIGNED
DATE REG NO.

BLACK & VEATCH
Building a world of difference.

DESIGNER LEK DRAWN MWS
CHECKED DATE

PACIFICORP
CURRANT CREEK POWER PROJECT – BLOCK 2
SITE PLAN
SIEMENS 5000F CLASS 2X1 COMBINED CYCLE

PROJECT / DRAWING NUMBER: 173604–2STA–G1201
REV: B
CODE
AREA



DESIGN CRITERIA

NORMAL VOLTAGE	345KV
BIL	1300KV
NOMINAL PHASE TO PHASE	20'-0"
MINIMUM PHASE TO PHASE (METAL TO METAL)	9'-11"
MINIMUM PHASE TO GROUND	8'-8"
CLEARANCE ABOVE GRADE	18'-0"
DISCONNECT SWITCH INSULATORS	TR369
CABLE SUPPORT INSULATORS	TR324
BUS SUPPORT INSULATORS	TR367 OR TR369
LOW BUS HEIGHT	22'-0"
HIGH BUS HEIGHT	34'-0"
TOTAL GENERATION	550MW

LEGENDS

S – SLIP FITTINGS
F – FIXED FITTINGS
E – EXPANSION FITTING
– CT/PT COMBINED UNITS
⊗ – CCVT UNITS
□ – HIGH BUS SUPPORTS
■ – LOW BUS SUPPORTS
– FENCE
▲ – STATIC MAST
⊠ – DISCONNECT SWITCH MOTOR OPERATOR
– DISCONNECT SWITCH MANUAL OPERATOR
– LIGHTING ARRESTER
– CABLE TRENCH

NOTES

1. ALL SWITCHYARD JUMPER CONDUCTORS TO BE (2) 954 KCMIL ACSR "RAIL" PER PHASE UNLESS NOTED OTHERWISE.
2. STRAIN BUS CONDUCTOR CONNECTION TO GENERATION UNIT 1, 2 AND 3 TO BE (2) 954 KCMIL ACSR "RAIL" PER PHASE UNLESS NOTED OTHERWISE.
3. ALL SWITCHYARD CONDUCTOR TO BE 4" DIA. IPS ALUMINUM TUBE UNLESS NOTED OTHERWISE.
4. DRILL 1/4" DIA. WEEP HOLE IN BOTTOM OF HORIZONTAL RUNS AT POINT OF MAX. DEFLECTION. BURNISH HOLES.
5. INSTALL 954 KCMIL AAC CONDUCTOR INSIDE ALL HORIZONTAL RUNS OF 4" DIA, IPS ALUMINUM TUBE FOR DAMPING. TACK WELD ONE END OF THE CABLE TO HOLD IN PLACE.
6. ALL STATIC WIRE CONDUCTOR TO BE 3/8", 7 STRAND EHS UNLESS NOTED OTHERWISE.
7. LOCATION AND QUANTITIES OF BUS SUPPORTS AND SHEILD MAST ARE APPROXIMATES, AND WILL BE FINIALIZED DURING DETAIL DESIGN.
8. LOCATIONS OF FENCE GATES TO BE FINIALIZED DURING DETAIL DESIGN.
9. SIZE OF THE CONTROL BUILDING, MANHOLE, CABLE TRENCH AND DUCT BANK TO BE FINALIZED DURING DETAIL DESIGN.
10. DISTANCE TO BE FINALIZED DURING DETAIL DESIGN.

NOT TO BE USED
FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
C	11/14/08	ISSUED FOR CLIENT REVIEW	RAS	RPK			LAL
B	07/02/08	ISSUED FOR PROPOSAL SUBMITTAL	RAS	RPK			LAL
A	06/20/08	ISSUED FOR PROPOSAL PREPARATION	RAS	RPK			LAL

N

SCALE: 1"=300'-0"

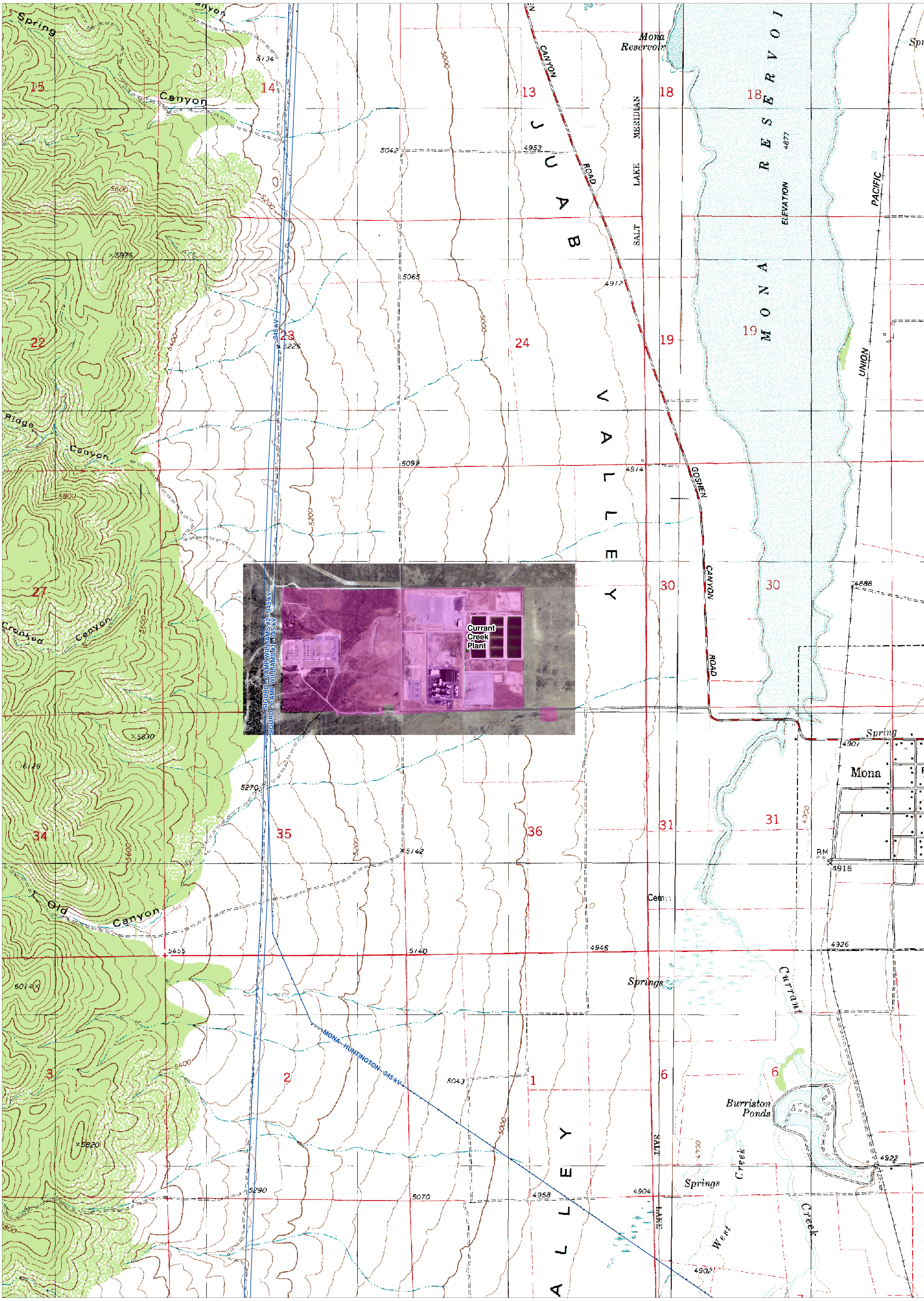
I HEREBY CERTIFY THAT THIS DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF UTAH
SIGNED
DATE REG NO.

BLACK & VEATCH CORPORATION
ENGINEER RPK DRAWN RAS
CHECKED LAL DATE

PACIFICORP
A MIDAMERICAN ENERGY HOLDING COMPANY

345KV CURRANT CREEK SWITCHYARD, MONA, UTAH
ELECTRICAL PLAN

PROJECT DRAWING NUMBER 162628-2PPA-E8100
REV C
CODE
AREA



Currant Creek Plant

USGS Topographic Map

Legend

- PacifiCorp Ownership
- Transmission Line

0 1,000 2,000 Feet

N S E W

ROCKY MOUNTAIN POWER
A DIVISION OF PACIFICORP

Data Management/
Geographic Information Systems
gisdept@pacificorp.com

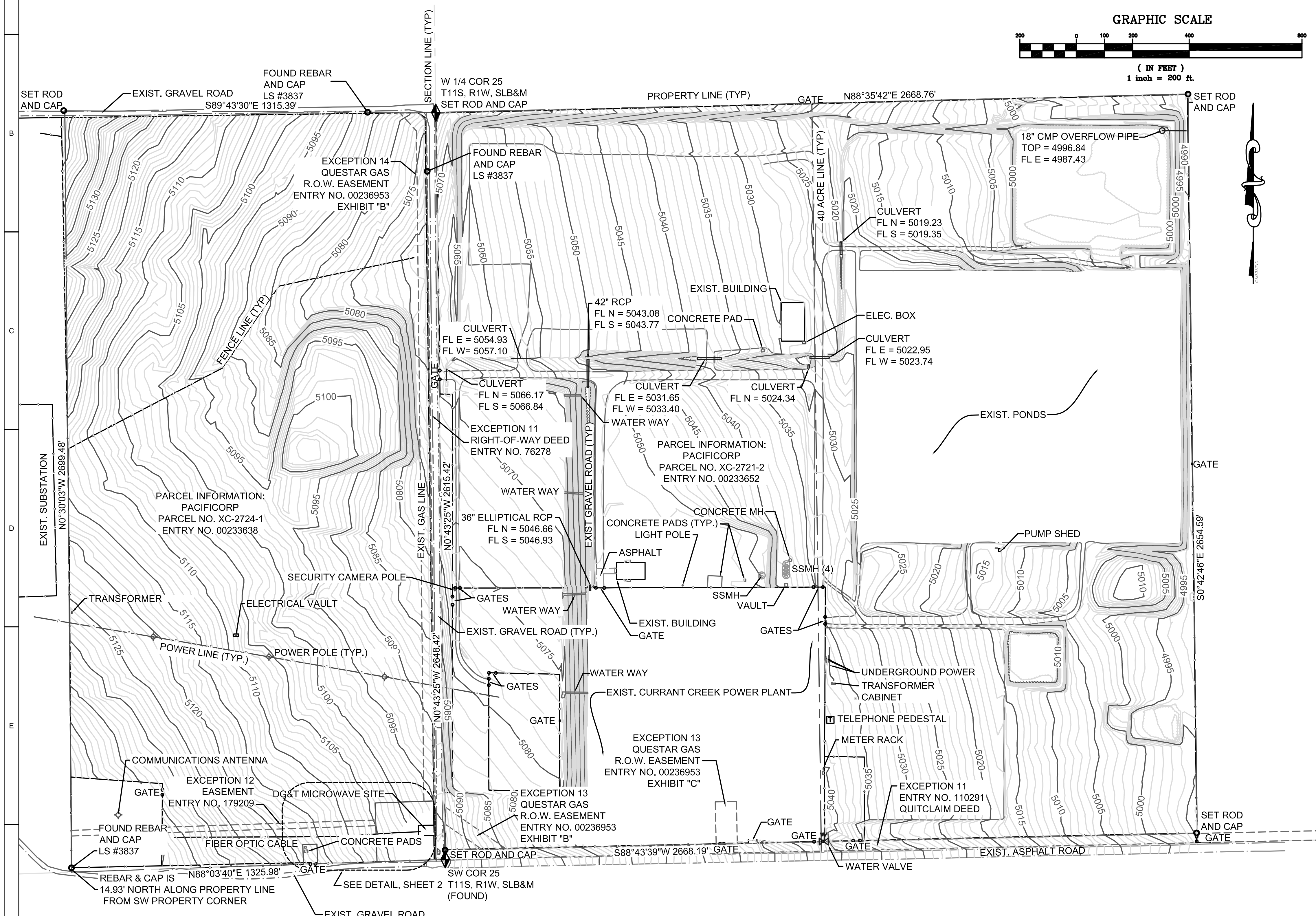
Data are projected in UTM Zone 12, NAD83, meters.

PacifiCorp GIS collects data from a variety of government and private sources. This map is not to be released nor put into any location that is accessible electronically or otherwise available to market affiliates. PacifiCorp makes no warranty as to the accuracy, reliability, or completeness of these data for individual or aggregate use with other data. For complete validation, the source organization should be contacted or source documents consulted to verify the findings of this product.

11/21/08 U:\Projects\2008\08-257\currant_creek_plant.mxd gisdept@pacificorp.com

CURRANT CREEK ALTA/ACSM LAND TITLE SURVEY

LOCATED IN THE SOUTHWEST QUARTER OF SECTION 25 &
THE SOUTHEAST QUARTER OF SECTION 26,
TOWNSHIP 11 SOUTH, RANGE 1 WEST, SALT LAKE BASE & MERIDIAN.
JUAB COUNTY, UTAH.
JULY 2008



NARRATIVE:

The purpose of this survey: ALTA/ACSM Land Title Survey.
The Basis of Bearings is N.00°43'25"W between the Southwest Corner and the West Quarter Corner of Section 25, Township 11 South, Range 1 West, Salt Lake Base and Meridian.
This survey was prepared in reliance with a Commitment for Title Insurance, Order No. 26471 & 26473, effective June 9, 2008 by Juab Title & Abstract Company. Also used in the preparation of this survey was that certain ALTA/ACSM Land Title Survey prepared by Jerry Timmins Surveying Inc. dated November 19, 2003.

PARCEL DESCRIPTION FROM COMMITMENT FOR TITLE INSURANCE POLICY:

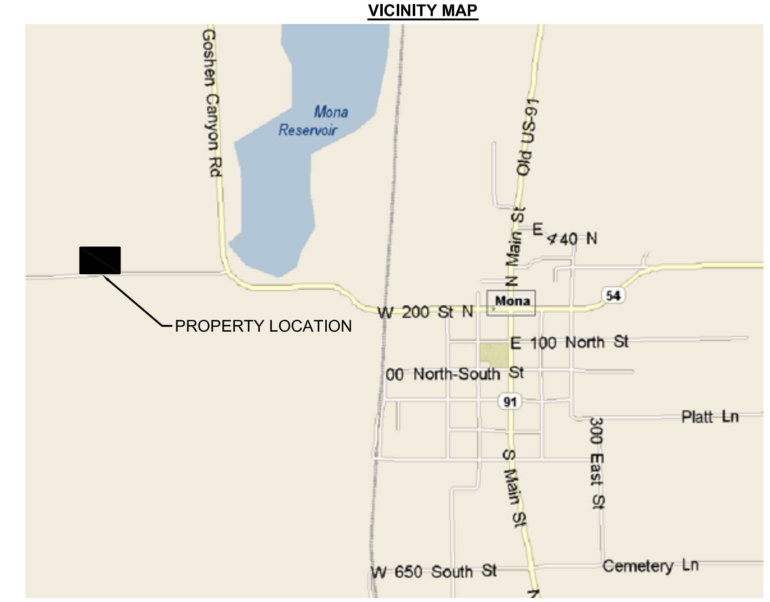
Parcel No. XC-2721-2

The West Half of the Southwest Quarter and the East Half of the Southwest Quarter of Section 25, Township 11 South, Range 1 West, Salt Lake Meridian, less the South 2 rods thereof.

Parcel No. XC-2724-1

The East half of the Southeast Quarter of Section 26, Township 11 South, Range 1 West, Salt Lake Meridian. Less the following: Commencing at the Southeast Corner of Section 26, Township 11 South, Range 1 West, Salt Lake Meridian, thence West along the South line of said Section 26 a distance of 33.0 feet to the point of beginning, thence West along the South line of Section 26 a distance of 208.7 feet; thence North 208.7 feet; thence East 208.7 feet to a point 33.0 feet West of the East line of said Section 26, thence South 208.7 feet to the point of beginning. Also, less the following: Beginning West 452.76 feet along the Section line from the Southeast corner of Section 26, Township 11 South, Range 1 West, Salt Lake Meridian, thence West 50 feet, thence North 70 feet, thence East 50 feet, thence South 70 feet to the point of beginning.

VICINITY MAP



SURVEYOR'S CERTIFICATION

To: PacifiCorp, an Oregon corporation and Juab Title & Abstract Company:

This is to certify that this map or plat and the survey on which it is based were made in accordance with the "Minimum Standard Detail Requirements for ALTA / ACSM Land Title Surveys," jointly established and adopted by ALTA and NSPS in 2005, and includes Items 1, 2, 4, 5, 8, 10, 11(a) and 13 of Table A thereof. Pursuant to Accuracy Standards as adopted by ALTA and NSPS and in effect on the date of this certification, undersigned further certifies that in my professional opinion, as a land surveyor registered in the State of Utah, the Relative Positional Accuracy of this survey does not exceed that which is specified therein.

Date:______________________

Registration No. 6714204

ECI :VNDR
CURRANT CREEK :VNDR#

PREPARED BY:
"Engineering with Distinction"
ECI ELECTRICAL CONSULTANTS, INC

PROJ#	
W/O#	
DATE 9/2/08	
ENG	DES
DR ECI	CH
APPROVAL	
REDRAWN FROM	RD REV

CURRANT CREEK
ALTA SURVEY

PACIFICORP ENERGY
CURRANT CREEK

SCALE:	PLANT DRAWING No	SHEET	REV.
1"=200'		1 OF 2	0

ELECTRONIC FILE NAME = CURRANT CREEK
PLOT SCALE: 1 = 1

No.	DATE	REVISION	W/O No.	BY	CHK	APP

No.	DRAWING No.	REFERENCE DESCRIPTION/TYPE

CURRANT CREEK ALTA/ACSM LAND TITLE SURVEY

LOCATED IN THE SOUTHWEST QUARTER OF SECTION 25 &
THE SOUTHEAST QUARTER OF SECTION 26,
TOWNSHIP 11 SOUTH, RANGE 1 WEST, SALT LAKE BASE & MERIDIAN.
JUAB COUNTY, UTAH.
JULY 2008

EXCEPTIONS FROM SCHEDULE B SECTION 2 OF COMMITMENT FOR TITLE INSURANCE POLICY:

Parcel No. XC-2721-2
Commitment for Title Insurance Issued by Juab Title & Abstract Company. Order No. 26471 effective June 9, 2008.

10. Subject to items disclosed by that certain ALTA/ACSM Land Title Survey prepared by Jerry Timmins Surveying Inc. dated November 19, 2003, including but not limited to the following, to-wit:
A. Fence lines do not exactly match property lines. See survey for differences.
B. Juab County owns the South 2 rods of the Southwest quarter of Section 25, Township 11 South, Range 1 West, Salt Lake Meridian, in which a portion lies North of an existing fence line.
C. County road on West portion of property herein.

11. Quitclaim Deed dated January 12, 1959, reserves to the Grantor, THE STATE OF UTAH, all coal, oil, gas, mines, metals, gravel and all other minerals of whatsoever kind or nature in the above land, and to it, or persons authorized by it, the right to prospect for, mine and remove the same, together with the right to occupy and use so much of the surface of said land as may be required for all purposes reasonably incident to the mining and removal of said minerals, recorded on March 21, 1963, as Entry No. 110291, in Book 197, Page 621, of the records of Juab County, Utah.

12. Notice of Commencement dated March 10, 2004; 1. Project Name: Currant Creek Power Plant; 2. City/County/State: Mona/Juab/Utah; 3. Original Contractor: STONE & WEBSTER, INC.; recorded on March 11, 2004, as Entry No. 324491, in Book 462, Page 538, of the records of Juab County, Utah.

13. A perpetual easement and right of way conveyed to QUESTAR PIPELINE COMPANY, a Utah corporation A right-of-way 50 feet in width; recorded on November 12, 2004, as Entry No. 236953, in Book 471, Page 361, of the records of Juab County, Utah

14. Twentieth Supplemental Indenture dated March 1, 2007, among Pacificorp, as Trustor, The Bank of New York (as successor to JP Morgan Chase Bank, N.A.) as Trustee under PacifiCorp's Mortgage and Deed of Trust dated January 9, 1989, recorded on June 19, 2007, as Entry No. 249198, in Book 509, Page 798, of the records of Juab County, Utah.

Parcel No. XC-2721-1
Commitment for Title Insurance Issued by Juab Title & Abstract Company. Order No. 26473 effective June 9, 2008.

10. Subject to items disclosed by that certain ALTA/ACSM Land Title Survey prepared by Jerry Timmins Surveying Inc. dated November 19, 2003, including but not limited to the following, to-wit:
A. County road along the Easterly side of the East half of the Southeast quarter of Section 26, Township 11, Range 1 West, Salt Lake Meridian which width is 37.5 feet, more or less, from fence to fence.
B. County road along the Southerly portion of the East half of the Southeast quarter of Section 26, Township 11 South, Range 1 West, Salt Lake Meridian as shown on survey.
C. County road along the Northerly portion of the East half of the Southeast quarter of Section 26, Township 11 South, Range 1 West, Salt Lake Meridian as shown on survey.
D. Underground fiber optic cable easement along the Southerly portion of the East half of the Southeast quarter of Section 26, Township 11 South, Range 1 West, Salt Lake Meridian.
E. Fence lines do not exactly match property lines. See survey for differences.

11. Right of Way Deed dated May 28, 1947, conveys to JUAB COUNTY, a county of the State of Utah, a right-of-way and easement over and across the following described tracts of land situate in Juab County, State of Utah, to-wit: ....;the East 2 rods of the Southeast quarter of Section 26, Township 11 South, Range 1 West, Salt Lake Meridian, for the purpose of a public highway, recorded on September 12, 1947, as Entry No. 76278, in Book 134, Page 352, of the records of Juab County, Utah.

12. Right-of-Way Easement dated April 26, 1985 conveys to Deseret Generation & Transmission Co-Operative, a Utah corporation, a perpetual easement, right-of-way, and right on, over, under, above and across property described hereafter to construct, enlarge, reconstruct, rephase, repair, operate, maintain, place, relocate, and/or replace telecommunications systems, including but not limited to one or more telecommunication cables protected by one or more conduits, and/or pipelines and/or other underground facilities, and such other equipment appurtenances as may be necessary and/or convenient for such operation, to cut, trim and control the growth by chemical means, machinery or otherwise of trees, shrubbery, undergrowth and roots and other plants and to clear the easement of all structures, obstructions and/or other objects within 10 feet of the centerline of said line or systems or that may interfere with or threaten to endanger the operation or maintenance of said line or system; together with the right of ingress and egress thereto at convenient points for such purposes. Said right-of-way is described as follows: A right-of-way 20 feet in width being 10 feet on each side of the following described centerline: Beginning on the east boundary line of the Grantor's land at a point South 88°33' West along the section line (basis of bearing) 241.7 feet and North 01°03' West 138 feet from the Southeast corner of Section 26, Township 11 South, Range 1 West, Salt Lake Meridian and running thence South 88°33' West 1084 feet to the West boundary line of said Grantor's land at a point North 01°06' West 138 feet from the Southwest corner of the East half of the Southeast quarter of said Section 26 and being in the Southeast quarter of the Southeast quarter of said Section 26. Recorded on April 26, 1985, as Entry No. 179209, in Book 316, Page 83, of the records of Juab County, Utah.

13. Notice of Commencement dated March 10, 2004; 1. Project Name: Currant Creek Power Plant; 2. City/County/State: Mona/Juab/Utah; 3. Original Contractor: STONE & WEBSTER, INC.; recorded on March 11, 2004, as Entry No. 324491, in Book 462, Page 538, of the records of Juab County, Utah.

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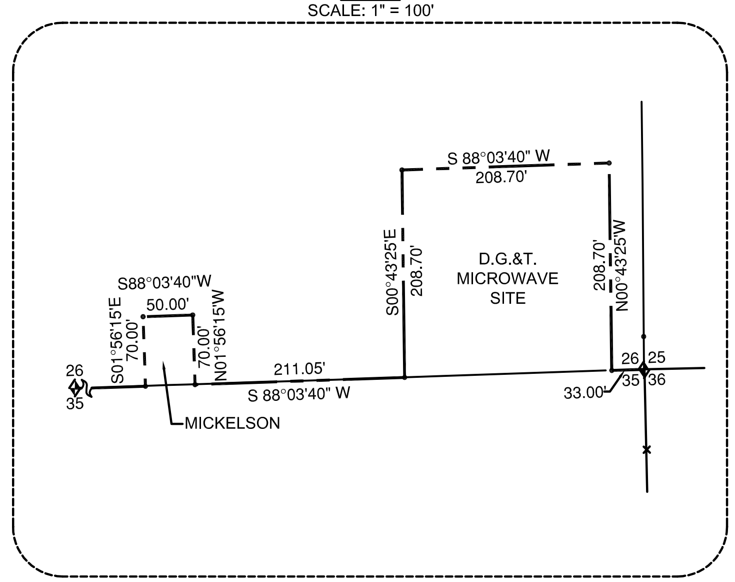
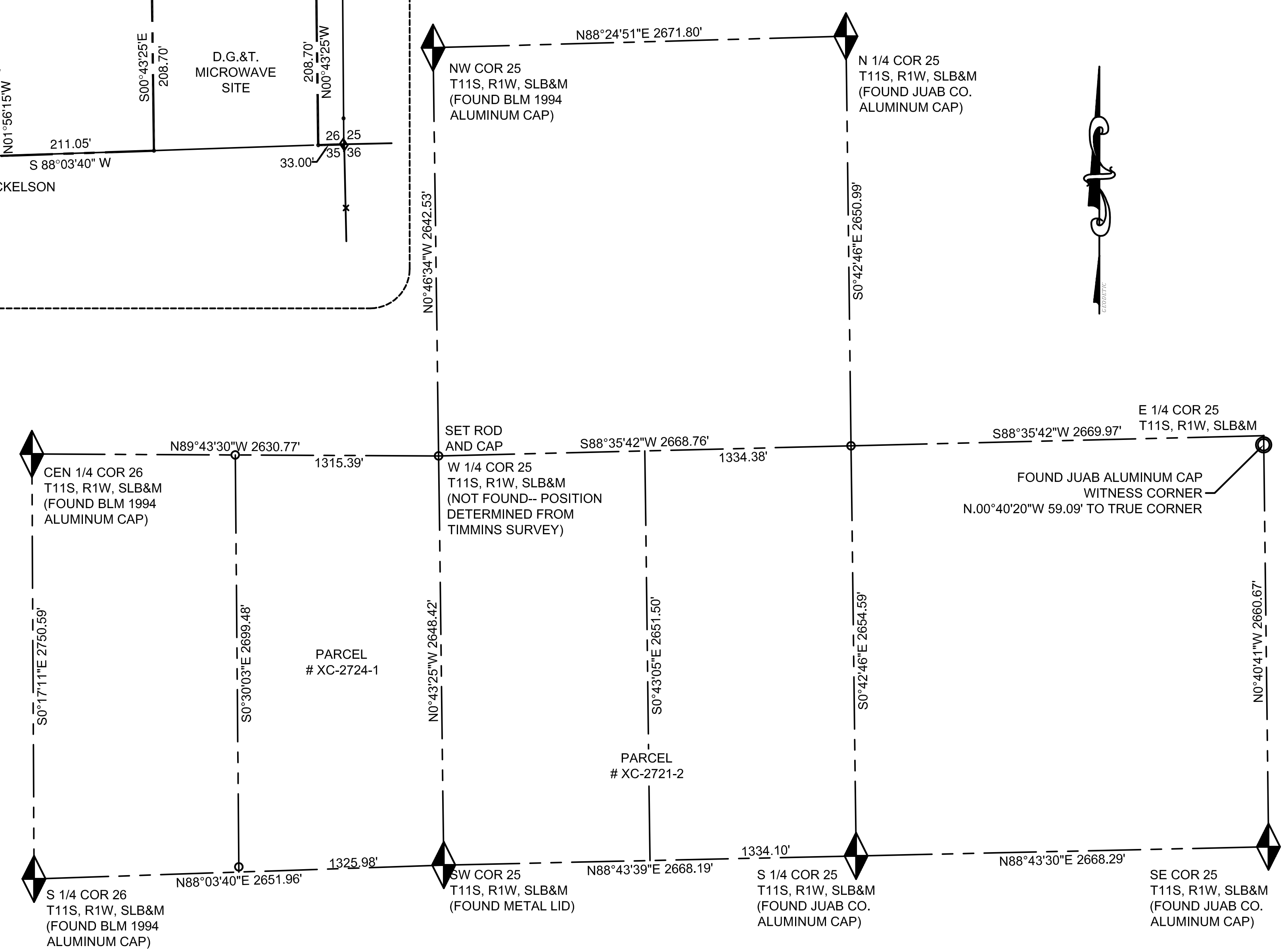
DETAIL
SCALE: 1" = 100'



SECTION BREAKDOWN
SCALE: 1" = 500'



ECI :VNDR
CURRANT CREEK :VNDR#

PROJ#	
W/O#	
DATE 9/2/08	
ENG	DES
DR ECI	CH
APPROVAL	
REDRAWN FROM	RD REV

PREPARED BY:
"Engineering with Distinction"
ELECTRICAL CONSULTANTS, INC

CURRANT CREEK
ALTA SURVEY

PACIFICORP ENERGY
A PACIFICORP COMPANY

CURRANT CREEK

SCALE:	PLANT DRAWING No	SHEET	REV.
1"=500'		2 OF 2	0

REFERENCE DESCRIPTION/TYPE | DRAWING No. | REFERENCE DESCRIPTION/TYPE | DRAWING No. | APP | CHK | BY | W/O No. | REVISION | DATE | No. | APP | CHK | BY | W/O No. | REVISION | DATE | No.

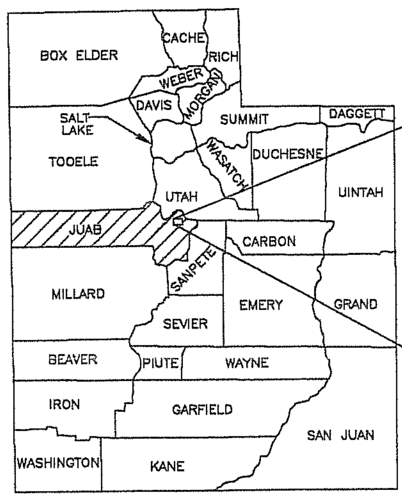
ELECTRONIC FILE NAME = CURRANT CREEK
PLOT SCALE: 1 = 1

BORDER REVISED

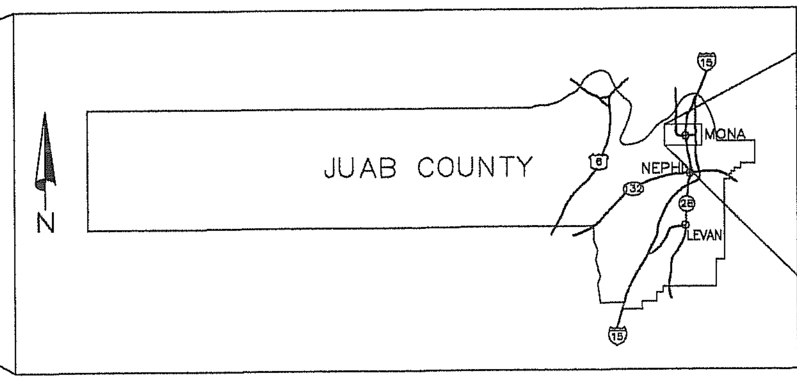
PACIFICORP

MONA WELLS AND PIPELINE

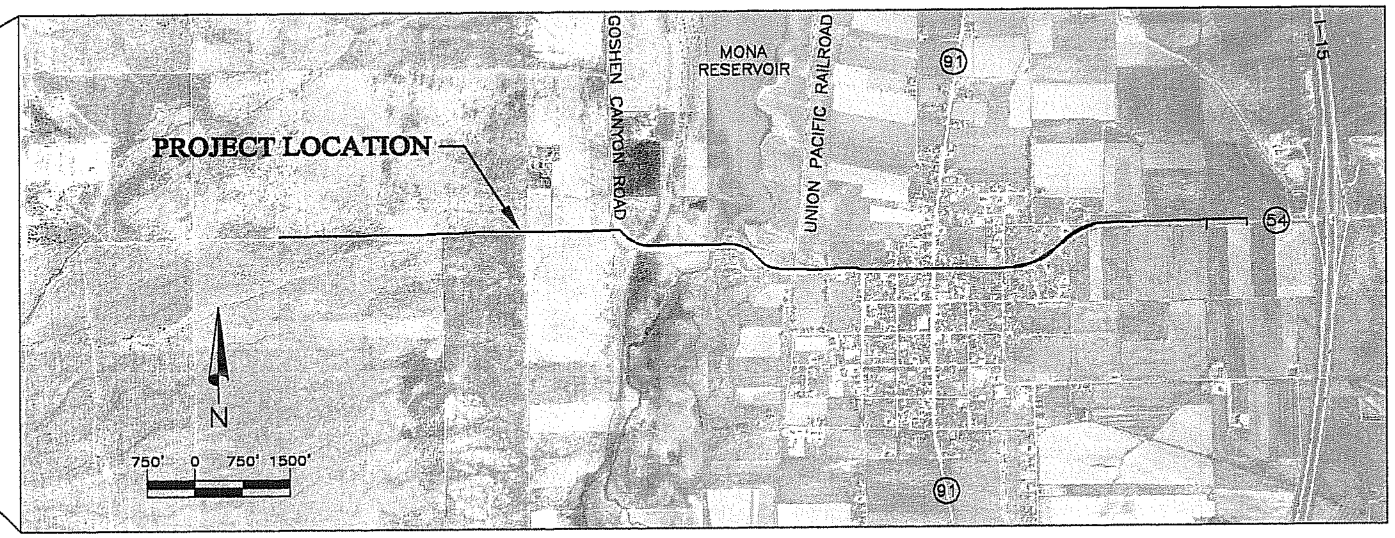
FEBRUARY 2004



STATE OF UTAH



VICINITY MAP



PROJECT LOCATION

RECORD DRAWING

These Record Documents have been prepared based on information provided by others. Hansen, Allen & Luce, Inc. has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated herein as a result.

LICENSED PROFESSIONAL ENGINEER
May 4, 2005
No. 318761
BENJAMIN D. MINER
STATE OF UTAH

LICENSED PROFESSIONAL ENGINEER
No. 184185
LARRY V. CHRISTIANSEN
4/6/05
STATE OF UTAH

HANSEN, ALLEN & LUCE DESIGN TEAM

MARVIN E. ALLEN, P.E. – PROJECT MANAGER
BENJAMIN D. MINER, P.E. – PROJECT ENGINEER

LARRY V. CHRISTIANSEN, P.E. – STRUCTURAL ENGINEER
(DEAN WEBB & ASSOCIATES)

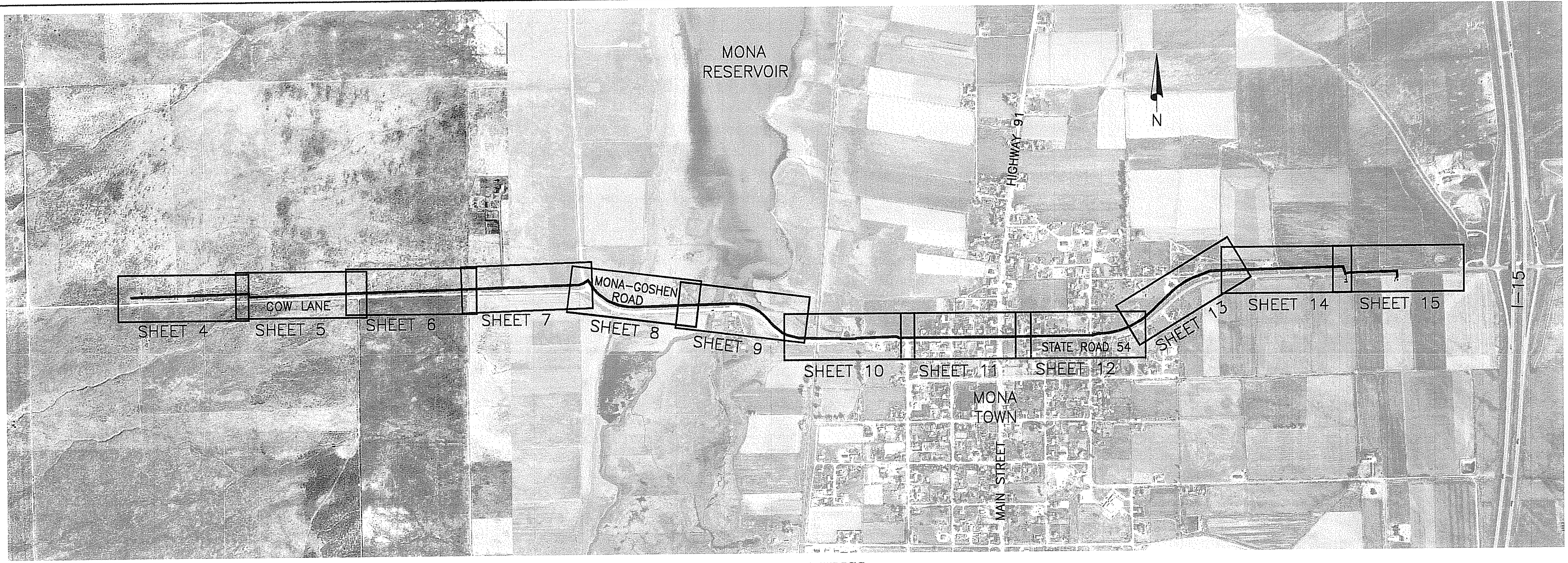
KEITH B. HEGERHORST, P.E. – ELECTRICAL ENGINEER
(HPE, INC. ELECTRICAL ENGINEERS)

CHRISTOPHER J. BECKMAN, P.E. – GEOTECHNICAL ENGINEER
(APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS)

HANSEN ALLEN & LUCE INC
ENGINEERS

FILE NAME: 005\16.100 (MONA WELL)\RECORD DWGS\COVER.DWG
FILE DATE: 4.25.2005 10:52:49 (JDB)

1/93



INDEX OF DRAWINGS

SHEET NO.	MONA WELLS & PIPELINE
	GENERAL
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G-2.	SHEET INDEX & LOCATOR
G-3.	GENERAL NOTES & ABBREVIATIONS
	PLAN & PROFILES
PP-4.	PLAN & PROFILE STA. 0+00 TO STA. 13+50
PP-5.	PLAN & PROFILE STA. 13+50 TO STA. 27+50
PP-6.	PLAN & PROFILE STA. 27+50 TO STA. 41+50
PP-7.	PLAN & PROFILE STA. 41+50 TO STA. 55+50
PP-8.	PLAN & PROFILE STA. 55+50 TO STA. 69+50
PP-9.	PLAN & PROFILE STA. 69+50 TO STA. 83+50
PP-10.	PLAN & PROFILE STA. 83+50 TO STA. 97+50
PP-11.	PLAN & PROFILE STA. 97+50 TO STA. 111+50
PP-12.	PLAN & PROFILE STA. 111+50 TO STA. 125+50
PP-13.	PLAN & PROFILE STA. 125+50 TO STA. 139+50
PP-14.	PLAN & PROFILE STA. 139+50 TO STA. 152+50
PP-15.	PLAN & PROFILE STA. 152+50 TO STA. 160+72.83

SHEET NO.	MONA WELLS & PIPELINE
	CIVIL
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C-17.	SITE PLAN NO. 2 (EAST WELL)
C-18.	BUILDING ELEVATIONS
C-19.	FLOOR PLAN
C-20.	BUILDING SECTION 1 & DETAILS
C-21.	BUILDING SECTION 2 & DETAILS
C-22.	FITTING SCHEDULE & SECTIONS
C-23.	TYPICAL BUILDING DETAILS
C-24.	PUMP TO WASTE & BUILDING DETAILS
C-25.	PUMP BASE & PUMP SETTING DETAILS
C-26.	THRUST BLOCK & TEST STATION DETAILS
C-27.	CASING & CURRANT CREEK DRAIN DETAIL
C-28.	TRENCH SECTIONS & AIR VALVE MANHOLE DETAILS
C-29.	PUMP-TO-WASTE SUMP DETAIL
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SHEET NO.	MONA WELLS & PIPELINE – CONT.
	CONNECTION TO MONA CITY WATER SYSTEM
C-31.	CONNECTION TO MONA CITY WATER SYSTEM
C-32.	CONNECTION TO MONA CITY WATER SYSTEM
C-33.	CONNECTION TO MONA CITY WATER SYSTEM
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E7.	LIGHTING PLAN
E8.	INSTRUMENTATION/CONTROL PLAN
E9.	POWER PLAN
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E11.	CONTROL PANEL CP-1 WIRING DIAGRAM
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E13.	OPERATIONAL LOGIC
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E15.	CONTROL DIAGRAMS, SHEET 1
E16.	WIRING DIAGRAMS, SHEET 1
E17.	WIRING DIAGRAMS, SHEET 2
E18.	DETAILS
E18A.	DETAILS

RECORD DRAWING

These Record Documents have been prepared based on information provided by others. Hansen, Allen & Luce, Inc. has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated herein as a result.

May 4 2005

LICENSED PROFESSIONAL ENGINEER No. 318761 BENJAMIN D. MINER STATE OF UTAH

FILE NAME: 005\16.100 (MONA WELL)\RECORD DWGS\P&P INDEX.DWG
FILE DATE: 4.25.2005 10:48:54 (JDB)

HANSEN ALLEN & LUCE INC ENGINEERS

PROJECT ENGINEER

DESIGNED BDM	3					
DRAFTED JVH	2					
CHECKED MEA	1	02/14/05	RECORD DRAWING	SDM	BDM
DATE DECEMBER 2004	NO.	DATE	REVISIONS	BY	APVD.

SCALE: NOT TO SCALE

VERIFY SCALE: 0" 1" BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

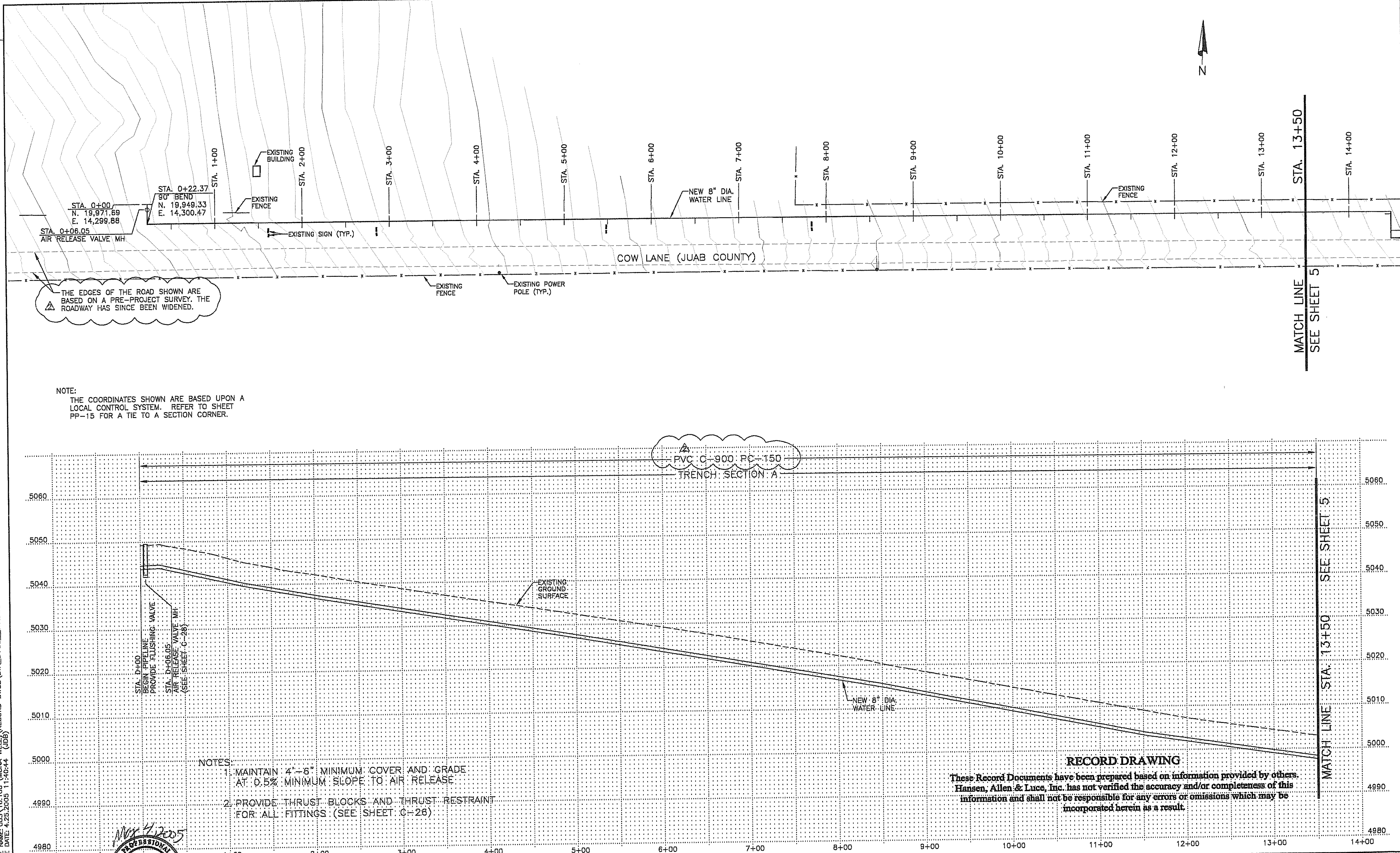
PACIFICORP

MONA WELLS AND PIPELINE
PLAN & PROFILE
SHEET INDEX & LOCATOR

SHEET G-2

005.16.100

5/01



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FILE DATE: 4.25.2005 11:40:44 (JDB)

HANSEN ALLEN & LUCE INC ENGINEERS

PROJECT ENGINEER

DESIGNED BDM	3					SCALE HORIZONTAL 1" = 50' VERTICAL 1" = 10'	VERIFY SCALE 0" 1" BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.
DRAFTED CAH	2	02/08/05	RECORD DRAWING	SDM	BDM		
CHECKED MEA	1	MAY 2004	CHANGED ALIGNMENT	BDM	MEA		
DATE FEBRUARY 2004	NO.	DATE	REVISIONS	BY	APVD.		

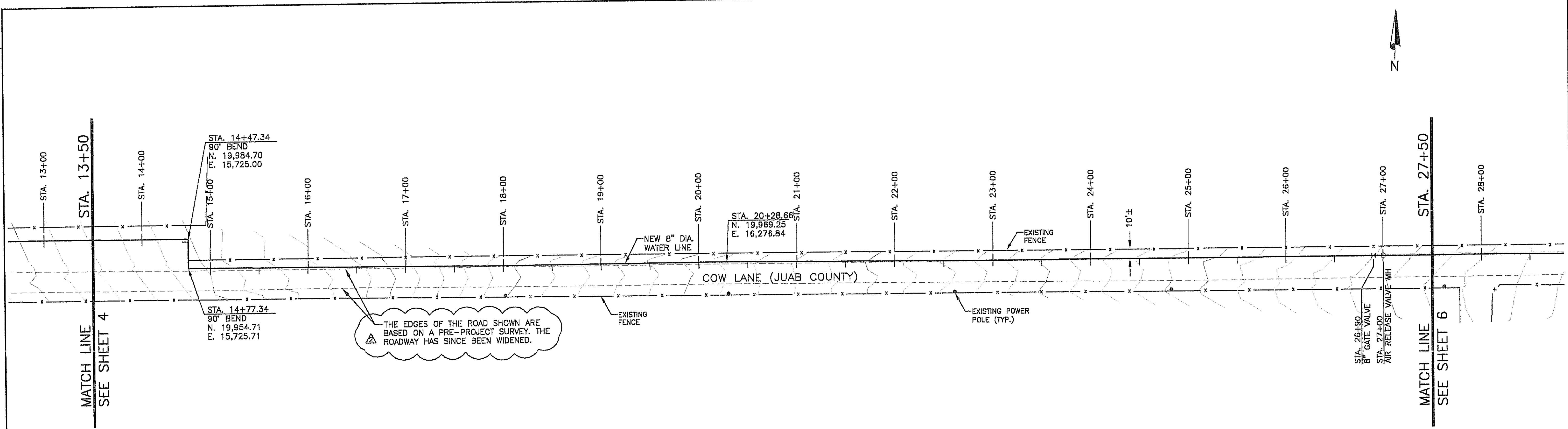
PACIFICORP

MONA WELLS AND PIPELINE
PLAN & PROFILE
STA. 0+00 TO STA. 13+50

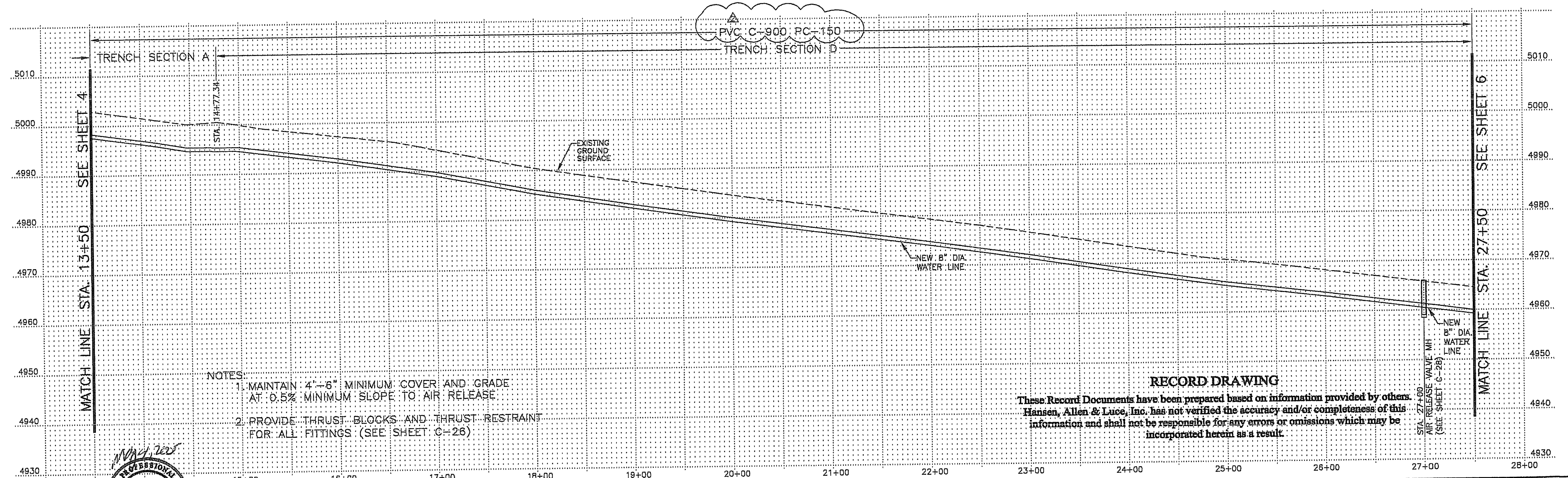
SHEET PP-4

005.16.100

6/01



NOTE:
THE COORDINATES SHOWN ARE BASED UPON A LOCAL CONTROL SYSTEM. REFER TO SHEET PP-15 FOR A TIE TO A SECTION CORNER.



NOTES:
1. MAINTAIN 4'-6" MINIMUM COVER AND GRADE AT 0.5% MINIMUM SLOPE TO AIR RELEASE.
2. PROVIDE THRUST BLOCKS AND THRUST RESTRAINT FOR ALL FITTINGS (SEE SHEET C-26)

RECORD DRAWING

These Record Documents have been prepared based on information provided by others. Hansen, Allen & Luce, Inc. has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated herein as a result.

MAY, 2005
LICENSED PROFESSIONAL ENGINEER No. 318761 BENJAMIN D. MINER STATE OF UTAH
PROJECT ENGINEER

HANSEN ALLEN & LUCE INC ENGINEERS

DESIGNED BDM	3						
DRAFTED CAH	△	02/08/05	RECORD DRAWING	SDM	BDM		
CHECKED MEA	1	MAY 2004	CHANGED ALIGNMENT	BDM	MEA		
DATE FEBRUARY 2004	NO.	DATE	REVISIONS	BY	APVD.		

SCALE
HORIZONTAL 1" = 50'
VERTICAL 1" = 10'

VERIFY SCALE
0" 1"
BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

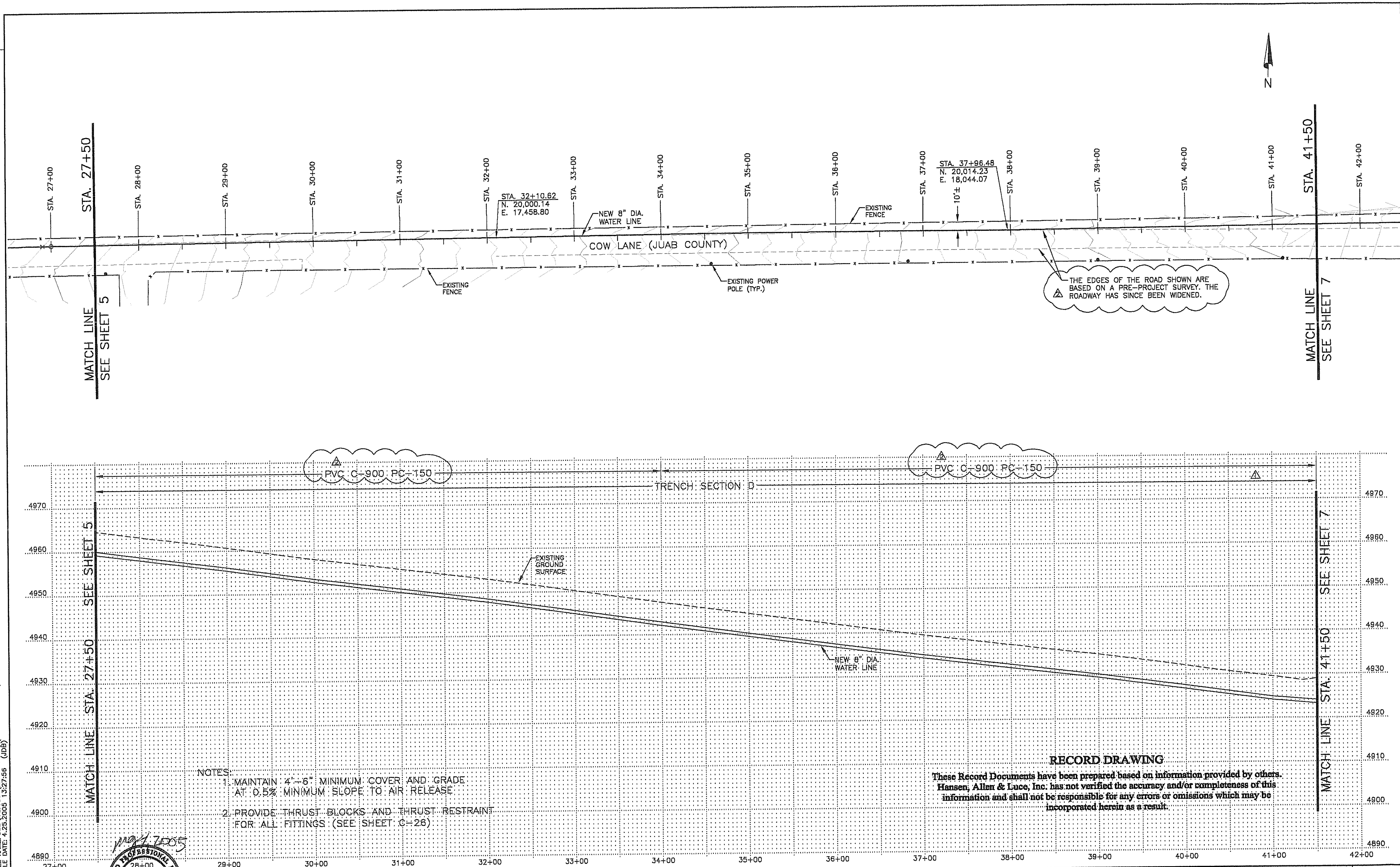
PACIFICORP

MONA WELLS AND PIPELINE
PLAN & PROFILE
STA. 13+50 TO STA. 27+50

SHEET PP-5
005.16.100

FILE NAME: 005\16.100 (MONA WELL)\RECORD DWGS\STA_13+50__R1.DWG
FILE DATE: 4.25.2005 13:25:54 (JDB)

6/01



NOTES:
1. MAINTAIN 4'-6" MINIMUM COVER AND GRADE AT 0.5% MINIMUM SLOPE TO AIR RELEASE
2. PROVIDE THRUST BLOCKS AND THRUST RESTRAINT FOR ALL FITTINGS (SEE SHEET C-26)

RECORD DRAWING

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May 1, 2005

FILE NAME: 005.16.100 (MONA WELL)\RECORD DWGS\STA_27+50-R-1.DWG
FILE DATE: 4.25.2005 13:27:56 (JDB)

HANSEN ALLEN & LUCE INC ENGINEERS

LICENSED PROFESSIONAL ENGINEER No. 318761 BENJAMIN D. MINER STATE OF UTAH

PROJECT ENGINEER

DESIGNED BDM	3				
DRAFTED CAH	2				
CHECKED MEA	1	5-4-2004	ADDENDUM NO. 1	JDB	BDM
DATE FEBRUARY 2004	NO.	DATE	REVISIONS	BY	APVD.

SCALE
HORIZONTAL 1" = 50'
VERTICAL 1" = 10'

VERIFY SCALE
0" 1"
BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

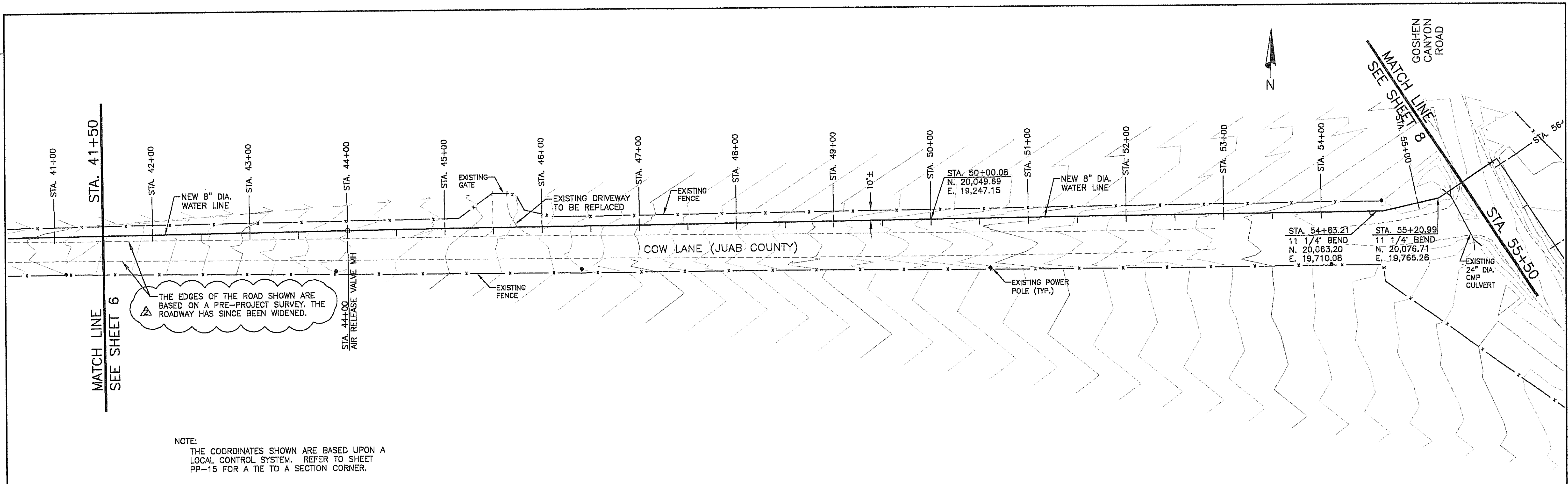
PACIFICORP

MONA WELLS AND PIPELINE
PLAN & PROFILE
STA. 27+50 TO STA. 41+50

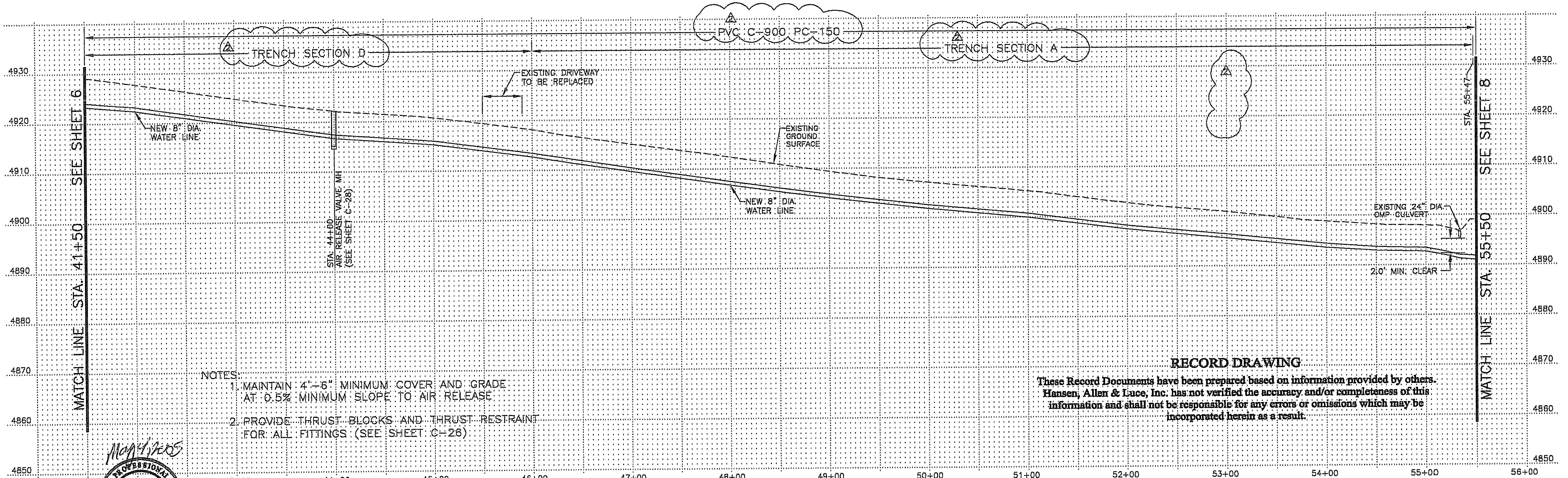
SHEET PP-6

005.16.100

6/01



NOTE:
THE COORDINATES SHOWN ARE BASED UPON A LOCAL CONTROL SYSTEM. REFER TO SHEET PP-15 FOR A TIE TO A SECTION CORNER.



NOTES:
1. MAINTAIN 4'-6" MINIMUM COVER AND GRADE AT 0.5% MINIMUM SLOPE TO AIR RELEASE
2. PROVIDE THRUST BLOCKS AND THRUST RESTRAINT FOR ALL FITTINGS (SEE SHEET C-26)

RECORD DRAWING

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May 4, 2005

LICENSED PROFESSIONAL ENGINEER No. 318761 BENJAMIN D. MINER STATE OF UTAH

FILE NAME: 005.16.100 (MONA WELL)\RECORD DWGS\STA_41+50-R-1.DWG
FILE DATE: 4.25.2005 13:29:21 (JDB)

HANSEN ALLEN & LUCE INC ENGINEERS

PROJECT ENGINEER

DESIGNED BDM	3				
DRAFTED CAH	△2	02/08/05	RECORD DRAWING	SDM	BDM
CHECKED MEA	△1	5-4-2004	ADDENDUM NO. 1	JDB	BDM
DATE FEBRUARY 2004	NO.	DATE	REVISIONS	BY	APVD.

SCALE
HORIZONTAL 1" = 50'
VERTICAL 1" = 10'

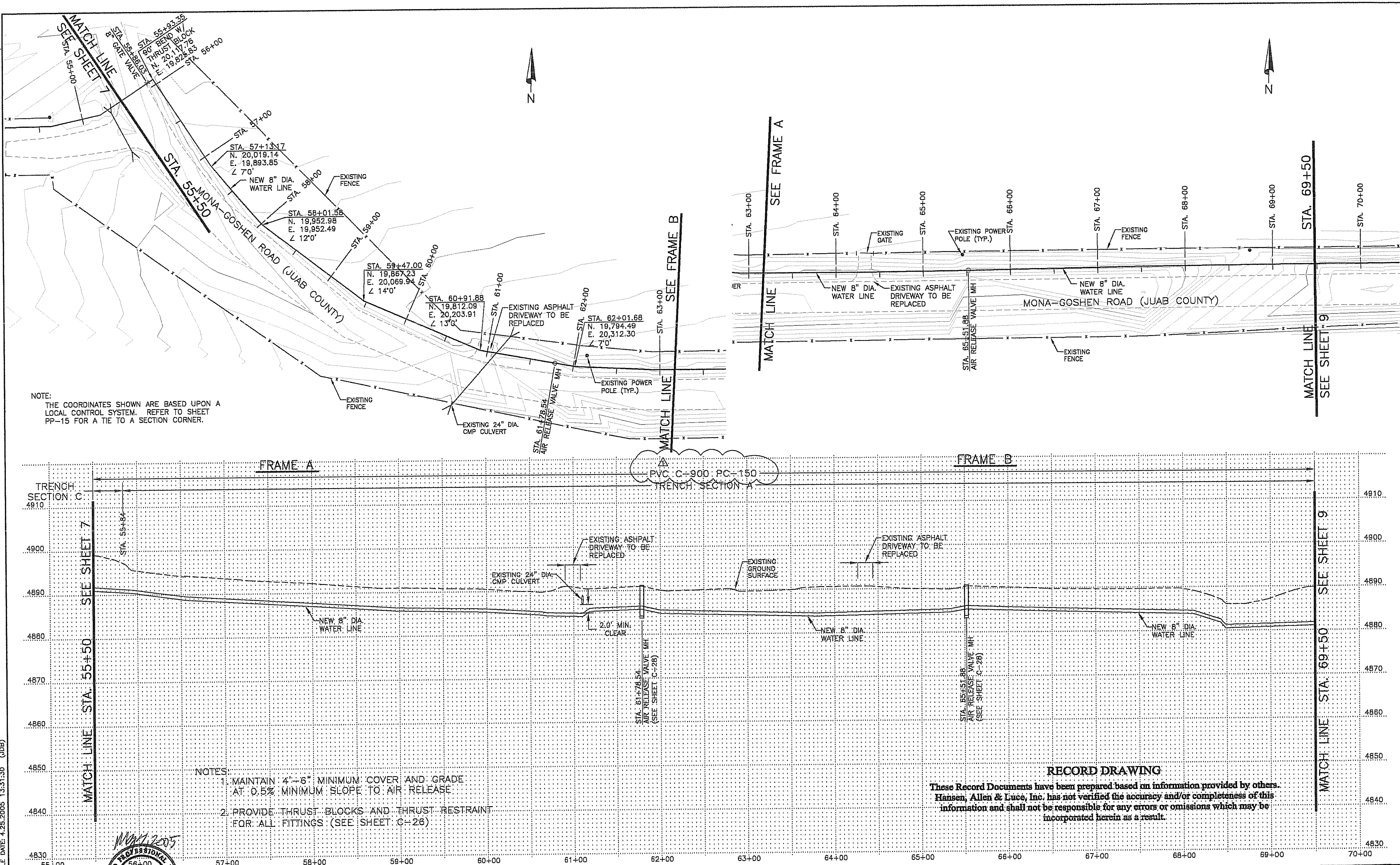
VERIFY SCALE
0" 1"
BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

PACIFICORP

MONA WELLS AND PIPELINE
PLAN & PROFILE
STA. 41+50 TO STA. 55+50

SHEET
PP-7
005.16.100

6/01



NOTES:

1. MAINTAIN 4'-6" MINIMUM COVER AND GRADE AT 0.5% MINIMUM SLOPE TO AIR RELEASE.
2. PROVIDE THRUST BLOCKS AND THRUST RESTRAINT FOR ALL FITTINGS (SEE SHEET C-26)

RECORD DRAWING

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FILE NAME: 005\16.100 (MONA WELL)\RECORD DWGS\STA_55+50.DWG
FILE DATE: 4.25.2005 13:31:30 (JDB)

HANSEN ALLEN & LUCE INC ENGINEERS

LICENSED PROFESSIONAL ENGINEER No. 318761 BENJAMIN D. MINER STATE OF UTAH

PROFESSIONAL ENGINEER

DESIGNED BDM	3				
DRAFTED CAH	2				
CHECKED MEA	1	02/08/05	RECORD DRAWING	SDM	BDM
DATE FEBRUARY 2004	NO.	DATE	REVISIONS	BY	APVD.

SCALE: HORIZONTAL 1" = 50'; VERTICAL 1" = 10'

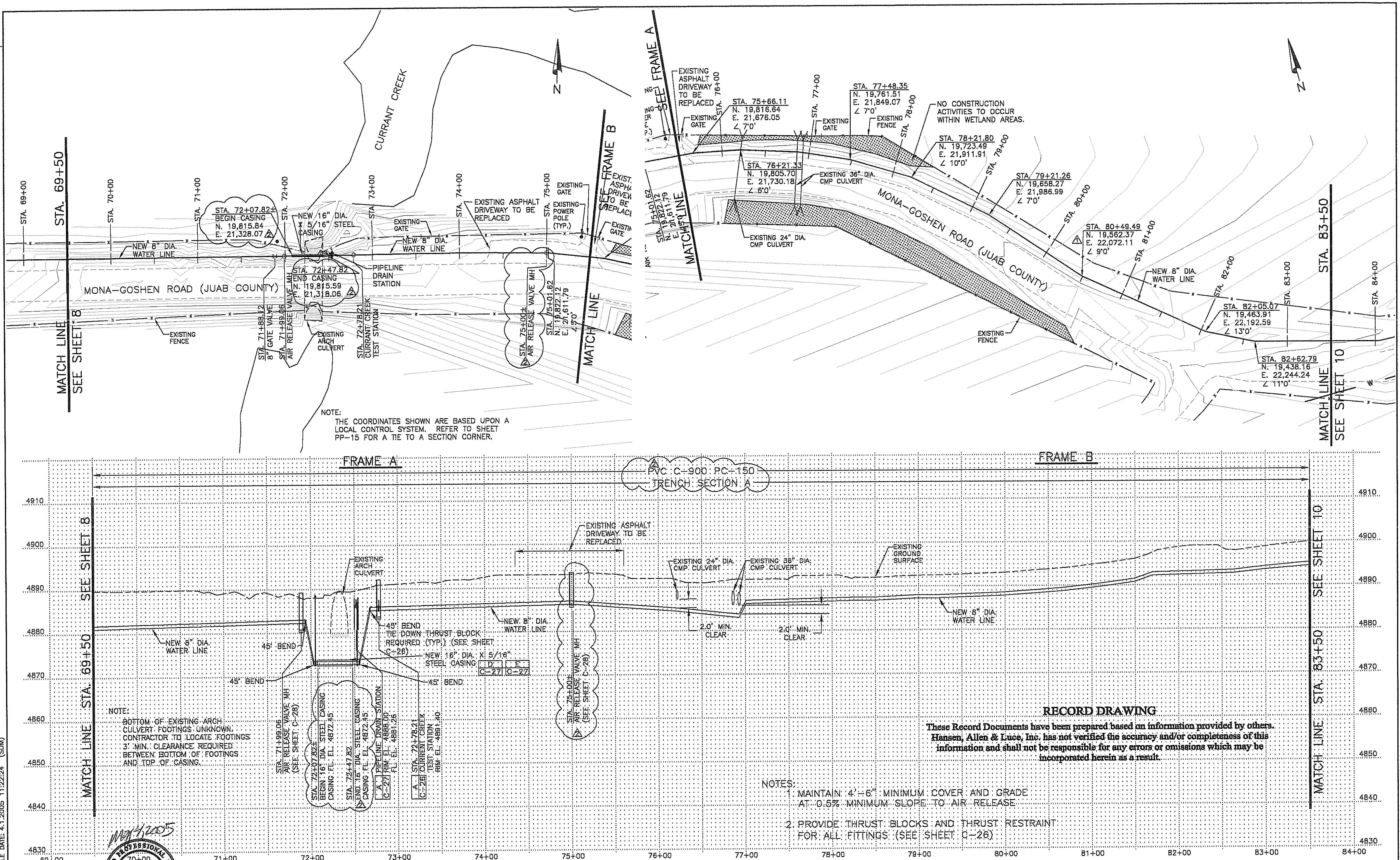
VERIFY SCALE: BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

PACIFICORP

MONA WELLS AND PIPELINE
PLAN & PROFILE
STA. 55+50 TO STA. 69+50

SHEET PP-8

005.16.100



FILE NAME: 005.16.100 (MONA WELL)\RECORD DWGS\STA_69+50__R1.DWG
FILE DATE: 4.1.2005 11:22:24 (SDM)

HANSEN ALLEN & LUCE INC ENGINEERS

REGISTERED PROFESSIONAL ENGINEER No. 318761 BENJAMIN D. MINER STATE OF UTAH

PROJECT ENGINEER

DESIGNED BDM	3				
DRAFTED CAH	2	02/08/05	RECORD DRAWING	SDM	BDM
CHECKED MEA	1	5/04	CHANGED EAST COORDINATE @ STA. 80+49.49	CAH	BDM
DATE FEBRUARY 2004	NO.	DATE	REVISIONS	BY	APVD.

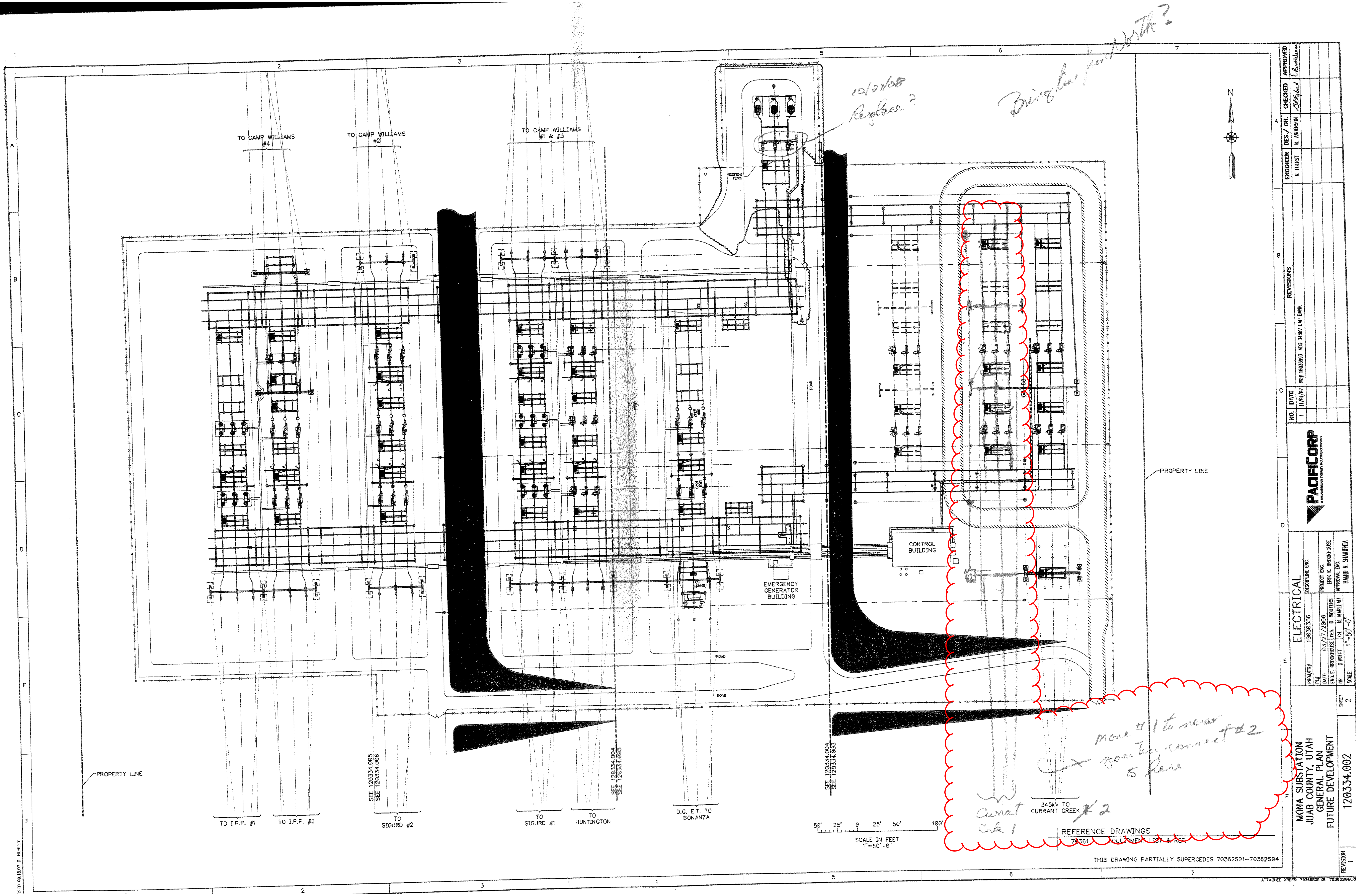
SCALE HORIZONTAL 1" = 50' VERTICAL 1" = 10'

VERIFY SCALE 0" 1" BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

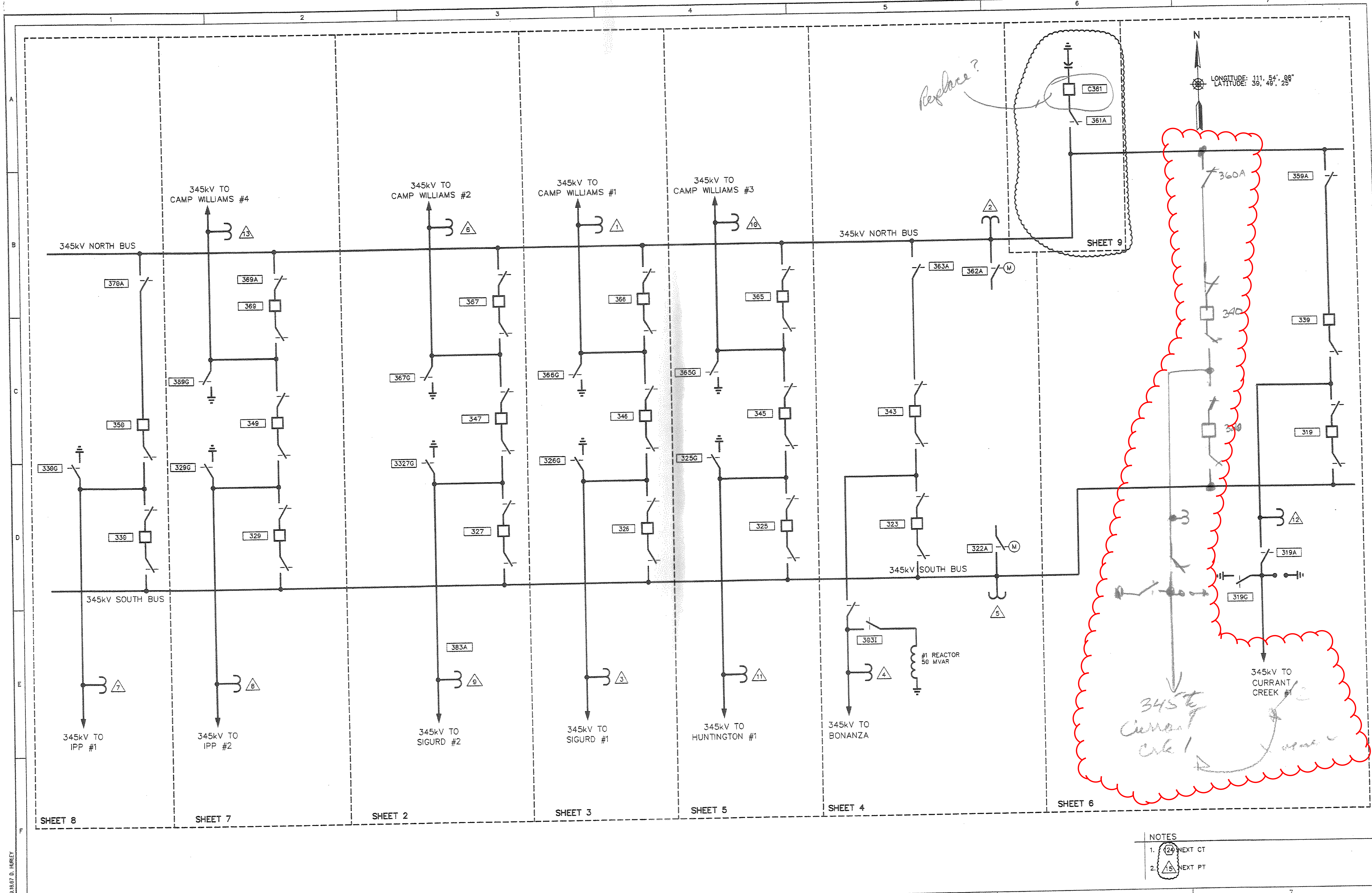
PACIFICORP

MONA WELLS AND PIPELINE
PLAN & PROFILE
STA. 69+50 TO STA. 83+50

SHEET PP-9
005.16.100



TO CAMP WILLIAMS #4
TO CAMP WILLIAMS #2
TO CAMP WILLIAMS #1 & #3
EXISTING FENCE
10/21/08 Replace?
Bring line from North?
N
ROAD
CONTROL BUILDING
EMERGENCY GENERATOR BUILDING
PROPERTY LINE
SEE 120334.005
SEE 120334.006
SEE 120334.004
SEE 120334.003
TO I.P.P. #1
TO I.P.P. #2
TO SIGURD #2
TO SIGURD #1
TO HUNTINGTON
D.G. E.T. TO BONANZA
SCALE IN FEET 1"=50'-0"
Current Crk 1
345kV TO CURRANT CREEK #2
move #1 to new position, connect #2 to here
REFERENCE DRAWINGS
70361 EQUIPMENT LIST & REF.
THIS DRAWING PARTIALLY SUPERCEDES 70362S01-70362S04
ENGINEER
DES./DR.
CHECKED
APPROVED
R. FUERST
M. ANDERSON
REVISIONS
NO.
DATE
1
11/01/07
WO# 10033993 ADD 345KV CAP BANK
PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY
ELECTRICAL
PROJ/ER# 10030356
DISCIPLINE ENG.
PL#
DATE: 03/27/2006
PROJECT ENG. ERIK K. BROOKHOUSE
ENG. E. BROOKHOUSE
DES. D. WOUTERS
DR. D.WOLFF
CH. M. MARLEAU
APPROVAL ENG. HAMID R. SHARIFNIA
SCALE: 1"=50'-0"
MONA SUBSTATION
JUAB COUNTY, UTAH
GENERAL PLAN
FUTURE DEVELOPMENT
SHEET 2
120334.002
REVISION 1
ATTACHED XREFS: 70366S00.XB, 70362S00.XI



NO.	DATE	REVISIONS	ENGINEER	DES./DR.	CHECKED	APPROVED
15	10/08/07	WO# 10033993 ADD 345kV CAP BANK, SHEET 9	R. SKAMYHORN	G. ANDERSON		

PACIFICORP

PROTECTION & CONTROL

MONA SUBSTATION
JUAB COUNTY, UTAH
ONE LINE DIAGRAM
KEY SHEET

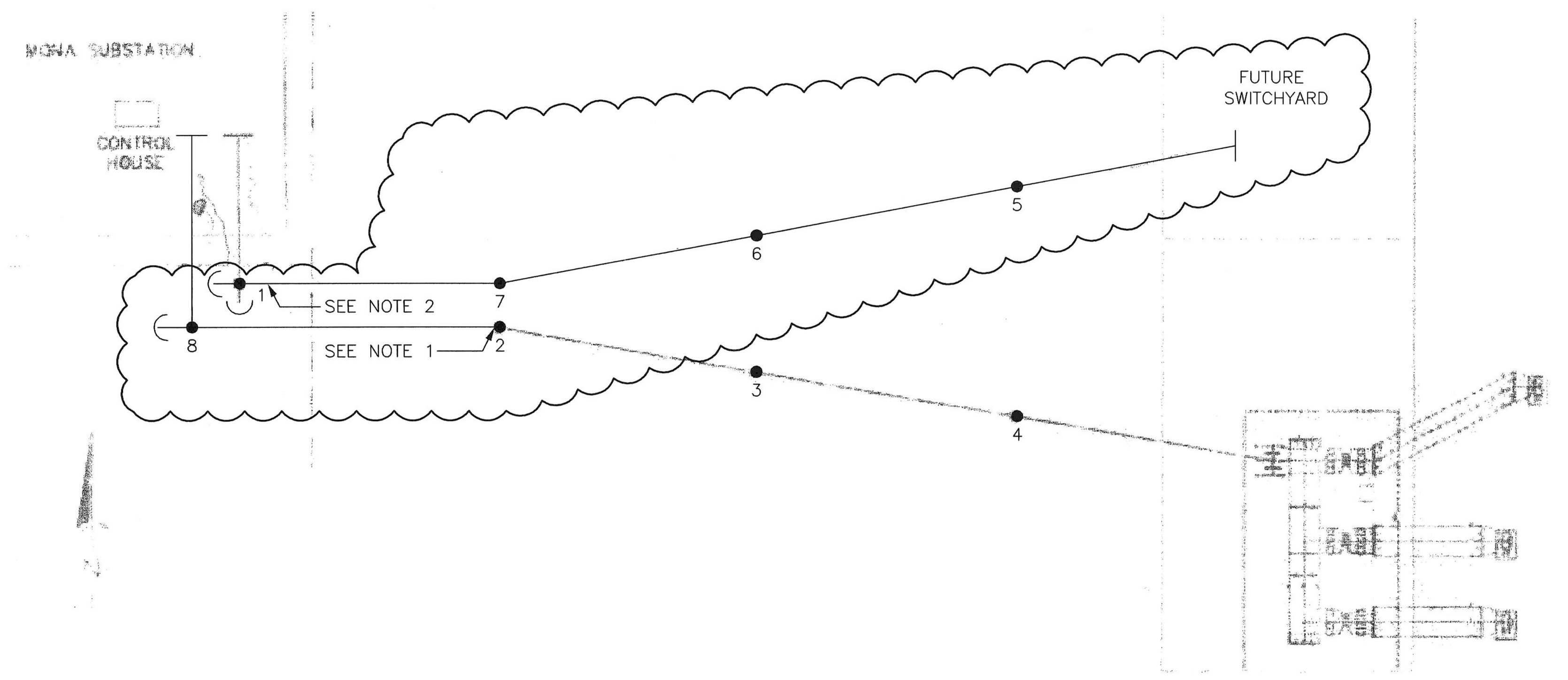
70456R01

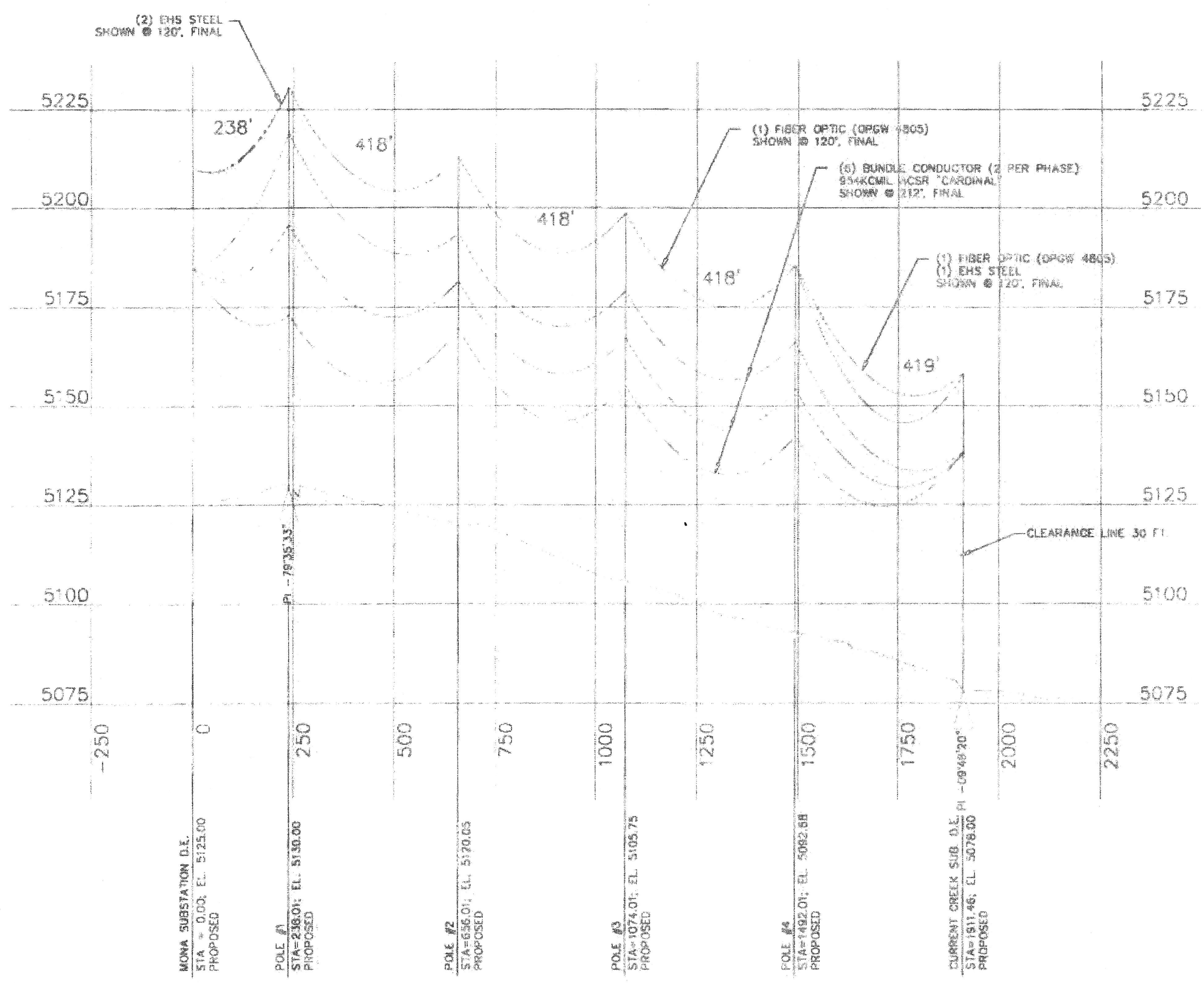
SHEET 1 OF 9

REVISION 15

SCALE: NONE

POLE NO.	POLE TYPE	DESCRIPTION	POLE DETAILS
1	TP301	1 CKT – 125' – DEADEND	110839.001
2	TP302	1 CKT – 110' – TANGENT	110840.001
3	TP302	1 CKT – 110' – TANGENT	110840.001
4	TP302	1 CKT – 110' – TANGENT	110840.001





NOTES

1. LOCATION OF OPGW TERMINATION BOX. CONDUIT TO BE INSTALLED FROM THIS LOCATION TO THE EXISTING TERMINATION BOX AT POLE 1.
2. LOCATION OF OPGW TERMINATION BOX.
3. CONTRACTOR RESPONSIBILITY ENDS AT POLES 1 AND 8. OWNER TO COMPLETE SUBSTATION MODIFICATIONS INCLUDING SPAN TO POLES 1 AND 8.

LEGEND

NOT TO BE USED FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
A	02/18/08	ISSUED FOR PROPOSAL PREPARATION	TDP	RPK			LAL

NOT TO SCALE

I HEREBY CERTIFY THAT THIS DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF UTAH

SIGNED ______
DATE ______ REG NO. ______

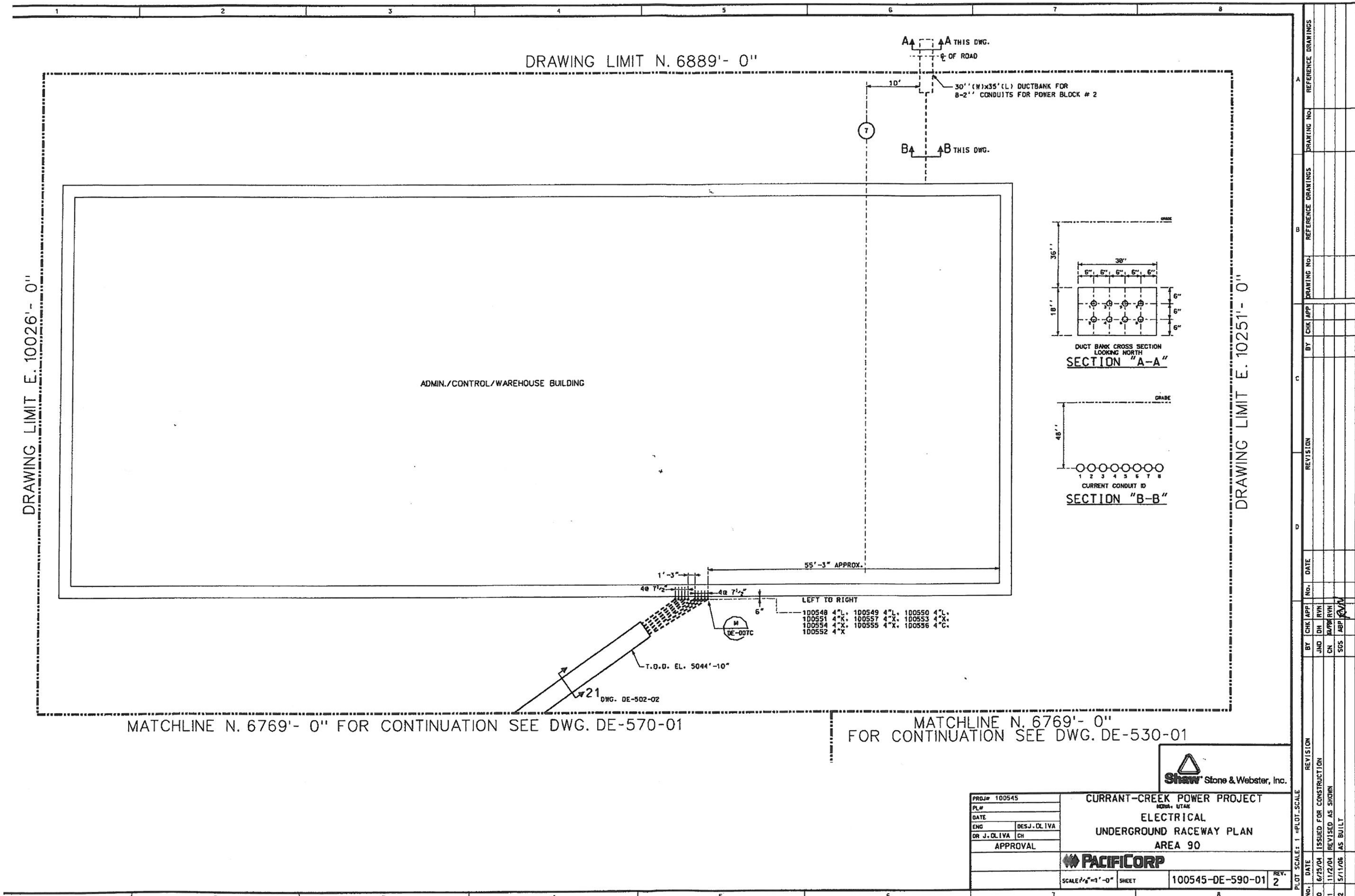
BLACK & VEATCH CORPORATION

ENGINEER RPK | DRAWN TDP
CHECKED LAL | DATE

PACIFICORP
A MIDAMERICAN ENERGY HOLDING COMPANY

345KV CURRANT CREEK SWITCHYARD, MONA, UTAH
PLAN & PROFILE

PROJECT: SKETCH | DRAWING NUMBER: 113910.001 | REV: –
CODE
AREA



DRAWING LIMIT N. 6889'- 0"
DRAWING LIMIT E. 10026'- 0"
DRAWING LIMIT E. 10251'- 0"
A THIS DWG.
℄ OF ROAD
10'
30''(W)x35'(L) DUCTBANK FOR
8-2'' CONDUITS FOR POWER BLOCK # 2
7
B THIS DWG.
ADMIN./CONTROL/WAREHOUSE BUILDING
GRADE
36''
30"
6" 6" 6" 6" 6"
18''
6" 6" 6"
DUCT BANK CROSS SECTION
LOOKING NORTH
SECTION "A-A"
GRADE
48''
1 2 3 4 5 6 7 8
CURRENT CONDUIT ID
SECTION "B-B"
55'-3" APPROX.
1'-3"
4@ 7½"
4@ 7½"
6"
LEFT TO RIGHT
100548 4"L, 100549 4"L, 100550 4"L,
100551 4"K, 100557 4"X, 100553 4"X,
100554 4"X, 100555 4"X, 100556 4"C,
100552 4"X
M
DE-00TC
T.O.D. EL. 5044'-10"
21 DWG. DE-502-02
MATCHLINE N. 6769'- 0" FOR CONTINUATION SEE DWG. DE-570-01
MATCHLINE N. 6769'- 0"
FOR CONTINUATION SEE DWG. DE-530-01
Shaw Stone & Webster, Inc.
PROJ# 100545
PL#
DATE
ENG
DES J.OLIVA
DR J.OLIVA
CH
APPROVAL
CURRANT-CREEK POWER PROJECT
MONA, UTAH
ELECTRICAL
UNDERGROUND RACEWAY PLAN
AREA 90
PACIFICORP
SCALE 1/8"=1'-0"
SHEET
100545-DE-590-01
REV. 2
PLOT SCALE: 1 =PLOT_SCALE
REFERENCE DRAWINGS
DRAWING No.
REVISION
No. DATE REVISION BY CHK APP
0 6/25/04 ISSUED FOR CONSTRUCTION JND DH RVN
1 11/2/04 REVISED AS SHOWN CN RVN
2 5/11/06 AS BUILT SGS ABP

APPENDIX D

CONCEPTUAL PROCESS FLOW DIAGRAMS AND WATER MASS BALANCE

APPENDIX D

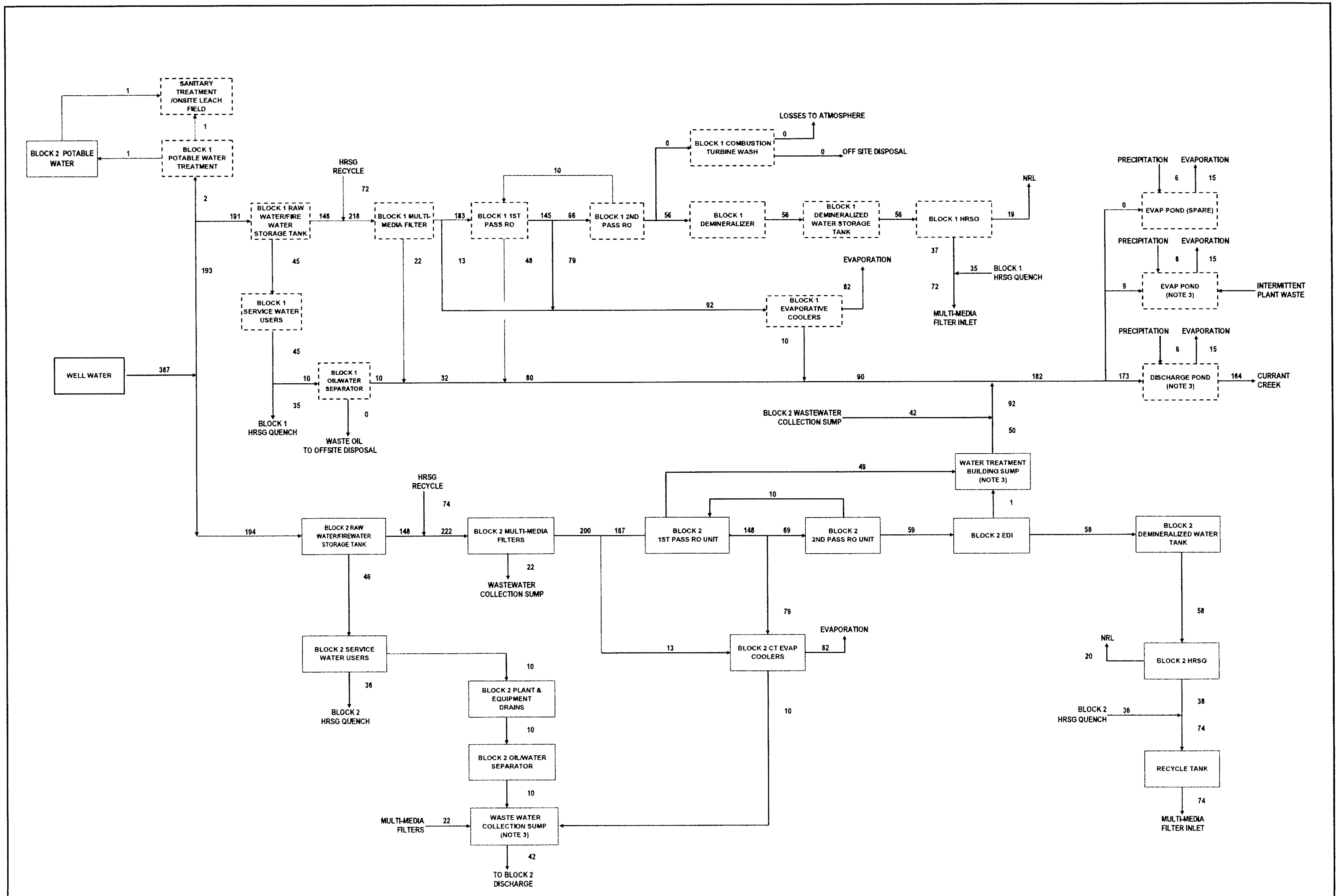
Conceptual Process Flow Diagrams and Water Balance

Conceptual Drawings

The following drawings are included to assist the Contractor in development of the Scope of Work. The Contractor shall be responsible for providing construction drawings for the Currant Creek Block 2 Facility in accordance with Exhibit A of these documents.

Drawing	Drawing Title
B&V WMB -1, Rev. A	Combined Cycle – Water Mass Balance
B&V 162628-2UUU-M2000, Rev. A	Piping Flow Diagram - Index

NOTE: This appendix includes the Conceptual Piping Flow Diagrams for the Systems indicated on the Index Sheet.



NOTES:
1. FLOWS ARE IN GPM.
2. DASHED BOXES ARE BLOCK 1 SYSTEMS.
3. SEE SECTION 1.2.3 FOR DESCRIPTION OF WASTEWATER COLLECTION.

BLOCK 2			
CONDITION	Annual Average	CYCLE MAKEUP	2%
COMBUSTION TURBINE FUEL	Natural Gas	1ST PASS RO RECOVERY	75%
TURBINE CONFIGURATION	Combined Cycle 2 x 1	2ND PASS RO RECOVERY	85%
CONDENSER COOLING SYSTEM	Dry	MULTI-MEDIA RECOVERY	90.0%
COMBUSTION TURBINE	GE 7 FA	EVAP COOLER CYCLES	9

BLACK & VEATCH

Eng:	HLL	Dwg:	HLL
Check:	VAC	Date:	1/5/2009

PacifciCorp
Currant Creek

COMBINE CYCLE
WATER MASS BALANCE

Project	Rev
162628	A

WMB-1

PACIFICORP
CURRANT CREEK BLOCK 2
F-CLASS

PIPING FLOW DIAGRAM INDEX

TABLE OF CONTENTS

NOT TO BE USED
FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
A	12/DEC/08	ISSUED FOR EPC BIDS	PRP				

I HEREBY CERTIFY THAT THIS DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF TENNESSEE.

SIGNED ____________

DATE ________ REG NO. ________

BLACK & VEATCH CORPORATION

ENGINEER | DRAWN PRP | CHECKED | DATE

PACIFICORP
CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM
INDEX

PROJECT: 162628 | DRAWING NUMBER: 2UUU-M2000 | REV: A

CODE | AREA

BAT52451 A1ASL015 01/23/09 14:08:40 D1 ACAD 16.1s (LMS Tech) 1=1

PIPING AND INSTRUMENT DIAGRAM LEGEND

PIPING ACCESSORIES

FUNCTION CODE	DESCRIPTION
EXJ	EXPANSION JOINT
	ISOLATING DIAPHRAGM
ORF	PRESSURE BREAKDOWN ORIFICE
ORF	PRESSURE BREAKDOWN ELEMENT
	STRAIGHTENING VANES
GG	GAGE GLASS
HRK	FIRE HOSE RACK
HYD	FIRE HYDRANT
FE	FLOW PRIMARY ELEMENT (ORIFICE)
FE	ANNUBAR
FE	FLOW PRIMARY ELEMENT (NOZZLE)
SFI	SIGHT FLOW INDICATOR
	DISPLACEMENT METER
	RATE OF FLOW INDICATOR
	SEPARATION CHAMBER
	DIFFUSER ORIFICE
TRP	TRAP
STR	STRAINER, Y-TYPE
FLT	FILTER
FHOS	FLEXIBLE HOSE
RPD	RUPTURE DISK
EHD	EXHAUST HEAD
CLR	SAMPLE COOLER
	HEAD CHAMBER
STR	STRAINER, CONE OR PLATE TYPE
STR	STRAINER, BASKET TYPE
STR	STRAINER, DUPLEX BASKET TYPE
	AUTOMATIC AIR RELEASE VALVE
	FLOAT VALVE
	THERMOSTATIC VALVE
	WASTE CONE
	CONDENSING RESERVOIR
	FIRE HYDRANT HOUSE
BFP	BACKFLOW PREVENTER
	PULSATION DAMPENER
TRP	RESIN TRAP
	FLAME ARRESTER
DSH	DESUPERHEATER
STR	BASKET
	FUEL OIL LEAK DETECTION PIT
	SET PUMP OR EDUCTOR

VALVES

- GATE VALVE
- GLOBE VALVE (Y AND T PATTERN)
- PLUG VALVE
- BALL VALVE
- NEEDLE VALVE
- DIAPHRAGM VALVE
- IN-LINE SAFETY VALVE
- DOUBLE DIAPHRAGM ANGLE
- DELUGE
- SAFETY OR RELIEF VALVE
- ANGLE VALVE
- THREE-WAY VALVE
- STOP CHECK VALVE
- AIR OPERATED CHECK VALVE
- BUTTERFLY VALVE
- CHECK VALVE
- WAFER CHECK VALVE
- PINCH VALVE
- ALARM CHECK VALVE
- DRY PIPE (FIRE PROTECTION SYSTEM)
- SV — THREE-WAY SOLENOID VALVE
- BALL DRIP VALVE
- BALANCING VALVE
- STEAM CONDITIONING VALVE
- SAFETY SHUTOFF VALVE
- SELF CONTAINED PRESSURE REGULATING VALVE
- COMPRESSED GAS PRESSURE REGULATOR

FIRE PROTECTION VALVES

- OS&Y GATE VALVE
- NONINDICATING/NONRISING STEAM VALVE
- POST INDICATING RATE VALVE
- INDICATING BUTTERFLY VALVE
- CHECK VALVE

FIRE PROTECTION SYSTEMS

- CLOSED-HEAD SPRINKLERS (FP SPRINKLER SYSTEM)
- OPEN-HEAD SPRINKLERS (FP DELUGE SYSTEM)
- CLOSED-HEAD SPRAY NOZZLES (FP PRE-ACTION SPRAY SYSTEM)
- OPEN-HEAD SPRAY NOZZLES (FP DELUGE WATER SPRAY SYSTEM)
- DRY PILOT DETECTION (PRE-ACTION OR DELUGE)
- ELECTRIC DETECTION (HEAT,SMOKE,LINEAR HEAT, SENSING CABLE, ETC.) (PRE-ACTION OR DELUGE)
- DENOTES WET PIPE (FIRE PROTECTION)
- DENOTES DRY PIPE (FIRE PROTECTION)

OPERATORS

- SOV — SOLENOID OPERATED
- MOTOR OPERATED
- HYDRAULIC OPERATED
- PISTON OPERATED
- PISTON OPERATED WITH POSITIONER
- CONTROL VALVE WITH HANDJACK
- SELF CONTAINED CONTROL
- DIAPHRAGM OR CYLINDER OPERATED SPRING OPENING
- DIAPHRAGM OR CYLINDER OPERATED SPRING CLOSING
- DIAPHRAGM OR CYLINDER OPERATED WITH POSITIONER
- DIAPHRAGM OR CYLINDER OPERATED
- DIRECT FLOAT OPERATED
- POST INDICATOR

PIPING DETAILS

- BLIND FLANGE
- FLANGE
- INSULATING FLANGE
- INSULATING UNION
- DRESSER OR VICTAULIC COUPLING
- OPEN DRAIN FUNNEL
- ROOF DRAIN OR FLOOR DRAIN
- SAFETY VALVE DRIP PAN
- CLOSURE, SCREWED CAP
- CLOSURE, WELDED CAP
- LINE SIZE CHANGE
- SCREENED VENT
- UNION
- EQUIPMENT CONNECTION
- BELL-UP
- HOSE CONNECTION
- QUICK DISCONNECT
- SPECTACLE FLANGE
- PLUGGED PORT/TAP
- FLOATING TANK SUCTION
- TIE IN POINT

INSTRUMENTS

COMPONENTS

- LOCAL INDICATOR OR TEST DEVICE
- LOCAL ELECTRONIC DEVICE
- LOCAL PNEUMATIC DEVICE
- LOCAL SURFACE SENSING DEVICE
- ELECTRONIC TRANSMITTER OR CONTROLLER
  - FIRST LINE – FUNCTION CODE
  - SECOND LINE – SEQUENCE NUMBER
- PNEUMATIC TRANSMITTER OR CONTROLLER
  - FIRST LINE – FUNCTION CODE
  - SECOND LINE – SEQUENCE NUMBER

IDENTIFICATION

FUNCTION CODE	INSTRUMENT
ANZ	ANALYZER
CC	CATION CONDUCTIVITY
CE	CONDUCTIVITY CELL
CT	CONDUCTIVITY TRANSMITTER
FC	FLOW CONTROLLER
FE	FLOW ELEMENT
FI	FLOW INDICATOR
FM	FLOW METER
FS	FLOW SWITCH
FT	FLOW TRANSMITTER
IRK	INSTRUMENT RACK
KXX	MISCELLANEOUS CONTROL COMPONENT
LC	LEVEL CONTROLLER
LI	LEVEL INDICATOR
LS	LEVEL SWITCH
LT	LEVEL TRANSMITTER
MOD	INSTRUMENT/CONTROL MODULE
PC	PRESSURE CONTROLLER
PDS	PRESSURE DIFFERENTIAL SWITCH
PDI	PRESSURE DIFFERENTIAL INDICATOR
PDIS	PRESSURE DIFFERENTIAL INDICATOR SWITCH
PHE	pH CELL
PHT	pH TRANSMITTER
PI	PRESSURE INDICATOR
PIS	PRESSURE INDICATING SWITCH
PIT	PRESSURE INDICATING TRANSMITTER
PS	PRESSURE SWITCH
PT	PRESSURE TRANSMITTER
SC	SPECIFIC CONDUCTANCE
SGM	SIGNAL MONITOR
SV	SOLENOID VALVE
TC	TEMPERATURE CONTROLLER
TE	TEMPERATURE ELEMENT
THS	THERMOSTAT
TI	TEMPERATURE INDICATOR
TS	TEMPERATURE SWITCH
TT	TEMPERATURE TRANSMITTER
TW	THERMOWELL
VS	VIBRATION SWITCH
ZS	LIMIT SWITCH
ZT	POSITION TRANSMITTER

PIPING

- PIPING
- FURNISHED WITH EQUIPMENT / EXISTING
- TEMPORARY
- FUTURE
- FREEZE PROTECTION

CODE JURISDICTIONAL LIMITS FOR PIPING

ASME | B31.1

ASME – BOILER EXTERNAL PIPING (BEP)

B31.1 – NONBOILER EXTERNAL PIPING (NBEP)

SYSTEM CODES

	SYSTEM NAME
ASB	BOTTOM ASH HANDLING
ASC	FLY ASH HANDLING
BMD	LIME UNLOADING TRANS & HANDLING
CAA	STATION AIR
CAB	CONTROL AIR
CCE	INDUCED DRAFT
CGA	HYDROGEN STORAGE
CGE	AMMONIA STORAGE AND SUPPLY
ECB	CLOSED CYCLE COOLING WATER
FPA	SITE AND EQUIPMENT FIRE PROTECTION
FWA	BOILER FEED
FWC	CONDENSATE
FWD	CONDENSATE POLISHING
FWE	CYCLE CHEMICAL FEED
HRA	CONDENSING
HRB	CONDENSER AIR EXTRACTION
HRC	CIRCULATING WATER
HRE	CIRCULATING WATER CHEMICAL FEED
PSA	AUXILIARY STEAM SUPPLY
SAC	STEAM CYCLE SAMPLING & ANALYSIS
SCA	BUILDING HEATING
SGD	AIR PREHEAT
SGE	BOILER IGNITER OIL
SGF	BOILER VENTS AND DRAINS
SGG	MAIN STEAM
SGI	SOOT BLOWING
SGJ	HOT REHEAT
SGK	COLD REHEAT
SGN	TEMPORARY BLOWOUT
TEA	HP EXTRACTION STEAM
TEB	LP EXTRACTION STEAM
TEC	EXTRACTION DRAINS
TEE	LP HEATER DRAINS
TGE	GENERATOR COOLING AND PURGE
UUU	INDEX
UUU	LEGEND
WSA	WELL WATER SUPPLY
WSC	SERVICE WATER SUPPLY
WTA	RAW WATER PRETREATMENT
WTD	DEMINERALIZED WATER TREATMENT
WWB	SANITARY DRAINAGE AND TREATMENT
WWC	WASTEWATER COLLECTION & DRAINAGE

ABBREVIATIONS

CONTROL FUNCTIONS

CA	CONDUCTIVITY ALARM
CNTL	CONTROL
CPL	CONTROL PANEL
FA	FLOW ALARM
FI	FLOW INTERLOCK
GA	GAS ALARM
IND	INDICATE
LA	LEVEL ALARM
LI	LEVEL INTERLOCK
MEH	MODULAR ELECTROHYDRAULIC CONTROL SYSTEM
PA	PRESSURE ALARM
PHA	pH ALARM
PI	PRESSURE INTERLOCK
REC	RECORD
SP	SPECIFIC CONDUCTANCE
TA	TEMPERATURE ALARM
TI	TEMPERATURE INTERLOCK

CONTROL FUNCTION PREFIX CODE

H	HIGH	L	LOW
HH	HIGH-HIGH	LL	LOW-LOW

GENERAL

BU	BELL UP
DCS	DISTRIBUTED CONTROL SYSTEM / PLC
DR	DRAIN
LC	LOCKED CLOSED
LO	LOCKED OPEN
LVL	LEVEL
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
PRESS	PRESSURE
PTC	PERFORMANCE TEST CONNECTION
SC	SAMPLE CONNECTION
TC	TEST CONNECTION
TEMP	TEMPERATURE
TT	TELL TALE
TYP	TYPICAL
UG	UNDERGROUND
VT	VENT
XFMR	TRANSFORMER
XMTR	TRANSMITTER

GENERAL NOTES

P&ID CONNECTION NUMBERING

XXXX — DRAWING #

XXXX — DRAWING NUMBER

TP-XXX — OWNER ◄–► TERMINATION POINT.

X-XX-YY — F◄–► TERMINATION POINT.

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A	12/DEC/08	ISSUED FOR EPC BIDS	PRP				

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ENGINEER | DRAWN PRP | CHECKED | DATE

PACIFICORP
CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM
LEGEND

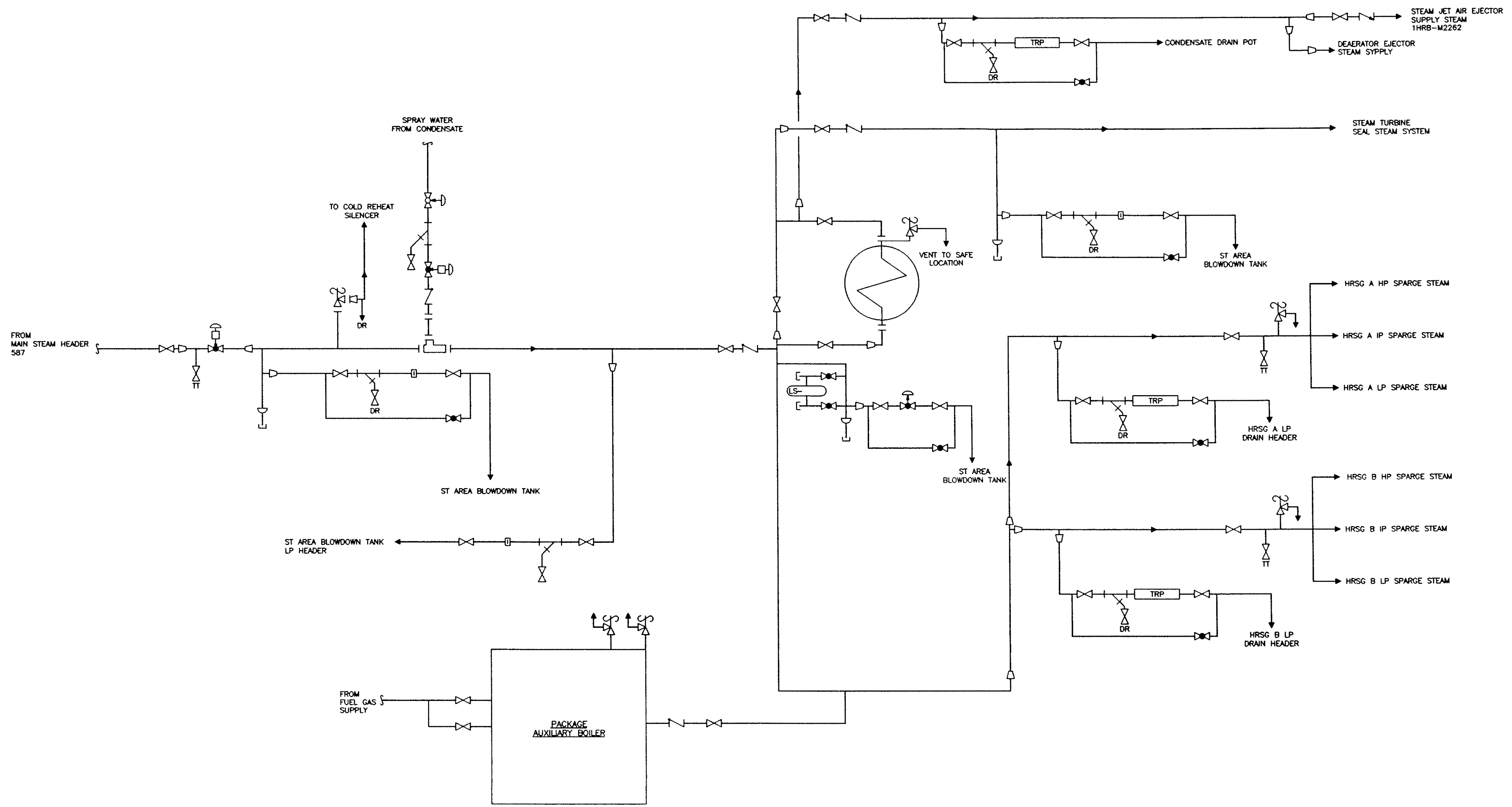
PROJECT / DRAWING NUMBER: 162628-2UUU-M2001 | REV: A

CODE | AREA

FAK33056 A1ASL015 06/27/08 11:20:32 ACAD 16.1s (LMS Tech) 01 1=1

NOTES:

1. THIS DRAWING IS THE BASIS FOR THE AUXILIARY STEAM SUPPLY SYSTEM DESIGN AND IS SUBJECT TO CHANGE AS A RESULT OF DETAILED DESIGN.



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NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
A	12/DEC/08	ISSUED FOR EPC BIDS	PRP				

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ENGINEER | DRAWN PRP | CHECKED | DATE

PACIFICORP
CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM
AUXILIARY STEAM SUPPLY

PROJECT DRAWING NUMBER 162628-2PSA-M2061 REV A

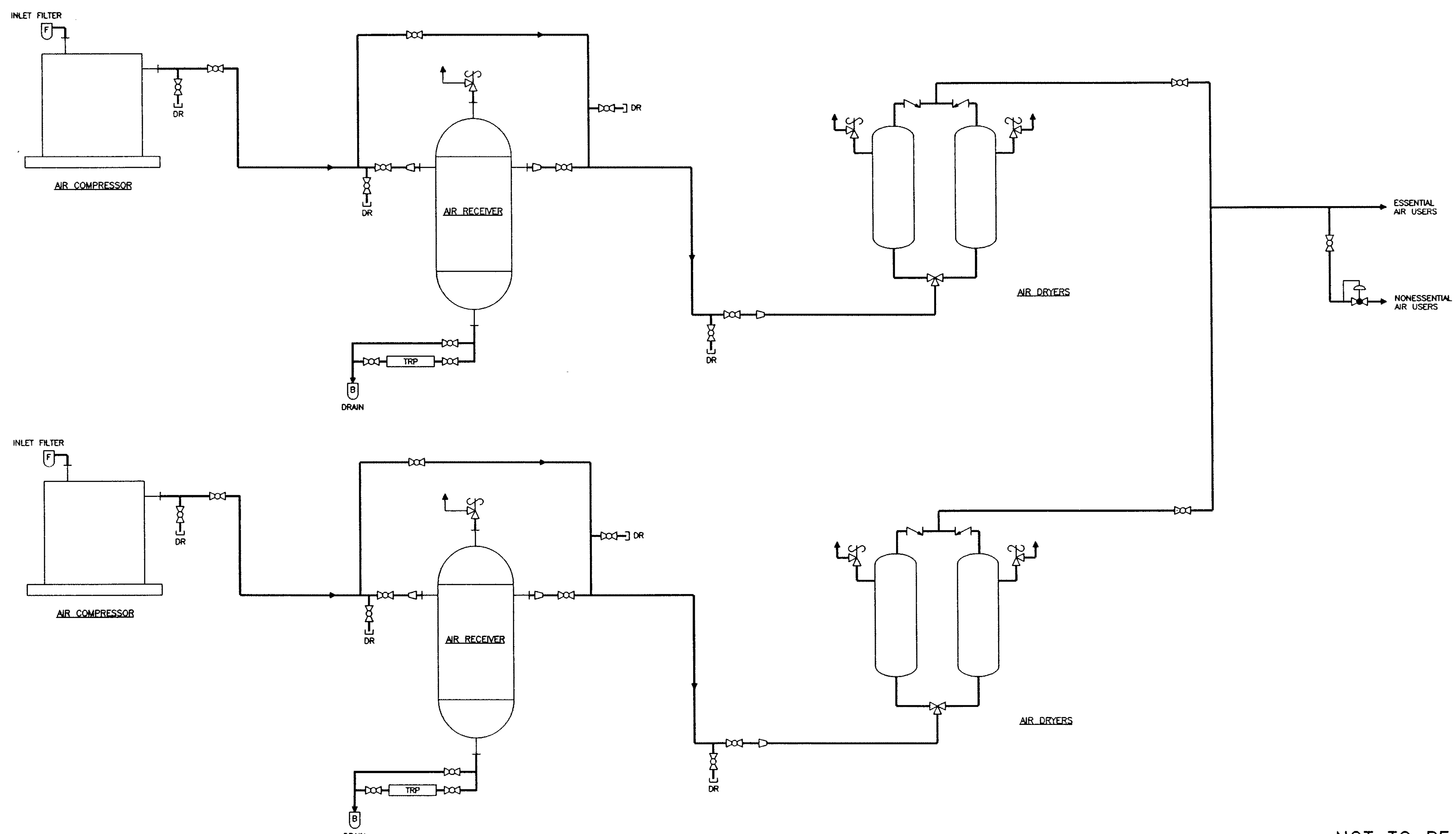
CODE

AREA

FAK33056 A1ASL015 06/30/08 D1 10:16:27 ACAD 16.1s (LMS Tech) 1=1

NOTES:

1. THIS DRAWING IS THE BASIS FOR THE STATION AIR SYSTEM DESIGN AND IS SUBJECT TO CHANGE AS A RESULT OF DETAILED DESIGN.



NOT TO BE USED FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
A	12/DEC/08	ISSUED FOR EPC BIDS	SSG				

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DATE ______ REG NO. ______

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ENGINEER | DRAWN PRP | CHECKED | DATE

PACIFICORP
CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM
STATION AIR

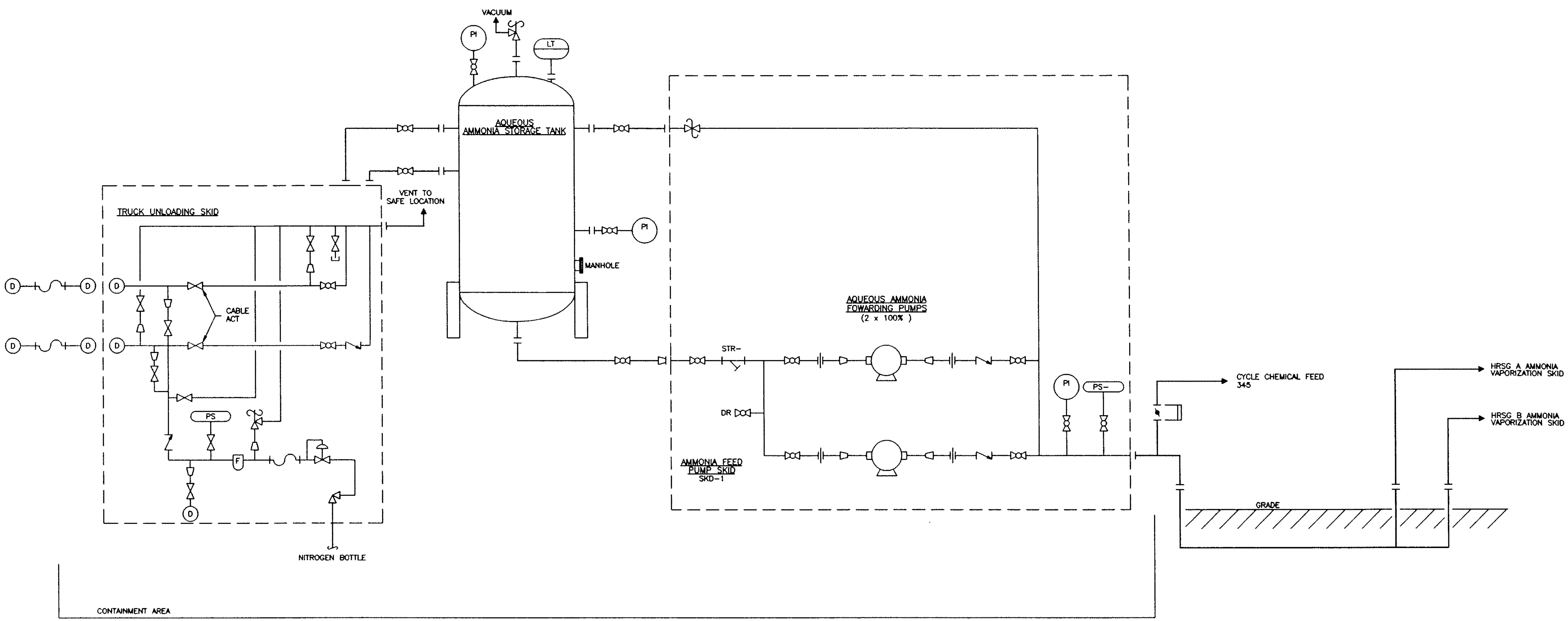
PROJECT / DRAWING NUMBER: 162628-2CAA-M2181 | REV: A

CODE | AREA

FAK33056 ATASL015 06/27/08 11:14:28 D1 1=1 ACAD 16.1s (LMS Tech)

NOTES:

1. THIS DRAWING IS THE BASIS FOR THE AQUEOUS AMMONIA SUPPLY AND STORAGE SYSTEM AND IS SUBJECT TO CHANGE AS A RESULT OF DETAILED DESIGN.



NOT TO BE USED FOR CONSTRUCTION

FAK33056 D1 ACAD 16.1s (LMS Tech)
A1ASL015 1=1
06/27/08 11:14:59

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
A	12/DEC/08	ISSUED FOR EPC BIDS	SSG				

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DATE REG NO.

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ENGINEER | DRAWN PRP

CHECKED | DATE

PACIFICORP
CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM
AQUEOUS AMMONIA SUPPLY AND STORAGE

PROJECT DRAWING NUMBER: 162628-2CGE-M2205

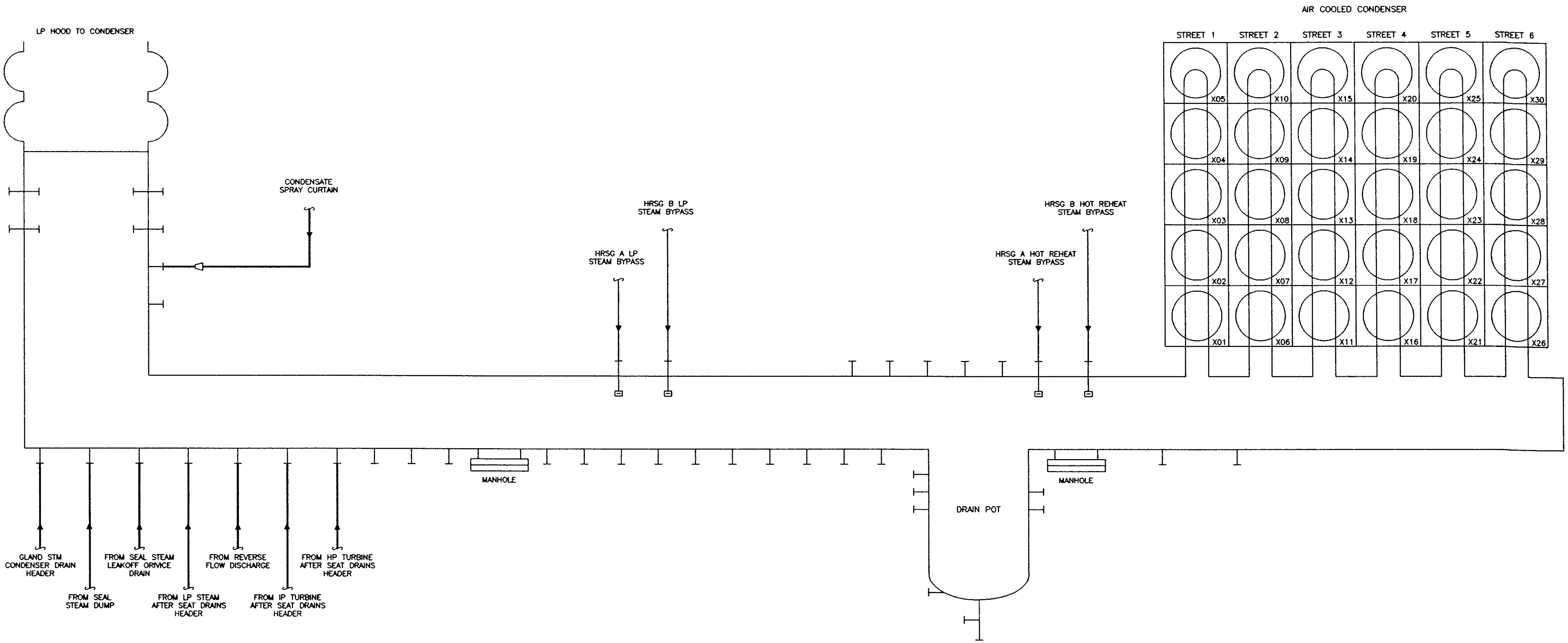
REV: A

CODE

AREA

NOTES:

1. THIS DRAWING IS THE BASIS FOR THE CONDENSING SYSTEM DESIGN AND IS SUBJECT TO CHANGE AS A RESULT OF DETAILED DESIGN.



NOT TO BE USED FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
A	12/DEC/08	ISSUED FOR EPC BIDS	PRP				

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ENGINEER | DRAWN PRP | CHECKED | DATE

PACIFICORP
CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM
CONDENSING

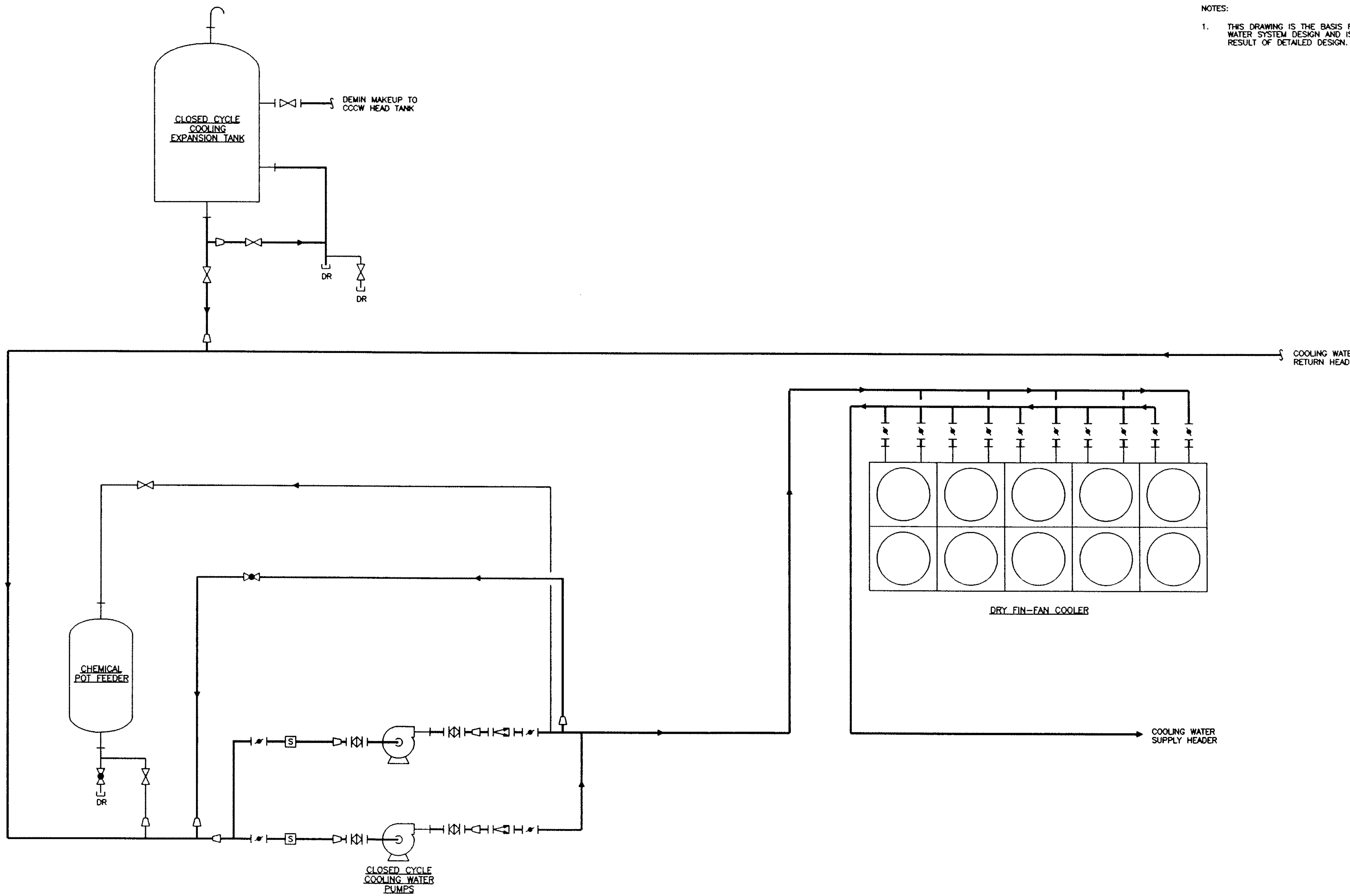
PROJECT / DRAWING NUMBER: 162628-2HRA-M2261 | REV: A

CODE | AREA

PRI03292 A1ASL013 12/11/08 16:24:58 D1 1=1 ACAD 16.1s (LMS Tech)

NOTES:

1. THIS DRAWING IS THE BASIS FOR THE CLOSED CYCLE COOLING WATER SYSTEM DESIGN AND IS SUBJECT TO CHANGE AS A RESULT OF DETAILED DESIGN.



NOT TO BE USED FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
A	12/DEC/08	ISSUED FOR EPC BIDS	SSG				

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DATE ______ REG NO. ______

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ENGINEER | DRAWN PRP | CHECKED | DATE

PACIFICORP
CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM
CLOSED CYCLE COOLING WATER

PROJECT DRAWING NUMBER 162628-2ECB-M2322 REV A

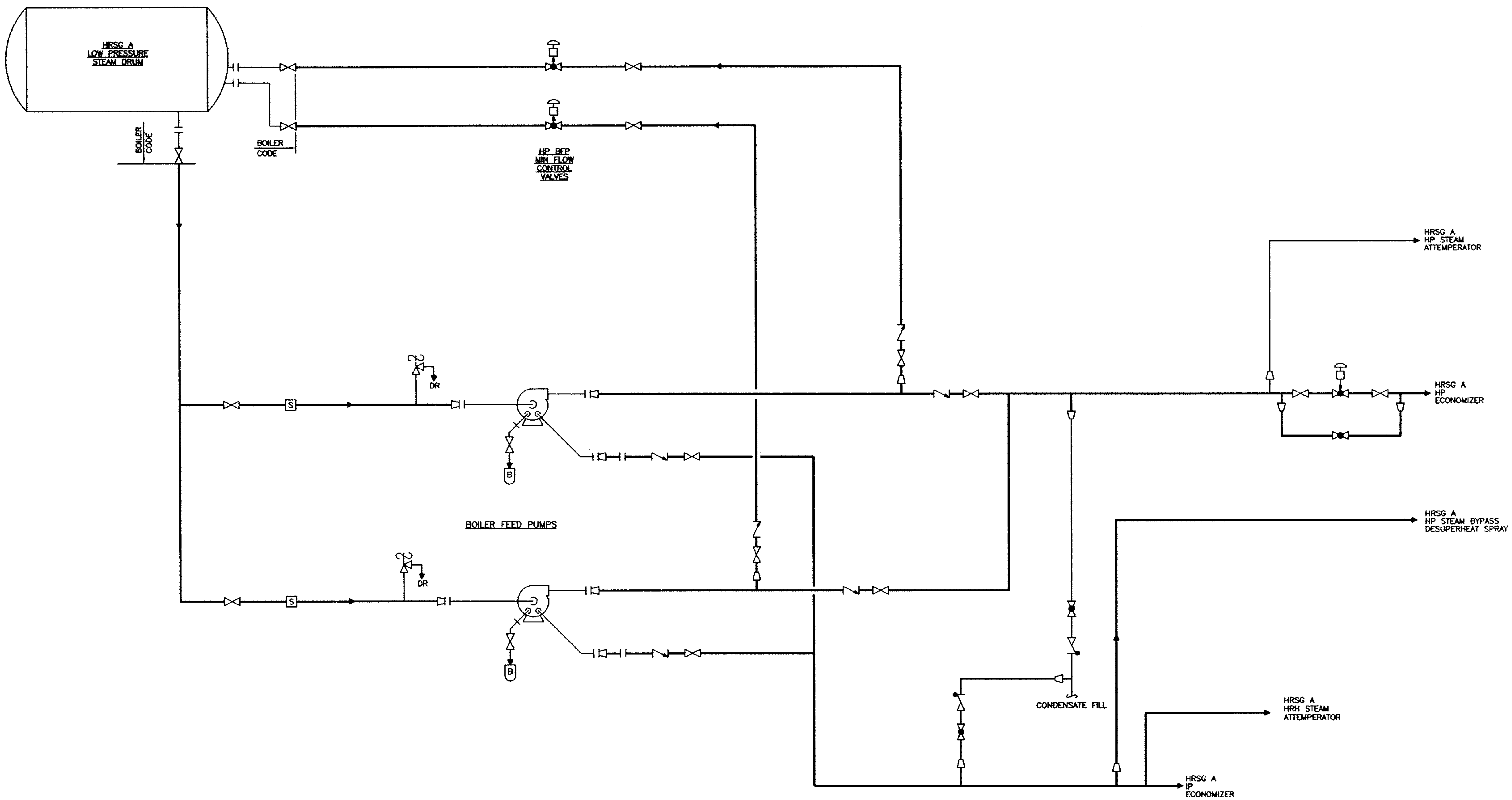
CODE

AREA

FAK33056 01 ACAD 16.1s (LMS Tech)
A1ASL015 1=1
06/27/08 09:23:21

NOTES:

1. THIS DRAWING IS THE BASIS FOR THE BOILER FEED SYSTEM DESIGN AND IS SUBJECT TO CHANGE AS A RESULT OF DETAILED DESIGN.
2. DESIGN IS TYPICAL FOR HRSG B.



NOT TO BE USED FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
A	12/DEC/08	ISSUED FOR EPC BIDS	PRP				

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ENGINEER | DRAWN PRP | CHECKED | DATE

PACIFICORP
CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM
BOILER FEED

PROJECT DRAWING NUMBER 162628-2FWA-M2341 REV A

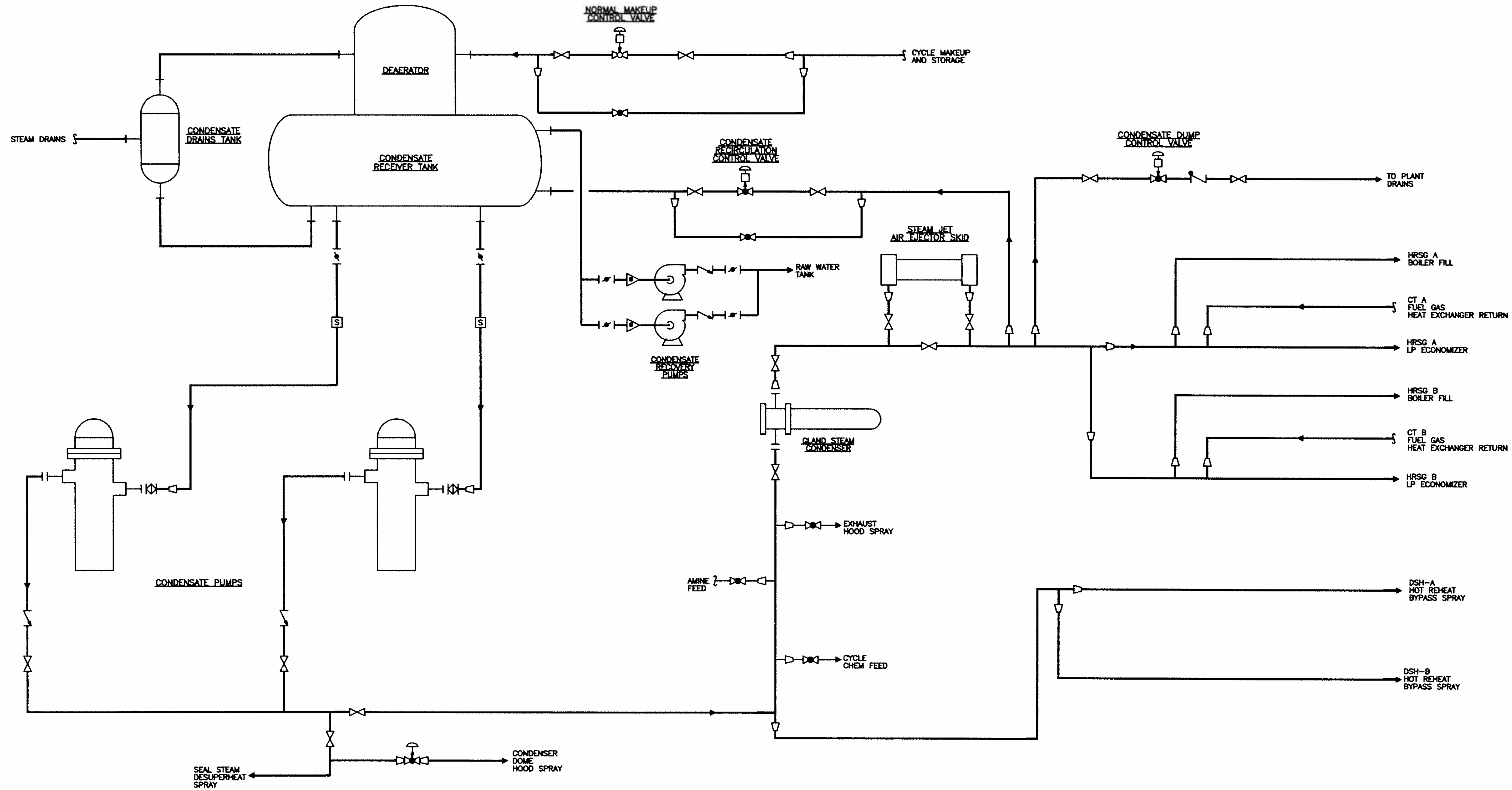
CODE

AREA

FAK33056 D1 ACAD 16.1s (LMS Tech)
ATKS0125 1=1
06/27/08 11:15:27

NOTES:

1. THIS DRAWING IS THE BASIS FOR THE CONDENSATE SYSTEM DESIGN AND IS SUBJECT TO CHANGE AS A RESULT OF DETAILED DESIGN.



NOT TO BE USED FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
A	12/DEC/08	ISSUED FOR EPC BIDS	PRP				

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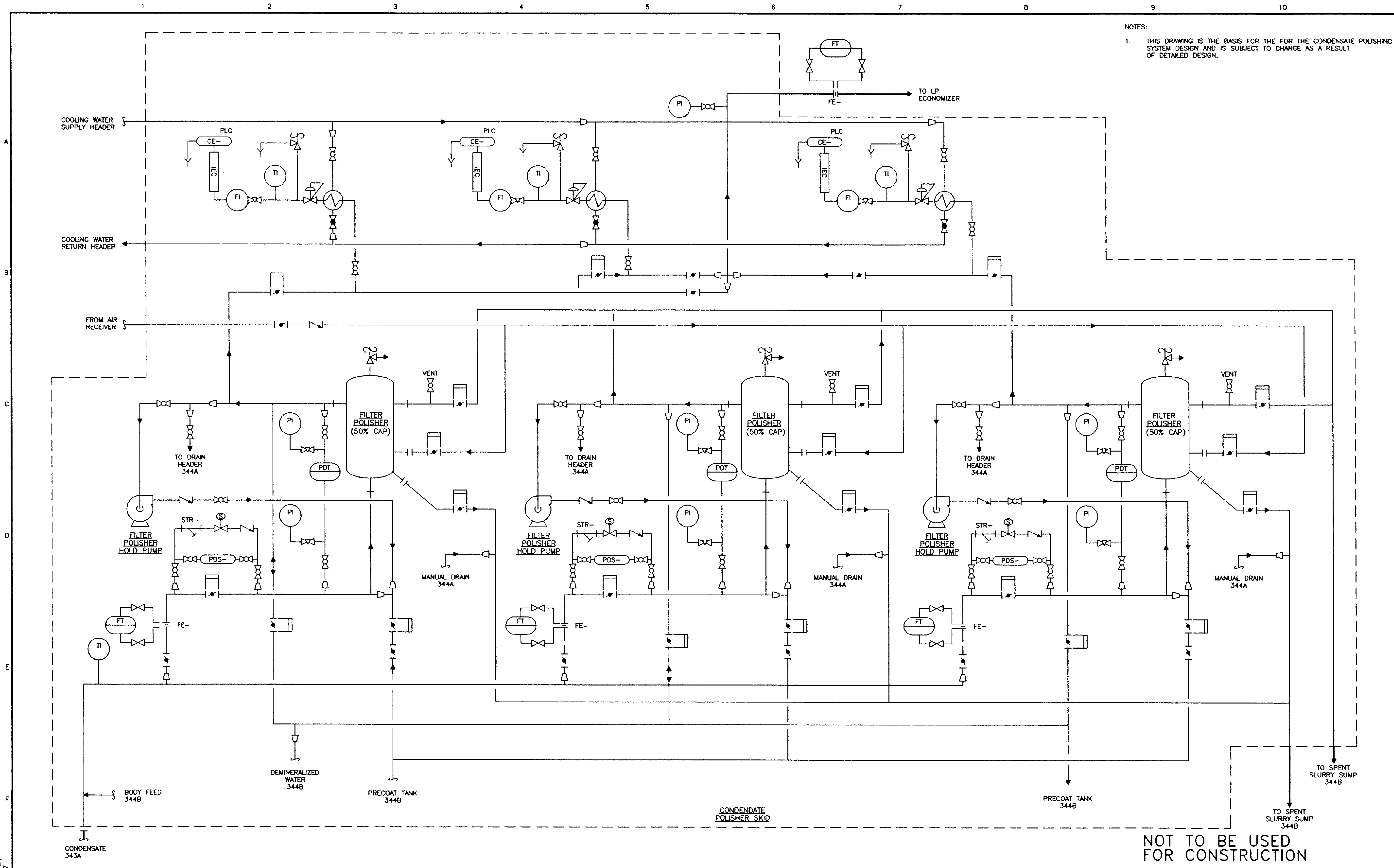
CHECKED ______ DATE ______

PACIFICORP
CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM
CONDENSATE

PROJECT / DRAWING NUMBER: 162628-2FWC-M2343
REV: A
CODE
AREA

PRK03292 A1ASLD15 12/11/08 D1 1=1 16:23:39 ACAD 16.1s (LMS Tech)



ACAD 16.1s (LMS Tech) D1 1=1 10:59:47
FAK33056 A1ASL015 06/27/08

NO	DATE	REVISIONS AND RECORD OF ISSUE	MFG ORN	DES	CHK	PDE	APP
A	12/DEC/08	ISSUED FOR EPC BIDS					

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ENGINEER | DRAWN PRP | CHECKED | DATE

PACIFICORP
CURRANT CREEK POWER PROJECT-BLOCK 2

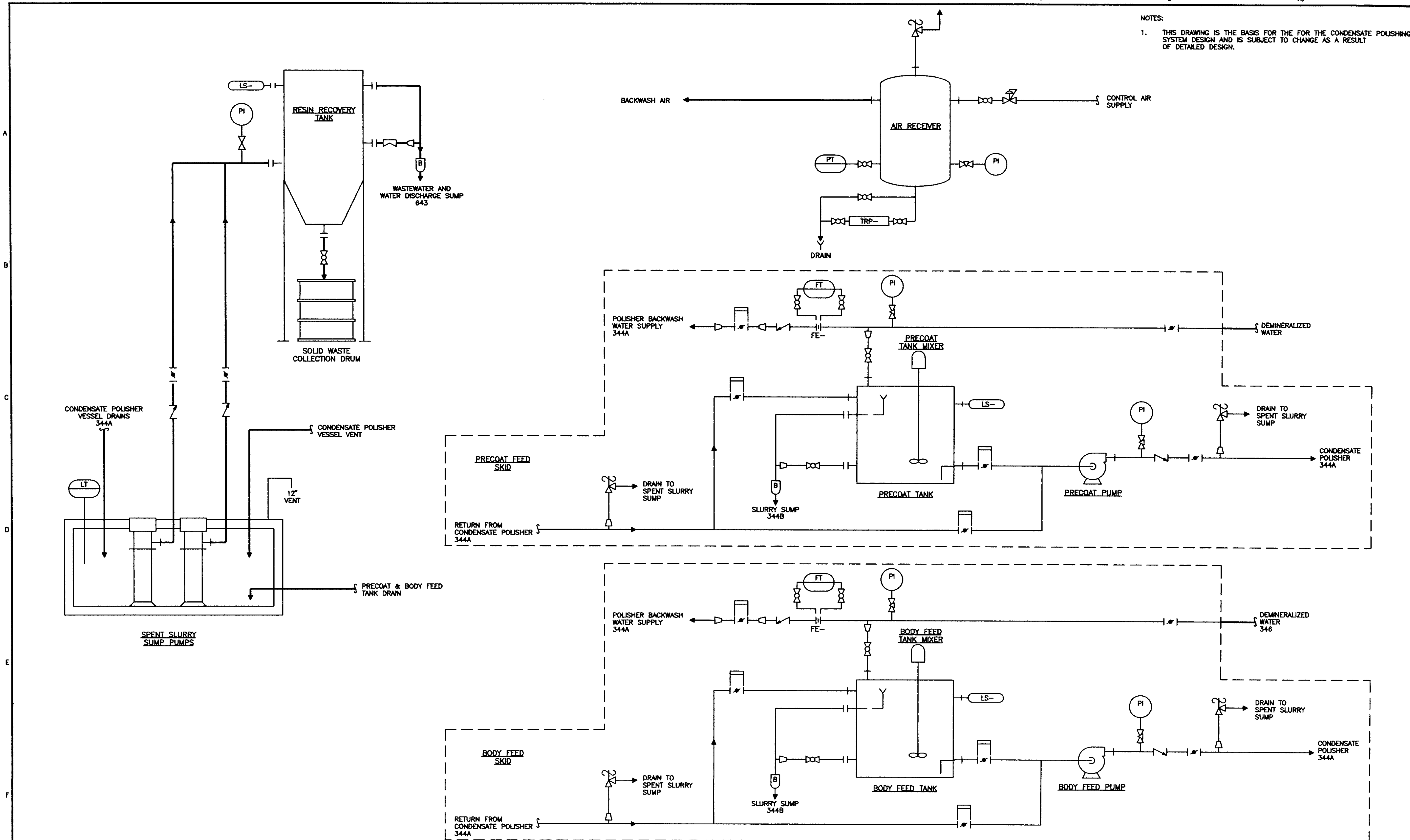
PIPING FLOW DIAGRAM
CONDENSATE POLISHING SYSTEM

PROJECT | DRAWING NUMBER | REV
162628-2FWD-M2344A | A

CODE
AREA

NOTES:

1. THIS DRAWING IS THE BASIS FOR THE FOR THE CONDENSATE POLISHING SYSTEM DESIGN AND IS SUBJECT TO CHANGE AS A RESULT OF DETAILED DESIGN.



NOT TO BE USED FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
A	12/DEC/08	ISSUED FOR EPC BIDS	MFG				

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ENGINEER | DRAWN PRP | CHECKED | DATE

PACIFICORP
CURRANT CREEK POWER PROJECT–BLOCK 2

PIPING FLOW DIAGRAM
CONDENSATE POLISHING SYSTEM

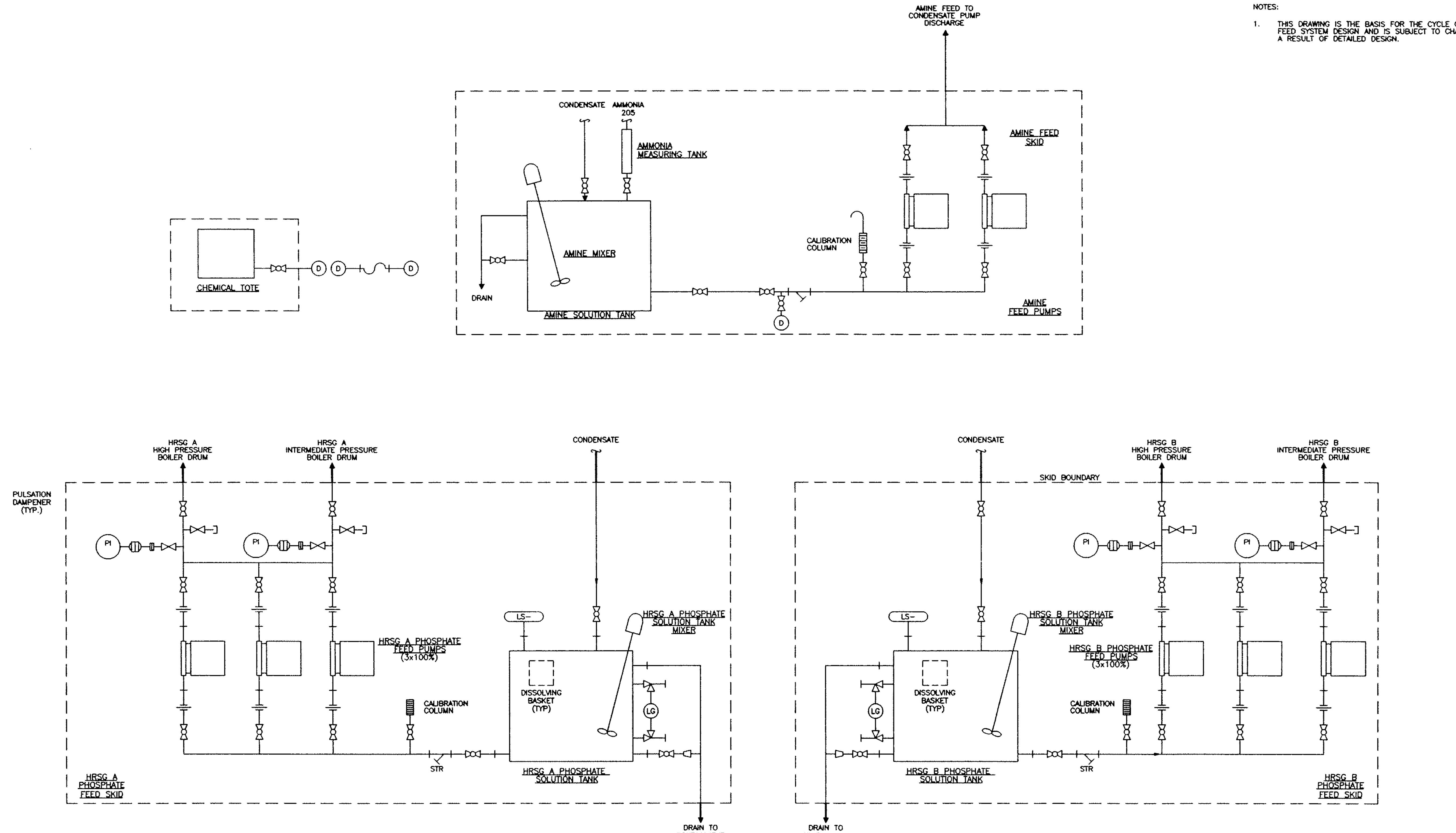
PROJECT | DRAWING NUMBER: 162628–2FWD–M2344B | REV: A

CODE | AREA

BAT52451 A1ASL015 01/23/09 14:11:01 D1 1=1 ACAD 16.1s (LMS Tech)

NOTES:

1. THIS DRAWING IS THE BASIS FOR THE CYCLE CHEMICAL FEED SYSTEM DESIGN AND IS SUBJECT TO CHANGE AS A RESULT OF DETAILED DESIGN.



NOT TO BE USED FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
A	12/DEC/08	ISSUED FOR EPC BIDS	PRP				

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PACIFICORP
CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM
CYCLE CHEMICAL FEED

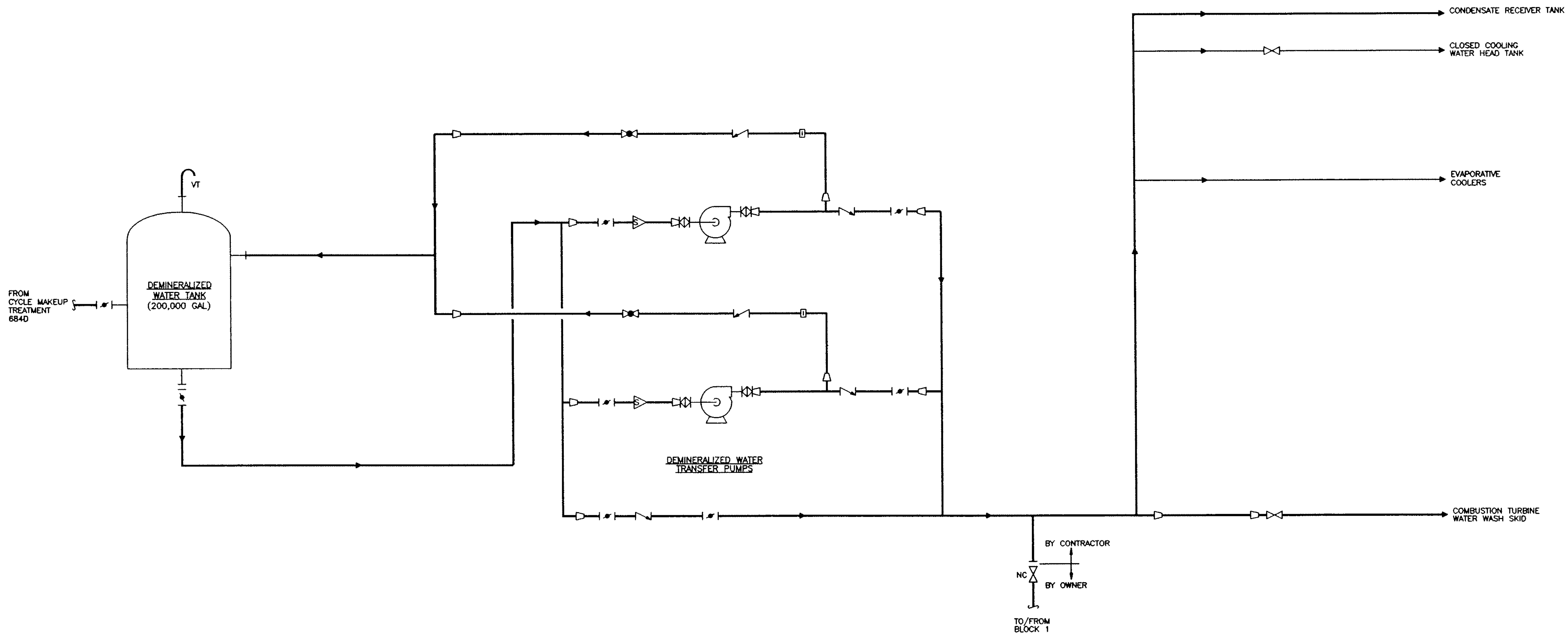
PROJECT / DRAWING NUMBER: 162628-2FWE-M2345 REV A

CODE
AREA

FAK33056 D1 ACAD 16.1s (LMS Tech)
A1ASLO15 1=1
06/27/08 09:26:13

NOTES:

1. THIS DRAWING IS THE BASIS FOR THE CYCLE MAKEUP AND STORAGE SYSTEM DESIGN AND IS SUBJECT TO CHANGE AS A RESULT OF DETAILED DESIGN.



NOT TO BE USED FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
A	12/DEC/08	ISSUED FOR EPC BIDS	SSG				

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ENGINEER DRAWN PRP

CHECKED DATE

PACIFICORP
CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM
CYCLE MAKEUP AND STORAGE

PROJECT DRAWING NUMBER REV
162628-2FWF-M2346 A

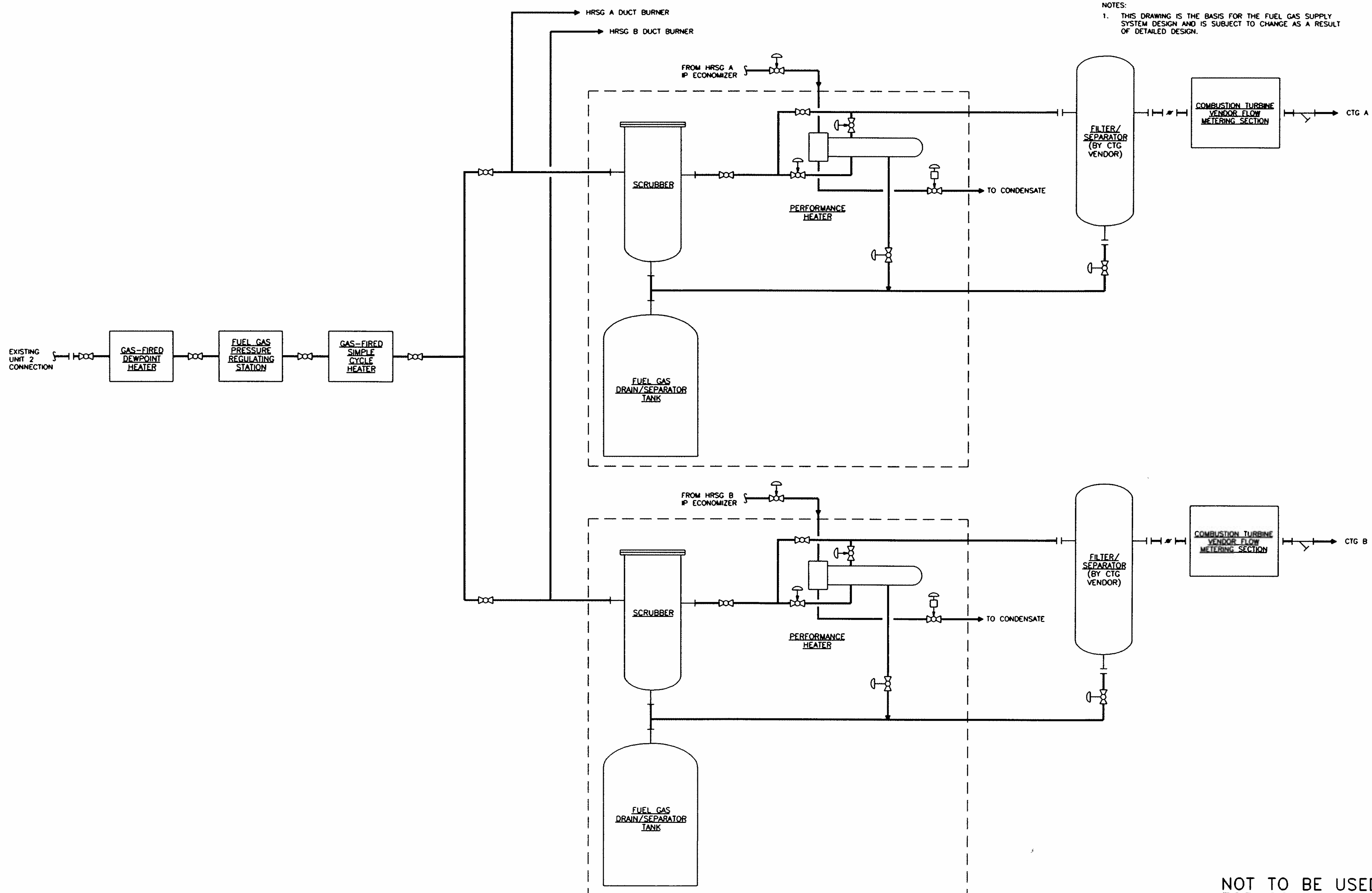
CODE

AREA

FAK33056 D1 ACAD 16.1s (LMS Tech)
A1ASL015 1=1
06/27/08 09:27:01

NOTES:

1. THIS DRAWING IS THE BASIS FOR THE FUEL GAS SUPPLY SYSTEM DESIGN AND IS SUBJECT TO CHANGE AS A RESULT OF DETAILED DESIGN.



NOT TO BE USED FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
A	12/DEC/08	ISSUED FOR EPC BIDS	PRP				

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CHECKED | DATE

PACIFICORP
CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM
FUEL GAS SUPPLY

PROJECT | DRAWING NUMBER: 162628-2FGA-M2381 | REV: A

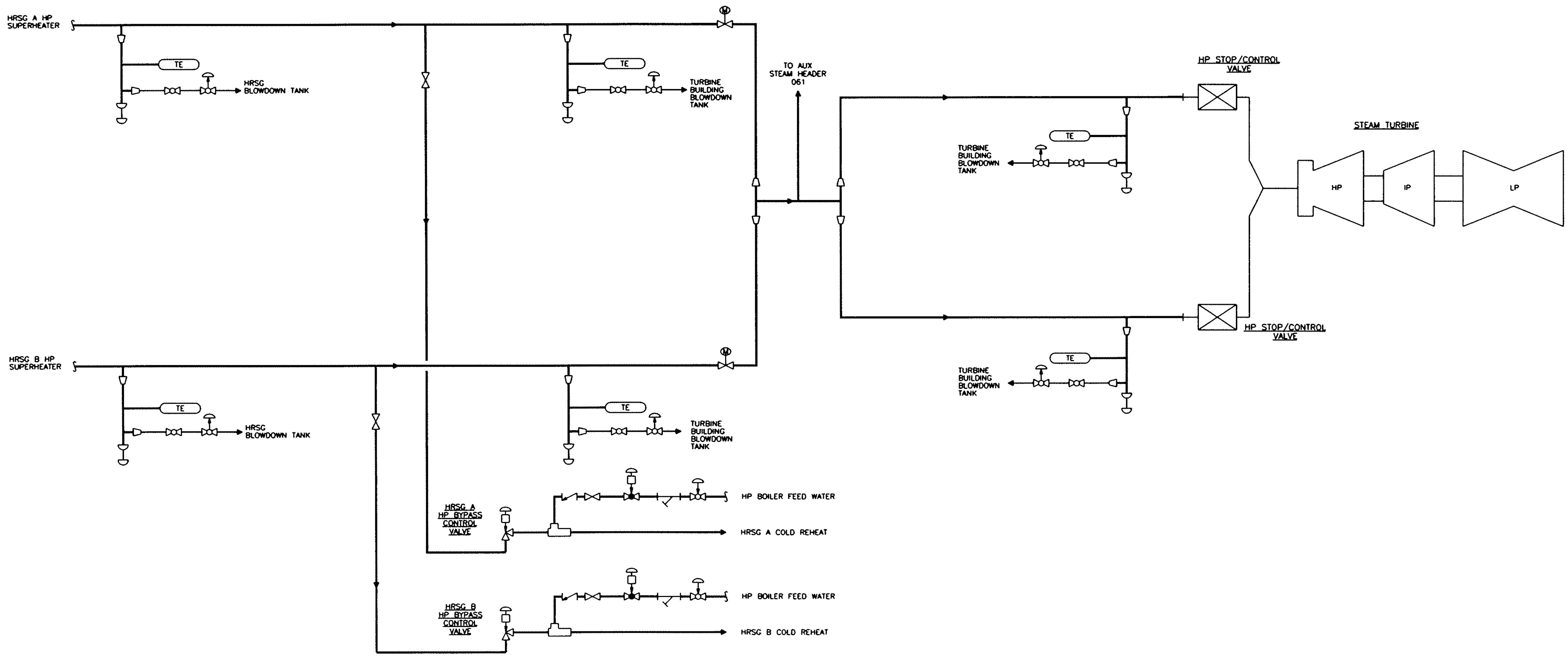
CODE

AREA

LOP07782 01 ACAD 16.1s (LMS Tech)
A1ASL015 1=1
07/03/08 09:50:00

NOTES:

1. THIS DRAWING IS THE BASIS FOR THE HIGH PRESSURE STEAM SYSTEM DESIGN AND IS SUBJECT TO CHANGE AS A RESULT OF DETAILED DESIGN.



NOT TO BE USED FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
A	12/DEC/08	ISSUED FOR EPC BIDS	PRP				

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PACIFICORP
CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM
HIGH PRESSURE STEAM

PROJECT DRAWING NUMBER 162628-2SGG-M2587 REV A

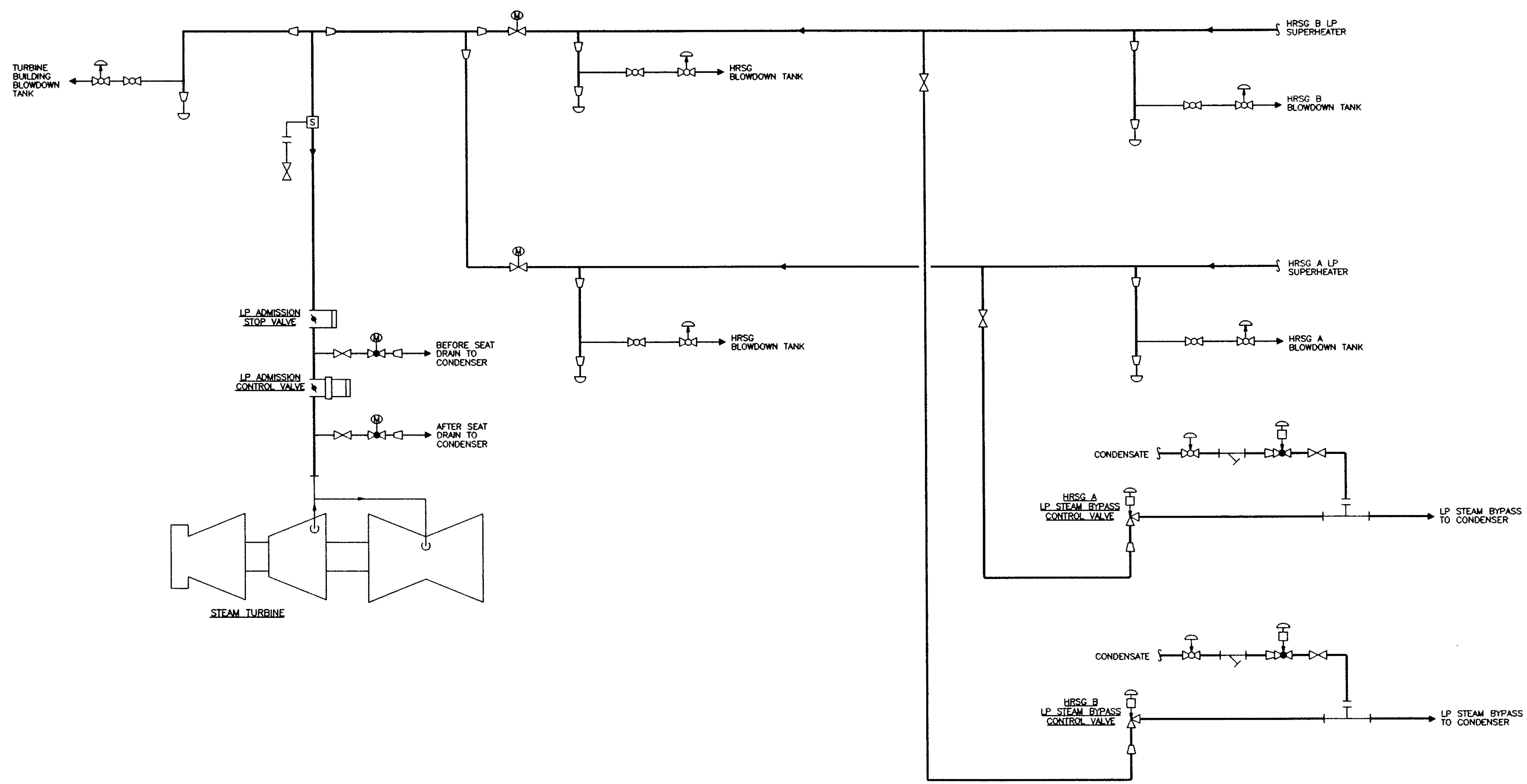
CODE

AREA

FAK33056 D1 ACAD 16.1s (LMS Tech)
A1ASL015 1=1
06/27/08 11:17:48

NOTES:

1. THIS DRAWING IS THE BASIS FOR THE LOW PRESSURE STEAM SYSTEM DESIGN AND IS SUBJECT TO CHANGE AS A RESULT OF DETAILED DESIGN.



NOT TO BE USED FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
A	12/DEC/08	ISSUED FOR EPC BIDS	PRP				

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DATE ______ REG NO. ______

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PACIFICORP
CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM
LOW PRESSURE STEAM

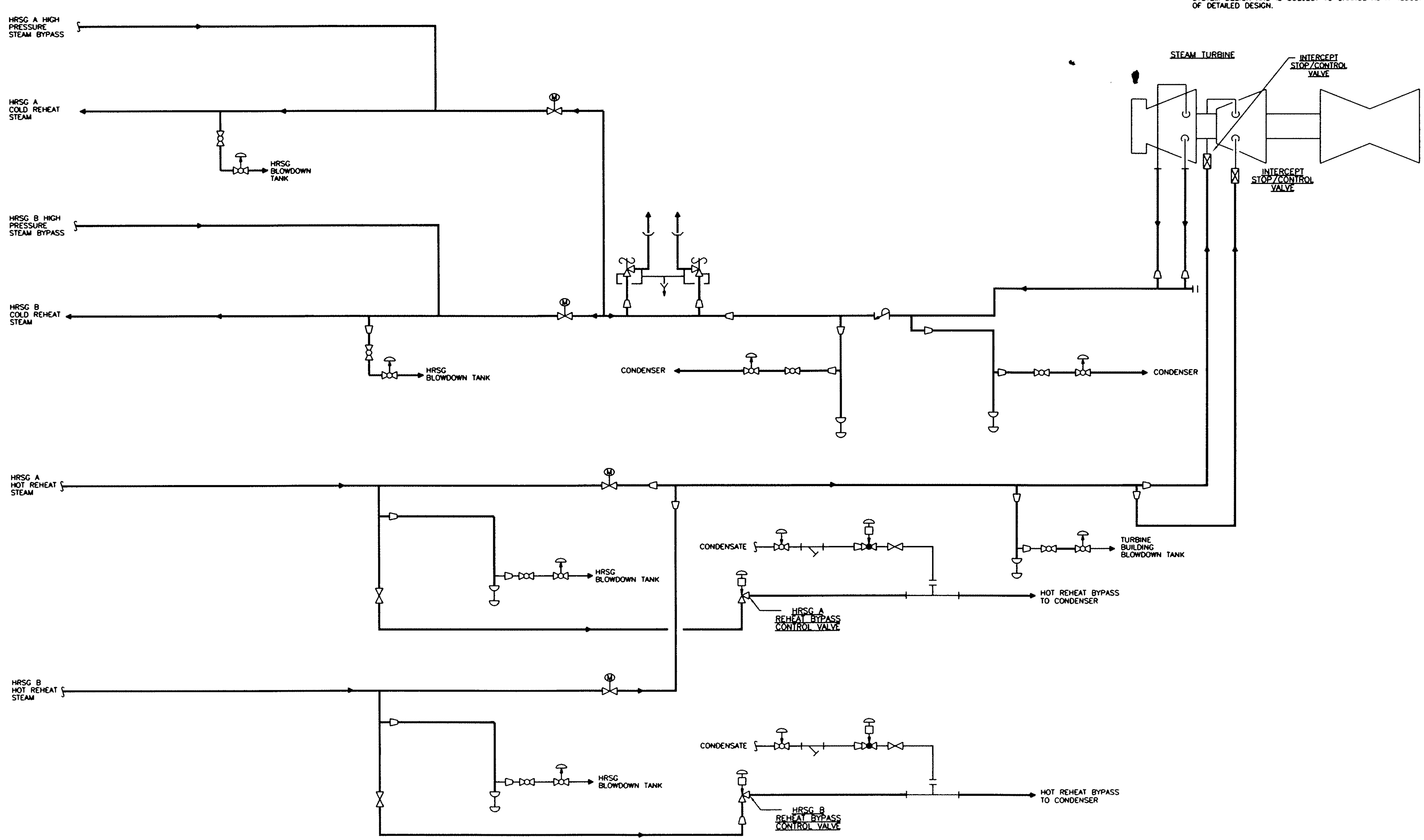
PROJECT DRAWING NUMBER: 162628-2SGL-M2588 | REV: A

CODE | AREA

PRI03292 A1ASL015 12/11/08 16:26:15 D1 1=1 ACAD 16.1s (LMS Tech)

NOTES:

1. THIS DRAWING IS THE BASIS FOR THE REHEAT STEAM SYSTEM DESIGN AND IS SUBJECT TO CHANGE AS A RESULT OF DETAILED DESIGN.



NOT TO BE USED FOR CONSTRUCTION

PRI03292 A1ASL015 12/08/08 D1 14:13:40 ACAD 1=1 16.1s (LMS Tech)

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
A	12/DEC/08	ISSUED FOR EPC BIDS	PRP				

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DATE ______ REG NO. ______

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ENGINEER | DRAWN PRP | CHECKED | DATE

PACIFICORP
CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM
REHEAT STEAM

PROJECT DRAWING NUMBER 162628-2SGJ-M2590

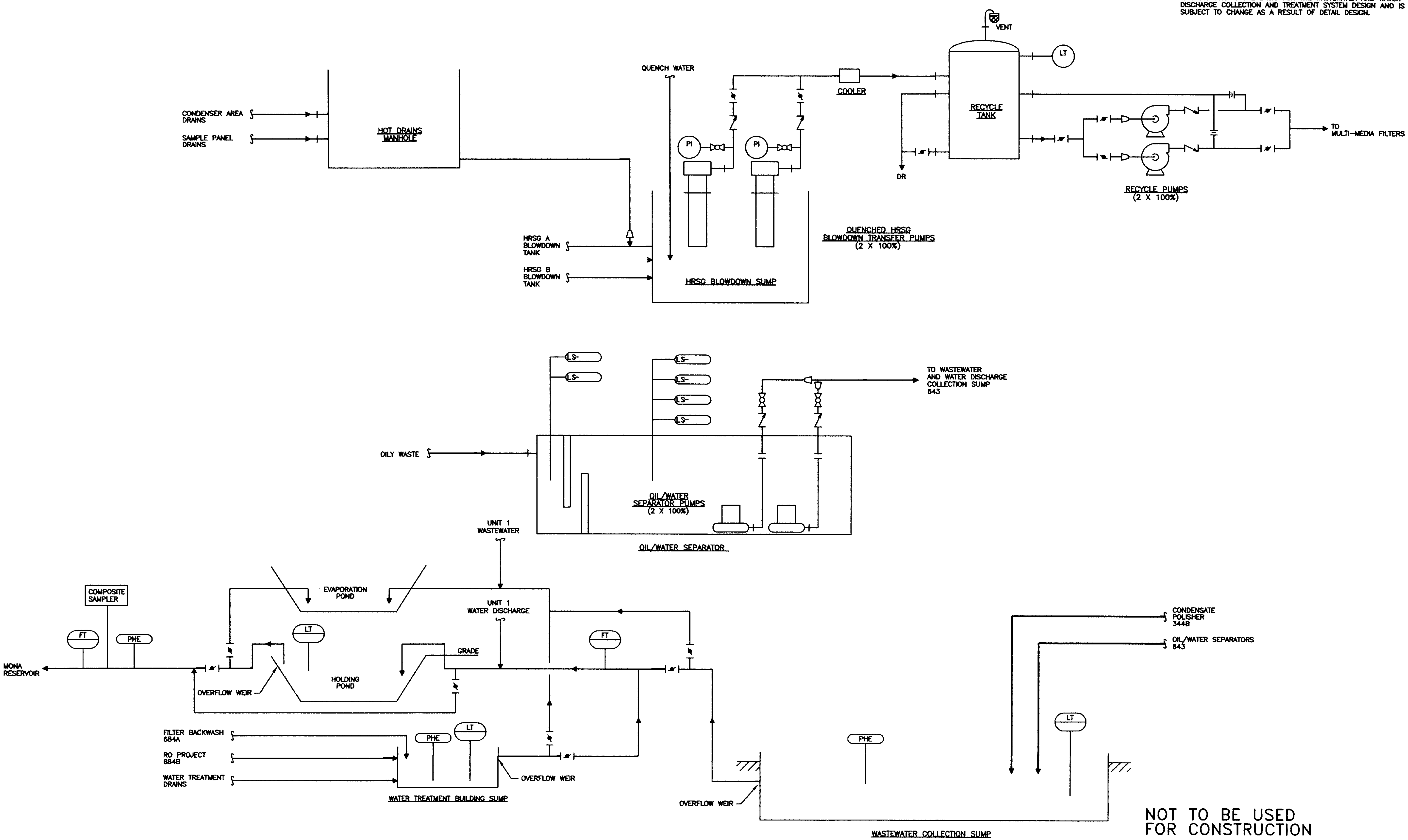
REV A

CODE

AREA

NOTE:

1. THIS DRAWING IS THE BASIS FOR THE WASTEWATER AND WATER DISCHARGE COLLECTION AND TREATMENT SYSTEM DESIGN AND IS SUBJECT TO CHANGE AS A RESULT OF DETAIL DESIGN.



NOT TO BE USED FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
A	12/DEC/08	ISSUED FOE EPC BIDS	PRP				

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DATE REG NO.

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ENGINEER | DRAWN PRP | CHECKED | DATE

PACIFICORP
CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM
WASTEWATER AND WATER DISCHARGE COLLECTION AND DRAINAGE

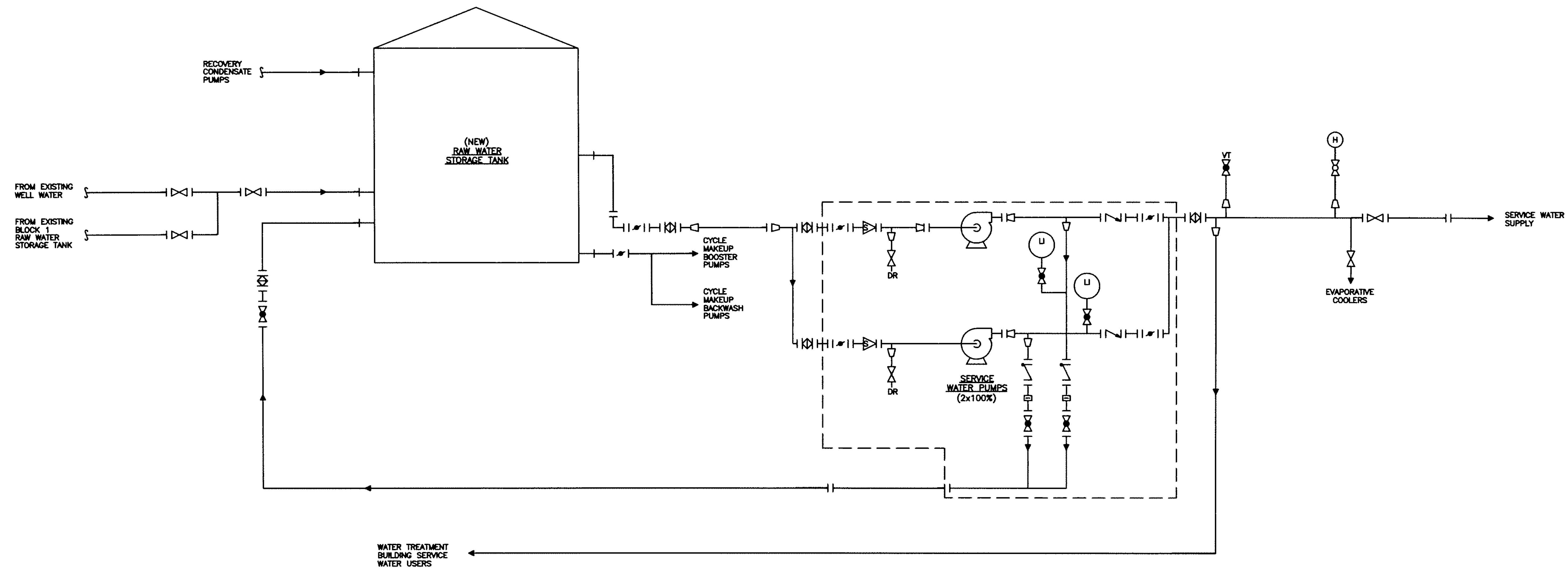
PROJECT | DRAWING NUMBER: 162628-2WWC-M2643 | REV A

CODE | AREA

BAT52451 A1ASL015 01/26/09 D1 13:22:22 1=1 ACAD 16.1s (LMS Tech)

NOTES:

1. THIS DRAWING IS THE BASIS FOR THE SERVICE WATER SYSTEM DESIGN AND IS SUBJECT TO CHANGE AS A RESULT OF DETAILED DESIGN.



NOT TO BE USED
FOR CONSTRUCTION

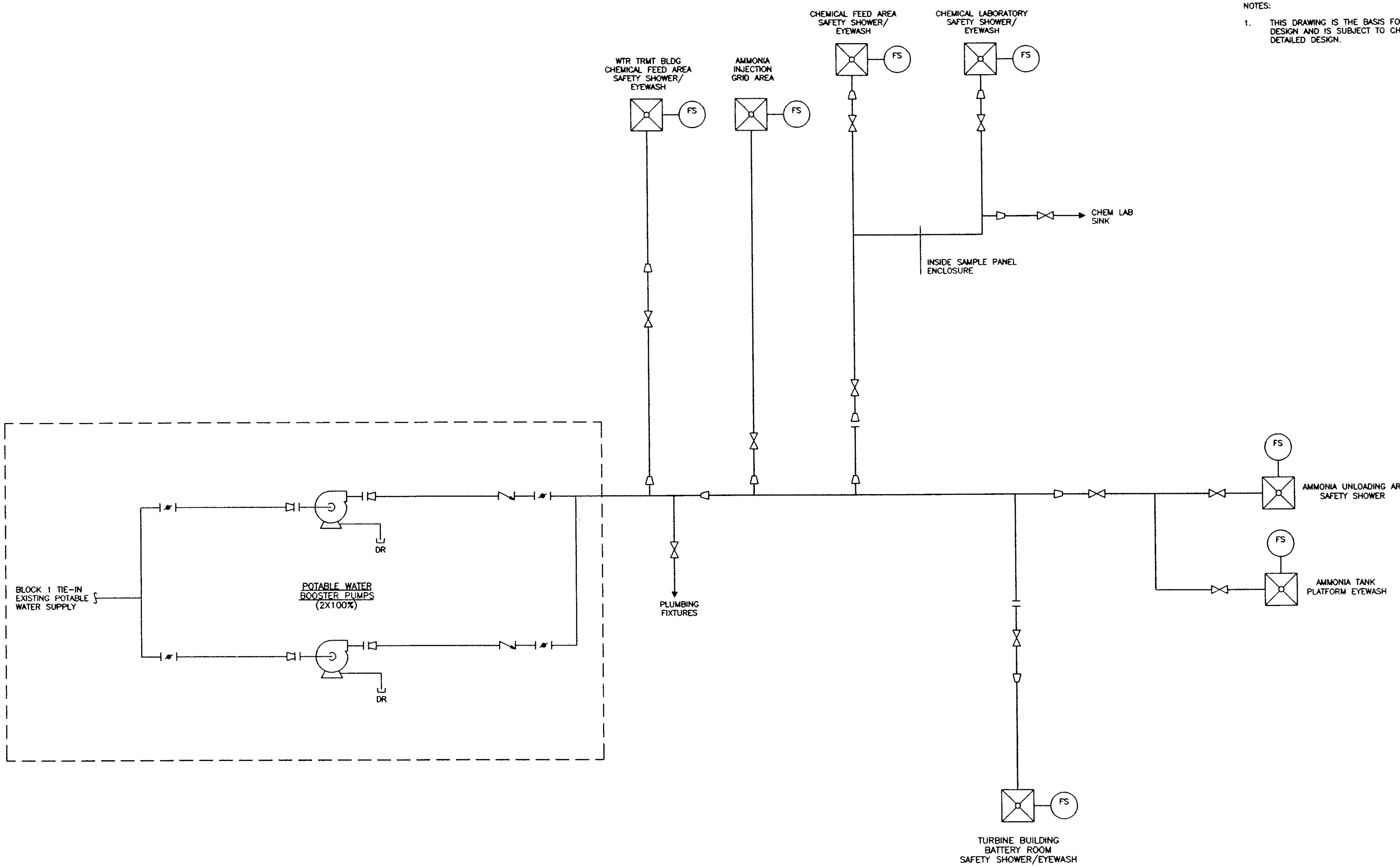
NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
A	12/DEC/08	ISSUED FOR EPC BIDS	PRP				

BLACK & VEATCH CORPORATION	PACIFICORP CURRANT CREEK POWER PROJECT-BLOCK 2	PROJECT / DRAWING NUMBER 162628-2WSC-M2663	REV A
ENGINEER / DRAWN PRP / CHECKED / DATE	PIPING FLOW DIAGRAM SERVICE WATER	CODE / AREA	

PRO3292 D1 ACAD 16.1s (LMS Tech)
A1ASLD15 1=1
12/11/08 16:27:03

NOTES:

1. THIS DRAWING IS THE BASIS FOR THE POTABLE WATER SYSTEM DESIGN AND IS SUBJECT TO CHANGE AS A RESULT OF DETAILED DESIGN.



NOT TO BE USED FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
A	12/DEC/08	ISSUED FOR EPC BIDS	PRP				

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DATE ____ REG NO. ____

BLACK & VEATCH CORPORATION

ENGINEER | DRAWN PRP | CHECKED | DATE

PACIFICORP

CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM POTABLE WATER SYSTEM

PROJECT DRAWING NUMBER: 162628-2WSD-M2664 | REV: A

CODE

AREA

PRI03292 D1 ACAD 16.1s (LMS Tech)
A1ASL015 1=1
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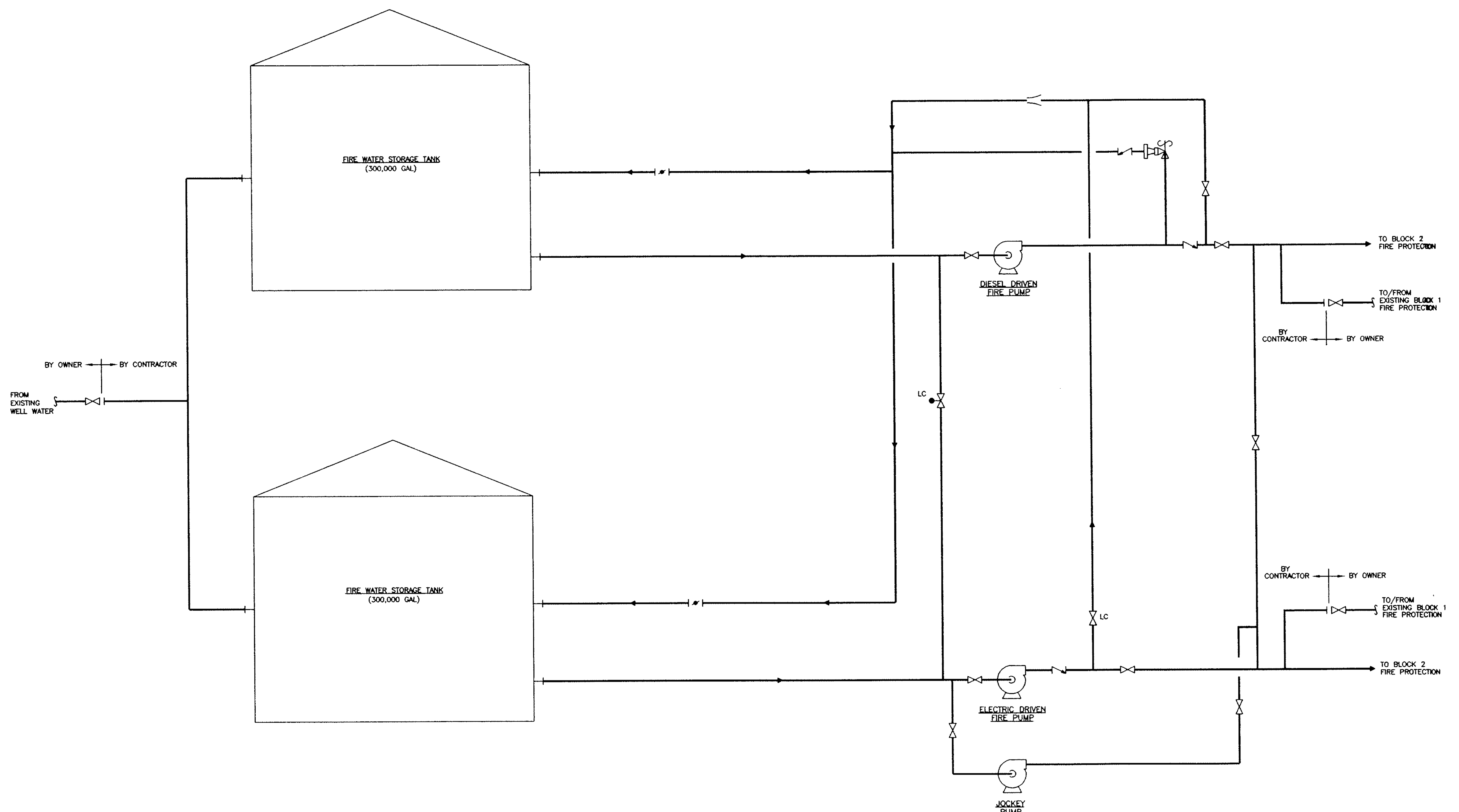
NOTES:

1. THIS DRAWING IS THE BASIS FOR THE FIRE PROTECTION WATER SUPPLY & STORAGE SYSTEM DESIGN AND IS SUBJECT TO CHANGE AS A RESULT OF DETAILED DESIGN.



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A	12/DEC/08	ISSUED FOR EPC BIDS	PRP				

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ENGINEER | DRAWN PRP | CHECKED | DATE

PACIFICORP
CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM
FIRE PROTECTION WATER SUPPLY AND STORAGE

PROJECT DRAWING NUMBER: 162628-2WSE-M2665

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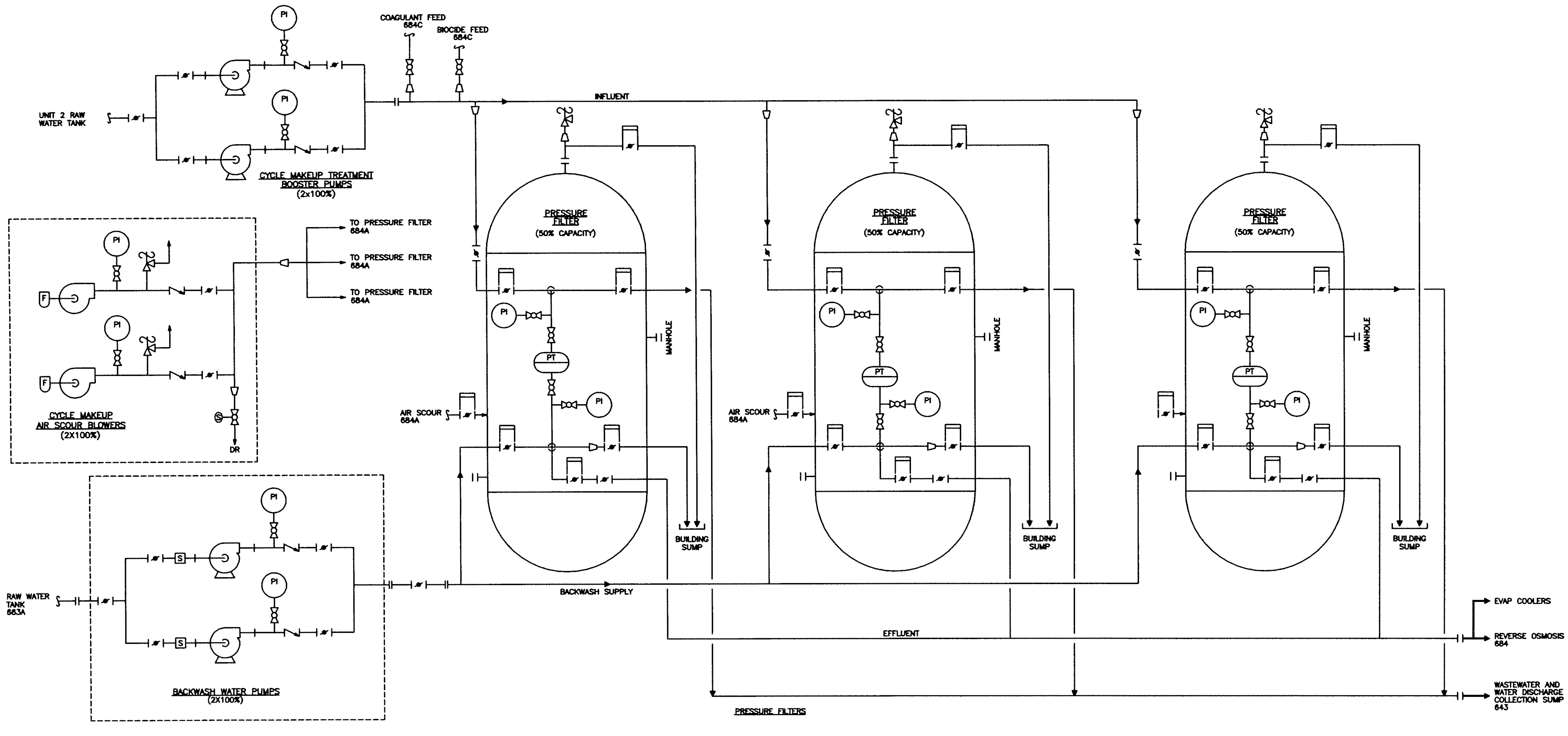

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CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM
CYCLE MAKEUP TREATMENT

PROJECT / DRAWING NUMBER: 162628-2WTD-M2684A REV A

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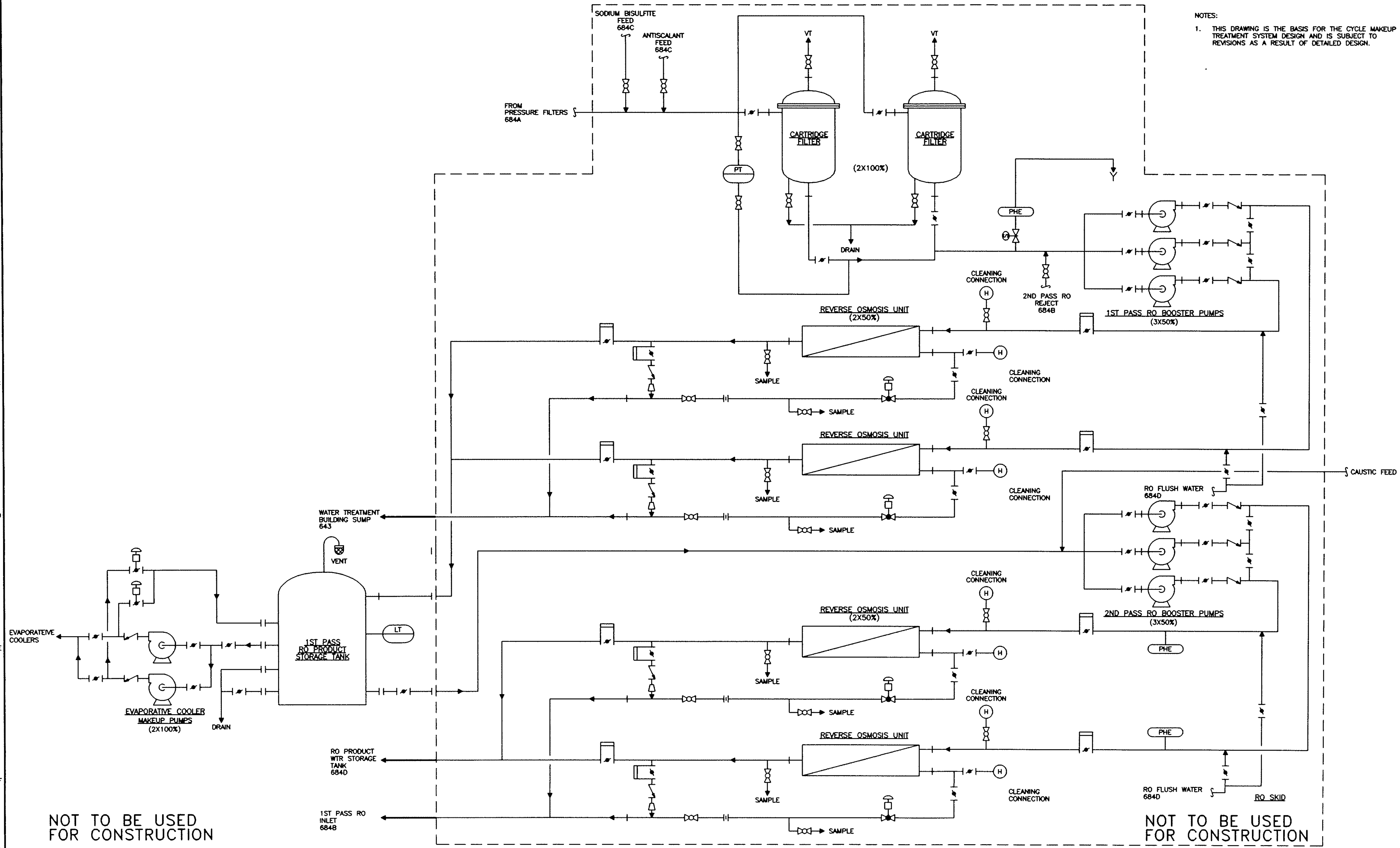

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PACIFICORP
CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM
CYCLE MAKEUP TREATMENT

PROJECT | DRAWING NUMBER: 162628-2WTD-M2684B | REV: A

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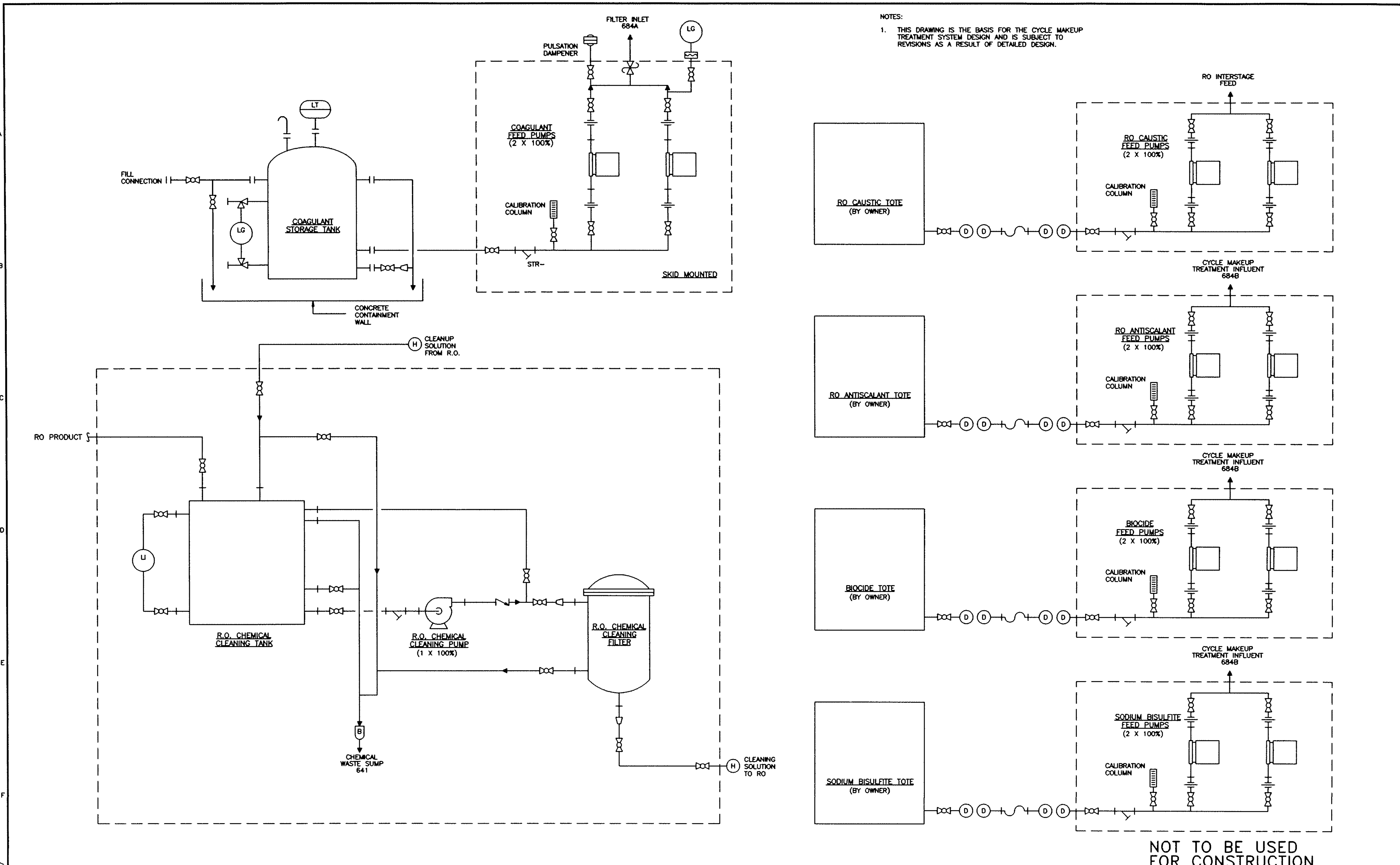

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CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM
CYCLE MAKEUP TREATMENT

PROJECT / DRAWING NUMBER: 162628-2WTD-M2684C | REV: A

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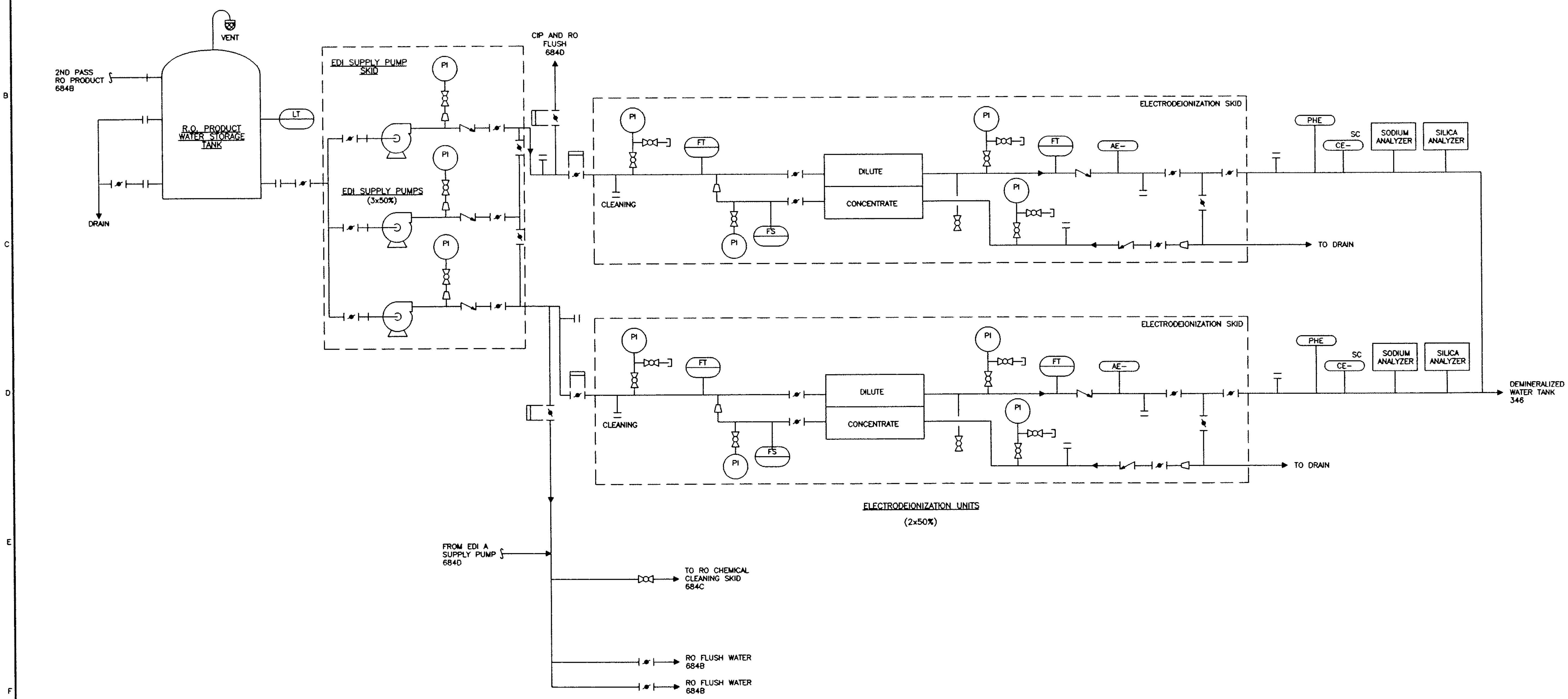

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PACIFICORP
CURRANT CREEK POWER PROJECT-BLOCK 2

PIPING FLOW DIAGRAM
CYCLE MAKEUP TREATMENT

PROJECT | DRAWING NUMBER: 162628-2WTD-M2684D | REV: A

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APPENDIX E

CONCEPTUAL ONE-LINE DIAGRAMS

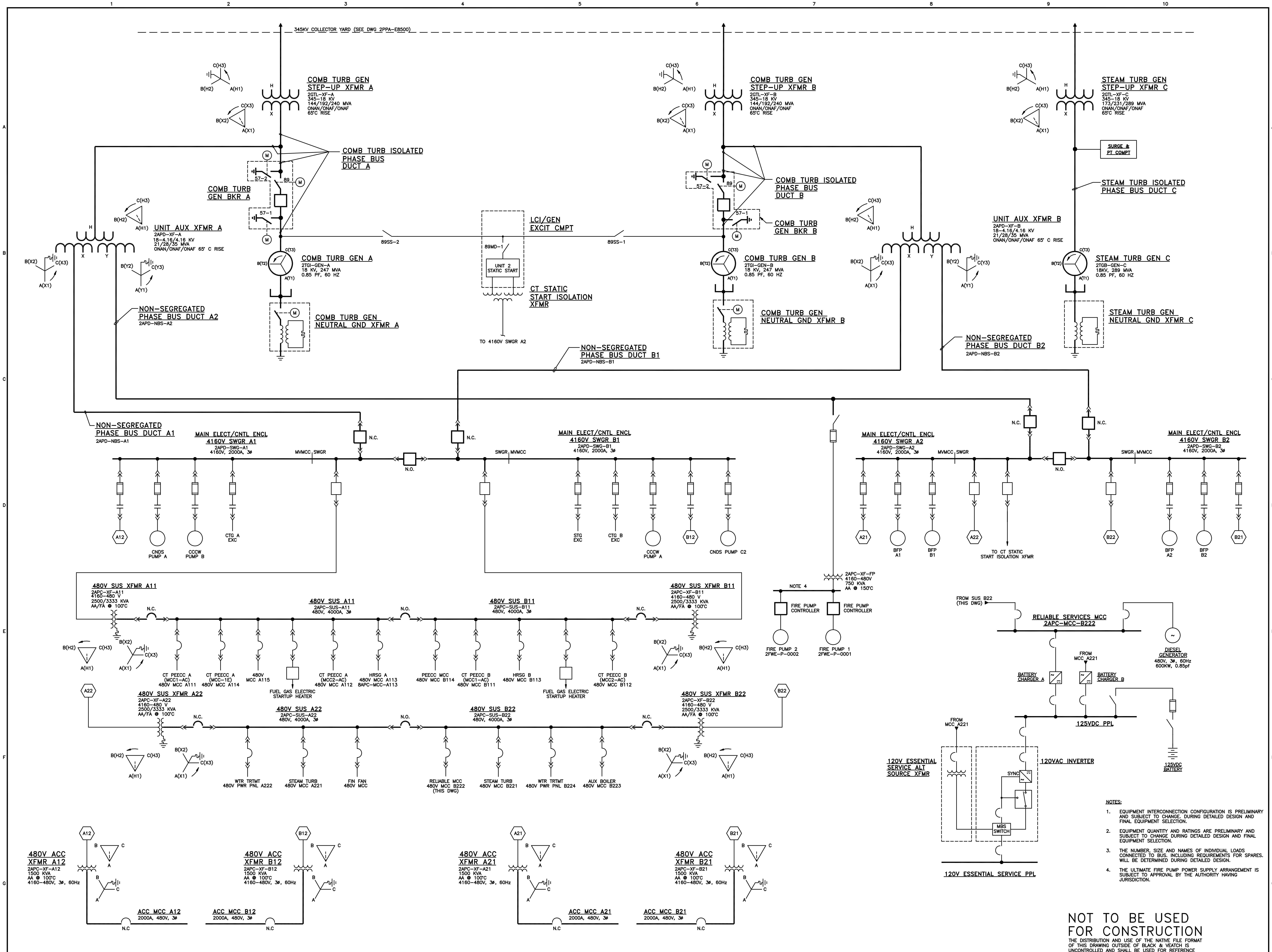
APPENDIX E

Conceptual One-Line Diagrams

Conceptual Drawings

The following drawings are included to assist the Contractor in development of the Scope of Work. The Contractor shall be responsible for providing construction drawings for the Currant Creek 2 Facility in accordance with Exhibit A of these documents.

Drawing	Drawing Title
B&V 162628-2APD-E1001, Rev. A	Overall One-Line Diagram
B&V 162628-2PPA-E8500, Rev. A	345kV Currant Creek Switchyard, Mona Utah One-Line Diagram



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B	30/OCT/09	REMOVED CROSS-TIE PROVISIONS					
A	12/DEC/08	ISSUED FOR EPC BIDS					

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ENGINEER | DRAWN
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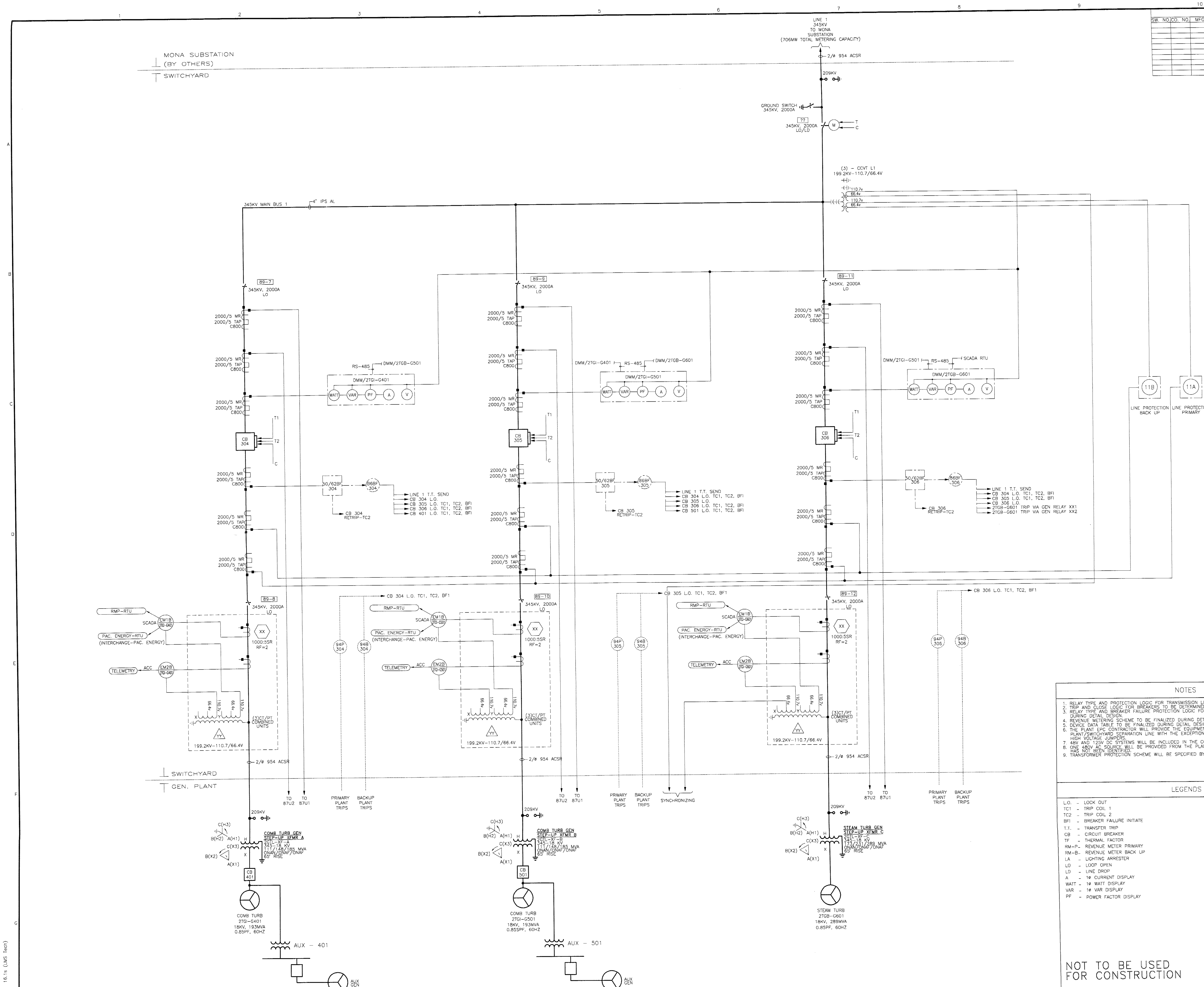
PACIFICORP
CURRANT CREEK POWER PROJECT - BLOCK 2
OVERALL ONE-LINE DIAGRAM

PROJECT 162628 | DRAWING NUMBER 2APD-E1001 | REV B
CODE
AREA

SW. NO.	CO. NO.	MFG	TYPE	KV	AMP	INIT. CAP.

DEVISE DATA

SEE NOTE 5



NOTES

1. RELAY TYPE AND PROTECTION LOGIC FOR TRANSMISSION LINE TO BE FINALIZED DURING DETAIL DESIGN.
2. TRIP AND CLOSE LOGIC FOR BREAKERS TO BE DETERMINED DURING DETAIL DESIGN.
3. RELAY TYPE AND BREAKER FAILURE PROTECTION LOGIC FOR BREAKERS TO BE FINALIZED DURING DETAIL DESIGN.
4. REVENUE METERING SCHEME TO BE FINALIZED DURING DETAIL DESIGN.
5. DEVICE DATA TABLE TO BE FINALIZED DURING DETAIL DESIGN.
6. THE PLANT EPC CONTRACTOR WILL PROVIDE THE EQUIPMENT AND DEVICES SHOWN BELOW THE PLANT/SWITCHYARD SEPARATION LINE WITH THE EXCEPTION OF THE TRANSFORMER HIGH VOLTAGE JUMPERS.
7. 48V AND 125V DC SYSTEMS WILL BE INCLUDED IN THE CONTROL BUILDING.
8. ONE 480V AC SOURCE WILL BE PROVIDED FROM THE PLANT. THE SECOND SOURCE HAS NOT BEEN IDENTIFIED.
9. TRANSFORMER PROTECTION SCHEME WILL BE SPECIFIED BY THE PLANT EPC CONTRACTOR.

LEGENDS

L.O. - LOCK OUT
TC1 - TRIP COIL 1
TC2 - TRIP COIL 2
BFI - BREAKER FAILURE INITIATE
T.T. - TRANSFER TRIP
CB - CIRCUIT BREAKER
TF - THERMAL FACTOR
RM-P- REVENUE METER PRIMARY
RM-B- REVENUE METER BACK UP
LA - LIGHTING ARRESTER
LO - LOOP OPEN
LD - LINE DROP
A - 1Ø CURRENT DISPLAY
WATT - 1Ø WATT DISPLAY
VAR - 1Ø VAR DISPLAY
PF - POWER FACTOR DISPLAY

NOT TO BE USED FOR CONSTRUCTION

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
C	11/14/08	ISSUED FOR CLIENT REVIEW	RAS	RPK			LAL
B	07/02/08	ISSUED FOR PROPOSAL SUBMITTAL	RAS	RPK			LAL
A	06/20/08	ISSUED FOR PROPOSAL PREPARATION	RAS	RPK			LAL

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SIGNED
DATE REG NO.

BLACK & VEATCH CORPORATION
ENGINEER RPK DRAWN RAS
CHECKED LAL DATE

PACIFICORP
A MIDAMERICAN ENERGY HOLDING COMPANY

345KV CURRANT CREEK SWITCHYARD, MONA, UTAH
ONE LINE DIAGRAM

PROJECT / DRAWING NUMBER: 162628-2PPA-E8500
REV: C
CODE
AREA

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APPENDIX F

PACIFICORP MATERIAL SPECIFICATIONS/STANDARDS

SUBSTATION DESIGN

APPENDIX F

PacifiCorp Material Specifications/Standards

Substation Design

Specifications/Standards

The following PacifiCorp specifications/standards are included to assist the Contractor in development of the Scope of Work for the Switchyard and Transmission Line. The Contractor shall be responsible for providing design, procurement and installation of the facilities for the Currant Creek 2 Facility in accordance with these specifications/standards and Exhibit A of these documents.

ZS 101 – Power Plant Equipment – Generator Step-Up Transformer, All ratings

SP-TRF-INST - Transformer Receiving, Installation and Testing Procedure

ZS 002 – Substation Equipment – Voltage Regulator, Three-Phase, All Ratings

ZS 013 – Substation Equipment – Power Circuit Breaker – Nominal 345kV and Above

ZS 018 – Substation Equipment – Flooded lead-Acid Stationary Batteries

ZS 019 – Substation Equipment – Battery Charger

ZS 026 Substation Equipment – Coupling Capacitor Voltage Transformer – Nominal 46kV and Above

ZS 050 – Substation Equipment – Group-Operated Air Switch

ZS 061 – Electrical Equipment – Insulating Oil

ZS 065 – Wind, Ice and Seismic Withstand

ZS 066 Contaminated-Environment protection

6B.5 Fence Application and Construction (17 Apr 09)

Standards Engineering

Power Plant Equipment—Generator Step-Up Transformer, All Ratings

Project Issue Date: ___________

Specification Approval Date: 27 May 11

PacifiCorp Project Info

Attachment to Exhibit _____, Section _____, Attachment No. _____

Project Name: ____

Edited By: ____

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Contents

SECTION	PAGE

Power Plant Equipment—Generator Step-Up Transformer, All Ratings

1 Scope

This material specification states the requirements for power plant generator step-up transformers of all ratings purchased by PacifiCorp. (This specification does not apply to auxiliary or startup transformers.)

2 References

The following publications shall be used in conjunction with this material specification, and form a part of this material specification to the extent specified herein. When a referenced publication is superseded by an approved revision, the revision shall apply.

2.1 Industry Publications

Referenced industry publications are:

ANSI C57.12.10, *Standard for Transformers 230 kV and Below...through 60000 / 80000 / 100000 kVA*

IEEE C2, *National Electrical Safety Code*

IEEE C57.12.00, *Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers*

IEEE C57.12.70, *Standard Terminal Markings and Connections for Distribution and Power Transformers*

IEEE C57.12.90, *Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and Guide for Short-Circuit Testing of Distribution and Power Transformers)*

IEEE C57.13, *Standard Requirements for Instrument Transformers*

IEEE C57.19.01, *Standard Performance Characteristics and Dimensions for Outdoor Apparatus Bushings*

IEEE C57.91, *Guide for Loading Mineral-Oil-Immersed Transformers*

IEEE C57.116, *Guide for Transformers Directly Connected to Generators*

NEMA TR1, *Transformers, Regulators, and Reactors*

NFPA 70, *National Electrical Code*

2.2 PacifiCorp Publications

Referenced PacifiCorp publications are:

Material Specification ZS 061, *Electrical Equipment—Insulating Oil*

Material Specification ZS 065, *Wind, Ice, and Seismic Withstand*

Material Specification ZS 066, *Contaminated-Environment Protection*

Procedure SP–TRF–INST, *Transformer Receiving, Installation and Energizing*

Design Review Data Sheets (revision 4, dated December 23, 2009)

3 General

3.1 Application Information

This material specification states both the general requirements for transformers and the transformer-specific requirements that vary depending on the installation and intended use (see Section 16 of this document, *Additional Transformer-Specific Requirements*).

This specification includes approximate metric conversions of American units and gauges which are for guidance only; the American standard shall take precedence.

3.2 Authorized Material Specification

This material specification is not considered valid until each page contains the approval signatures (or initials) of the persons named in the title blocks, and Section 16 of this document has been completed.

3.3 Approved Accessory Suppliers

PacifiCorp's list of approved accessory suppliers is included in Appendix A of this document. To submit alternate equipment for approval, the supplier shall provide PacifiCorp with the following information: manufacturer, part number, data sheets, spare part requirements, and experience with equipment. The supplier shall also provide the cost to PacifiCorp for training PacifiCorp field personnel on the use of the proposed alternative equipment. Costs shall include the estimated duration of the training and the rate the trainer will cost per day. The additional costs associated with PacifiCorp employees receiving the training will be evaluated by PacifiCorp and will be included in the equivalent total owning cost.

4 Basic Design Requirements

4.1 Codes, Standards and Terminology

Except as required otherwise by this material specification, the transformer specified herein shall be furnished in complete accordance with the latest applicable industry codes; ANSI, IEEE, and NEMA standards; and PacifiCorp standards and material specifications in effect on the date of invitation to bid. All hardware, including bolts, flanges, valves, and potential interface points, shall be ANSI standard sizes; IEC or metric-sized hardware is not acceptable.

In addition, the requirements of ANSI C57.12.10, which specifically apply only to a certain range of transformer ratings, shall nevertheless be considered applicable to all transformer ratings wherever reasonable and practical. The supplier shall advise PacifiCorp of any exceptions where such requirements will not apply to the subject transformer.

All values of voltage and current in this material specification are AC RMS unless otherwise specified.

In accordance with IEEE C57.12.70, this document uses H to designate the high−voltage winding, and X to designate the low−voltage winding, as applicable.

In accordance with IEEE C57.12.00, this document uses the term Class I to designate a transformer with the H−terminals rated for a nominal system voltage of 69 kV or below, and Class II to designate a transformer with the H−terminals rated for a nominal system voltage of 115 kV or above.

4.2 Type

The transformer shall be outdoor, 60-hertz, oil-immersed, 65 °C average winding temperature rise, 80 °C hot-spot winding temperature rise, 65°C top-oil temperature rise, suitable for generator step-up class of service, and core-form or shell-form as specified in Section 16.4 of this document.

Circuit breakers, contactors, auxiliary relays, switches and devices shall be NEMA-rated. IEC-rated devices are not acceptable.

4.3 Cooling Class and Rated Capacity

The cooling class shall be as specified in Section 16.9 of this document. The rated capacity shall be as specified in Section 16.10 of this document.

4.4 Elevation

Unless otherwise specified in Section 16.5 of this document, the transformer shall be rated for elevations up to 3,300 feet (1,000 meters). For elevations above 3,300 feet, or above the elevation specified in Section 16.5 of this document, any required de-rating of the dielectric strength shall not exceed the IEEE C57.12.00 correction factor of 1.0 percent for each 330 feet of elevation increase, and any required de-rating of the kVA rating shall not exceed the IEEE C57.91 correction factors of 0.4 percent (self-cooled rating) and 0.5 percent (forced-cooled ratings) for each 330 feet of elevation increase.

4.5 Ambient Temperature

Unless otherwise specified in Section 16.6 of this document, the transformer and all associated components shall be rated for an ambient temperature range of −30°C daily minimum to +40°C daily peak, with a daily average of +30°C.

4.6 Phase Designation

The phase of the transformer shall be single-phase or three-phase, as specified in Section 16.7 of this document.

4.7 Impedances

Transformer impedances shall be in accordance with specific PacifiCorp requirements, as specified in Section 16.12 of this document. The total impedances used for the short-circuit-withstand design of the transformer shall be the transformer impedances only, without considering any benefit of system impedances.

4.8 Single-Phase Transformer Bank

The following requirements for a single-phase transformer bank shall apply on all de-energized and load tap positions, with impedances on all tap positions in compliance with the IEEE tolerance.

If the transformer is single-phase, and if specified in Section 16.12.1 of this document, the transformer shall be suitable for operation in a three-phase bank with the identified similar transformers.

4.9 Transformer Loading

4.9.1 Loading Guide Application

The complete transformer, including the windings, the cooling system, and all external and internal auxiliary components and capabilities (such as bushings, current transformers, leads, tap changers, oil expansion, pressure in sealed units, stray flux heating, etc.) shall be suitable for operation in accordance with IEEE C57.91. It is the intent of this requirement that no transformer auxiliary component or capability shall have or cause greater loss of life, or result in more restrictive limitations on transformer loading, than the loss of life and loading limitations associated with the transformer windings and cooling system.

4.10 Flux Density

4.10.1 General Step-Up Transformer Requirement

With the transformer energized at no-load, at 100 percent rated tap voltage, the maximum flux density in the core shall not exceed the value determined by the following formula:

$$MFD = 1.7 - (IZ - .10)(0.0093) \text{ Tesla}$$

where

MFD = maximum flux density on any de-energized tap

IZ = per unit impedance at the respective rated tap voltage and the rated maximum forced-cooled capacity

This formula is valid for IZ of ten percent or greater. For values of IZ below ten percent, the maximum flux density shall be 1.7 Tesla.

At the maximum forced-cooled rating, the maximum flux density in magnetic shunts shall not exceed 1.2 Tesla.

4.11 Winding Design and Insulation Materials

For a three-phase core-form transformer with a self-cooled rating of 7500 kVA or above, or a single-phase core-form transformer with a self-cooled rating of 2500 kVA or above, the winding design shall be circular. For a core-form transformer with a capacity rating below those specified above, the winding design shall be circular or rectangular. The core hot spot temperature shall be limited to 125°C at full load, with a voltage excitation of 105 percent.

For all transformers, the following requirements shall apply:

1. All conductor material shall be copper.
2. All pressboard insulation for winding cylinders, barriers, key spacers, etc. shall be EHV–Weidmann or approved equivalent with comparable mechanical and electrical properties.
3. Excluding lead supports and clamping rings, all insulation material shall be thermally upgraded (suitable for a hot-spot temperature up to 120°C under daily cyclic loading).
4. All conductor paper insulation on CTC (continuously transposed conductor) shall be Dennison paper or an approved equivalent with the same mechanical and electrical properties.
5. At a minimum, the outside two layers of conductor insulation on all strap conductors shall be Dennison paper (or an approved equivalent).
6. When using CTC that is fully insulated with paper, the transformer supplier shall design the radial cooling ducts to have sufficient radial spacer thickness to meet the cooling requirements. A thickness of 5 mm is preferred, but where experience and modeling demonstrate a lower value is adequate, a reduced thickness of 4.5 mm will be accepted.
7. When using netting type CTC, the transformer supplier shall design the radial cooling ducts to have a minimum radial spacer thickness of 3 mm.
8. Each clamping ring, top and bottom, shall be one piece, with no reduction in the thickness of the ring in the core window. The bottom clamping ring shall be fully supported from below to handle the weight of the windings without any visible deformation of the ring. Coils on core-form designs shall have their full circumference supported by the frame assembly.
9. The winding design shall not utilize internal surge protection devices. It is recognized that in the special case of the regulating winding located on the HV–side with a relatively high lightning impulse rating (850 kV or higher applied to the terminal that is directly connected to the regulating winding), these devices may be necessary and may be acceptable; this is to be clearly indicated in the bid documents.
10. The average dielectric stress at any location in the core-and-coil assembly shall not exceed 2.65 kV RMS/mm with the transformer energized at 100 percent rated voltage on the maximum-stress tap position(s). Applicable stresses include but are not limited to turn-to-turn, winding-to-winding, winding-to-ground, phase-to-phase, and lead-to-lead. However, if the configuration is similar to a plane-to-plane stress, such as a phase-to-phase stress for a center line entry, then the maximum stress of 3.0 kV RMS/mm may be permitted. The stress shall be calculated accurately using a verifiable computer modeling technique. Design calculations shall also demonstrate compatibility with the manufacturer's design criteria for all voltage conditions.

11. All brazed connections in CTC shall be strand-to-strand, i.e., each strand shall be individually brazed and installed. Inner-shield designs shall be implemented with CTC cable.
12. Conductors insulated with Formvar (Vinylec) enamels (or an equivalent type) are not acceptable, except in CTC.
13. For a rectangular-design transformer, the allowable impedance change after short-circuit testing shall be 2 percent, the same as specified in IEEE C57.12.90 for a circular-design transformer.
14. The conductor ratio, based on individual un-insulated strands, shall not exceed 6.5 to 1.
15. When a layer winding is used, the radial build shall be a minimum of $^{3}/_{8}$-inch (10 mm) for transformers with a self-cooled rating below 75 MVA. For transformers with a self-cooled rating of 75 MVA and above, the radial build shall be a minimum of $^{7}/_{16}$-inch (12 mm). Only one conductor in the radial direction is allowed unless the cable used is CTC.
16. Weidmann Klackband or approved equivalent (with paper on both sides of the blocks) shall be used for cooling ducts in a winding, where applicable.
17. Care shall be taken to prevent chafing of the winding insulation due to contact with the lead support structure, for example, by rounding the lead support structure material.
18. For all transformers with a self-cooled rating of 75 MVA and above, all leads shall be clamped with blocks. Ties and tie-wraps shall not be used.
19. All coil spacers shall be keyed to the winding cylinder and to vertical key strips on the outside of the coil.
20. All winding crossovers shall be made between adjacent key spacer columns. If a manufacturer feels there is no way to manufacture the windings without a crossover in between the key spacer columns, then this statement, along with an explanation, shall be issued to PacifiCorp during the bidding stage.
21. The winding hot spot must limit the loading rather than the leads or accessories. The hot spot of the leads must not exceed the maximum hot spot in the windings by more than 1°C.

All winding supports and supports in the area of high-voltage field shall have a minimum compression strength parallel-to-grain of 7,800 psi (53.8 MN/m^2) and compression strength perpendicular-to-grain of 1,400 psi (9.65 MN/m^2). Preference will be given to products having compression strength exceeding 10,000 psi (69 MN/m^2)$^{(1)}$, such as TX and T-IV boards. The supplier shall state in the proposal the type of winding insulation, blocking and lead support being used within the transformer.

$^{(1)}$: To IEC 60763–3–1 with a density up to 0.75 oz/in^3 (1.30 g/cm^3).

Buckling stresses shall not exceed 150 N/mm^2. Spiraling force shall not exceed 350 kN. When layer windings are used, each layer shall be designed for “free” buckling independent of the other layers.

For shell form transformers the following design parameters shall apply:

1. The manufacturer shall state their process of maintaining compression on each phase assembly (windings and insulation assembly) during the drying process and the core stacking process. The phase assembly shall be compressed to a slightly undersized dimension so residual compression exists after the core is stacked.
2. The top and bottom coil support members, such as T beams, are to be insulated from the core. The core shall also be insulated from the tank. Leads shall be brought from each section of the core and from each T beam for grounding as specified in Section 7.8 of this specification.
3. The inside and outside perimeter of every coil shall be insulated with individual pressboard channels. These channels shall be designed to support all turns of the coil for short-circuit forces and to allow for adequate heat transfer from every turn.
4. The manufacturer shall mitigate the probability of static electrification. The average oil flow rate through the windings is to be $\leq$0.4 ft/sec (12.2 cm/sec).
5. The leakage flux heating analysis is to be performed with a three-dimensional analysis technique.

4.12 Short-Circuit Withstand

All windings subject to inward radial buckling shall be designed to withstand “free” (unsupported) buckling in addition to “forced” (supported) buckling. The control of inward radial forces shall not depend upon bracing to the core. The manufacturer shall supply epoxy-bonded conductors (CTC) for the low-voltage windings. Short-circuit calculations shall be based on 105 percent of the maximum calculated fault voltage. Upon completion of the transformer design, the supplier shall furnish to PacifiCorp the calculated free and forced buckling forces and the withstand values, clearly indicating the factors of safety based on worst-case fault conditions.

When layer windings are used, each layer shall be designed for “free” buckling independent of the other layers. The radial build of any layer shall be at least 0.50 inches (12.7 mm). Multiple strap conductors in the radial direction are not acceptable. Epoxy-bonded cable is required for windings subject to inward radial buckling.

The axial mechanical support structure for the core and coils, e.g., tie plates, shall not be stressed more than 65 percent of the elastic limit for the material of the tie plate during the worst-case condition of lifting or short circuit.

4.13 Wind and Seismic Withstand

The wind and seismic withstand capability of the transformer shall be in accordance with PacifiCorp Material Specification ZS 065.

4.14 Design for Shipment

Regardless of the method (truck or rail; see Section 15.7 of this document) to be employed for shipment of the transformer from the factory to the specified destination, the transformer shall be designed for standard US shipment by rail. This requirement will ensure that the transformer has sufficient strength for possible later reshipment by rail. It is preferred that in North America a Schnabel-type railroad car not be used. If a manufacturer must use a Schnabel-type railroad car in North America, PacifiCorp may apply a penalty up to $700,000 per tank to the estimated equivalent total owning cost. There is a possibility of a lesser penalty when the use of a Schnabel-type railroad car is discussed with the manufacturer at the bidding stage and is determined to be appropriate.

Transformer core and coils shall be designed for shipment without temporary internal shipping braces. Temporary internal shipping braces may be used to support bushing leads. Any bracing used for leads shall be well-documented and flagged for removal before energization. The transformer shall be designed to withstand a minimum shipping force of 2G in the lateral direction, 5G in the longitudinal direction, and 3G in the vertical direction.

4.15 Contaminated-Environment Protection

If specified in Section 16.3 of this document, the transformer shall be furnished in accordance with the contaminated-environment protection requirements of PacifiCorp Material Specification ZS 066. (Note that the exposed fasteners and hardware on *all* transformers shall meet the requirements of Section 7.16 of this document.)

4.16 Streaming Electrification

The transformer shall be designed so that streaming electrification is minimized and does not affect transformer operation or reliability within the specified temperature range. For transformers rated 345 kV and above with pumps, the bidder shall include a statement on the design philosophy (e.g., oil-flow velocities) employed to control this phenomenon.

4.17 Core

Every core step shall be supported by inserting a non-conductive material between the core step and the base bar that connects the core clamps. The bottom of every core step shall be supported from a base bar that connects to the low-voltage and high-voltage core clamps. Every core step shall also be supported at the ends. Bolting through the core steel is not acceptable.

All core tie bars and core clamps in direct contact with any cellulose material shall be insulated with Nomex enhanced insulation.

Step-lap core construction is required. All cores must use a mitered-core design. The edges of the laminations on the core legs shall be protected against rust with paint or epoxy; however, the top yoke shall not have paint or epoxy applied.

The design of the bottom core clamps and tank shall allow inspection of the underside of the bottom yoke. A design where the bottom yoke sits in a bottom tank trough is not allowed.

The use of four single-phase cores to construct a five-limb core is not allowed. The top and bottom yokes shall be continuous except for building joints.

For core laminations, the maximum allowed burr height is 0.4 mil for slitting and 0.8 mil for shearing.

4.18 Match the Existing Site

The purpose of this specification is to provide a generator step-up transformer that will fit the existing site locations. Dimension requirements apply to:

1. re-use of existing PacifiCorp conduits and wires into the control panel,
2. connection to the existing ISO phase bus,
3. existing foundations, and
4. existing oil containment volume.

4.19 Match the Existing Transformers

If a new transformer is being purchased to replace a transformer in an existing installation, the new transformer shall be suitable to replace the existing transformer as shown in the outline drawing(s) listed in Section 16.29. The control cabinet, bushings, arresters, radiators, fans, and terminal board wiring layouts shall closely match the design of existing transformers, such that the new transformer can be installed at the existing location. The new transformer design shall allow the re-use of existing underground wiring without splicing. Suppliers shall design the new transformer to physically fit on the existing pad and be within the weight limitations of the existing pad. Bids will be penalized by evaluating the additional cost to revise or remove the existing foundation and construct a new transformer foundation to meet civil, oil-containment, and seismic requirements. The new transformer pump and fan voltages and configuration shall be identical to the transformer being replaced.

4.20 Match the Existing ISO Phase Bus

The low-voltage bushing insulated outdoor aluminum bus generator lead connections shall match the existing terminations. Details of the low-side bushing connections are shown on the drawing(s) listed in Section 16.29.

4.21 Prohibited Materials

4.21.1 Mercury

- Mercury, or any mercury-containing device or auxiliary equipment, is not allowed in the equipment design (unless an exception is granted by PacifiCorp in writing prior to contract award; see below).
- Should any mercury or mercury-containing device be an integral part of the design for the equipment, with no mercury-free substitutes available, the supplier shall include detailed information on such parts (or sub-parts) in

the bid proposal documents, including Material Safety Data Sheets (MSDS) and a detailed explanation of why the parts are necessary and cannot be substituted.

- Any necessary mercury-containing parts shall also be clearly identified in all bill of materials, drawings, and instruction books as containing mercury, and all associated MSDS shall be included in the instruction books.
- Mercury-containing parts shall be clearly labeled with red nameplates (with white lettering), with the words, “CAUTION – MERCURY-CONTAINING DEVICE” wherever such parts are mounted on the equipment.

4.21.2 Asbestos

- Asbestos, or any asbestos-contaminated device or material, is not allowed in the equipment design (unless an exception is granted by PacifiCorp in writing prior to contract award; see below).
- Should any asbestos or asbestos-contaminated device be an integral part of the design for the equipment, with no asbestos-free substitutes available, the supplier shall include detailed information on such parts (or sub–parts) in the bid proposal documents, including Material Safety Data Sheets (MSDS) and a detailed explanation of why the parts are necessary and cannot be substituted.
- Any necessary asbestos-contaminated parts shall also be clearly identified in all bill of materials, drawings, and instruction books as containing asbestos, and all associated MSDS shall be included in the instruction books.
- Asbestos-contaminated parts shall be clearly labeled with red nameplates (with white lettering) with the words, “CAUTION – ASBESTOS-CONTAMINATED DEVICE” wherever such parts are mounted on the equipment.

4.22 Site Visit

If specified in the bid documents, a site visit will be scheduled during the bidding process. This visit will allow suppliers to view the existing transformer installation site, oil containment, ISO–phase bus connections, cabinet locations, conduit locations, foundation, pad size, and any site complications. Site conditions and access shall be accounted for when determining the cost to deliver the transformer.

4.23 Warranty

The following combustible gas levels are based upon normal loading and shall be used to initiate warranty discussion for the root causes and remediation.

Gas	Maximum Level
Methane	2 ppm/year
Ethane	1 ppm/year
Ethylene	Trace ppm/year
Acetylene	Trace ppm for 5 years
Hydrogen	10 ppm/year
Carbon Monoxide	30 ppm for 5 years
Carbon Dioxide	300 ppm for 5 years

5 Cooling Equipment

5.1 Winding Hot-Spot Control

The cooling equipment shall be controlled from winding hot-spot temperature. Equipment to simulate winding hot-spot temperature(s) and control the cooling equipment shall be furnished as specified below. Necessary current transformer(s) shall be in addition to the current transformers specified in Section 16.16 of this document.

5.1.1 Main Tank Top-Oil Resistance Temperature Detector

An approved resistance temperature detector (RTD), with associated thermowell, shall be furnished to detect the transformer main tank top-oil temperature. The RTD shall be 10-ohm copper or 100-ohm platinum as specified in Section 16.17.1 of this document, with a compatible connector and shielded cable. The length of the shielded RTD cable may be shortened as necessary but must connect directly between the RTD and the temperature monitor. It shall not be connected through a terminal block. The RTD with associated thermowell and the shielded cable connector shall be compatible with the temperature monitor specified in Section 5.1.4. The oil RTD cable shall be protected in rigid steel conduit.

5.1.2 Ambient Temperature Resistance Temperature Detector

An approved resistance temperature detector (RTD) shall be furnished to detect the ambient temperature near the transformer. The RTD shall be 10-ohm copper or 100-ohm platinum as specified in Section 16.17.2 of this document, with a sun shield, a compatible connector, and shielded cable. The length of the shielded RTD cable may be shortened as necessary but must connect directly between the RTD and the temperature monitor. It shall not be connected through a terminal block.

The RTD shall be mounted on the underside of the control compartment in a location that will not conflict with workable access to the compartment bottom drill plate. The resistance temperature detector (RTD) with sun shield and shielded cable connector shall be compatible with the temperature monitor specified in Section 5.1.4.

5.1.3 Current Transformer(s)

An approved 10 A clamp-on current transformer, input range 0–10 A, shall be furnished for winding hot-spot temperature simulation as specified below. The current transformer secondary leads shall be wired to terminal blocks in the control compartment and connected to the temperature monitor.

The approved 10 A clamp-on transformer shall be compatible with the temperature monitor specified in Section 5.1.4.

5.1.4 Temperature Monitor

An approved-type temperature monitor shall be furnished for indication of the top-oil temperatures in the main tank and the winding hot-spot temperature(s), and for control of the cooling equipment.

All temperature monitor input and output terminals, except for terminals connecting to the RTD(s), shall be wired to terminal blocks in the control compartment and connected to the current transformer(s) and cooling equipment.

It is preferred that the temperature monitor be flush-mounted on a panel in the control compartment; the monitor shall be readily visible when the compartment door is open (the monitor shall not be located behind a hinged panel or other concealment). If necessary, the monitor may be mounted near the control compartment in a separate approved-type enclosure (NEMA 4), equipped with a 120 VAC space heater.

The approved supplier model numbers are specified in Appendix A and are determined by the main tank top-oil RTD requirements specified in Section 16.17.

Detailed temperature monitor requirements are as follows:

1. The monitor power supply will be DC, from PacifiCorp's substation battery.
2. The eight output control/alarm contacts shall be wired to terminal blocks and connected as follows:
    a. Start first stage of forced–cooling equipment
    b. Start second stage of forced–cooling equipment
    c. Future use
    d. Activate PacifiCorp's winding hot-spot temperature alarm
    e. Initiate winding hot-spot temperature trip of PacifiCorp's switching device
    f. Activate PacifiCorp's main tank top-oil temperature alarm

g. Future use

h. Future use

3. The eight input modules shall be connected as follows. See Section 5.1.3 to determine applicable current transformer quantity, type, and locations.

   a. Main oil temperature RTD

   b. NO CONNECTION

   c. Ambient temperature

   d. Low-voltage or common winding CT (depending on transformer type, see Section 5.1.3)

   e. High-voltage or series winding CT or NO CONNECTION (depending on transformer type and configuration, see Section 5.1.3)

   f. NO CONNECTION

   g. NO CONNECTION

   h. NO CONNECTION

4. The diagnostics alarm contact shall be wired to a terminal block.

5. The RS-485 communication terminals shall be wired to a terminal block.

6. The four mA outputs shall be wired to terminal blocks.

5.1.5 Direct Winding Temperature Measurement

In addition to current transformers for hotspot temperature simulation, the transformer shall include Qualitrol direct-winding temperature measurement equipment utilizing inert fiber optic (FO) probes placed at the calculated hotspot portion of the three-phase transformer windings.

The FO temperature probes shall be Neoptix T2 Fiber Optic Temperature Sensor. The probes shall utilize Neoptix Optical Tank Wall Feedthrough, Neoptix Stainless Steel Bolted Transformer Wall Plate, and Neoptix Optical Feedthroughs Junction Box. The wall plate shall be located on the side of the transformer where it can be accessed during operation of the transformer. Location of the feedthrough plate shall be agreed upon between the Purchaser and the transformer Supplier. Gaskets shall be Viton O–ring type.

The Qualitrol temperature monitor shall utilize the Qualitrol Optical hot spot module (MOD–638) for connection of eight FO temperature sensors.

The Qualitrol temperature monitor shall be delivered with an optional portable FO thermometer (KIT–057–1) manufactured by Qualitrol.

The Supplier shall guarantee the operation of at least six FO temperature probes connected to the feedthrough plate. FO probes shall be installed in each phase at the hottest spots of each of the phase windings (two per winding). The installation shall use Weidmann NOMEX spacers, or equivalent, to insure the tips are positioned and remain in the proper location. The locations of the probe shall be proposed by the Supplier and finalized by agreement of the Purchaser.

Each FO probe and cable shall be identified on drawings and tagged.

All six FO probes shall be brought through the transformer wall plate and routed to the control cabinet.

Additional FO probes, if installed by the Supplier, shall be brought through the transformer wall plate if optical tank wall feedthrough connecter space is available. Any FO probes not brought through the wall plate shall have adequate slack to allow for the interchanging of probes to the wall plate. FO probes shall be secured inside the transformer such that the probe or probe connectors cannot be damaged by shipping, seismic, or short-circuit forces. The connectors shall be located in an area of the transformer so as to avoid any chance of electrical interference and such that if a connector breaks off it falls through and into an electrically neutral area inside the transformer. The Supplier shall leave all temperature probes and FO cable that may have been used for other testing available so that the Purchaser may utilize them for future testing.

FO cables shall be routed so that they are not subject to damage during the assembly of the transformer, work in the transformer, and/or dismantling of the transformer. Proper conduits or tubes inside the transformer tank shall be used for the FO cables where electric fields allow, proper slack shall be left in each run of the FO cable to insure the cables do not become taut and have slack during all foreseeable temperatures, including temperatures during shipment. Tie wraps, glue, or similar devices shall not be used to attach the FO cables for the routing from the hotspot location to the control cabinet controller.

The six FO extension cables external to the tank shall be routed from the transition plate to the control cabinet in a separate conduit for use of FO cables only. A yellow panduit and/or FO corrugated plastic conduit shall be used exclusively for any FO extensions inside the control cabinet. The FO extensions shall not be bundled or tie-wrapped with the control cable. The Supplier shall instruct all personnel working on the transformer that the fiber optic cables must be treated only in accordance with the Manufacturer's specified procedures.

Conduit used for FO cable routing shall NOT use "condulet" fittings for routing. Conduit must utilize standard sweep bends to maintain cable minimum bend radius.

Temperature rise test measurements shall be made with the FO thermometers. The Qualitrol equipment shall be operational during temperature tests and demonstrated during these tests. During probe verification, the hottest probes for each phase shall be identified, and temperature data for all probes recorded and reported in the test report. If the Supplier's calculated values for the hotspot temperature fall below the FO thermometer measurements, the Supplier shall determine the cause and may be required to repeat the temperature rise test.

5.1.6 Temperature Monitor Settings and Cooling Equipment Control Connections

The temperature monitor settings and cooling equipment control connections required for the most common transformer cooling classes are as specified below. Note that the actual values of the temperature settings will be selected by PacifiCorp; the temperatures specified below are the normal values used for most applications.

1. For all transformers, one temperature monitor output relay operated from the main tank top-oil temperature will be used to activate PacifiCorp's alarm (normally at 90°C).
2. For a transformer with a self-cooled rating and one forced-cooled rating, three temperature monitor output relays operated from the winding hot-spot temperature (or the hottest of the three winding hot-spot temperatures) will be utilized: one shall be connected by the supplier to start the forced-cooling equipment (Temperature Monitor Output Relay 1, normally at 80°C); one will be used to activate PacifiCorp's alarm (Temperature Monitor Output Relay 4, normally at 110°C); and one will be used to trip PacifiCorp's switching device (Temperature Monitor Output Relay 5, normally at 130°C).
3. For a transformer with a self-cooled rating and two forced-cooled ratings, four temperature monitor output relays operated from the winding hot-spot temperature (or the hottest of the three winding hot-spot temperatures) will be utilized: one shall be connected by the supplier to start the first stage of forced-cooling equipment (Temperature Monitor Output Relay 1, normally at 75°C); one shall be connected by the supplier to start the second stage of forced-cooling equipment (Temperature Monitor Output Relay 2, normally at 80°C); one will be used to activate PacifiCorp's alarm (Temperature Monitor Output Relay 4, normally at 110°C); and one will be used to trip PacifiCorp's switching device (Temperature Monitor Output Relay 5, normally at 130°C).
4. For a transformer with two forced-cooled ratings (no self-cooled rating), four temperature monitor output relays operated from the winding hot-spot temperature (or the hottest of the three winding hot-spot temperatures) will be utilized: one shall be connected by the supplier to start the first stage of forced-cooling equipment (Temperature Monitor Output Relay 1, set at −100°C to ensure it is always engaged); one shall be connected by the supplier to start the second stage of forced-cooling equipment (Temperature Monitor Output Relay 2, normally at 80°C); one will be used to activate PacifiCorp's alarm (Temperature Monitor Output Relay 4, normally at 110°C); and one will be used to trip PacifiCorp's switching device

(Temperature Monitor Output Relay 5, normally at 130°C). Each stage of cooling equipment must be connected to a Temperature Monitor Output Relay such that the automatic bank switching feature may be enabled.

5.2 Radiators or Coolers

The radiators or coolers shall be completely supported by their attachment to the transformer tank; external supports are not acceptable. The radiators or coolers shall be removable and shall be equipped with lifting eyes. The radiators or coolers shall be filled with 5–10 psi gauge (0.35–0.70 atm gauge) of dry nitrogen air with a nitrogen pressure valve and gauge, and a protective cover if removed for shipment. The supplier shall furnish suitable valves on the transformer side of the radiator or cooler mounting flanges, and the radiators or coolers shall be furnished with pipe taps and plugs (minimum 1/2-inch) on the top and capped valves (minimum 1/2-inch) on the bottom, to permit draining and removal of the radiators or coolers without draining oil from the transformer tank. The preferred radiator panel steel thickness shall be a minimum of 18 gauge (1.2 mm), but consideration will be given to 19 gauge (1 mm) where experience with a suitable corrosion protection system can be shown. The bottom of the radiator shall be no less than 18 inches (460 mm) above foundation level.

After all welding, the exterior surface of the radiators shall be hot-dip galvanized.

Radiators or coolers shall not use oil piping for support attachments.

Radiators or coolers shall be designed to withstand a minimum internal operating pressure of 10 psi.

5.3 Cooling Fans

Cooling fans shall be weatherproof and corrosion-resistant, with sealed ball bearings. Fan guards shall be OSHA approved. The motors shall be approved NEMA type and suitable for local servicing.

Fans for radiators shall be located toward the top of the radiator, or as high as is practical on the sides (not on the top) of the radiator, while maintaining safe work clearances from live parts in the case of required maintenance in the field. Fans for radiators may also be allowed to be mounted under the radiators with a 60-inch (1.524 m) minimum clearance to the foundation, but this option must be presented to PacifiCorp for review and approval. The coolers shall be located as low as is practical on the transformer, to provide maintenance accessibility with adequate safety clearances from transformer live parts.

Fans for radiators shall be an approved type.

5.4 Circulating Pumps

If the cooling equipment includes oil circulating pumps, an oil flow indicator with alarm contact shall be furnished for each pump to indicate low oil flow. Oil pumps shall be located near the foundation level. The supplier shall furnish suitable valves on both sides of each pump, and a pipe tap with plug (minimum 1/2 inch) at the lowest and highest point on the pump section between the valves to permit draining, removal, and reinstallation of the pump without draining oil from the radiators or the transformer tank. If the power supply to the pumps is made through connectors which must also seal the oil system, suitable mechanical guards shall be furnished to prevent breakage of the connectors and the resultant oil leakage.

The oil circulating pumps shall be “Harley by Cardinal” or an approved equivalent, with the latest enhanced-bearing-system design.

A TecSonics online bearing monitoring system shall be provided. The monitor shall be used to quantitatively measure the bearing surface wear of the oil circulating pumps while they are operating.

The supplier shall provide a spare fan and motor.

5.5 Fan and Pump Control

If the cooling equipment includes two or more cooling fans, the wiring and protection for the fans shall be furnished in a minimum of two completely separate groups, so that each group will be independent of any problem or outage in the other group(s). If two stages of forced cooling are specified in Section 16.10 of this document, separate wiring and protection for each stage of fans will satisfy the requirements of this paragraph. Each pump shall be protected by a separate circuit breaker and labeled as described in Section 9.5.

A three-position switch shall be provided for each forced cooling stage, with which each cooling stage may be switched between AUTO (forced-cooling enabled by temperature monitor), OFF, and MANUAL (forced-cooling manually engaged) independent of the other stage of cooling. This switch shall include the labels “AUTO,” “OFF,” and “MANUAL” to identify the three switching positions. The power to the cooling groups consists of redundant 480V three-phase supplies with a transfer throwover contactor arrangement.

If the cooling equipment includes two or more oil circulating pumps, the wiring and protection for the pumps shall be furnished in a minimum of two completely separate groups, so that each group will be independent of any problem or outage in the other group(s). If two stages of forced cooling are specified in Section 16.10 of this document, and both stages include pumps, separate wiring and protection for each stage of pumps will satisfy the requirements of this paragraph.

If the cooling equipment includes both cooling fans and oil circulating pumps, the wiring and protection for the fans shall be completely separate from the wiring and protection for the pumps, so that each system will be independent of any problem or outage in the other system.

Wiring for the cooling fans, and the oil circulating pumps if applicable, shall be arranged to allow for complete de-energization of these circuits on command from an external PacifiCorp relay in the event of a PacifiCorp transformer lockout operation.

The supplier shall provide a spare pump and motor.

5.6 Auxiliary Relay

An auxiliary relay shall be furnished to provide an alarm indication of loss of power to the cooling equipment. This relay shall have a 30-second time delay to avoid an alarm for a momentary power loss.

5.7 Location of Control Devices

Cooling equipment control devices shall be housed in the control compartment (see Section 7.7 of this document).

6 Bushings and Surge Arresters

6.1 Bushings

Bushings shall be in accordance with the dimensional and performance requirements of IEEE Standard C57.19.01.

Bushings, except the core ground bushing (see Section 7.8 of this document), shall be capacitor graded oil–impregnated paper–insulated (OIP) type. Consideration will be given to resin-impregnated paper-insulated (RIP) core and other composite bushings where sound service experience can be demonstrated or where, because of the installation constraints, there is a clear advantage in using that type, which is stated clearly in the bid documents. Bushings shall be manufactured by an approved supplier.

The current rating of each bushing shall be at least 20 percent higher than the current it will carry at the maximum forced-cooled rating. Additionally, the current rating of each neutral bushing shall not be less than the current rating of the associated line bushings. The H0X0 bushing, when required, shall be rated to sustain the maximum operating current of the common winding. All high-current bushings (with ratings greater than 3,000 amps) shall be supplied with Viton gaskets and high-temperature (125°C) class insulation.

For X-winding and Y-winding nominal voltage ratings below 13.8 kV, the BIL of the phase and neutral bushings, as applicable, shall not be less than 150 kV BIL, unless the winding terminals are directly connected to enclosed bus. Refer to Section 16.14 of this document for all BIL requirements.

The external clearances between the phase and neutral bushings of each winding (H and X, respectively), as applicable, shall meet the requirements of Section 16.14 of this document (and Table 9 therein), except that the live-part clearances between bushings for a winding nominal voltage rating of 69kV or below shall not be less than 30 inches. If this requirement for 69 kV or below cannot be met, the supplier shall state non-compliance to this requirement in the bid documents, and ensure that the live-part clearance is as large as possible.

Bushings shall be shipped in crates suitable for long-term storage, either in an upright position or at an incline, as specified by the bushing manufacturer.

6.1.1 Bushing Lead Connections

A draw-lead connection is required for all bushings whenever possible. In cases where the transformer winding leads are bolted to the bottom of the bushings, two-bolt connections shall be used; single-bolt connections are not acceptable.

6.1.2 Bushing Stud Sizes and Flat-Pad Terminals

The terminal stud sizes for the bushings shall be as specified in Table 1.
The minimum length of usable threads shall be 2.25 inches (57 mm); the thread class shall be UNF–2A.

Table 1—Bushing Terminal Stud Sizes

Amperes	Stud Size	
	Diameter (inches)	Threads Per Inch
≤1200	1.5	12
1600	2.0	12
2000	2.0	12
3000	3.0	12

A straight flat-pad terminal with NEMA standard 4-hole drilling shall be furnished for each bushing. The terminals shall be bronze, copper, or aluminum, with tin plating; the minimum plating thickness shall be 0.001 inch (0.026 mm).

6.1.3 Winding Neutral Grounds

Provisions shall be furnished for protection of PacifiCorp's 4/0 (equivalent to 107.2 mm^2) copper conductor connecting the H0 or X0 neutral bushing terminal to the substation ground grid. The protection provision shall consist of a removable vertical length of 1-inch (25.4 mm bore) schedule 80 gray PVC pipe with a wall thickness of 0.19 in (4.83 mm), mounted by straps bolted to supporting brackets. The pipe shall be located no more than 12 inches (305 mm) away from the transformer main tank side wall.

The supporting brackets shall be factory-welded to the transformer tank, or factory-welded or bolted to other suitable structural components; field welding or drilling is not acceptable.

The pipe shall be open at the top and bottom. The top of the pipe shall be approximately 12 inches (305 mm) below the H0 or X0 neutral bushing terminal, and the bottom of the pipe shall be approximately one foot above foundation level. PacifiCorp will furnish and install the copper conductor.

Transformer shall be provided with provisions to connect to the existing neutral bus if the neutral bus drawings are referenced in Section 16.20.

6.2 Surge Arresters

The transformer shall be furnished with approved type metal-oxide, gapless-type, station-class surge arresters, as specified in Section 16.11 of this document.

If the H-terminals are rated for a nominal system voltage of 525 kV (see Section 16.11 of this document), the H-terminal arresters will be furnished by PacifiCorp and installed separately.

6.2.1 Terminals

Each surge arrester shall be furnished with a straight, vertical flat-pad line terminal with NEMA standard four-hole drilling, and with a clamp-type ground terminal connector. The terminals shall be bronze, copper, or aluminum, with tin plating; the minimum plating thickness shall be 0.001 inch (0.026 mm).

6.2.2 Mounting Brackets

A mounting bracket for each arrester shall be furnished on the transformer adjacent to the associated bushing.

6.2.3 Discharge Counters

Discharge counters, if specified in Section 16.15 of this document, shall each be furnished with a built-in grading-leakage current indicating meter. These counters shall be manufactured by General Electric or Ohio Brass. The supplier shall also furnish necessary arrester insulating sub-bases, and provisions for mounting each counter on the transformer. Counters shall be positioned approximately five feet (1.5 m) above foundation level for convenient inspection.

7 Other Construction Requirements

7.1 Accessory Location

Bushings and surge arresters shall be located as shown in Figure 1 unless shown differently in the supplied drawings in Section 4.19. Other accessories shall be located in accordance with standards wherever applicable, or as convenient for design if not covered by standards.

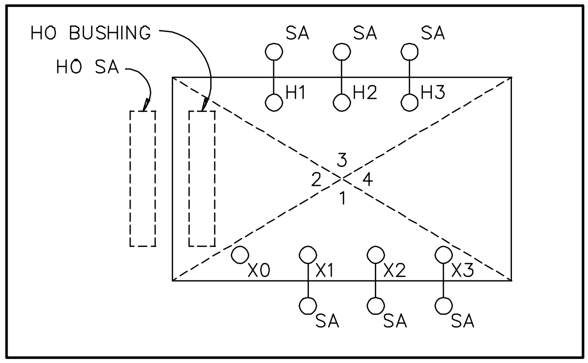

Figure 1—Accessory Location

7.2 De-energized Tap Changer(s), Reconnection Switch(es), and Reconnection Terminal Board(s)

See Section 16.11 of this document for the specific required winding taps, winding reconnections, and means of reconnection.

Two-bolt connections shall be used to connect the transformer winding leads to the tap changer(s), switch(es), and terminal board(s), as applicable; single-bolt connections are not acceptable.

Single-bolt connections may be used only on tap changers, however double-bolt connections should be used whenever possible. Single-bolt connections require locking devices on nuts to prevent loosening from vibration.

The de-energized tap changer(s) shall be designed such that neither tap-change operations, nor periodic movement of contacts are required to prevent coking or fouling of the contacts during the life of the transformer.

7.2.1 Tap Changer(s) and Reconnection Switch(es)

If de-energized voltage taps are specified in Section 16.11.1 of this document for the H-winding, X-winding, or both windings of a single-phase transformer, a de-energized tap changer shall be furnished for each specified winding; each tap changer shall be operated by one external handle.

If de-energized voltage taps are specified in Section 16.11.1 of this document for the H-winding, X-winding, or both windings of a three-phase transformer, a de-energized tap changer shall be furnished for each specified winding; each tap changer shall be three-phase or a three-phase internally-ganged assembly, operated by one external handle.

If de-energized series-parallel or wye-delta reconnection by means of a switch is specified for the H-winding, X-winding, or both windings of a three-phase transformer (see Section 16.11.3 of this document), a de-energized switch shall be furnished for each specified reconnection; each switch shall be three-phase or a three-phase internally-ganged assembly, operated by one external handle. Geneva gear type mechanisms are not acceptable.

Each tap changer or reconnection switch shall be located under oil and shall be designed to ensure positive positioning and correct external position indication. Each external operating handle, with its associated position-indication plate, shall be mounted at a height between one and five feet above foundation level and shall be furnished with provisions for padlocking in any position. An identification nameplate shall be furnished and mounted adjacent to each operating handle.

7.3 Surge Arrester Ground Connections

The supplier shall furnish suitable electrical ground connections using bus bar between the arrester ground terminals and ground pads at the base of the transformer tank. If arrester discharge counters are specified in Section 16.15 of this document, connections between the arrester ground terminals and the discharge counter live terminals shall be insulated cable, minimum 5 kV rating; the connections from the discharge counter ground terminals to the transformer ground pads shall be bus bar.

7.4 Current Transformers

7.4.1 Thermal Current Rating Factor

All current transformers, including the current transformer(s) for winding hot-spot control, shall have a continuous thermal current rating factor of 2.0 at an average ambient air temperature of 65°C.

7.4.2 Secondary Terminal Blocks

All bushing current transformer secondary leads shall be wired to six-point short-circuiting-type terminal blocks in the control compartment, as shown in Figure 2, Figure 3 and Table 10. The current transformer terminal blocks shall be laid out and each conductor marked as shown in Figure 2 and Figure 3. A separate terminal block, complete with shorting screws, shall be provided for each bushing current transformer. (See Section 16.16 of this document.) The current transformer leads running from the CT to the feed-throughs on the tank and from the feed-throughs on the tank to the terminal blocks shall not be spliced.

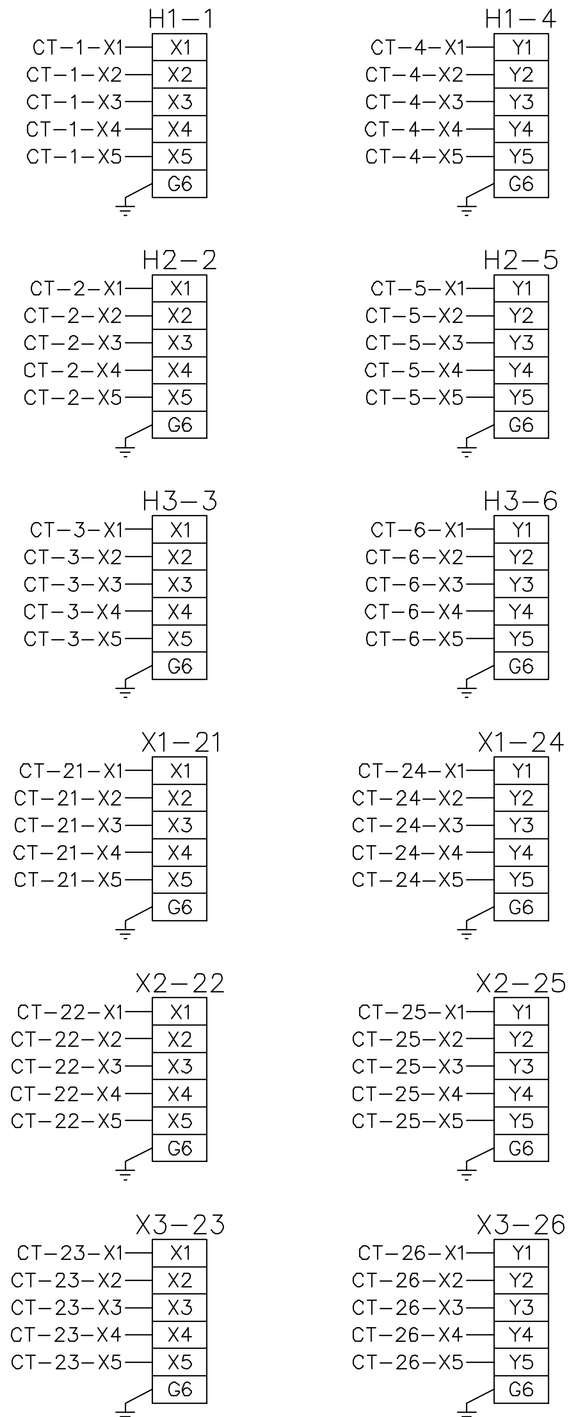

Figure 2—Typical Connection Diagram for CT Terminal Blocks

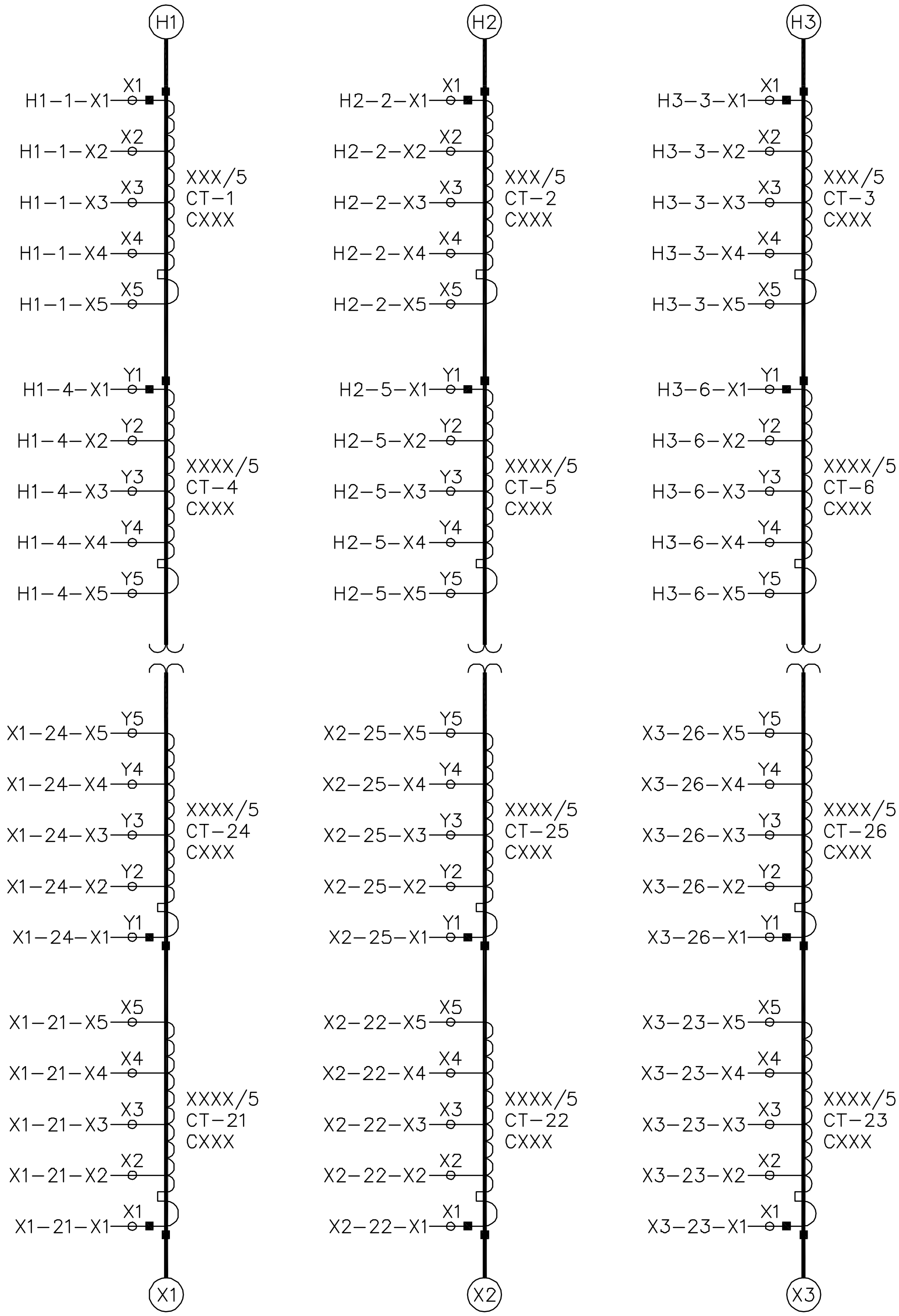

Figure 3—Typical CT Location Diagram

7.5 Auxiliary Equipment Voltages

All output contacts for PacifiCorp use shall be rated for operation at a supply voltage up to 125 VDC. All equipment shall be capable of being operated at voltages up to 140 VDC when the station battery is being equalize-charged. All other auxiliary equipment shall be rated for operation with the AC and DC power supplies specified in Section 16.18 of this document. PacifiCorp will furnish the AC and DC supplies.

7.6 Wiring

7.6.1 General Requirements

The auxiliary power and control wiring shall consist of stranded copper conductor, 600-volt class, XL-insulated, type SIS or approved equivalent, with insulation (or outer covering over the insulation) that is flame-retardant, heat-resistant, oil-resistant, and moisture-resistant. Each terminal block point shall be clearly marked with the designation shown on the supplier's wiring diagrams. Each end of each conductor shall be clearly marked with two designations: the designations of the terminal block points at both the origin and the destination of the conductor. The wiring for all power circuits shall be run in a separate conduit from the wiring for control and alarm circuits.

Wiring runs outside of weatherproof enclosures shall be in rigid steel conduit or flexible, ultraviolet-resistant, waterproof, properly attached conduit capable of mechanically protecting cables from physical damage. All conduit, fittings and connections shall be weatherproof, and all conduit connections to the enclosures shall be on the sides or bottom (not on the top) of the enclosures. For rigid conduit, all conduit and fitting connections shall be threaded; compression connections are not acceptable. All conduit- and raceway-cut ends shall be reamed or otherwise finished smooth to remove rough edges. Also for rigid conduit, a condulet outlet body (with angled, domed cover) shall be furnished at each 90° change of direction; 90° bends in the conduit itself are not acceptable.

The wiring materials and installation shall comply with the requirements of NFPA 70, except that the conductor fill in all conduit (calculated by area) and in all associated fittings and enclosures (calculated by volume) shall not exceed 25 percent. All exposed live parts in the control compartment or other auxiliary compartments operating above 150 V to ground shall be guarded as specified in IEEE C2.

7.6.2 Terminals and Terminal Blocks

All wires shall be terminated with uninsulated, seamless, ring–tongue compression terminals, of an approved type; except where a device has terminal mountings with nonremovable screws, the compression terminals shall be uninsulated, seamless, and fork–tongued. Each terminal shall be the proper size for the associated wire, each terminal shall be installed on only one wire, and the terminal installation on the wire shall be accomplished using the terminal manufacturer's recommended crimping tool with a full-cycle ratchet mechanism.

All terminal blocks shall be one-piece molded type, rated 600 volts, 30 amperes, equipped with #10–32 washer-head binder screws with slotted head, and suitable for wire sizes #18 (0.823 mm^2) through #10 (5.26 mm^2) AWG. Extra terminal blocks shall be furnished and installed as spares for PacifiCorp's use; the quantity of spare terminal blocks shall be at least 10 percent of the total quantity of PacifiCorp-interface terminal blocks furnished for the necessary factory wiring.

The terminal blocks shall be GE type EB–25 or EB–27, Buchanan type 2B or 4B, or Penn Union catalog #6006 SCS shorting terminal blocks or catalog #6006 non-shorting terminal blocks. Terminal blocks from other manufacturers that are functionally equivalent to GE, Buchanan, or Penn Union can be used following review and approval by PacifiCorp.

All non-PacifiCorp-interface terminations shall also be made on suitable terminal blocks; no wires shall be spliced.

All current transformer secondary leads shall be wired to short-circuiting type terminal blocks in the control compartment. A separate six-point terminal block, complete with shorting screws, shall be furnished for each current transformer, and all current transformer secondary wiring shall be #10 (5.26 mm^2) AWG.

7.6.3 Fan and Pump Wiring

The wiring to each cooling fan shall consist of an approved type power cord with a weatherproof plug and receptacle at the fan to provide a convenient and independent means for disconnection.

The wiring to each circulating pump, as applicable, shall consist of an approved type power cord with a weatherproof plug and receptacle at the pump to provide a convenient and independent means for disconnection.

7.7 Control Compartment

A NEMA 4 control compartment shall be furnished to house cooling equipment control devices and terminal blocks for terminating all auxiliary wiring. PacifiCorp will bring all external auxiliary power and control wiring in conduit to the control compartment; the compartment shall be furnished with a removable bottom plate for drilling by PacifiCorp. The compartment door shall be vertically hinged, removable, and operated by a single handle.

The controls, terminal blocks, and other devices requiring access for operation and maintenance shall be mounted in the compartment at a height less than 6 feet (1.83 m) above foundation level. The bottom elevation of the compartment shall be situated to connect to the existing bottom entry electrical conduits installed on the existing transformer.

The compartment shall be furnished with two 240 VAC space heaters. One heater shall be connected to operate continuously. The second heater shall be controlled by a thermostat; the thermostat shall be adjustable, and the adjustment provisions shall include clear indication of at least three specific temperatures on the adjustment range. Alternate heating options will be considered for approval.

The compartment shall be furnished with one 120 VAC, 20 A, industrial grade, duplex convenience receptacle as shown in Figure 4 below.

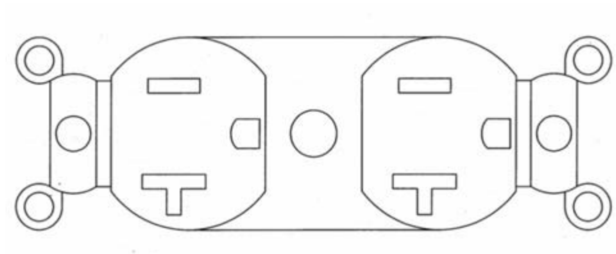

Figure 4—120 VAC Duplex Receptacle

The PacifiCorp equipment number (see Section 16.1.1 of this document) shall be stenciled on the control compartment door.

The control cabinet(s) shall be oversized, and shall include NEMA 4 rated window(s) to allow the annunciators' indicating lights to be viewed without opening the control cabinet door.

7.8 Core Ground

The core ground shall be external. For each core section, a separate insulated cable shall be furnished for grounding. These cables shall be brought up to a location near the top of the tank and there connected together; this connection shall be removable, and shall be designed with captive hardware. The connection location shall be easily accessible from a manhole or handhole on the transformer cover, and the location shall be clearly identified on the transformer nameplate and marked on the appropriate manhole or handhole cover.

A single insulated cable shall be brought from the connection location described above to a single core ground bushing mounted on the tank cover or near the top of the tank wall, with a removable strap between the external bushing terminal and the tank. If more than one core ground bushing is required, all shall be located in the same area. The bushing(s) shall be located and labeled to avoid confusion with other bushings, and shall be protected with a removable, weatherproof metal cover. The transformer shall be shipped with this bushing installed. The core ground bushing shall be rated 2.5 kV for 1 minute.

An instruction plate shall be furnished and mounted near the core ground bushing specifying that the external bushing terminal must be connected to the tank whenever the transformer is energized. The same instructions shall be shown on the main transformer nameplate.

In core form transformers, the core frame ground shall be independent of the core ground. These grounds may be combined in one junction box if both bushings and links are clearly and permanently identified.

7.9 Insulating Oil

The supplier shall furnish the necessary quantity of insulating oil (independently of the party responsible for shipping or installing the transformer). The oil shall meet the requirements of PacifiCorp Material Specification ZS 061.

7.10 Oil Preservation System

As specified in Section 16.21 of this document, one of the following oil preservation systems shall be furnished. The design and mounting arrangement of the associated pressure-vacuum gauge shall permit reading the dial from the ground. The transformer shall be shipped with the pressure-vacuum gauge installed.

7.10.1 Conservator

7.10.1.1 Conservator System

A conservator system shall include a conservator tank with a nitrile or urethane bladder. The air space inside the bladder shall be vented to outside air through an approved desiccant-type breather. One conservator tank is preferred. As an alternate arrangement, if necessary or advantageous for the transformer design, the supplier may furnish two conservator tanks. A conservator tank located directly above the transformer is not acceptable. The conservator tank shall be sized to accommodate a volume change over a temperature range of –40°C to 125°C.

The tank and its mounting bracket shall be removable. A handhole shall be provided on the end of the conservator, sufficiently sized for installation or removal of the bladder.

The conservator tank(s) and supporting structure(s) shall not conflict with mounting and proper use of PacifiCorp's fall arrest equipment (see Section 7.17 of this document) and safety railing equipment (see Section 16.24 of this document), or with convenient, workable access to the necessary manholes and handholes (see Section 7.11 of this document). The conservator tank(s) shall not be located on the same side of any of the bushings brought out the top of the tank, including the tertiary when specified. The conservator tank and any piping associated with the tank shall fit within the existing oil containment.

For each conservator tank, the bladder shall be designed for flange installation (clamps are not acceptable), and shall be sealed to prevent contact between the oil in the conservator tank and the air. In terms of total oil temperature, each conservator tank shall be of sufficient volume to operate through an oil temperature range as specified in Section 16.6 without causing the low-oil-level alarm contacts to close and without exceeding the recommended maximum oil level. The bottom of each conservator tank shall be at a height sufficient to ensure an adequate oil level for bushings with draw-lead or draw-rod connections, and to ensure that the bushing current rating is not deficient. Each conservator tank shall be designed for full-vacuum filling with pressures equalized inside and outside the bladder.

For each conservator tank, the opening to the oil line at the bottom of the tank shall be shielded to prevent being closed off by the bladder in the event of a drop in the oil level below that point.

For each conservator tank, the desiccant container in the air-space vent line shall be located so it can be safely maintained from ground level with the transformer energized.

A temporary pressure-vacuum gauge shall be furnished for monitoring the pressure in the main transformer tank during shipment. The gauge shall be of an approved type, with a dial range of ±10 psig (±0.7 atm gauge).

Refer to Section 7.13 of this document for specific requirements related to the field processing and filling procedure.

7.10.1.2 Gas Collection Design

The transformer shall be designed to provide for gas collection adequate for transformer protection purposes. Specifically, the transformer shall be furnished in accordance with the requirements described below and in Section 11.6 of this document.

The transformer cover shall have a minimum upward slope of three degrees from the outer edges of segments 1 and 3 (of Figure 1) of the cover toward the center of the cover. Gas collecting ports shall be furnished on the central ridge of the cover at intervals not exceeding 30 inches (762 mm). In addition, all manholes and bushing turrets shall have collecting ports. All collecting ports shall be connected to the gas detector chamber (see Section 8.6 of this document) with piping having a minimum upward slope of three degrees. All gas piping, fasteners, and hardware shall be stainless steel with compression fittings (see Section 7.16 of this document).

7.11 Tank Design

The transformer tank shall be designed for full–vacuum filling. The main tank cover and all tank joint flanges shall be welded.

Except for welding associated with a shipping cover (see Section 15.5 of this document), any requirement for field welding on a tank surface adjacent to the tank interior is not acceptable.

All external supports or stiffeners shall be of box-beam construction, continuously welded, and not pressurized, to provide sufficient support. The tank shall be designed to withstand a minimum internal operating pressure of 10 psi.

Manholes and hand-holes shall be furnished and located to provide convenient, workable access to the interior of the tank for all necessary installation and maintenance procedures, including items such as terminal board connections, internal bushing terminal connections, removal and replacement of bushing current transformers, and full personnel access for internal inspection. Each manhole and hand-hole shall be furnished with a gasketed, bolted cover, with lifting eyes if necessary to conveniently handle the weight.

Manholes, hand–holes, and all other openings in the tank cover which employ gaskets shall be raised at least 0.75 inches (19.05 mm) above the cover surface to prevent moisture accumulation around the gasket joints.

All openings in the tank for personnel entrance and egress shall be designed with a minimum internal diameter of 24 inches. A warning sign shall be placed adjacent to each opening that can be used as a personnel entrance, stating that confined space entry procedures are to be followed before entering. The word “danger” shall be included, in white letters on a red background.

The transformer shall be furnished with a permanent base suitable for moving the fully assembled transformer, full of oil, on rollers in a direction parallel to either axis of the transformer. The transformer base shall be designed such that it can support the weight of the transformer when installed upon either of two types of concrete foundations: rectangular (flat), or spread-footing type (with walls that extend above-grade).

The transformer centers of gravity, horizontal and vertical, both as prepared for shipment and as completely assembled for service, shall be clearly identified and marked on appropriate instruction plates mounted on the segment 1 or 3 side (of Figure 1), and on the segment 2 or 4 end of the tank wall.

Facilities for lifting and moving the complete transformer shall be suitable for handling the transformer filled with oil. Lifting bolts not designed for lifting the full weight of the transformer shall be clearly labeled as such. The jacking pads shall be no less than 18 inches (457 mm) and no greater than 24 inches (610 mm) above foundation level.

The transformer tank shall be designed with sufficient oil-overfilling volume to temporarily hold radiator oil during long-term storage so that when radiators are installed, no additional oil shall need to be added. The transformer tank shall be designed to handle foundation pad deviations of up to $^1/_8$-inch under a ten-foot straight edge section.

All internal/external connections made on the tank, such as CT junction boxes or core ground bushings, shall be located just below the tank cover on the side or on the cover of the transformer tank.

Four ground pads shall be provided – one on each corner of the transformer tank near the base. Each pad shall be suitable for a NEMA 2–hole grounding terminal.

The corner joints of the tank shall not be butt welds. Corner joints may be formed of a single piece of steel or of panels intersecting in a “T” with inside and outside welds. Welders are to be certified in accordance with AWS D1.1, or equivalent.

7.12 Valve Requirements

All valves shall be full port. All valves shall be ball-type except the combination drain and lower filter valve described below, and the radiator valves if applicable. All valves open on one or both sides to the interior of the transformer tank or other oil–containing components, shall be flange-mounted, with gasket, on the side(s) open to the interior; threaded fittings are not acceptable.

The upper filter valve shall be located on the tank cover in segment 1 (of Figure 1) in accordance with ANSI C57.12.10, and the valve size shall be two-inch (51 mm). The valve shall be installed at a 90° angle to the tank cover to allow for easy access to oil-filling equipment. An angled bracket shall be welded inside the tank below the valve to spread the oil during filling. If a conservator oil preservation system is specified by PacifiCorp or selected by the supplier in accordance with Section 16.21 of this document, a four-inch (102 mm) valve for vacuum connection shall be furnished on the tank cover in segment 3. The valve shall be installed at a 90° angle to the tank cover with a four-inch, female, camlock fitting and plug, located as far away from the upper filter valve as possible.

The two combination drains and lower filter valves shall be globe-type, two-inch (51 mm) and shall be located, one each, in segments 3 and 1. A 90° elbow assembly shall be furnished on the interior side of the valve, oriented downward with the bottom face (opening) of the elbow assembly parallel to the bottom of the tank to allow pumping the oil out of the transformer to within 3/8–1/2” (10–13 mm) from the bottom.

A two-inch sampling ball valve shall be furnished within the bottom third of the transformer tank wall.

7.13 Valves and Field Oil-Filling Procedure for Transformer with Conservator System

If a conservator oil preservation system is specified by PacifiCorp or selected by the supplier in accordance with Section 16.21 of this document, the transformer will be field processed and filled with oil in accordance with the procedure specified in this section. The supplier shall furnish the specified valves and design the transformer for convenient application of the specified procedure.

The list below describes the procedure. See Figure 5 for the valve locations and Table 2 for the initial valve positions.

1. Verify that all devices that cannot withstand full vacuum are isolated, including the rapid-pressure-rise relay(s).
2. Remove the de-hydrating breather and install a nitrogen cylinder or dry air cylinder.
3. Start the vacuum pump.
4. After the required vacuum has been reached, introduce oil through valve 6.
5. Fill with oil to approximately 2 inches (51 mm) below the main cover.
6. Close valve 1 and shut down the vacuum pump.
7. Close valves 5 and 7. Remove the sight tube.
8. Open valve 3 to equalize the pressure between the conservator bladder and tank.
9. Open valves 5 and 9.
10. Close valve 4 and pressurize the bladder to 0.5 psig.
11. Feed additional oil until air is bled off at valves 5 and 9. Close valves 5 and 9.
12. Close valve 3 and disconnect the nitrogen cylinder or dry air cylinder.
13. Slowly open valve 3 to release the pressure on the bladder.
14. Continue to feed oil until the oil level is approximately at the 25°C level.
15. Adjust the oil to the correct level based on temperature. Use the oil level gauge to determine the level. Close valve 6.
16. Reconnect the de-hydrating breather to valve 3.
17. Bleed all cover items that do not have piping to the gas detector relay.
18. Verify that the oil level is at the 25°C level, that all valves are set to the normal transformer operating positions, and that all devices isolated in step 1 above are returned to normal operation.

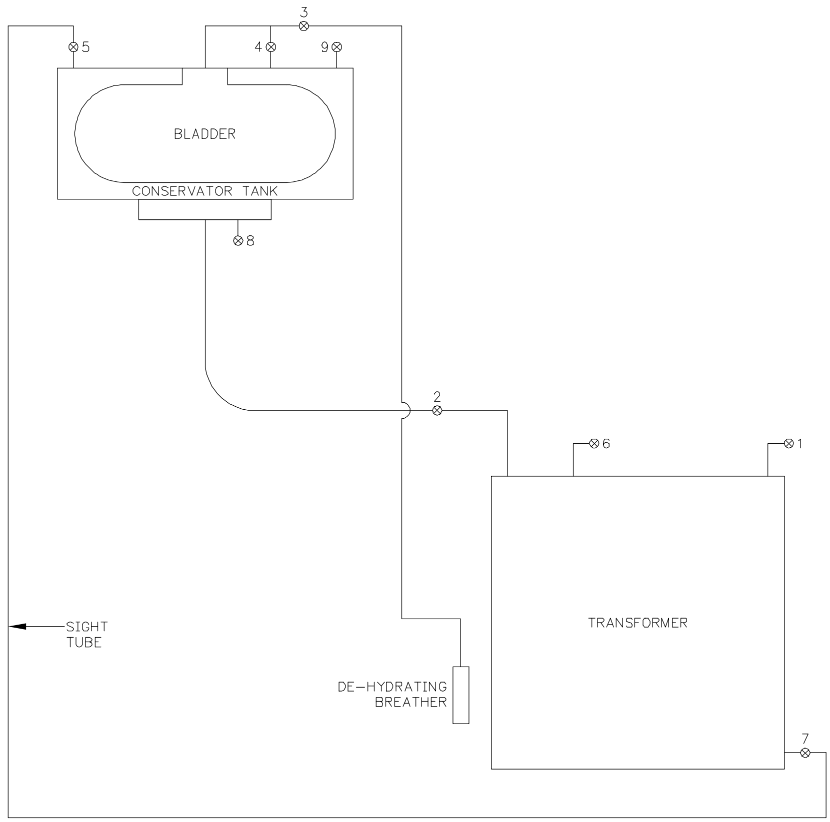

Figure 5—Valve Location Schematic Drawing

Table 2—Initial Valve Positions For Pulling Vacuum

Valve No.	Position	Function
1	Open	Permanent valve for vacuum connection
2	Open	Connecting valve between conservator and main tank
3	Closed	Connects to de-hydrating breather
4	Open	Equalizing valve between bladder and conservator
5	Open	Connects to temporary sight tube
6	Open	Upper filter valve; connects to oil supply hose
7	Open	Drain and lower filter valve; connects to temporary sight tube
8	Closed	Conservator drain valve
9	Closed	Conservator vent valve

7.14 Gaskets and Internal Washers

All gasketed surfaces shall be designed with gasket grooves. Gasket stops are not acceptable. Internal split-lock washers are not acceptable. All gaskets shall be Buna-N rubber, unless otherwise specified.

7.15 Welds

For all components and accessories attached by welding, the welds shall be continuous; spot welds are not acceptable.

Pipes placed through penetrations of the tank for valves and gauges shall be welded on both the inside and outside of the tank walls.

All oil-sealing welded joints shall be welded inside and outside with continuous bead welds.

7.16 Exposed Fasteners and Hardware

With the exception of nuts, all exposed fasteners and hardware (such as bolts, screws, washers, hinges, handles, brackets, and ground pads) shall be 300-series stainless steel, if not welded. If welded, 304L stainless steel shall be used. All nuts shall be silicon-bronze to prevent galling. Other stainless steel grades will be considered if equivalence to U.S. grades can be demonstrated. If supplier prefers, the ground pads may instead be copper-faced steel as permitted by ANSI C57.12.10.

7.17 Fall Arrest Equipment Base Plate

The supplier shall furnish a weld-on base plate of approved type on the top of the transformer cover for each manhole cover. The plate shall be permanently welded in a location not more than 12 inches (305 mm) from each manhole cover, and shall comply with all requirements for fall arrest and confined space rescue as determined by Pelsue, the manufacturer of PacifiCorp's OSHA-certified fall arrest equipment.

7.18 Safety Railing Equipment

If specified in Section 16.24 of this document, the supplier shall supply safety railing equipment designed to provide perimeter fall protection for personnel on the tank cover, and to prevent tools from falling off the cover. The equipment shall comply with OSHA requirements.

The safety railing equipment shall consist of posts located around the perimeter of the top of the main tank, three separated courses of rope barrier supported by eyes on the posts, and a kickboard located along the perimeter of the main tank cover (see Figure 6 and Figure 7).

The railing posts shall be arranged for temporary installation on permanent supporting studs near the top of the tank side walls. The posts will be removed before energizing the transformer. The spacing between all other posts shall be as convenient for the transformer design, but not more than approximately 48 inches (1.2 m). Each post shall be round aluminum pipe, 1.5-inch (38.1 mm) ID, 52 inches (1.32 m) long, with three vertical eyes (1-inch / 25.4 mm ID) welded in line on the side of the post facing the transformer to support the rope; the eyes shall be located at 20, 35, and 50 inches (0.51, 0.90 and 1.27 m) from the bottom of the post. Two inches (51 mm) from the bottom of each post, the post shall be drilled in the direction parallel to the tank side wall, and a pin shall be furnished for securing the post to the supporting stud; to avoid loss, the pin shall be attached to the post by a short length of small chain. All welds shall be ground smooth, and the edges on both ends of each post shall be ground and reamed smooth for safety.

The supporting stud furnished for each post shall be welded to a standoff bracket welded to the tank side wall, with the top of the stud level with the top of the tank cover. Each stud shall be 1.4375-inch (36.5 mm) OD, 4 inches (102 mm) long, and drilled in the direction parallel to the tank side wall for the post securing pin. Each stud shall be located so as not to interfere with any transformer component or hardware, and so that there will be a gap between the installed post and the edge of the tank cover of approximately 0.5 inch (13 mm).

The kickboard shall be furnished in removable sections along the entire perimeter of the tank cover. The kickboard shall be mounted by bolting to permanent supporting brackets welded in place near the edge of the cover. The kickboard will remain in place when the transformer is energized, and therefore shall be taken into account in the design of electrical clearances; the kickboard is intended to be temporarily removed only when necessary, such as for any modifications. The kickboard shall consist of vertical 0.25 x 3 inch (6.36 x 76.2 mm) steel bar. The spacing between the mounting brackets shall be as convenient for the transformer design, but not more than approximately 24 inches (610 mm). The bracket design shall be such that the bottom edge of the kickboard will be supported approximately 0.5 inch (13 mm) above the surface of the main tank cover to allow for drainage.

The rope shall be of approved type, 0.5-inch (13 mm) diameter, 3-strand, polypropylene-polyester combination, and white color with red marker. Each rope will be tied off so that it is taut, with a maximum deflection (including the free hanging sag in the rope) of 3 inches (76.2 mm) in any direction when a load of 200 pounds (91 kg) is applied in any direction at any point on the rope.

An aluminum cabinet shall be furnished and mounted on the transformer to store the removable equipment.

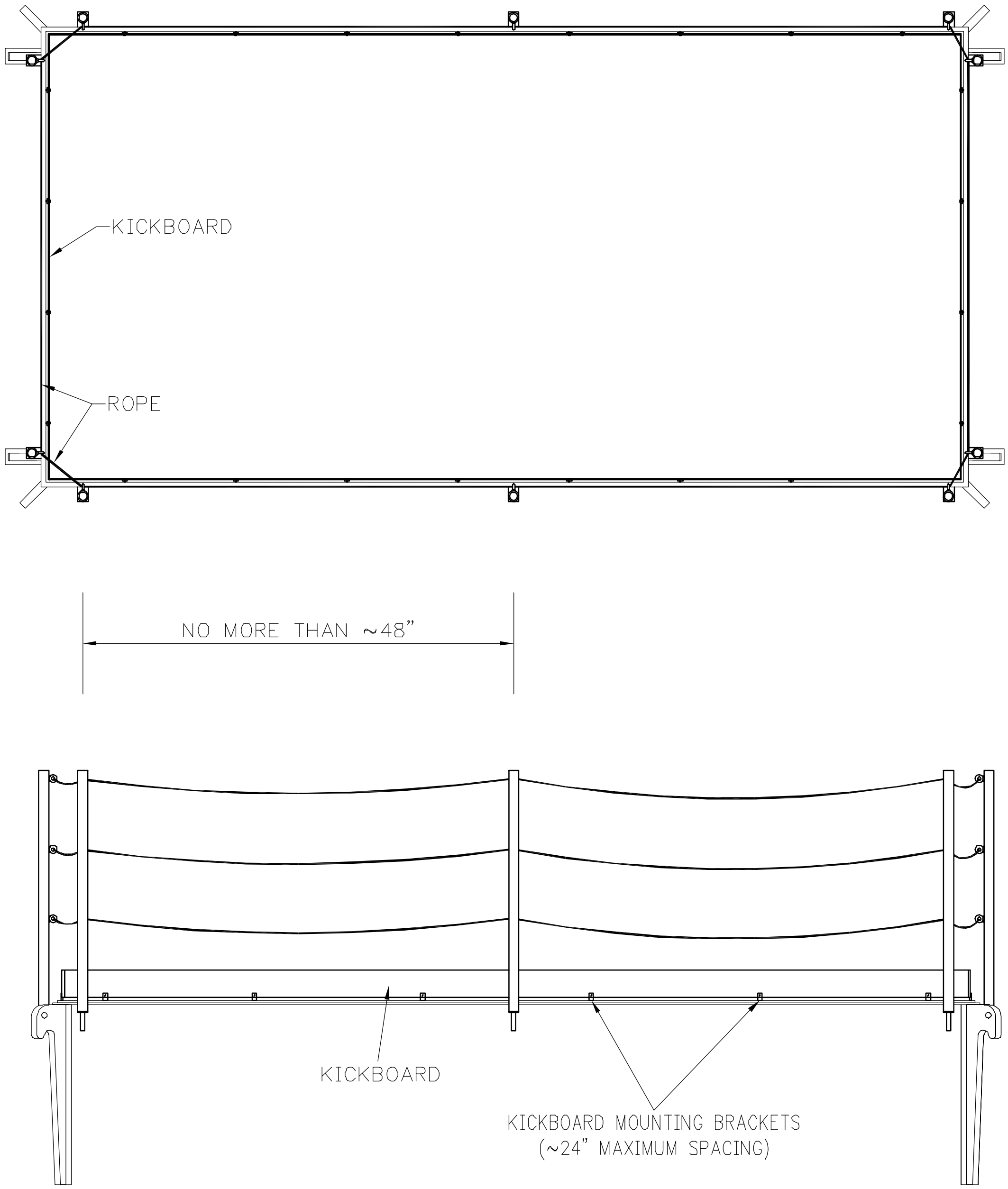

Figure 6—Safety Railing System Overview

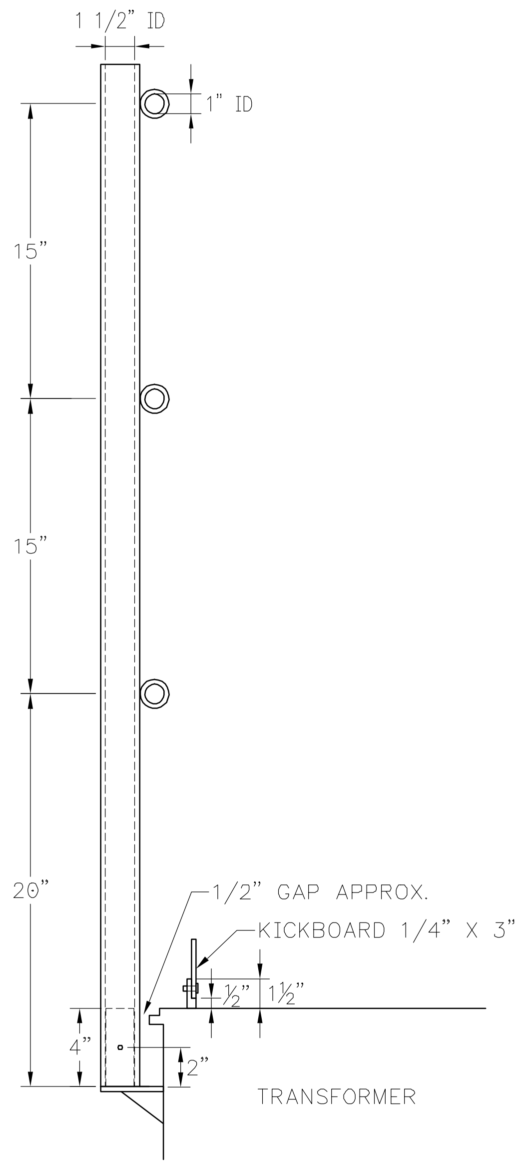

Figure 7—Safety Railing Post and Kickboard Detail

7.19 Accessory and Spare Part Storage

An aluminum cabinet shall be furnished and mounted on the transformer to store the small accessories and spare parts which are not normally attached or in service. This includes, but is not limited to, spare gaskets, blanking plates for the radiators and bushing turrets, etc. Instead of a separate cabinet, extra space may be provided in the aluminum cabinet already being furnished for the removable safety railing equipment but there shall be enough space to store all of the accessories and spare parts. All accessories shall be stored in such a manner that they can be easily removed from or returned to storage without causing damage to those parts or accessories or other parts or accessories stored in the same location. Gaskets and other environment-sensitive parts or accessories shall be packaged such that they are protected from damage or deterioration. The storage cabinet(s) shall be located such that parts and accessories can be accessed without interfering with the normal operation of the transformer.

7.20 Bolted Connections

For both metallic and non-metallic bolted connections, a minimum of three bolt threads shall extend beyond the end of the nut.

7.21 Gauge and Indicator Positioning

Gauges and indicators mounted to the transformer shall be positioned for easy reading from ground level. Gauges and indicators shall be such that the information needed is provided on the gauge or indicator; tables or charts shall not be required to interpret the gauge or indicator.

8 Other Auxiliary Protection Device Requirements

8.1 Auxiliary Device Contacts

All auxiliary device contacts shall be normally open and ungrounded. Both sides of each contact shall be isolated from all other contacts and independently wired to terminal blocks in the control compartment. All contacts specified to be used to trip PacifiCorp's switching device shall be non-failsafe.

8.2 Indicating Lights

All indicating lights shall be long-life, high-visibility LEDs.

8.3 Oil Level Indication

A dial-type oil level indicator of an approved type shall be furnished on the main transformer tank, or on each conservator tank, if applicable. Each indicator on a conservator tank shall be shielded to prevent the bladder from interfering with the operation of the indicator.

Each indicator shall be 6 inches (152 mm) with a lever drive, two contacts, and a compatible connector and cable. The indicator mounting arrangement shall permit reading the dial from the ground. Each oil level gauge shall have a 25°C mark.

For all transformers, one contact shall be set to close at the minimum safe operating level, and will be used to activate PacifiCorp's alarm. The second contact shall be set to close at a level below the minimum safe operating level but above the level that would result in transformer failure, and may be used to trip PacifiCorp's switching device.

8.4 Main Tank Pressure Relief Device(s)

A self-resealing mechanical pressure relief device(s) of an approved type shall be furnished on the main transformer tank, as specified below. Each device shall be set to operate at 10 psig (0.68 atm gauge). Each device shall be furnished with an integral directional shield that can be rotated 360 degrees, a high-visibility indicator pin and alarm contact mounted on the shield, and a compatible connector and cable. The mounting location of each device shall be so as to ensure visibility of the indicator pin from the ground.

For three-phase units, if the H-terminals are rated for a nominal system voltage of 345 kV or above, three pressure relief devices shall be furnished. If the H-terminals are rated for a nominal system voltage below 345 kV, one pressure relief device shall be furnished for each 10,000 gallons (38 000 liters) (or a fraction thereof) of insulating oil in the main tank and oil preservation and cooling systems.

The pressure relief device shall be mounted on the top of the transformer near the tip of the side wall of the main tank. The electrical connector and the 8-inch (203 mm) opening in the shield on each device shall be pointed directly down. If more than one device is furnished as specified above, the devices shall be installed at widely separated locations along the perimeter of the tank wall, and the alarm/trip contacts shall be wired in parallel so that closing of any contact will activate the alarm/trip.

A steel pipe, 8-inch ID (Ø203 mm bore), shall be furnished to conduct the effluent from the 8-inch (203 mm) opening in the shield on each device, down the side of the transformer, to a point approximately 18 inches (460 mm) above the transformer base. The pipe bottom shall be directed to an area along the transformer base where PacifiCorp personnel access is not frequently required, such as between radiators. Directing the pipe to a point near the control cabinet, for example, is not acceptable. The pipe shall be securely mounted to the shield, securely supported by brackets attached to the transformer tank, and furnished with a stainless steel screen at the bottom end.

Two sets of contacts shall be provided in the control cabinet for each device and shall be wired in parallel. One set will be used to activate PacifiCorp's alarm and the other set may be used to trip PacifiCorp's switching device.

8.5 Main Tank Rapid-Pressure-Rise Relay

One oil-space, rapid-pressure-rise relay or provisions for such relay, as specified in Section 16.19 of this document, shall be furnished on the transformer tank, located near the control compartment and approximately seven feet (2.1 m) above foundation level.

The rapid-pressure-rise relay shall be of an approved type, vented, with bolted-flange mounting, one normally open and one normally closed contact, provisions for testing relay operation without removing the relay from the transformer, and a matching connector-and-cable assembly. One seal-in relay of an approved type shall be furnished in the control compartment for the rapid-pressure-rise relay.

A suitable two-inch (51 mm) ball valve shall be furnished for mounting the rapid-pressure-rise relay, to permit removing the relay without draining oil from the transformer tank. The valve shall have provisions for padlocking in both the fully opened and fully closed positions.

Provisions for future installation of the rapid-pressure-rise relay shall include the following furnished on the transformer: the ball valve, the terminal blocks necessary to complete all future wiring, and provisions for future installation of the seal-in relay.

8.6 Gas Detector Relay

If a conservator oil preservation system is specified by PacifiCorp or selected by the supplier in accordance with Section 16.21 of this document, one gas detector relay of an approved type shall be furnished.

8.7 Alarm Monitor

If specified in Section 16.20 of this document, an approved type 12-point alarm monitor shall be furnished. The monitor shall include the following for each point:

1. One input contact
2. An individual indicating long-life, high-visibility LED
3. Individual points labeled as specified below
4. One retransmitting auxiliary contact

The monitor shall be mounted in the control compartment in such a manner that the monitor will be readily visible through the window when the compartment door is closed; the monitor shall not be located behind a hinged panel or other concealment. The supplier shall furnish individual wiring of alarm circuits from dedicated alarm terminal blocks in the control compartment to the monitor, and individual wiring from the monitor retransmitting auxiliary contacts to a separate terminal block in the control compartment for PacifiCorp's use.

Applicable alarms shall be arranged on the monitor as specified in Section 16.20, and each point shall be labeled with the identification wording shown. In some cases more than one alarm is specified on a single point with the intent that any one of the specified alarms will activate that point. All unused points shall be grouped together at the bottom of the monitor and shall serve as spares (with blank nameplates) or may be used by the supplier for other necessary alarms.

The supplier shall provide three CDs containing software and instructions and three cables to connect the monitor to a laptop. The monitor shall be programmable from a local push button or touch screen.

8.8 On-Line DGA Monitor

All power transformers rated 345 kV and above shall be furnished with an approved on-line DGA monitor capable of monitoring eight or more gases. If the transformer is below 345 kV but has one or more of the features specified in Section 16.28, an approved on-line DGA monitor shall be furnished. The monitor shall be mounted to the tank with mounting brackets solidly mounted near the corner of the transformer on a stiffener and a dampening mounting structure to prevent vibration transfer to the monitor. The supply and return valves shall be located near the monitor. A set of contacts and a breaker shall be furnished in the control cabinet for providing power to the monitor. The DGA monitor should have communication ports available for remote monitoring of data and alarms. The preferred communication protocols are DNP3.0 and IEC 61850 via RS232, RS485, and Ethernet.

If a monitor is not specified, provisions for future installation of a monitor shall be provided. The future provisions, at a minimum, shall consist of the appropriate valves to properly install the monitor in the field. The supply and return valves shall be two inches (50.8 mm), located within the same area of the transformer tank and located near the control cabinet for convenience. The return valve shall be located near the bottom of the tank, within 1.64 feet (0.5 m) of ground level, and the supply valve shall be approximately 6.56 feet (2 m) from ground level. An area close to the valves and control cabinet shall be left clear and without gauges, controls or other necessary access points to the transformer that the monitor stand may possibly obstruct. The future provisions shall also include a set of contacts and a breaker in the control cabinet for providing power to the monitor.

8.9 Winding Temperature Simulation System

In addition to the temperature monitor specified in Section 5.1, a dial-type winding temperature simulation system shall be furnished on the transformer tank. The simulation system shall be provided with up to four contacts wired to terminal blocks in the control cabinet, a lever drive, and compatible connectors and cables. The outputs shall be wired in parallel to the temperature monitor outputs as described in Section 5.1.5. The indicator mounting arrangement shall permit reading the dial from the ground. The resistance temperature detectors (with associated thermowells) and CTs shall be furnished as specified in Sections 5.1 and 16.18.

9 Nameplate Requirements

9.1 General

All wording on transformer and accessory identification labels, nameplates, and instruction plates shall be in English only (all numerical values shall be in U.S. customary units only).

9.2 Main Transformer Nameplate

The main transformer nameplate, as shown in Figure 8 and titled "Power Transformer," shall be furnished and mounted externally on or near the control compartment in a location to permit reading from the ground. Information shown on the nameplate shall include the following items in addition to or in clarification of those specified in IEEE C57.12.00.

1. PacifiCorp equipment number;
2. rated elevation;
3. rated daily minimum and daily peak ambient temperatures;
4. transformer winding and current transformer polarity marks;
5. applicable instructions concerning the core ground bushing (see Section 7.8);
6. weight of the transformer prepared for shipment;
7. listing of the separate volumes and weights of oil in the main transformer tank, the radiators, and the conservator tank(s) if applicable, and
8. seismic rating level the transformer is designed to withstand as specified in ZS 065.

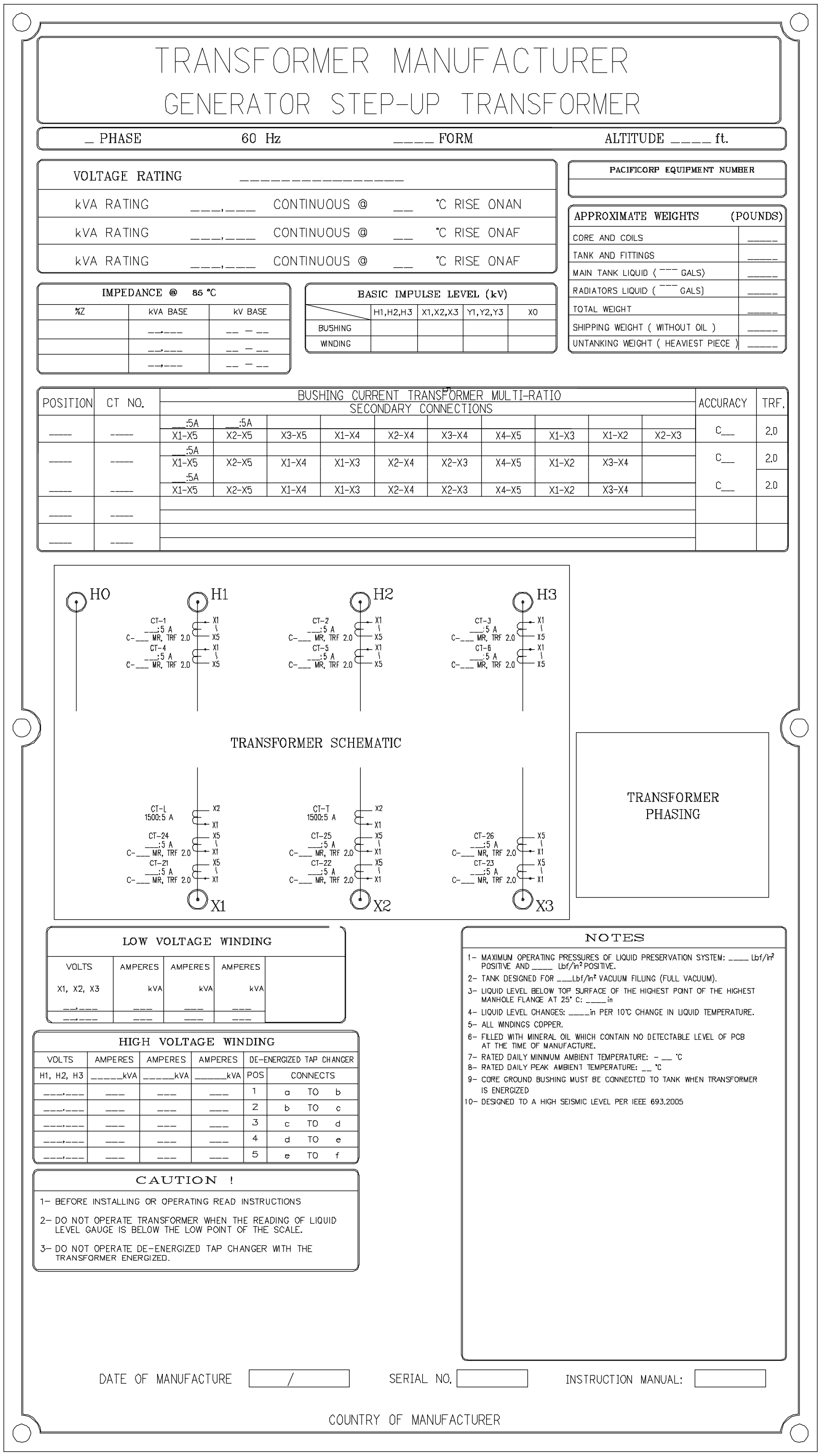

Figure 8—Main GSU Transformer Nameplate Example

9.3 Valve Identification and Location Nameplate

A separate nameplate showing the valve locations, titled “Valve Identification and Location”, shall be furnished and mounted externally near the main transformer nameplate in a location to permit reading from the ground. The nameplate shall include a transformer outline drawing showing the location of all valves, and a chart identifying the type, size and purpose of each valve and specifying the initial position of each valve for the field oil-filling procedure and the position of each valve when the transformer is energized.

9.4 Field Oil-Filling Procedure Nameplate

For a transformer with a conservator system, a separate nameplate describing the field oil-filling procedure, titled “Field Oil-Filling Procedure”, shall be furnished and mounted externally near the main transformer nameplate in a location to permit reading from the ground. The nameplate shall include the following from Section 7.13 of this document: the complete procedure as listed in steps 1 through 17, the valve location schematic drawing similar to that shown in Figure 5, and the list of initial valve positions as shown in Table 2. In the list of initial valve positions, the supplier’s valve numbers (from the supplier’s drawings) shall be shown next to the corresponding PacifiCorp valve numbers 1 through 10 where applicable.

9.5 Auxiliary Device Nameplates

Meters, relays, circuit breakers, controls, switches, and instruments shall be identified with nameplates specifically naming the device they control. The nameplate material shall be engraved laminated plastic (or an approved equivalent), with white letters on a black background. Minimum letter height shall be $^1/_8$ inch, and nameplate edges shall be beveled.

10 Finish Requirements

10.1 Tank Exterior Finish and Porcelain Color

The transformer tank exterior paint finish, the surge arrester ground-bus-bar paint finish, and all bushing and surge arrester porcelain shall be ANSI 70/Munsell 5.0 BG 7.0/0.4 light gray unless otherwise specified in Section 16.30. The exterior paint on the transformer cover shall be a nonskid composition.

10.2 Tank Interior Finish

The transformer tank interior and winding clamps shall be painted white.

11 Special Test Requirements, Measurements, and Calculations

11.1 General

All applicable standard and special test requirements apply to each transformer, whether manufactured separately from, or simultaneously with, other identical units. All test results, measurements, and calculated values shall be recorded on the supplier's certified test report. A test report summary sheet containing the information shown in Figure 9 shall be provided along with the full and certified test report. All data shall be reviewed by the supplier before the transformer is shipped. Transformers shall not be released for shipping until PacifiCorp Energy has approved the test reports.

If a Y-winding is specified, whether the terminals are specified to be brought out or buried, the Y-winding voltage and capacity ratings shall be shown on the test report.

Transformer Test Report

PacifiCorp W.O. #:		Date	
		Equipment #:	
		Serial #:	

Rating					
Type		Class	H - Winding	X - Winding	Y - Winding
Phase			V	V	V
Hertz			kVA	kVA	kVA
Temp. Rise			kVA	kVA	kVA
Insul. Liquid			kVA	kVA	kVA

ADDITIONAL TAP VOLTAGES	
H Winding	
X Winding	

CONNECTIONS FOR OPERATION						
Transformers in Bank	To Transformer From	Phase	Connected	To Transformer To	Phase	Connected

PERFORMANCE BASED ON A LOADING OF		
H Winding	kV	kVA
X Winding	kV	kVA
Y Winding	kV	kVA

DIELECTRIC TESTS		
Applied Voltage	H Winding	kV
	X Winding	kV
	Y Winding	kV
Induced Voltage	Line to Line	kV
	Line to Ground	kV

INSULATION LEVELS		
ITEMS	Basic Lightning Impulse Insulation Level	Low Frequency Voltage Insulation Level
H line		
H neutral		
X line		
X neutral		
Y line		

PERFORMANCE DATA, Based on	°C Reference Temperature					
Losses and Exciting Current					Regulation	
Excitation	% Ex I	No Load	Load	Total Loss	Power factor	% Regulation
100%					1.0	
110%					0.8	

AUXILIARY LOSSES		
Transformer kVA	Class	Watts Aux. Loss
W		W
W		W
W		W
Average Sound Level		

PERCENT IMPEDANCE VOLTS					
% IZ	Between Windings	At kVA	$\%IZ_0$	Between Windings	At kVA
	H-X				
	H-Y				
	X-Y				

EFFICIENCIES					
Load		Full Load	3/4 Load	1/2 Load	1/4 Load
%					

MECHANICAL DATA (Not For Construction Purposes)		
Outline Drawing No.		
Dimensions (Approximate) Ft (m)		
Height	(A)	
Width	(B)	
Depth	(C)	
Height Over Cover	(D)	
Untanking (Plus Slings)	(E)	
Masses (Approximate) pounds (kg)		
Core and Coils		
Tank and Fittings		
Liquid	Gallons (m^3)	
Total Mass		
Shipping Mass lb (kg)		
Shipped lb (kg)		

Figure 9—Test Report Summary Sheet

11.2 Test Sequence

The temperature tests, if specified in Section 16.22 of this document, Table 11 or Table 12, shall precede all dielectric tests. The dielectric tests shall occur immediately following the conclusion of final temperature test so the transformer is still at or near operating temperature.

The lightning impulse tests or quality control lightning impulse tests as applicable, if required by standards or specified in Section 16.22 of this document, Table 11, shall precede the low–frequency dielectric tests.

The switching impulse tests, if specified in Section 16.22 of this document, Table 12, shall precede the low–frequency dielectric tests.

The final dielectric test(s) performed shall be the induced voltage test(s).

11.3 Surge Protection Devices

Internal or external surge protection devices (varistors) shall not be used during transformer testing. It is recognized that in the special case described in Section 4.11, Item 8, the use of internal surge protectors may be necessary. The supplier shall include in the proposal a statement confirming compliance with this requirement.

For lightning-impulse tests, the reduced-voltage waveform and full-voltage waveform must match for a successful test. The reduced current waveform and full current waveform must also match.

11.4 Test Bushings

The bushings, radiators, fans, and any other components installed for transformer tests shall be those that will be furnished with the transformer.

11.5 Dissolved Gas Analysis

A dissolved gas analysis shall be performed on transformer oil samples taken (1) after the unit is filled and before any tests are performed, (2) immediately after the temperature tests at the maximum force-cooled rating, if temperature tests are performed (see Section 16.22 of this document, Table 11 or Table 12), (3) immediately after temperature tests at 125 percent of the maximum force-cooled rating, if this overload test is performed (see Section 11.14.2 of this document), and (4) after all tests have been completed, except the unintentional-core-ground test (see Section 11.22 of this document).

The total measured levels of gasses generated during the temperature tests, sample (2) levels minus sample (1) levels, and sample (3) levels minus sample (1) levels, shall not exceed the limits specified in Table 3.

At least one full set of oil quality tests shall be performed with the dissolved gas analysis.

Table 3—Dissolved Gas Limits

Gas	Maximum Level (PPM) Sample (2) minus Sample (1)	Overload Maximum Level (PPM) Sample (3) minus Sample (1)
Hydrogen (H2)	10	10
Carbon Dioxide (CO2)	200	300
Carbon Monoxide (CO)	20	30
Methane (CH4)	2	2
Ethane (C2H6)	1	1
Ethylene (C2H4)	trace ppm	trace ppm
Acetylene (C2H2)	trace ppm	trace ppm

11.6 Gas Collection Tests

If a conservator oil preservation system is specified by PacifiCorp or selected by the supplier, gas collection test provisions shall be furnished and tests performed as described below. A temporary fitting for gas injection shall be installed at each corner of the tank near the top of the tank wall; these fittings shall be welded closed after the completion of testing. Four separate gas collection tests shall be performed, using in turn the gas injection fitting furnished at each corner of the tank. With the oil circulating pumps turned off and without prior injection of nitrogen, each test shall be performed by rapidly injecting (within 20 seconds) 300 cc, or 100 cc more than the gas detector model’s designed tripping point, of dry nitrogen into one of the gas injection fittings. Each individual test is successful if a trip occurs near the gas detector’s designated trip point within two minutes after injection.

11.7 Positive-Sequence Impedance

Impedance shall be measured on all series, parallel, delta, and wye connections, as applicable. The H-winding to X-winding positive-sequence impedance shall be measured at the de-energized tap nominal-rated voltage connection and de-energized tap extremes.

11.8 Zero-Sequence Impedance

Zero-sequence impedances (both R and X values) shall be measured if the transformer is three-phase core form.

11.9 No-Load Loss and Excitation Current

No-load loss and excitation current shall be measured both at nominal rated voltage and at 110 percent of nominal rated voltage, both before and after impulse tests.

11.10 Loss Compliance

Values of no-load loss and excitation current measured at nominal rated voltage after impulse tests shall be the values used in determining compliance with the supplier’s quoted loss and excitation performance. These values shall not exceed the values measured before impulse tests by more than 7.5 percent.

IEEE tolerances from the supplier's performance quotation for no-load loss at nominal rated voltage shall also apply to the excitation current at nominal rated voltage.

No supplier shall ship to PacifiCorp a transformer that exceeds the quoted loss value by 10 percent or more for no-load losses (NL) or load losses (LL) or by 6 percent or more for total losses (NL + LL).

11.11 Insulation Resistance

Insulation resistance shall be measured at 2.5 kVDC and shall include a 1-minute:10-minute comparative polarization index. The certified test report shall include actual readings and readings corrected to 20 °C. Resistance shall be measured between the windings, and between each winding and ground.

11.12 Power-Factor and Excitation-Current Tests

A power-factor test shall be performed on all windings and bushings at 10 kV. No winding shall exceed a 0.5 percent power factor. For each H-terminal, and for each H-winding connection if series-parallel, an excitation-current test shall be performed at 10 kV on each de-energized tap. Both the power-factor and the excitation-current tests shall be performed using Doble procedures and format. The supplier shall include the original electronic power-factor and excitation-current test results in Doble software format with the certified test report.

11.13 Auxiliary Wiring

Auxiliary wiring shall be tested with 60-hertz voltage of 1500 volts applied for 60 seconds. Test jigs may be used to apply the test voltage to multiple terminals at the same time. "Touch testing" for periods less than 60 seconds is not acceptable.

CT wiring shall be tested with 60-hertz voltage of 2500 volts applied for 60 seconds.

11.14 Temperature Tests

11.14.1 General Test Requirements

The winding average temperature rise for each phase of each winding shall be separately measured at the self-cooled rating and at the maximum forced-cooled rating, as applicable. If any temperature rise on one phase exceeds the corresponding temperature rise on any other phase by more than 4°C, PacifiCorp shall be consulted and further investigative tests shall be performed as necessary.

In addition to all standard temperature test data, the supplier shall furnish the bottom-oil temperature rise corresponding to each value of top-oil temperature rise. The supplier shall also furnish the calculated winding hot-spot temperature rise corresponding to the highest measured value of winding average temperature rise at both the self-cooled rating and the maximum forced-cooled rating.

The sequence of the temperature rise test shall be performed as shown in Figure 10.

An oil leak test shall be performed at the conclusion of one of the heat runs while the transformer is at operating temperature.

11.14.2 Overload Test Requirements

If the H-terminals are rated for a nominal system voltage of 115 kV or above, and the rated self-cooled capacity is 12 MVA or above, the duration of the temperature test at the maximum forced-cooled rating (including full representation of the total losses at this rating) shall be per IEEE C57.12.90.

Following the shutdown for measurements, the test shall be immediately resumed at 125 percent of the maximum forced-cooled rating (including full representation of the increased total losses at this overload rating) and continued for a minimum of eight additional hours, including the time necessary to reach thermal stability. At the conclusion of the test, measurements shall again be made and winding temperature rises determined for the hottest measured phase seen during the maximum forced-cooled rating temperature test.

During the 125 percent overload test, the transformer shall meet the following requirements:

1. The hotspot winding temperature rise shall not be greater than 110°C.
2. The top-oil temperature rise shall not be greater than 80°C.
3. The core hotspot temperature shall not be greater than 130°C with a 30°C ambient at 125 percent of full load and a voltage excitation of 100 percent.

During the period of thermal stability just before the current is reduced to determine the winding average temperature rise at the end of the eight-hour overload portion of the test, an infrared scan of all four segments of the tank and cover shall be performed. The measured temperatures of the tank and cover shall not exceed an 80°C rise above the ambient air temperature.

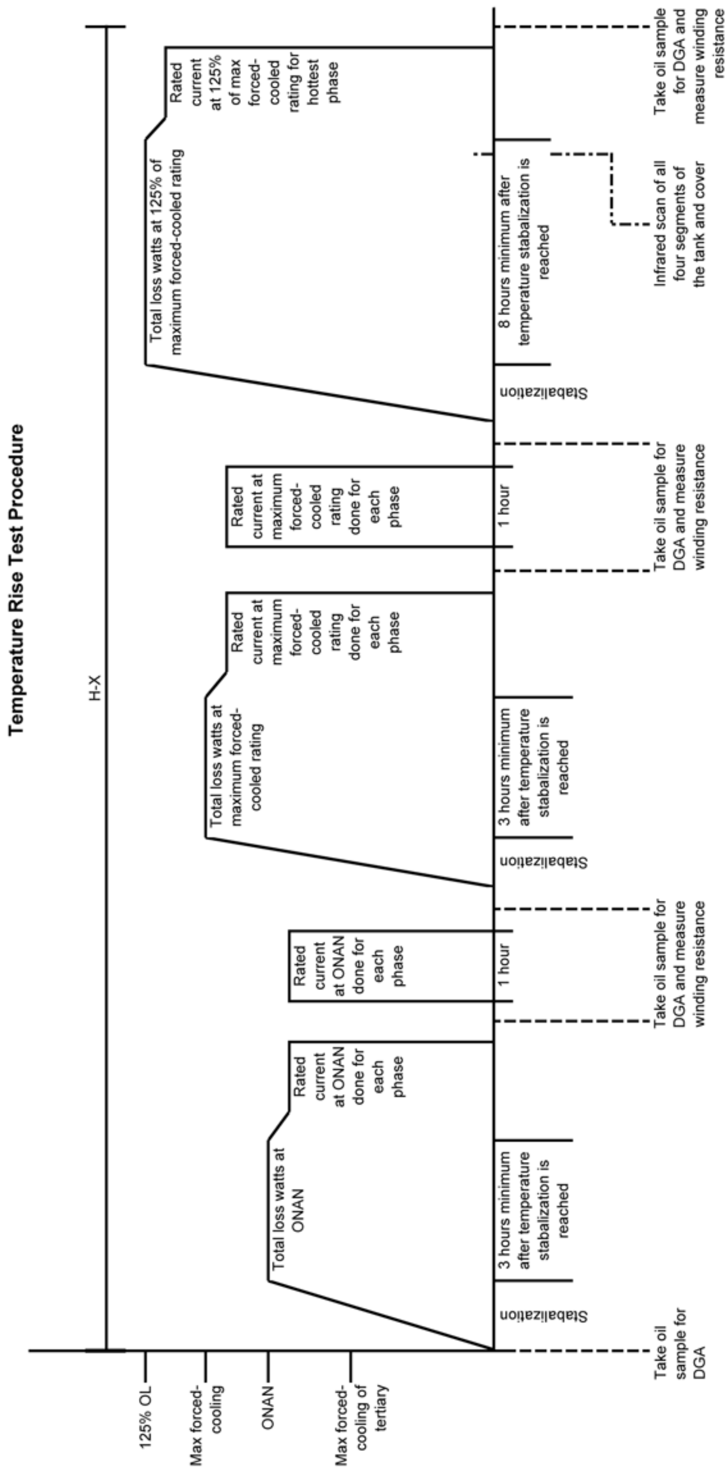

Figure 10—Temperature Rise Test Procedure

11.15 Test Data Required for Temperature Monitor

To facilitate setting the advanced winding hot-spot temperature elements in the approved temperature monitor (see Section 5.1.4 of this document), the supplier shall complete a reproduction of the following table with the specified temperature test data, and shall attach the table to the certified transformer test report.

The data in Table 4 is required for transformers where a single hot-spot is measured on 2-winding transformers.

Table 4—Approved Temperature Monitor, Table of Temperature Test Data

MVA	Top-Oil Temperature Rise (Degrees C)	Ambient Temperature (Degrees C)	Winding Hot-spot Temperature Rise (Degrees C)	Winding Time Constant (Minutes)
Self Cooled Rating	(A)	(B)	(C)	(D)
			(I)	(J)
Maximum Forced Cooled Rating	(E)	(F)	(G)	(H)
			(K)	(L)

(A) and (E): The top-oil temperature rise above ambient temperature at the specified MVA rating.

(B) and (F): The ambient temperature at the time of measuring the temperature rises at the specified MVA rating.

(C), (G), (I), and (K): The winding hot-spot temperature rise above ambient temperature at the specified MVA rating for the specified winding.

(D), (H), (J), and (L): The time required to reach 63.2% of the final winding temperature rise at the specified MVA rating for the specified winding (also known as the winding temperature time constant value). This will require a non-boosted heat run so that a smooth heating curve can be recorded for time-constant measurement.

11.16 Lightning Impulse

For a Class I transformer, lightning impulse tests or supplier's quality control lightning impulse tests shall be performed if specified in Section 16.22 of this document, Table 11.

(Note that if the transformer is Class II, IEEE standards require lightning impulse tests as routine.)

11.17 Switching Impulse

If specified in Section 16.22 of this document, Table 12, IEEE switching impulse tests shall be performed. Impulse tests are standard on transformers rated 345 kV and above.

11.18 Induced Voltage Tests and Partial Discharge Measurement

11.18.1 Partial Discharge Measurement

Partial discharge shall be measured both in terms of the radio-influence voltage (in microvolts – μV) and in terms of the apparent charge (in picocoulombs – pC).

11.18.2 Class I Transformer

Partial discharge shall be measured during the 7200-cycle induced voltage tests if specified in Section 16.22 of this document, Table 11. The instrumentation for measurement shall be the same as that used for a Class II transformer. The measured partial discharge shall not exceed 200 microvolts and 500 picocoulombs. Partial discharge tests are not usually specified on Class I transformers but may be required in some cases if specified.

A combined 7200-cycle and one-hour induced voltage test with partial discharge measurement shall be performed if specified in Section 16.22 of this document, Table 11. The test procedure shall be the same as that used for a Class II transformer. The measured partial discharge shall not exceed 200 microvolts and 500 picocoulombs during the enhancement level, and 100 microvolts and 300 picocoulombs during the one-hour level.

11.18.3 Class II Transformer

A combined 7200-cycle and one-hour induced voltage test with partial discharge measurement is required by IEEE standards as routine. The measured partial discharge shall not exceed 200 microvolts and 500 picocoulombs during the enhancement level, and 100 microvolts and 300 picocoulombs during the one-hour level.

11.19 Short-Circuit Testing

At PacifiCorp's option, the transformer supplied under this specification may be short-circuit tested in accordance with IEEE C57.12.90, at a location of PacifiCorp's choice. If required, the added cost of performing a short circuit test shall be negotiated with the manufacturer.

In the event of an order being placed, or as part of prospective pre-order clarification stage, the manufacturer shall supply a detailed analysis of the mechanical and thermal stresses, clearly demonstrating adequate safety margins against recognized failure modes for all windings under the worst-case through-fault conditions.

11.20 Audible Sound Level

If specified in Section 16.22 of this document, Table 11 or Table 12, the following sound level tests shall be performed:

1. Average audible sound level tests
   a. without forced-cooling equipment in operation, and
   b. with forced-cooling equipment in operation for each forced-cooled capacity rating.
2. One-third octave-band audible sound level test at maximum forced-cooled capacity rating for mid-band frequency of 125 Hz.

Audible noise levels shall be in accordance with the requirements of Section 16.23 of this document and shall account for the total noise level (the load and no-load noise levels). The guaranteed sound levels shall be met without the use of external devices such as sound panels, sound enclosure, or dampening material in bracing.

11.21 Frequency Response Analysis

A sweep frequency response analysis (SFRA) shall be performed at the factory after all other tests have been completed (except the unintentional-core-ground test; see Section 11.22 of this document) and prior to disassembling the transformer for shipment. An SFRA shall again be performed by the supplier in the field after the transformer has been completely reassembled and prepared for energization. Doble equipment shall be used for all SFRA measurements.

Supplier shall include the original SFRA electronic test results in Doble software format with the certified test report.

The SFRA tests shall be done per the Doble Power Transformer—Test Specification, Transformer Sweep Frequency Response Analysis (SFRA) Test.

Prior to acceptance of the transformer by PacifiCorp, the SFRA measurements shall be compared and analyzed to ensure compliance with Doble criteria as indication that the transformer has not been damaged during shipment.

11.22 Unintentional Core Ground

A final test for unintentional core grounds shall be performed after all other tests are complete and as late as practical in the handling sequence prior to shipment. The core ground test shall be performed using a 1000-volt test voltage. The insulation resistance from core to ground shall read 1000 MΩ or greater for a new unit.

11.23 Core–Form Clamping System Tightness

It is preferred that spring or isostatic pressure shall be applied during the winding sizing process. The complete core-and-coil assembly shall be dried and preferably oil impregnated as a unit prior to final clamping of the windings. After final clamping, and before the core-and-coil assembly is placed inside the tank and released for testing, the tightness of the windings must be verified by a PacifiCorp representative. The transformer will not be accepted if any winding, block or spacer column is found to be loose by PacifiCorp's Quality Assurance Inspector.

12 Technical Documentation

Drawings shall be full size (not reduced). All wording on drawings and other information shall be in English only; all numerical values shall be in U.S. customary units only, or in both U.S. customary and SI units.

The PacifiCorp PM order number, PO number, equipment number, manufacturer's serial number, and installation location, all specified in Section 16.1.1 of this document, shall be shown in the title block on all drawings, and in the title heading on all other information.

Each item identification number on the transformer and component outline drawings shall be enclosed in a small circle and located outside the outline of the equipment for convenient reading and to avoid confusion with dimensions and other data. A fine line shall be drawn to connect each item identification number to the associated item on the equipment.

When changes are made to any set of drawings, a revision cloud shall be placed around the changes with the revision letter or number next to it so PacifiCorp can easily identify what has been changed in the latest revision.

"Review drawings" are those submitted to PacifiCorp to check for general conformance with the contract and/or specification documents. Exceptions or comments made on these drawings do not constitute approval of the document or an amendment of the contract between PacifiCorp and the parties producing the document. The drawing review does not relieve such parties from compliance with the requirements of the plans and specifications, accuracy of dimensions and quantities indicated, suitability of construction materials, or fabrication and installation techniques. All review drawing submitted with revisions shall be identified with a letter, i.e. "A" for the first revision, "B" for the second revision, etc.

"Final for manufacturing" drawings are those that have been reviewed by PacifiCorp and with which the equipment will be manufactured. PacifiCorp will use these drawings for engineering design and if there are any changes made to the drawings after these are issued, penalties may be incurred as stipulated in the contract. Manufacturing tolerances listed on these drawings shall be at an absolute minimum due to the implications this may have on the engineering design work. All final for manufacturing drawings submitted shall be identified with a revision number, i.e. "0" for the first drawings submitted (after they have been reviewed and are considered final for manufacturing), "1" for the first revision, etc.

"As-built drawings" are those issued after the equipment has been manufactured and shall reflect the exact condition of the equipment at the time of shipment. There shall be no manufacturing tolerances listed on these drawings as they should be a direct representation of the equipment dimensions and the accessory locations. All as-built drawings shall be identified with revision numbers in the same fashion as final for manufacturing drawings.

12.1 Review Drawings

If specified in Section 16.1.4 of this document, the following shall be furnished for approval, and shall be sent to PacifiCorp as specified in Section 12.4.12 of this document.

1. One set of electronic copies submitted via email of applicable drawings and other information from Section 12.3 of this document.
2. The document for seismic qualification prepared per ZS 065, which was reviewed, stamped, and signed by a Professional Engineer licensed in the United States, shall be submitted by the equipment manufacturer at the same time as the review drawings.

12.2 Final for Manufacturing Drawings

Applicable final for manufacturing drawings and all other information from Section 12.4 of this document shall be furnished as specified in the following list as specified in 12.4.12 of this document after the review period has occurred for the review drawings.

1. One set of electronic copies submitted via email of applicable drawings and other information from Section 12.4 of this document.
2. One compact disc (CD) of applicable drawings in AutoCAD, or in DXF file format if not available in AutoCAD.
3. A certified set of foundation and anchorage location drawings (and one compact disc) shall be furnished by the equipment manufacturer immediately after the wind and seismic analysis calculations have been approved. This set of certified foundation and anchorage location drawings will be used for the design and construction of the transformer's foundation.

12.3 As-Built Drawings

For the temperature monitor (see Section 5.1.4 of this document), one electronic copy on compact disc (CD) of the configuration software and the configuration file, and one copy of associated printed information as necessary, shall be sent to PacifiCorp as specified in Section 12.4.12 of this document.

Applicable as–built drawings, instruction manuals, test reports, and all other information from Section 12.4 shall be furnished as specified in the following list.

1. One set of as–built drawings, instruction manuals, test reports and all other information specified in Section 12.4 shall be shipped with the transformer in a weatherproof envelope or in a compartment.
2. Seven additional sets of as–built drawings, instruction manuals, test reports, and all other information specified in Section 12.4 shall be sent to PacifiCorp as specified in Section 12.4.12.
3. Two additional sets of final drawings in AutoCAD file format (or in DXF file format if not available in AutoCAD), instruction manuals, test reports, and all

other information specified in Section 12.4 of this document shall be sent to PacifiCorp as specified in Section 12.4.12 of this document.

4. If the supplier performs the equipment installation, two sets of final field test results on two separate compact discs (CDs) in the same format as the factory test report shall be sent to PacifiCorp as specified in Section 12.4.12.

12.4 Technical Documentation Description

12.4.1 Certification of Insulating Oil

The supplier shall furnish certification that the insulating oil used to fill the transformer for testing, and the oil supplied with the unit if applicable, contains less than 1.0 ppm polychlorinated biphenyl contamination.

12.4.2 Certified Test Report

The supplier shall furnish a complete certified test report (see Section 11.1 of this document) for PacifiCorp's review before the unit is shipped.

12.4.3 Outline Drawing

The supplier shall furnish an assembled transformer outline drawing with all four sides and the top shown. Information shown on the drawing shall include the following items in addition to or in clarification of the information normally included:

1. Structural details of the transformer base;
2. Weight and center of gravity of the installed unit and the unit prepared for shipment;
3. Minimum dimensions of the unit prepared for shipment, and
4. Foundation reactions produced by equipment operation, and by wind and seismic forces.

In addition to the requirements of Sections 12.1 and 12.2, one electronic copy of the outline drawing shall be supplied to PacifiCorp two weeks before the design review to allow appropriate time for review.

12.4.4 Nameplate and Instruction Plate Drawings

The supplier shall furnish a drawing of each nameplate and instruction plate. In addition to the requirements of Sections 12.1 and 12.2, one electronic copy of the nameplate and instruction plate drawing shall be supplied to PacifiCorp two weeks before the design review to allow appropriate time for review.

12.4.5 Bushing Outline Drawings

The supplier shall furnish detailed bushing outline drawings.

12.4.6 Surge Arrester Outline Drawings

The supplier shall furnish detailed surge arrester outline drawings.

12.4.7 Schematic and Wiring Diagrams

The supplier shall furnish schematic and wiring diagrams showing complete auxiliary equipment wiring, including:

1. Customer connection points;
2. The number, size, and power requirements of fans and pumps;
3. The fan and pump control;
4. The alarm and relay connections; and
5. The current transformer connections.

12.4.8 Current Transformer Nameplate Drawings

The supplier shall furnish current transformer nameplate drawings or include this information on the main transformer nameplate drawing.

12.4.9 Current Transformer Information

The supplier shall furnish CT test certificates to include the following:

1. Current transformer resistance per winding tap;
2. If lead provided, resistance of each lead;
3. Curves showing ratio correction and secondary excitation for relaying, and
4. Curves showing ratio and phase angle correction for interchange, revenue, or tariff metering.

12.4.10 Instruction Manuals

The supplier shall furnish instruction manuals covering the receiving, handling, installation, operation, and maintenance of the transformer and all auxiliary equipment. Manuals shall include instructions for abnormal operating conditions, troubleshooting guides, and detailed maintenance instructions and maintenance intervals.

12.4.11 Renewal Parts

The supplier shall furnish a complete list of renewal parts for the transformer and all auxiliary equipment, including identification of each part by name and part number. Renewal parts list for the no-load tap changing equipment shall be accompanied by detailed drawings and exploded views as required to facilitate complete maintenance by PacifiCorp. Parts lists and drawings shall relate specifically to the equipment covered by this specification; typical drawings are not acceptable.

12.4.12 Drawing Destination

All drawings and other information specified in Section 12 of this document shall be mailed to the following department:

PacifiCorp Standards Engineering Documentation
Lloyd Center Tower

825 NE Multnomah St., Suite 1600
Portland, OR 97232

All electronic drawing submittals shall be emailed to:
ManufacturerDrawings@PacifiCorp.com

All electronic seismic document submittals shall be emailed to:
Seismic@PacifiCorp.com.

13 Shipping Requirements

13.1 Air-filled or Oil-filled

As specified in Section 16.26 of this document, the transformer prepared for shipment shall be filled with oil and with dry nitrogen in the gas space at a pressure of three psig (0.2 atm gauge), or shall be filled with dry breathable air at a pressure of three psig (0.2 atm gauge) (see Sections 7.9 and 15.7 of this document). If the manufacturer's standard delivery procedure employs a different pressure or method, approval for the shipment must be obtained from PacifiCorp. A conspicuous tag shall be furnished identifying the gas contents of the transformer prepared for shipment and specifying the actual gas pressure and the ambient temperature at the time of filling.

13.2 Factory Assembly and Component Location Marking

The complete transformer, including all auxiliary power and control wiring, shall be completely assembled at the factory to ensure proper fit and operation of all components.

Major transformer components that must be shipped detached for field installation (including, but not limited to, components such as radiators, pumps, conservator supports, and surge arrester supports) shall be marked for installation by means of permanent metal stamping. This metal stamping shall include adjacent marks on the component and the main transformer assembly to show both component location and orientation.

Major transformer components that must be stored detached before field installation in situations where temporary storage will occur shall be shipped properly packaged (e.g., placed on pallets) and covered with tarpaulins to protect them from damage and weather. The packaging shall be adequate to protect the components for up to several years at a minimum.

13.3 Shipping Dimensions and Weight

The supplier shall be responsible for checking the shipping dimensions and weight of the proposed transformer design for suitability for shipment to the specified destination.

13.4 Notice of Shipment

The supplier shall notify PacifiCorp two weeks prior to the expected arrival of the transformer. Additionally, the PacifiCorp contact person named in Section 16.1.6 of this document, shall be notified on the day of shipment and 48 hours prior to the delivery of the transformer to ensure provisions for unloading.

At the time of shipment, the supplier shall provide to their PacifiCorp contact the shipper's name and telephone number, the bill of lading, and other shipment information as needed to track the location of each transformer.

13.5 Impact Recorders (for Shipment)

For all modes of shipment, an electronic impact recorder shall be furnished and installed by the supplier. If rail shipment is specified, an additional impact recorder shall be mounted on the railcar. The impact recorder shall be furnished with a sealed protective cover. Impact recorders from the railroad will not be acceptable. Not less than one hour prior to scheduled pickup of the transformer or truck, the supplier shall start the recorder and verify that it is operating properly. The electronic impact recorder trip information file shall become the property of PacifiCorp at the time of delivery.

If parts and accessories are shipped by rail, they shall be on the same train as the main unit. A single two-directional impact recorder shall be installed on each rail car if accessories are shipped in separate rail cars.

13.6 Rail Shipment

13.6.1 Rider

For shipment by rail, PacifiCorp may employ a qualified rider to accompany the shipment.

13.6.2 Unloading Allowance

For shipment by rail, three normal working days, Monday through Friday, shall be allowed for unloading the transformer from the railcar.

13.7 Supplier Representative

If specified in Section 16.1.7 of this document, the supplier shall furnish a mutually agreed upon representative to be present at the delivery site to verify the transformer condition as received, before unloading from the railcar. A qualified factory representative shall: 1) review and sign any impact recorder chart(s) or electronic files, 2) witness the SFRA testing, 3) witness unintentional core-ground testing (using a 1000-volt test voltage), and 4) perform the internal inspection and submit a report on findings.

14 Other Inspection Requirements

14.1 Design Review

A design review will be conducted upon completion of the transformer design. PacifiCorp may employ a consultant as its agent to oversee the review. The supplier shall include in the quoted schedule sufficient time for the review, and shall not order transformer materials prior to completion of the review without the written approval of PacifiCorp. Items likely to be investigated during design review include the following:

1. The insulation design shall have sufficient margin to allow for deterioration in dielectric properties that may occur in service, assuming that reasonable maintenance practices have been performed.
2. The designer shall document how acceptance criteria for stresses were determined, i.e. model tests, tests on full size transformers, etc. The supplier shall have sizing and compression procedures to ensure that the winding will remain tight in transportation and service.

If PacifiCorp, in its reasonable discretion, finds that the design does not conform to the contract requirements, then the supplier and PacifiCorp will confer regarding the nonconformity and the supplier shall have the right to submit a corrected design to PacifiCorp. If PacifiCorp and the supplier cannot reach an agreement on the transformer design, PacifiCorp may reserve the right to cancel the order per the terms of the contract, Article 27, *Cancellation for Convenience*.

14.2 Quality Assurance Inspections and Surveillance

The following quality assurance inspections shall be conducted during the manufacture of the equipment:

1. Winding inspection and core inspection (before windings are nested and before windings are installed on the core);
2. Pre-tanking inspection and witnessing the tanking of the core-and-coil assembly;
3. Testing;
4. Final inspection before shipment.

The supplier shall provide PacifiCorp with a production schedule that specifies these quality assurance inspection hold points and shall continually provide updates of this schedule as manufacturing progresses.

A quality surveillance representative (QSR) will be employed by PacifiCorp to be present at the supplier's facility during the manufacturing and testing times. The QSR will comply with the supplier's safety and procedural requirements at all times while in the supplier's facility, and the following additional guidelines shall apply. Please contact PacifiCorp engineer Matthew Weisensee at (503) 813-6901 or *Matthew.Weisensee@PacifiCorp.com* for coordination of the surveillance representative.

14.2.1 Cooperation with Quality Surveillance Representative

The supplier shall cooperate with the QSR and arrange a reasonable and mutually agreeable schedule for the required inspections and witnessing of tests, consistent with maintaining scheduled progress of the transformer through the supplier's facility. Supplier shall not pre-test transformer prior to the QSR witnessing tests.

PacifiCorp requires the QSR to witness all factory tests unless given written approval by PacifiCorp not to witness specific factory tests.

14.2.2 Authority of Quality Surveillance Representative

The QSR will have full authority from PacifiCorp to make whatever decisions are necessary to ensure that the complete transformer equipment complies with all requirements of PacifiCorp's procurement documents, and to ensure that all required inspection and witness activities are carried out.

14.2.3 Disagreements

In the event of significant disagreement between the supplier and the QSR concerning scheduling of inspection or witness activities, or concerning interpretation of PacifiCorp's procurement documents, the supplier and the QSR shall promptly and jointly contact PacifiCorp to resolve the matter as described in the contract, Article 25, *Claim Notice and Resolutions Procedure*.

14.3 Field Engineer

Services of the supplier's field engineer(s), if specified in Section 16.1.8 of this document, shall be furnished for supervision of field installation of all parts detached for shipment, and for complete pre-energization inspection of the transformer. The field engineer(s) shall have a thorough working knowledge of the complete transformer (all internal and external components).

14.4 Inspection Photographs

The manufacturer shall provide photographs of the following:

- The core and coils before they are assembled. These photographs shall clearly show all pertinent information such as general construction and any taps.
- The assembled core and coils before installation in the transformer tank, taken from each side, each end, top, and bottom.
- The assembled transformer after the dielectric tests have been successfully completed. A minimum of five photographs shall be taken from all four sides and from above to identify and locate all equipment on the transformer top.

Prints of the photographs shall be supplied for each instruction book furnished. A compact disc containing a digital copy of each photograph is to be furnished at time of shipment. Resolution on each digital photograph is to be a minimum of 5.0 megapixels.

15 Evaluation

15.1 Product Evaluation

PacifiCorp will evaluate the supplier and the quality of the supplier's transformers by using a systematic evaluation process established by PacifiCorp. PacifiCorp will perform a preliminary transformer design review on a short list of suppliers prior to issuing a purchase order and the manufacturer will be asked to fill out PacifiCorp's Design Review Data Sheet (Revision 4, dated December 23, 2009). PacifiCorp will technically evaluate the manufacturer's proposed electrical, mechanical, and thermal design, as well as its compliance with PacifiCorp's specification, using the Design Review Data Sheet.

15.2 Loss Evaluation Method

An Equivalent Total Owning Cost (*ETOC*) will be calculated from the bid price and the present value of the supplier's guaranteed maximum losses as shown below. The *ETOC* will be used in determining bid awards.

$$ETOC = BID\ PRICE + (A \times NL) + (B \times LL) + (C \times AP)$$

where:

ETOC	=	Equivalent total owning cost in dollars
BID PRICE	=	supplier-quoted bid price in dollars
A	=	Loss cost multiplier for no-load losses in dollars per watt
B	=	Loss cost multiplier for load losses in dollars per watt
C	=	Cost multiplier for auxiliary power in dollars per watt
NL	=	Guaranteed maximum no-load losses at 20° C in watts
LL	=	Guaranteed maximum load losses at 85° C in watts, excluding auxiliary power (The load losses shall be quoted at the maximum forced-cooled rating.)
AP	=	Guaranteed maximum auxiliary power requirement in watts (with all forced-cooling equipment in service)

15.3 Loss Cost Multipliers

The loss cost multipliers to be used in the loss evaluation method will be as specified in Section 16.2 of this document.

15.4 Loss Penalty

In the event that the combined evaluated cost of actual tested no-load losses (NL), load losses (LL), and auxiliary power (AP) exceeds the combined evaluated cost of the respective guaranteed maximum losses and auxiliary power, credit shall be given to PacifiCorp for the dollar difference. Any dollar difference shall be deducted from the transformer invoice by the supplier.

15.5 Shipping Cover

PacifiCorp prefers that the transformer be shipped in its own complete tank. If a shipping cover must be employed, the supplier shall clearly state that fact in the proposal and shall quote a separate cost for the supplier to remove the shipping cover and install the permanent welded cover at the job site; PacifiCorp will apply this cost as an addition to the equivalent total owning cost (see Section 15.2 of this document). PacifiCorp will also apply an additional $15000 to the equivalent total owning cost for added PacifiCorp labor requirements and inconveniences associated with the shipping cover.

15.6 Horizontal Shipment

PacifiCorp prefers that the transformer be shipped in the upright position. If horizontal shipment must be employed, the supplier shall clearly state that fact in the proposal. If horizontal shipment is intended, PacifiCorp will apply an additional cost to the equivalent total owning cost (see Section 15.2 of this document) for added PacifiCorp labor requirements and inconveniences associated with uprighting the transformer. The additional cost, based on the size of crane required, will be as follows:

Crane size: 45-ton or below	$ 5000
Crane size: 46-ton to 90-ton	$10000
Crane size: above 90-ton	$15000
Plus use of leveraged uprighting rocker shoes	$ 5000

15.7 Method of Shipment

A transformer with the H-terminals rated for a nominal system voltage of 161 kV or above shall be shipped without oil and filled with dry breathable air.

The method of shipment for a transformer with the H-terminals rated for a nominal system voltage below 161 kV shall be as specified below:

1. A transformer with a self-cooled rating above 18000 kVA shall be shipped without oil and filled with dry breathable air.
2. For a transformer with a self-cooled rating of 18000 kVA or below and above 12000 kVA, it is preferred that shipment be made by truck, oil filled.
3. A transformer with a self-cooled rating of 12000 kVA or below shall be shipped by truck, oil filled.

16 Additional Transformer-Specific Requirements

The transformer information and specifications in this section are for the equipment referenced in Section 16.1.1 of this document, and shall be used in conjunction with the other requirements of this material specification.

In this section, a box checked (✓) next to an item indicates that the item is required or applicable; a box not checked indicates that the item does not apply or is not acceptable.

The meanings of the following symbols used by PacifiCorp are defined as:

- ✓ Denotes a normal requirement.
- * Denotes a requirement which will be specified at the time of order.
- ** Denotes a requirement to be specified by the supplier.
- • Denotes a requirement which may be specified at the time of order; the supplier shall provide a price adder.

16.1 Equipment Identification and Order Requirements

16.1.1 Equipment Identification

PM Order number: ______________________

REQ number: ______________________ PO number: ______________________

Equipment number(s): ____

Location: ____

16.1.2 Commercial Issues

Correspondence regarding commercial issues shall be sent to the PacifiCorp purchasing department, with copies to:

Project engineer: ____

Address: ____

City: ____________________________ State: __________ Zip: ___________

Telephone: _________________________

16.1.3 Technical Issues

Technical questions regarding this material specification, or notice of any other technical issues that arise during equipment design, manufacture, or test, shall be directed to the project engineer (see Section 16.1.2 of this document).

16.1.4 Review Drawings

If checked (✓), drawings and other information shall be furnished for approval (see Section 12 of this document) . . . . ❑

Review drawings on compact disc (CD) shall be as checked (✓) below:

AutoCAD version ________ . . . . ❑
DXF file format . . . . ❑

16.1.5 As-Built Drawings on Compact Disc (CD)

If checked (✓), one additional set of as-built drawings shall be furnished on a compact disc (CD) as specified (see Section 12 of this document):

AutoCAD version ________ . . . . ❑
DXF file format . . . . ❑

16.1.6 Notice of Shipment

The supplier shall notify the person named below, as specified in Section 13.4 of this document.

Name: ____

Address: ____

City: ______________________ State: ______ Zip: __________

Telephone: ____________________

16.1.7 Supplier Representative

If checked (✓), the supplier shall furnish a mutually agreed upon representative to be present at the delivery site as specified in Section 13.7 of this document. ❑

16.1.8 Field Engineer

If checked (✓), the supplier's field engineer(s) shall furnish supervision for field installation as specified in Section 14.3 of this document. . . . . ❑

16.1.9 Installation

If checked (✓), the supplier shall be responsible for delivery of the transformer to the foundation pad and installing transformer according to PacifiCorp Procedure SP–TRF–INST, *Transformer Receiving, Installation and Energizing*. . . . . . . ❑

16.2 Loss Cost Multipliers

The loss cost multipliers are as follows (see Section 15.3 of this document):

No-load loss cost multiplier (A) = $____.___ / watt

Load loss cost multiplier (B) = $____.___ / watt

Auxiliary power cost multiplier (C) = $____.___ / watt

16.3 Contaminated Environment Protection

If checked (✓), the transformer shall be suitable for operation in contaminated environments as specified in Section 4.15 of this document. . . . . ❑

16.4 Design Form

The transformer design form shall be as checked (✓) below.

Core–form . . . . ❑
Shell–form . . . . ❑
Core–form or shell–form (supplier's choice) . . . . ❑

16.5 Elevation

The transformer shall be designed for special high–elevation operation without de-rating, up to the specified elevation, if checked (✓) below.

_____ feet . . . . ❑

16.6 Ambient Temperature

If checked (✓) below, the transformer and all associated components shall be designed for special low-temperature and/or high-temperature operation without de-rating.

–50°C daily minimum . . . . ❑
–40°C daily minimum . . . . ❑
+45°C daily peak . . . . ❑
______________________________ . . . . ❑

16.7 Phase Designation

The phase of the transformer shall be as checked (✓) below.

Single-phase . . . . ❑
Three-phase . . . . ❑

16.8 Winding Designation

The IEEE winding designation shall be as follows:

H–winding____

X–winding____

16.9 Cooling Class

The cooling class shall be as checked (✓) below:

Self-cooled rating

ONAN . . . . ❑

Self-cooled rating and one forced-cooled rating

ONAN / ONAF . . . . ❑

Self-cooled rating and two forced-cooled ratings

ONAN / ONAF / ONAF . . . . ❑

ONAN / ONAF / ODAF . . . . ❑

ONAN / ODAF / ODAF . . . . ❑

One of the classes checked above (supplier's choice) . . . . ❑

One forced-cooled rating (no self-cooled rating)

ODAF . . . . ❑

ODWF . . . . ❑

Two forced-cooled ratings (no self-cooled rating)

ODAF / ODAF . . . . ❑

ODWF / ODWF . . . . ❑

Other class, as follows: . . . . ❑

16.10 Capacity Ratings

The capacity ratings at 65° C average winding temperature rise for the H– and X– terminals as specified below in Table 5.

Table 5—Transformer Capacity Ratings

Terminals	Self-Cooled (MVA)	First Stage Forced-Cooled (MVA)	Maximum Forced-Cooled (MVA)
H & X			

Note: If designated by "**" in the table, the self-cooled and first-stage forced-cooled capacity ratings shall be selected by the supplier and need not be the standard values normally associated with the specified maximum forced-cooled capacity rating(s).

16.11 Voltage and Surge Arrester Ratings

The transformer shall be furnished with the voltage ratings, BIL ratings, de-energized taps, and surge arrester ratings for each terminal designation, specified in the rows and columns checked (✓) below in Table 6. If applicable, specific de-energized tap ratings shall be as specified in Section 16.11.1.

If series–parallel reconnection is specified for a three–phase transformer for H–winding, X–winding, or both windings (see Section 16.11.2 of this document), the two associated voltage ratings for each winding, as applicable, are specified in Table 6. If wye-delta reconnection is specified for a three–phase transformer for H–winding, X–winding, or both windings, the voltage rating specified in Table 6 for each winding, as applicable, is for the wye connection.

Table 6—Transformer Voltage and Surge Arrester Ratings

(✓) Desired Rating	Nominal System Voltage (kV)	Center Tap Voltage Rating (kV)	De-energized Taps Table 7 (yes/no)	Winding BIL (kV crest)	Arrester Duty Cycle Rating (kV)		Maximum Continuous Operating Voltage (MCOV) (kV)	
					Grounded System	Ungrounded System	Grounded System	Ungrounded System
$H_{1,2,3}$ or H_1 Terminal(s)					Station Class			
❑	525			1425	n/a	n/a	n/a	n/a
❑	345			1050	❑ 264	n/a	212	n/a
❑	230			750	❑ 180	n/a	144	n/a
❑	161			650	❑ 132	n/a	106	n/a
❑	138			550	❑ 120	n/a	98	n/a
❑	115			450	❑ 96	❑ 120	76	98
❑	69			350	❑ 60	❑ 72	48	57
❑	46			250	❑ 39	❑ 48	31.5	39
❑	34.5			200	❑ 30	❑ 36	24.4	29
❑								
H_0, H_0X_0, H_2, or H_2X_2 Terminal					Station Class			
❑	n/a	n/a	n/a		n/a		n/a	
$X_{1,2,3}$ or X_1 Terminal(s)					Station Class			
❑	345			1050	❑ 264	n/a	212	n/a
❑	230			750	❑ 180	n/a	144	n/a
❑	161			650	❑ 132	n/a	106	n/a
❑	138			550	❑ 120	n/a	98	n/a
❑	115			450	❑ 96	❑ 120	76	98
❑	69			350	❑ 60	❑ 72	48	57
❑	46			250	❑ 39	❑ 48	31.5	39
❑	34.5			200	❑ 30	❑ 36	24.4	29
❑	25.0			150	❑ 21	❑ 27	17	22
❑	20.8			150	❑ 21	❑ 27	17	22
❑	13.8			110	❑ 12	❑ 15	10.2	12.7
❑	13.2			110	❑ 12	❑ 15	10.2	12.7
❑	13.09			110	❑ 12	❑ 15	10.2	12.7
❑	12.5			110	❑ 12	❑ 15	10.2	12.7
❑								
X_2 Terminal					Station Class			
❑	n/a	n/a	n/a		n/a			

16.11.1 De-Energized Tap Changer

The de-energized tap rating shall be as specified by the row check (✓) in Table 7. See Section 7.2 of this document.

Table 7—De–energized Tap Voltage Ratings (kV, L–L)

(✓) Desired Rating	Nominal System Voltage (kV, L–L)	Center Tap Voltage Rating (kV, L–L)	De–energized Tap Voltage Ratings (kV, L–L)
❑	525	525	550 / 537.5 / 525 / 512.5 / 500
❑	345	345	362.25 / 353.625 / 345 / 336.375 / 327.75
❑	230	230	241.5 / 235.75 / 230 / 224.25 / 218.5
❑	161	161	169 / 165 / 161 / 157 / 153
❑	138	138	145 / 141.5 / 138 / 134.5 / 131
❑	115	116	122 / 119 / 116 / 113 / 110
❑	69	67	70.6 / 68.8 / 67 / 65.2 / 63.4
❑	46	46	48.3 / 47.15 / 46 / 44.85 / 43.7
❑	34.5	34.5	36.2 / 35.4 / 34.5 / 33.6 / 32.8
❑			

16.11.2 Series-Parallel Reconnection

If checked (✓), means for series-parallel reconnection shall be furnished for the specified winding(s) as follows. See Section 7.2 of this document.

H-winding . . . . ❑

Reconnection by a de-energized switch . . . . ❑

Reconnection by a terminal board . . . . ❑

X-winding . . . . ❑

Reconnection by a de-energized switch . . . . ❑

Reconnection by a terminal board . . . . ❑

Special requirements:

____

16.11.3 Wye-Delta Reconnection

If checked (✓), means for wye-delta reconnection shall be furnished for the specified winding(s) as follows. See Section 7.2 of this document.

___-winding . . . . ❑

Voltage rating on the wye connection as shown above in Table 6: _______kV

Voltage rating on the delta connection: _______kV

Winding BIL on the delta connection: ______kV

Reconnection by a de-energized switch . . . . ❑

Reconnection by a terminal board . . . . ❑

___-winding . . . . ❑

Voltage rating on the wye connection as shown above in Table 6: ______kV

Voltage rating on the delta connection: ______kV

Winding BIL on the delta connection: ______kV

Reconnection by a de-energized switch . . . . ❑

Reconnection by a terminal board . . . . ❑

Special requirements:

____

16.12 Impedance(s)

Transformer impedance(s) shall be as checked (✓) below (see Section 4.7 of this document).

As specified below in Table 8 . . . . ❑

Table 8—Transformer Impedance(s)

Winding to Winding	V_{LL}	Percent Impedance	Base kVA
1. H to X	________ to ________	__________	__________

____

____

16.12.1 Bank Operation

If the transformer is single-phase operated in a three-phase bank, and if checked (✓), the transformer bank shall be suitable for operation in a bank with similar transformer(s) as specified in Section 4.8 of this document. The similar transformer(s) are identified below, and the associated impedance test data and nameplate drawings are attached. . . . . ❑

____

____

____

16.13 Polarity or Angular Displacement

If the transformer is single–phase, the polarity shall be subtractive. If the transformer is three-phase, the angular displacement shall be as checked (✓) below in Figure 11.

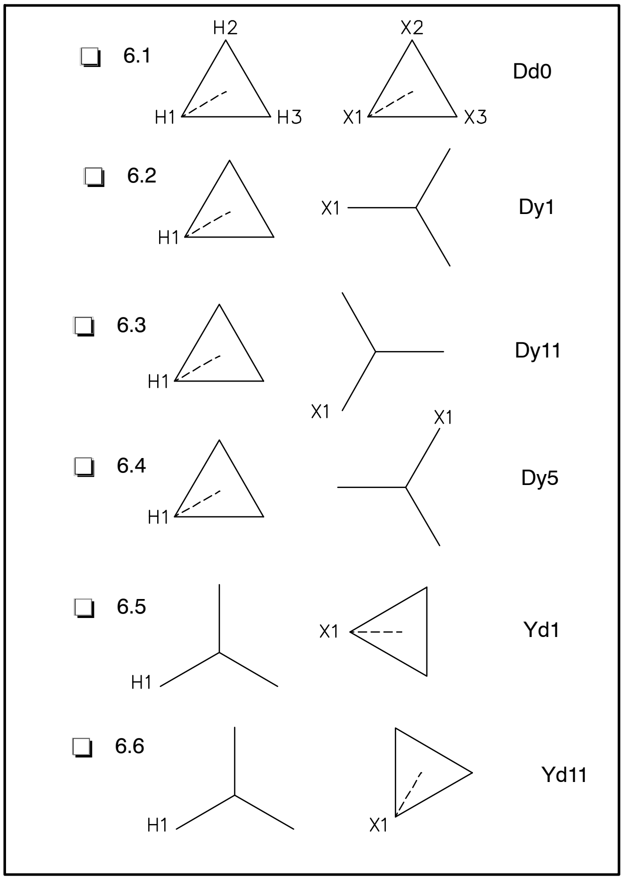

Figure 11—Three-Phase Transformer Angular Displacement

16.14 Bushing BIL Requirements

The bushing BIL requirements shall be as specified in Table 9.

Table 9—Bushing BIL Requirements

(✓) Desired Rating	Nominal System Voltage (kV)	Bushing BIL (kV crest)	Min. Live-to-Live Clearances at 3,300'	Min. Live-to-Live Clearances at 7,000'
$H_{1,2,3}$ or H_1 Terminal(s)				
❑	525	1800*	13'-10"	15'-4"
❑	345	1300	9'-11"	11'-1"
❑	230	900	7'-5"	8'-3"
❑	161	750	6'-0"	6'-8"
❑	138	650	5'-3"	5'-10"
❑	115	550	4'-5"	4'-11"
❑	69	350	2'-7"	2'-11"
❑	46	250	2'-6"	2'-6"
❑	34.5	200	2'-6"	2'-6"
❑				
H_0, H_0X_0 Terminal(s)				
❑	n/a			
H_2, H_2X_2 Terminal(s)				
❑	n/a			
$X_{1,2,3}$ or X_1 Terminal(s)				
❑	345	1300	9'-11"	11'-1"
❑	230	900	7'-5"	8'-3"
❑	161	750	6'-0"	6'-8"
❑	138	650	5'-3"	5'-10"
❑	115	550	4'-5"	4'-11"
❑	69	350	2'-7"	2'-11"
❑	46	250	2'-6"	2'-6"
❑	34.5	200	2'-6"	2'-6"
❑	25	150	2'-6"	2'-6"
❑	20.8	150	2'-6"	2'-6"
❑	13.8	150	2'-6"	2'-6"
❑	13.2	150	2'-6"	2'-6"
❑	13.09	150	2'-6"	2'-6"
❑	12.5	150	2'-6"	2'-6"
❑				
X_2 Terminal				
❑	n/a			

* Bushing BIL at 525 kV shall be 1800 kV at elevations of 3,300 feet. Section 16.5 of this document does not apply for this size bushing. The supplier shall provide the same 525 kV bushing rated for 1800 kV BIL at 3,300 feet regardless of the elevation at the intended transformer site.

16.15 Surge Arrester Discharge Counters

If checked (✓), surge arrester discharge counters shall be furnished as specified in Section 6.2.3 of this document. . . . . ❑

16.16 Current Transformers

The supplier shall furnish five-tap multiratio bushing current transformers (BCT) as specified below in Table 10. (See Section 7.4.2 of this document.)

Table 10—Bushing Current Transformers

Terminals	BCT Position	Full-Winding Amperes	Relaying Accuracy
$H_{1,2,3}$ or H_1	Top		
$H_{1,2,3}$ or H_1	Middle		
$H_{1,2,3}$ or H_1	Middle		
$H_{1,2,3}$ or H_1	Bottom		
$X_{1,2,3}$ or X_1	Top		
$X_{1,2,3}$ or X_1	Middle		
$X_{1,2,3}$ or X_1	Bottom		
X_2	n/a		
HO	n/a		

16.17 Resistance Temperature Detector

16.17.1 Main Tank Resistance Temperature Detector

The main tank top-oil resistance temperature detector shall be the type checked (✓) below (see Section 5.1.1 of this document).

10 ohm, copper . . . . ❑
100 ohm, platinum (hydroelectric plant transformers only) . . . . ❑

16.17.2 Ambient Temperature Resistance Temperature Detector

The ambient temperature resistance temperature detector shall be the type checked (✓) below. (See Section 5.1.2 of this document.)

10 Ohm, copper . . . . ❑
100 Ohm, platinum (hydroelectric plant transformers only) . . . . ❑

16.18 Auxiliary Equipment Voltages

16.18.1 AC Voltage

The AC power supply will be as checked (✓) below:

120/240 VAC, three-wire . . . . ❑
208 VAC, single-phase . . . . ❑
___ VAC, single-phase . . . . ❑
___ VAC, three-phase . . . . ❑

16.18.2 DC Voltage

The DC power supply will be as checked (✓) below:

48 VDC . . . . ❑
125 VDC . . . . ❑

16.19 Main Tank Rapid-Pressure-Rise Relay

One rapid-pressure-rise relay, or provisions for such relay, shall be furnished on the main transformer tank as checked (✓) below (see Section 8.5 of this document):

One rapid-pressure-rise relay shall be furnished . . . . ❑

Provisions shall be furnished for one future rapid-pressure-rise relay . . . . ❑

16.20 Alarm Monitor

If checked (✓), the transformer shall be furnished with the alarm monitor and applicable alarms as specified (see Section 8.7 of this document):

Gas detector relay/gas accumulation . . . . ❑
Cooling equipment power loss . . . . ❑
Main tank oil low level . . . . ❑
Top oil temp alarm . . . . ❑
Winding temp alarm . . . . ❑
Pressure relief main tank . . . . ❑
Sudden pressure relay . . . . ❑
480V normal source failure . . . . ❑
480V backup source failure . . . . ❑
Control power failure . . . . ❑
Spare . . . . ❑
Spare . . . . ❑
____________________ . . . . ❑
____________________ . . . . ❑
____________________ . . . . ❑
____________________ . . . . ❑

16.21 Oil Preservation System

The type of oil preservation system shall be as checked (✓) below (see Section 7.10 of this document).

Sealed-tank system . . . . ❑
Nitrogen-gas pressure system . . . . ❑
Conservator system . . . . ❑
Nitrogen-gas pressure or conservator system (supplier's choice) . . . . ❑

16.22 Additional Test Requirements

In addition to the tests required by industry standards and the special requirements specified in Section 11 of this document, optional tests shall be performed as checked (✓) below in Table 11 (Class I transformer) or Table 12 (Class II transformer). Note that temperature test data from an identical or thermal duplicate transformer is *not* an acceptable alternative to specified temperature tests.

Table 11—Optional Tests for Class I Transformer

(✓)	Optional Test Description
❑	Temperature tests, including self-cooled temperature test and maximum forced-cooled temperature test
❑	Lightning impulse tests
❑	Quality control lightning impulse tests
❑	Partial discharge measurements during 7200-cycle induced voltage tests
❑	Combined 7200-cycle/one-hour induced voltage test with partial discharge measurements
❑	Audible sound level tests including an octave band test

Table 12—Optional Tests for Class II Transformer

(✓)	Optional Test Description
❑	Temperature tests, including self-cooled temperature test and maximum forced-cooled temperature test
❑	Switching impulse tests
❑	Audible sound level tests including an octave band test

16.23 Audible Sound Level

The transformer shall be designed to comply with the decibel rating as checked (✓) below.

−10 dB relative to NEMA TR1 (__/__/__) . . . . ❑
NEMA TR1 (__/__/__) . . . . ❑

16.24 Safety Railing Equipment

If checked (✓), safety railing equipment shall be furnished as specified in Section 7.18 of this document . . . . ❑

16.25 Winding Connections for Shipment

The transformer shall be shipped with the windings connected as follows:

____

____

16.26 Tank Contents for Shipment

The transformer tank shall be filled for shipment as checked (✓) below (see Section 13.1 of this document).

Oil and dry nitrogen . . . . ❑
Dry air . . . . ❑

16.27 SFRA Testing on Railcar (Applies when PacifiCorp Takes Ownership on Railcar)

If checked (✓), a second SFRA without oil shall be performed by the supplier at the factory immediately after the unit is loaded onto the railcar. The transformer is to be shipped with small test bushings similar to the core ground bushing or equivalent. The bushing provided shall be strong enough to mechanically support the lead weight during shipment and shall be fitted to the bushing cover to allow this test to take place with transformer on the railcar. The supplier shall perform the SFRA again as soon as the transformer arrives on site and before unloading from the railcar. . . . . ❑

16.28 On-Line DGA Monitor

If checked (✓) below, the transformer shall be furnished with an on-line DGA monitor with the features specified in Section 8.8 of this document. Transformers 345 kV and above shall have at least one of the following features:

Monitors one main tank and at least 8 gases . . . . ❑
Monitors up to three separate single phase tanks and at least 8 gases . . . . ❑
Monitors one main tank and at least 2 gases . . . . ❑
____ ❑

16.29 Reference Drawings

If checked (✓) below, the new transformer shall match the existing transformer as described in Sections 4.18, 4.19, and 4.20 of this document.

Nameplate Drawing ________________________ . . . . ❑
Plant Plan View ________________________ . . . . ❑
ISO Phase Bus Drawing ________________________ . . . . ❑
Transformer Foundation ________________________ . . . . ❑
Outline Drawing ________________________ . . . . ❑
Control Cabinet Layout Drawings ________________________ . . . . ❑
Pictures of Existing Equipment ________________________ . . . . ❑
Other ________________________ . . . . ❑

16.30 Tank Exterior Finish and Porcelain Color

If checked (✓) below, the new transformer tank exterior paint and color shall be as specified.

ANSI # __________ . . . . ❑

17 Issuing Department

The Standards Engineering Documentation Department of PacifiCorp is responsible for issuing this material specification. Comments and suggestions are welcome. Submit comments or requests for additional copies of this document to:

PacifiCorp Standards Engineering Documentation
825 NE Multnomah St., Suite 1600, Portland, OR 97232
telephone: (503) 813-5293, fax: (503) 813-6804

Technical questions regarding this material specification may be submitted to:

Staff Engineers, PacifiCorp Standards Engineering
825 NE Multnomah St., Suite 1600, Portland, OR 97232
telephone: (503) 813-6883, fax: (503) 813–6804

Appendix A—Schedule of Approved Accessory Suppliers

The following schedule is a list of suppliers and materials approved by PacifiCorp. Manufacturers wishing to supply materials not listed must receive the express permission of PacifiCorp, showing experience list and NEMA or other recognized accreditation.

Table A1—List of Approved Material Suppliers

Material	Manufacturer	Product Ref.	Comments
A1. Insulation/Conductor			
Conductor insulation paper	Weidmann		
	Tullis - Russell		widely used in Europe
CTC conductor insulation	Weidmann	Dennison type	
	Tullis - Russell		widely used in Europe
CTC			Phelps-Dodge material has proven to be of inadequate quality in the past and, consequently, is not currently approved
Laminated Board	Weidmann	TIV, TX2	
A2. Cooling			
Top-oil resistance temperature detector (RTD)	Qualitrol	103-045 Series or	10-ohm copper - to include connector and shielded cable
		103-044 Series	100-ohm copper - to include connector and shielded cable
Ambient air resistance temperature detector (RTD)	Qualitrol	103-026-01 or	10-ohm copper - to include connector and shielded cable
		103-049-01	100-ohm copper - to include connector and shielded cable
Winding hot-spot clamp-on current transformers	Qualitrol	TRA-017-01	0 -10 amp input range
Temperature monitors for top-oil temperature and hot -spot temperature	Qualitrol	Model # IED509−00041412 Config # IED509−2837	10-ohm copper – two winding xfmr panel mount in control compartment
		Model # IED509−00041414 Config # IED509−2838	10-ohm copper – two winding xfmr in separate enclosure
		Model # IED509−00041408 Config # IED509−2835	100-ohm platinum – two winding xfmr panel mount in control compartment

Material	Manufacturer	Product Ref.	Comments
		Model # IED509–00041410 Config # IED509–2836	100-ohm platinum – two winding xfmr in separate enclosure
Radiator fans	Krenz-Vent		To be OSHA approved
Circulating Pumps	Cardinal	Harley™ sleeve bearing	
A3. Surge Arresters			
Station Class Arrester	ABB Power	EXLIM-Q, -P	
Station Class Arrester	Cooper power Systems	VariStar AZE	
Station Class Arrester	General Electric	Tranquell XE, XGA, XTA	
Station Class Arrester	Joslyn	ZS, ZSH	
Station Class Arrester	Ohio Brass	Dynavar VL, VN	
Discharge Counter	General Electric		
Discharge Counter	Ohio Brass		
A4. Wiring			
Compression terminals	Burndy	YAV HYLUG	Ring tongue
Compression terminals	Burndy	YAV-T-HYLUG	Fork-tongue
Crimping tool	Burndy	HYTOOL	
Terminal Blocks	GE	EB-25 or EB-27	
Terminal Blocks	Buchanan	2B or 4B	
Terminal Blocks	Penn Union	Cat. #6006	Shorting or non-shorting
Fan wiring	Krez-Vent	Power cord	
Pump wiring	Harley	WeatherAll power cord	
A5. Oil preservation System			
Pressure-vacuum gauge	Qualitrol	070-35C 050-35E	
Bleeder device	Qualitrol	351-2A	
A6. Conservator (Oil preservation system)			
Dehydrating Breather	Messko	MTraB	Maintenance-free and HT type for temperatures below 0°C
Pressure-vacuum gauge	Qualitrol	050-35E	For transport
A7. Fall Arrest Equipment/Safety Railing			
Base Plate	Pelsue	FB-SW1 (PPNUH4000-2 = obsolete)	
Rope for safety rail	U.S. Rope & Cable		
A8. Auxiliary Protection Devices			
Dial type oil-level indicator	Qualitrol	Series 032 or similar Series 042 or similar	To include connector and cable
Pressure relief device	Qualitrol	XPRD00-00016608	For main tank, 10 psi
Pressure relief device	Qualitrol	XPRD00-00021642	For main tank, 12 psi
Stainless steel screen for pressure relief device pipe	Qualitrol	SCN-600-1	
Rapid-pressure-rise relay	Qualitrol	900-009-03	

Material	Manufacturer	Product Ref.	Comments
Connector and cable assembly	Qualitrol	CON-603	For rapid-pressure-rise relay
Seal-in relay	Qualitrol	909-210-01	For control compartment
Winding temperature simulation system	Qualitrol	Series 104	
Gas detector relay	ABB	Type 11	
Gas detector relay	Buchholz		
12-point alarm monitor – 48 VDC	Rochester Instrument Systems	AN6100B; Part Number: B2HX1WINTS12W24WMN/OF48C12FODC1FPLPCPPL	
12-point alarm monitor – 125 VDC	Rochester Instrument Systems	AN6100B; Part Number: B2HX1WINTS12W24WMN/OF125C12FODC2FPLPCPPL	
A9. Bushings			
Bushings	ABB Power		
Bushings	Siemens		Previously Trench and HSP
Bushings	AREVA		Previously Passoni & Villa
Bushings	PCORE		Previously Lapp
A10. On-Line DGA Monitors			
Monitor	Kelman/GE	TRANSFIX, MINITRANS, MULTITRANS	
Monitor	Morgan Schaffer	Calisto 2	
Monitor	Serveron/Siemens	TM8	

Procedure

TRANSFORMER RECEIVING, INSTALLATION AND TESTING PROCEDURE

(Previously known as Document 002)

SP-TRF-INST

Author: Substation Technical Services
Approval: Manager, Substation Technical Services
Authoring Department: Substation Technical Services
File Location: Pdxfil01\\DATA\SHARED\SUBSTATION LIBRARY\Forms-Policies-Procedures
File Number-Name: SP-TRF-INST
Issued: 02/15/10

Revision History		
R5	11/06/08	Several revisions
R6	4/17/09	Updated oil processing requirements, paragraph 6.9
R7	8/11/09	Formatting changes
R8	12/23/09	Format changes, corrections to Section 7, 8.

TABLE OF CONTENTS

TRANSFORMER RECEIVING, INSTALLATION, TESTING AND ENERGIZING

1 Scope

The purpose of this procedure is to provide general guidelines for the receipt, inspection, installation, baseline testing and energizing of all relocated, temporary and new substation class transformers, shunt reactors, large voltage regulators and other similar oil-filled devices. Throughout this procedure, the term transformer is used in the generic sense, and is meant to include all the equipment described above. For most of these devices, the installation activities are essentially similar to those for a transformer other than specific testing requirement and items that may not apply to a particular device; for example, testing of load tap changers which are not present on reactors.

This procedure may not cover all types of transformers and/or accessories. Most transformer manufacturers require specific tests for validation of warranty. The manufacturer's guidelines may include additional tests or procedures that exceed this guideline. Obtain the manufacturer's installation guidelines before work is begun. When there is a conflict between the owner procedures and the manufacturer procedures, the owner procedures shall prevail unless specifically agreed to by substation technical services.

Specific instructions for transformers that are to be stored as spares are listed at the end of this document in section eight.

Completion of owner forms will be required as part of the transformer receiving, installation and energizing work scope. These forms are listed in this document in section five. Form SF-TRF-INST must be filled out per this transformer receiving, installation, and testing procedure. Section numbers from this procedure correspond to areas of the form SF-TRF-INST that need information recorded. Completed forms shall be forwarded by e-mail to "Substation Documentation."

2 References (procedures, manuals and standards)

2.1 Equipment manufacturer instruction manuals

2.2 Industry standards

2.3 Confined space entry procedure

2.4 SP-INSRES - Insulation Resistance Test procedure

2.5 SP-OIL-QUAL -Oil Quality Analysis Sampling procedure

2.6 SP-TTR - Transformer Turns Ratio (TTR) Test procedure

2.7 SP-TRF-OILPROC - Transformer Vacuum Processing procedure

2.8 SP-OIL-DGA - Dissolved Gas Analysis (DGA) Test procedure

2.9 321 - Current Transformer Test procedure

2.10 322 - Transformer Temperature Monitor - Qualitrol Test procedure

2.11 323 - Transformer LTC Position Indicator - Incon 1250 Test procedure

2.12 324 - Transformer LTC Controller - Beckwith M-2001B & M-2270 Test procedure

2.13 SP-HIPOT - Applied Voltage Test procedure

2.14 Doble SFRA Test Guide - obtained from Doble Engineering

3 Precautions

3.1 Follow all applicable PacifiCorp safety procedures.

3.2 Follow all testing precautions in referenced manuals, standards and procedures.

3.3 Follow all requirements from the PacifiCorp Confined Space Entry procedure.

4 Equipment used

4.1 TTR test set

4.2 Insulation resistance test set

4.3 Power factor test set

4.4 Oil quality sample containers

4.5 DGA sample cylinders

4.6 Moisture/dew point test set (required if transformer pressure is less than or equal to 0 PSI)

4.7 Current transformer excitation, ratio and polarity test set

4.8 Current and voltage power system simulator

4.9 RTD (resistive temperature device) temperature calibrator

4.10 Current, voltage and resistance multi-meter

4.11 Timer

4.12 Sweep Frequency Response Analyzer (SFRA) – Doble M5x00

4.13 Applied Voltage test set (if required for load tap changer acceptance testing)

5 Required forms and test results

The forms and electronic test results listed below shall be completed and submitted to the owner for review before the transformer installation work can be accepted by the owner. See section 10 for details.

5.1 SF-TRF-INST -Transformer Installation form

5.2 SF-OIL-DGA - Oil Sample form

5.3 SF-TTR - Transformer Turns Ratio test form

5.4 SF-INSRES - Insulation Resistance test form

5.5 Power factor test and excitation test (test set-generated form)

5.6 SF-TRF-VACLOG Oil Processing form

5.7 323F - Transformer LTC Position Indicator - Incon 1250 test form

5.8 322F - Transformer Temperature Monitor (Qualitrol 509-100) test

5.9 321F - Current Transformer test form

5.10 324F - Transformer LTC Controller - Beckwith M-2001B & M2270 test form

5.11 Doble power factor and excitation test results in electronic raw data files in Doble M4000 software format

5.12 Doble SFRA test result electronic raw data files in Doble M5x00 software format

5.13 Impact recorder print-out or electronic recorded data file (if applicable)

6 Receiving, installation and testing requirements

NOTE!

Activities 6.1 – 6.6 shall be performed before responsibility for or transfer of ownership of the transformer takes place between the manufacturer and the owner, with the following conditions:

1. For all transformers shipped FOB Rail Siding or FOB site by rail or ship, activities 6.1 - 6.6 shall be performed before the transformer is removed from the rail car or truck.
2. For all other transformers, activities 6.1 - 6.6 shall be performed once the transformer has been placed on the pad, except as noted in 6.3.1 and 6.6.
3. Where the transformer manufacturer or his authorized contractor is responsible for turnkey delivery, installation and assembly of the transformer to the pad, activities 6.1 - 6.6 may be performed once the transformer has been placed on the pad, regardless of the method of shipment of the transformer.

6.1 Visual inspection – outside of transformer

6.1.1 Verify that the tank has a positive pressure. If pressure is 0 PSI or less, contact the owner immediately. Pressure at 0 PSI or less will require a moisture/dew point test to be taken (see section 6.4).

6.1.2 Verify that there are no oil leaks.

6.1.3 Inspect for signs of impact or any other damage: broken tie downs, movement, etc.

6.1.4 Inventory and inspect the auxiliary components (bushings, radiators, radiator fans, surge arrestors, device supports and braces, grounding materials, etc.). Refer to the manufacturer's parts list to inventory parts shipped separately from the transformer.

6.2 Impact recorder

6.2.1 Review the impact recorder data. Recorders must be operational and recording. If it is not, contact the owner.

6.2.2 Note impacts greater that 3 g.

6.2.3 Contact the owner immediately if impacts are greater than 5 g (do not unload until a complete internal inspection is performed).

6.2.4 Forward the impact recorder data (tapes, recordings or electronic data) to substation technical services.

6.3 Core ground test

6.3.1 If ship, rail car and/or trailer are used for transportation, a core ground test of each individual core ground connection shall be performed on the transformer before it is unloaded from all modes of transportation.

6.3.2 Perform the test per the "Core Ground Test" section located in the SP-INSRES-Insulation Resistance test procedure. Record values on form SF-TRF-INST.

6.3.3 Contact substation technical services immediately if the reading is below 1,000 megohms for new equipment or below 100 megohms for existing equipment. The test voltage shall be 500 VDC, unless the manufacturer specifies a different test voltage.

6.4 Moisture/dew point test (when required by company or manufacturer)

6.4.1 If the transformer is not under a positive pressure (refer to section 6.1), add dry air or nitrogen to reach 2.0 to 3.0 psi and allow 12 hours for moisture to reach equilibrium. Notify substation technical services immediately for guidance before proceeding with oil filling.

6.4.2 Perform a moisture/dew point test as per manufacturer guidelines, if required.

6.4.3 Forward the results to substation technical services.

6.5 Internal inspection

An internal inspection shall be performed on all ship and rail car shipments unless waived by the company.

6.5.1 Refer to the Confined Space Entry procedure for requirements regarding breathing atmosphere monitoring and fall protection and retrieval equipment.

6.5.2 Before entering a transformer tank, check for acceptable breathing atmosphere. Refer to the PacifiCorp Confined Space Entry procedure.

6.5.3 Ensure that all personal belongings (keys, pocket change, jewelry, watches, etc.) are removed before entering the tank.

6.5.4 Ensure that all tools and equipment inside the tank are tied off to the personnel inside the tank, or by line to the outside of the tank.

6.5.5 Keep all loose items (bolts, nuts, tools, etc.) on top of the transformer tank away from any open manhole lid.

6.5.6 Always apply a constant dry air purge when working internally to prevent atmospheric air from entering the transformer tank.

6.5.7 Never allow rain or snow to enter the transformer.

6.5.8 Visually inspect the inside of the transformer for any foreign materials such as metal filings, dirt or other abnormal conditions.

6.5.9 Visually inspect all accessible internal components for damage incurred during loading and shipping of the transformer.

6.5.10 Contact substation technical services immediately if any abnormal conditions are found in the transformer.

6.6 Sweep Frequency Response Analysis (SFRA) - If required before unloading the transformer from rail car of trailer

The owner may sometimes elect to have a secondary set of SFRA tests performed on critical units. This set of tests shall typically be performed with the transformer still on the rail car or trailer, and the transformer will have special dummy test bushings installed for that purpose.

6.6.1 For transformers with dummy test bushings, a SFRA test must be performed in accordance with Doble Engineering's guide titled "Power

Transformer – Test Specification Transformer Sweep Frequency Response Analysis Test" (version 5.2 dated October 2006).

6.6.2 This guide is available from Doble Engineering, or a copy can be obtained from substation technical services.

6.6.3 The tests shall be performed using exactly the same test configurations and tap positions as those performed at the factory.

6.6.4 Test results shall be compared to the equivalent tests performed by the manufacturer before the transformer was shipped from the factory. If any discrepancies are found, contact substation technical services immediately.

6.6.5 Test results shall be labeled and identified for their purpose, date of test and location of test. The results shall be submitted to PacifiCorp documentation department on a CD-ROM in raw electronic data format (file.sfra) in addition to any other paper or scanned test reports.

6.7 Oil test - bulk oil

6.7.1 Draw an oil quality test sample on bulk oil prior to filling the transformer, per the owner's SP-OIL-QUAL - Oil Quality test procedure.

6.7.2 Use form SF-OIL-DGA for logging the samples and submit the samples and form to a PacifiCorp-approved laboratory for analysis. A copy of the completed sample form shall be included with the documentation to be submitted to the owner.

6.8 Assembly

6.8.1 Inspect the load tap changer for shipping damage, and follow manufacturer guidelines for acceptance testing.

6.8.2 Clean the bottom glass and draw-lead tubes on all bushings prior to installation.

6.8.3 Verify that the bushings have correct oil levels.

6.8.4 Perform power factor tests on all bushings and arrestors prior to their installation. Measure C1 and C2 capacitances and power factor on bushings when test or voltage taps are available.

6.8.5 Install components (bushings, radiators, radiator fans, surge arrestors, oil pumps, device supports and braces, grounding materials, temperature and monitoring devices, etc).

6.8.6 Note the draw lead condition and length. Draw lead slack should not be greater than two inches.

6.8.7 Arrestors that are made up of stacked units shall be checked to ensure the correct serial numbers are used in each phase stack.

6.8.8 Attach test equipment-generated report for bushing power-factor tests. The original electronic data file generated by the test set shall be included on a CD-ROM in the "file.xml" format, in addition to any other scanned or paper documents. Label the test files to clearly indicate the purpose of the tests, date of tests and location of bushings.

6.8.9 Verify that all radiator valve-packing nuts are tight.

6.9 Fill transformer with oil

6.9.1 The **contractor is required to follow the owner's procedure** for oil processing of transformers, **SPC-TRF-OILPROC**. The transformer shall be dried out using the "Hot Oil Circulation Dry-out" process, which shall include the use of a cold trap. Taking a dew point measurement to determine dryness in lieu of this dry-out method is not acceptable. Any substantial deviation from the owner's procedure shall be pre-approved prior to the contractor's mobilization for the work site.

6.9.2 Before filling the transformer with oil, the contractor shall perform a dielectric test on the oil. If the oil dielectric test results differ by more than 15% from the manufacturer specification, the owner shall be contacted immediately before the oil is introduced into the transformer. Filling shall not proceed until owner approval has been obtained.

6.9.3 Fill the transformer with oil per the procedure for oil processing of transformer SP-TRF-OILPROC. Use form SF-TRF-OILPROC - Vacuum Processing Log to record all pertinent data as described in the procedure.

6.9.4 After filling the transformer with oil, check that all valves are in their normal operating position (radiator, conservator, nitrogen, etc.).

6.10 Oil tests - baseline

Draw an oil quality test sample and dissolved gas test sample from the transformer per SP-OIL-QUAL - Oil Quality Test procedure and SP-OIL-DGA - Dissolved Gas Analysis (DGA) test procedure. Use form SF-OIL-DGA for both samples and submit the samples to a PacifiCorp-approved laboratory for analysis.

6.11 Core ground test – after assembly

6.11.1 Perform an additional core ground test for each separate core ground connection after the transformer is fully assembled and placed on the pad, per the core ground test procedure located in SP-INSRES - Insulation Resistance test procedure. Record the values on form SF-TRF-INST.

Note: Contact substation technical services immediately if the reading is below 1,000 megohms for new equipment or below 100 megohms for existing equipment. The test voltage shall be 500 VDC.

6.11.2 All core ground straps must be reconnected to the end frame after tests, and external bushing or ground connections made up for normal operation according to manufacturer instructions.

6.12 Transformer Turns Ratio (TTR) test

6.12.1 Perform a TTR test on all de-energized tap positions with the load tap changer in the neutral position.

6.12.2 Perform a TTR test on all load tap changer positions with the de-energized tap changer on the highest tap position.

6.12.3 Testing shall be done per SP-TTR - Transformer Turns Ratio test procedure.

6.12.4 Testing results shall be recorded on form SF-TTR - Transformer Turns Ratio.

6.12.5 Set the final de-energized tap position per the company-issued relay setting document.

6.12.6 A final test shall be performed with the de-energized tap set at its operating position and the LTC on neutral.

6.12.7 Any test values that are not within the acceptable criteria outlined in the document shall be brought to the attention of substation technical services.

6.13 Power factor/exciting current test

6.13.1 Power factor tests:

6.13.1.1 Perform a power factor test on all windings, bushings, arrestors and the oil.

6.13.1.2 Power factor testing shall be done in accordance with the test equipment manufacturer's published data.

6.13.1.3 Any test results that deviate from the manufacturer's published acceptable values shall be brought to the attention of substation technical services.

6.13.1.4 Test set-generated reports shall be forwarded to substation technical services.

6.13.1.5 In addition to any printed reports, the original electronic test file in raw data format (file.xml) will be included on a CD-ROM.

6.13.2 Excitation tests:

6.13.2.1 Perform exciting current tests on all de-energized tap positions with the LTC on neutral.

6.13.2.2 Perform exciting current tests on all LTC positions with the de-energized tap changer on the highest tap position.

6.13.2.3 Exciting current testing shall be done in accordance with the test equipment manufacturer's published data.

6.13.2.4 Any test results that deviate from the manufacturer's published acceptable values shall be brought to the attention of substation techncial services.

6.13.2.5 Test set-generated reports shall be forwarded to substation technical services or e-mailed to "Substation Documentation".

6.13.2.6 In addition to any printed reports, the original electronic test file in original Doble software raw data format (file.xml) will be included on a CD-ROM.

6.14 Sweep frequency response analysis (required once placed on pad)

6.14.1 Perform a Sweep Frequency Analysis Test in accordance with Doble Engineering's guide titled "Power Transformer – Test Specification Transformer Sweep Frequency Response Analysis Test" (version 5.2, dated October 2006).

6.14.2 This guide is available from Doble Engineering, or a copy can be obtained from substation technical services.

6.14.3 Perform a full set of tests using exactly the same test configuration and tap (load tap changer and de-energized tap changer) positions as those performed at the factory.

6.14.4 These test results shall be compared to the equivalent tests performed by the manufacturer prior to shipping the transformer. If any discrepancies are found, contact substation technical services immediately.

6.14.5 If the standard configuration tests for the specific winding layout are different from the tests performed at the factory, repeat a full set of tests in the recommended test positions as described in the Doble Engineering test specification listed in 6.6.1 to obtain a set of standardized baseline tests for future reference.

6.14.6 All test results shall be submitted to the PacifiCorp documentation department on a CD-ROM in original electronic Doble software raw data format (file.sfra), in addition to any other paper or scanned test reports. If more than one set of tests were performed, each shall be clearly identified for the exact purpose both in the software comments and in the documentation submittals.

6.15 Insulation resistance test

Caution: Any DC test may magnetize the core.

6.15.1 Perform an insulation resistance test as per SP-INSRES - Insulation Resistance test procedure.

6.15.2 Use form SF-INSRES - Insulation Resistance to record the test results.

6.16 Test and calibrate all auxiliary devices

Perform operational and calibration checks on all applicable auxiliary devices listed below. This list may not include all transformer auxiliary devices installed on the transformer. Additional devices not listed in this document may also need testing.

6.16.1 Fans

Each fan shall be checked for proper operation. The test shall include a check for correct fan rotation.

6.16.2 Pumps (if applicable)

Each pump shall be bump tested for proper operation. The test shall include a check for correct pump rotation. Each pump oil flow indicator shall be checked to ensure proper operation.

6.16.3 Temperature gauges (if applicable)

6.16.3.1 Each temperature gauge and its micro-switch contacts (for fans, alarming and tripping) shall be checked for proper operation.

6.16.3.2 Contact temperature set points shall be set per PacifiCorp's transformer specification.

6.16.3.3 The alarm and trip logic shall be consistent with the transformer wiring diagrams and schematics, and verified at the transformer output terminal blocks.

6.16.3.4 Record the transformer oil temperature as indicated on each gauge on SF-TRF-INST.

6.16.4 Liquid level gauges

6.16.4.1 Each liquid level gauge and its micro-switch contacts (alarming and tripping) shall be checked for proper operation.

6.16.4.2 The alarm and trip logic shall be consistent with the transformer wiring diagrams and schematics, and verified at the transformer output terminal blocks.

6.16.4.3 Record the liquid level as indicated on each gauge on SF-TRF-INST.

6.16.5 Pressure relief device

Each pressure relief device shall be inspected and its alarm contacts shall be checked for proper operation. The alarm contact shall be consistent with the transformer wiring diagrams and schematics, and verified at the transformer output terminal blocks.

6.16.6 Sudden pressure relay

6.16.6.1 Each sudden pressure relay and associated seal-in auxiliary relay shall be tested for proper operation.

6.16.6.2 The sudden pressure relay shall be mechanically tested per the testing procedures outlined in the Qualitrol device manual.

6.16.6.3 All auxiliary seal-in relay contacts shall be consistent with the transformer wiring diagrams and schematics, and verified at the transformer output terminal blocks.

6.16.7 Current transformers

6.16.7.1 Current transformers shall be tested per the 321-Current Transformer Testing procedure.

6.16.7.2 Use form 321F - CT Test to record the test results.

6.16.8 Temperature monitor/controller

Test and set the Qualitrol 509 electronic temperature control device per 322-Transformer Temperature Monitor (Qualitrol 509-100) test procedure. Use form 322F-Qualitrol 509-100 test to record the test results.

6.16.9 Load Tap Changer (LTC) step continuity

Verify continuity between steps for all LTC positions by performing a continuous current excitation test and monitor the test set volt/current displays while stepping the LTC through all step positions in both directions to verify that there are no momentary open circuits during any tap changes.

6.16.10 LTC position indicator

Test and set the LTC position indicator and accessories per the 323 - Transformer LTC Position Indicator (Incon 1250) test procedure. Use form 323F-Incon 1250 test to record the test results.

6.16.11 LTC controller

Test and set the LTC electronic controls per the 324 -Transformer LTC Controller (Beckwith M-2001B & M-2270) test procedure. Use form 324F-Beckwith M2001B and M2270 test to record the test results.

6.16.12 Nitrogen system (if applicable)

The nitrogen system shall be tested to ensure the system regulates correctly and that there are no leaks. Testing shall be done per the manufacturer's testing procedures. All microswitch alarm contacts (empty cylinder, high pressure, low pressure, etc) shall be consistent with the transformer wiring diagrams and schematics, and verified at the transformer output terminal blocks. Record the pressure indicated on gauge on SF-TRF-INST.

6.16.13 Cooling loss of power

Each under-voltage alarm relay shall be tested for proper operation. Relay contacts will be consistent with the transformer wiring diagrams and schematics, and verified at the transformer output terminal blocks.

6.16.14 LTC off tap (if applicable)

The LTC off tap indication alarm shall be tested for proper operation in accordance with the manufacturer's specifications. The alarm contact shall be consistent with wiring diagrams and schematics, and verified at the transformer output terminal blocks.

6.16.15 LTC failure (if applicable)

The LTC failure indication alarm shall be tested for proper operation in accordance with the manufacturer's specifications. The alarm contact shall be consistent with the transformer wiring diagrams and schematics, and verified at the transformer output terminal blocks.

6.16.16 LTC filter (if applicable)

The LTC filter indication alarm shall be tested for proper operation in accordance with the manufacturer's specifications. The alarm contact shall be consistent with the transformer wiring diagrams and schematics, and verified at the transformer output terminal blocks.

6.16.17 Desiccant/dehydrating breathers (if applicable)

Verify that desiccant breathers for both the main tank and LTC compartment are assembled in accordance with the manufacturer's instructions.

Verify that the breathing cups are properly filled with oil, and that the desiccant containers are properly filled with new desiccant.

7 Post – energizing (if applicable)

7.1 For new transformers, it is not required to “soak” the transformer before putting load on it.

7.2 For used transformers, contact substation technical services for recomm-endations on soaking.

7.3 When loading the transformer for the first time, if possible, slowly increase the load (one feeder per hour). This is to prevent the formation of steam on units that may have high moisture levels.

7.4 Check for balanced load on all phases.

7.5 Check for proper voltage.

7.6 Check the LTC for proper operation.

7.7 Check all temperature gauges for proper operation.

7.8 Check for oil leaks on radiators, pumps, valves, door gaskets, etc.

7.9 Perform a DGA and oil quality test two weeks after energizing the transformer. Test shall be performed per SP-OIL-DGA - Dissolved Gas Analysis (DGA) test procedure and SP-OIL-QUAL - Oil Quality test procedure. Use form SF-OIL-DGA to submit samples to a PacifiCorp-approved lab.

7.10 Static delectrification (if applicable)

WARNING: Do not test run cooling pumps on energized transformers when the top oil temperature is below 50° C.

8 Spare transformer receiving and installation

Transformers that are designated to be stored as spares shall be handled in the same manner as transformers that are to be installed in facilities to be energized, with the following additional requirements:

8.1 On a case by case basis, and only with specific prior approval from substation technical services: Transformers that are earmarked for installation in a substation and will be in temprary storage for less than three months may be exempted from oil filling, dress out and testing until they are moved to their final destination. Contact substation technical services for approval and specific instructions before work is started.

8.2 Transformers shall be installed on suitable treated timbers. Timbers shall be of quality and size that they will withstand the weight of the transformer and they shall be treated to withstand years of outdoor exposure.

8.3 Unless instructed otherwise, radiators and radiator fans will not be installed. These devices shall be stored beside the transformer and be clearly marked to identify the transformer they belong with. These devices shall be stored on pallets and covered with tarpolins in a manner that will ensure they will not be damaged if stored for any length of time. The pallets shall be located to allow easy access so they can be ready for shipment in a short period of time. Radiators shall be filled with nitrogen to keep moisture from coming in contact with the radiator internal walls.

8.4 Transformers that are filled with oil but without the radiators installed shall be overfilled to compensate for the oil that would normally held by the radiators. This is to minimize or avoid the need for make-up oil.

WARNING: Verify that sufficient expansion space remains in the overfilled transformer to prevent damage due to expansion of oil as a result of ambient temperature changes.

8.5 If make-up oil needs to be added to a transformer, it shall be added by following all the requirements of the owner procedure SPC-TRF-OILPROC. Oil that is added shall be processed by degassing and heating first. A vacuum shall not be pulled on an oil-filled transformer before adding oil.

8.6 All equipment and accessories shall be installed and tested as described in this document, with the exception of the radiators, cooling fans and lightning arresters.

8.7 After all testing has been completed, short all bushings together with suitable copper wire. The shorted bushings shall then be connected to the tank wall.

8.8 If AC power is available, connect the power source to the transformer to power the control cabinet heaters.

8.9 Any miscellaneous parts associated with the transformer that are not installed on the transformer shall be clearly marked and stored near the transformer. This would include items such as lightning arrestors, arrestor brackets, bushing cover plates, etc. These devices shall be stored on pallets and covered with tarpolins in a manner that will ensure they will not be damaged if stored for any length of time. The pallets shall be located to allow easy access so they can be ready for shipment in a short period of time.

9 Minimum acceptance criteria

In order for the owner to accept the transformer as being ready for service, the following acceptance criteria apply for new transformers: (If the transformer fails to pass any of the tests below, corrective action will have to be negotiated with the owner before the transformer can be accepted.)

9.1 TTR test: No mismatch greater than 5% from manufacturer test results is accepted. Each tap position (16L-16R) must be tested with the de-energized tap changer in the nominal position.

9.2 Power factor test: Overall power factor and bushing tests should have no more than 5% deviation from factory tests, with a maximum absolute power factor value of 0.5%. Bushings must be tested on both the C1 and C2 taps. All tests should have a pass rating assigned by the internal software analysis feature, if applicable.

9.3 Excitation test: No mismatch greater than 5% from the factory test results is accepted. The core shall not be magnetized. Tests shall be performed with the de-energized tap changer in the nominal position, and all load tap changer positions from 2L – 16R.

9.4 Core ground test: A minimum of 1,000 megohms for new transformers and of 100 megohms for used transformers is required.

9.5 All mechanical and electrical accessories must be installed and functioning as designed.

9.6 All receiving and installation checks and tests must be documented and submitted as described in section 10.

10 Test reports and documentation submittal

Failure to submit proper test reports as described below may lead to a delay of acceptance of the transformer by the owner, which may result in a delay of payment to the manufacturer or contractor. Field copies of installation tests and reports shall be submitted to substation technical services for review during and no less than two days after completion of installation work. After all installation and testing is completed, a final field installation test report shall be submitted in duplicate on two separate CD-ROMs (in addition to any e-mailed or paper reports) to substation technical services and e-mailed to “Substation Documentation” and shall include the following:

10.1 A cover page listing the transformer test location, transformer serial number, transformer PO number, transformer equipment number (SAP number), date of tests, name of test company and their test personnel contact numbers.

10.2 An index page listing all test results included in the report.

10.3 Doble power factor and excitation electronic data test files (in "file.xml" format) and Doble SFRA electronic data test files (in "file.sfra" format) shall be included with the electronic test report as attachments in addition to any other printed results for those tests.

10.4 Final copies of all field installation forms used for recording accessory inspections, testing or verification and electrical test results such as transformer turns ratio, insulation resistance (e.g. Megger) and vacuum processing log sheets shall be included as attachments with the test report.

10.5 Copies of lab test results for oil samples (DGA and oil quality, corrosive sulfur, etc.) shall be included with the test report.

Substation Equipment—Voltage Regulator, Three-Phase, All Ratings

1 Scope

This material specification covers requirements for three-phase voltage regulators of all ratings to be purchased by PacifiCorp.

2 References

The following publications shall be used in conjunction with this material specification, and form a part of this material specification to the extent specified herein. When a referenced publication is superseded by an approved revision, the revision shall apply.

2.1 Industry Publications

Referenced industry publications are:

ANSI C2, *National Electrical Safety Code*

IEEE C57.15, *Standard Requirements, Terminology, and Test Code for Step–Voltage and Induction–Voltage Regulators*

IEEE C57.95, *Guide for Loading Liquid-Immersed Step-Voltage and Induction-Voltage Regulators*

2.2 Pacifiorp Publications

Referenced PacifiCorp publications are:

ZS 061, *Electrical Equipment—Insulating Oil*

ZS 065, *Wind, Ice and Seismic Withstand*

ZS 066, *Contaminated-Environment Protection*

3 General

3.1 Application Information

This specification states both the general requirements for three-phase voltage regulators and the regulator-specific requirements that vary depending on the installation and
intended use (see Section 8, *Additional Voltage Regulator–Specific Requirements*).

3.2 Authorized Material Specification

This material specification is not considered valid until each page contains the approval signature (initials) of the persons named in the title blocks and Section 8 is completed.

4 Design and Manufacturing Requirements

4.1 Codes and Standards

Except as required otherwise by this material specification, the regulator specified herein shall be furnished in accordance with the latest applicable industry codes, ANSI, IEEE, and NEMA standards, and PacifiCorp standards and material specifications in effect on the date of invitation to bid.

4.2 Type

The voltage regulator shall be: three-phase, outdoor, 60 hertz oil-immersed, 55/65°C average winding temperature rise and 65/80°C hot spot winding temperature rise.

4.3 Cooling Equipment Control

Forced air cooling equipment, if applicable, shall be controlled from top oil temperature.

4.4 Elevation

Unless otherwise specified in 7.14, the voltage regulator shall be rated for elevations up to 3,300 feet. For elevations above 3,300 feet, or above the elevation specified in 8.13, the regulator shall be suitable for operation in accordance with the capabilities and limitations described in IEEE C57.15 (including Appendix A), and IEEE C57.95.

4.5 Ambient Temperature

The regulator shall be rated for an ambient temperature range of −40°C daily minimum to +40°C daily peak, +30°C daily average.

4.6 Insulation Materials

All insulation materials shall be thermally upgraded (suitable for continuous operation at 120°C).

4.7 Wind and Seismic Withstand

The wind and seismic withstand capability of the regulator installed alone, and of the combination of the regulator and elevating structure installed together if applicable, shall be in accordance with PacifiCorp material specification ZS 065.

4.8 Contaminated Environment Protection

If specified in Section 8.8, the regulator shall be furnished in accordance with the contaminated environment protection requirements of PacifiCorp material specification

ZS 066, except that all exposed metal parts shall be stainless steel only, in accordance with the following requirements (note that the exposed fasteners and hardware on all regulators shall be furnished in accordance with Section 4.9):

1. The tank and all exposed metal components and accessories, other than those covered in Section 4.9, shall be 304L stainless steel.
2. All welds shall be of 300−series stainless steel.

4.9 Exposed Fasteners and Hardware

All exposed fasteners and hardware (such as bolts, screws, washers, hinges, handles, brackets, and ground pads) shall be 300−series stainless steel, except all nuts, which shall be silicon−bronze to prevent galling. If the supplier prefers, the ground pads may be
copper−faced steel as permitted by IEEE C57.15.

4.10 Terminal Connector

A flat pad with NEMA standard 4-hole drilling and tin plated to 0.001 inch shall be furnished for each bushing.

4.11 Load Tap Changer (LTC)

When the load tap changer (LTC) equipment is located in the main regulator tank, the regulator shall be furnished with a removable cover on the side of the tank adjacent to the LTC to allow for inspection, maintenance and replacement of components without the necessity of untanking the unit.

If specified in Section 8.7, a separate LTC oil-filled compartment shall be furnished, isolated from the main regulator tank by an oil-tight, non-conductive, terminal-board barrier. All LTC components shall be accessible for inspection, maintenance and replacement through the LTC compartment door, without the necessity of untanking the regulator core-and-coil assembly or lowering the oil level in the main tank.

4.12 Paralleling Equipment

The supplier shall furnish a Beckwith model M−0115A parallel balancing module as the the approved circulating−current type paralleling equipment. PacifiCorp will furnish the engineering and auxiliary equipment required to coordinate with the paralleling equipment on the parallel unit.

4.13 Pressure Relief Device(s)

A self-resealing mechanical pressure relief device shall be furnished on the main tank, and on the separate LTC compartment if applicable. Each pressure relief device shall be Qualitrol model 208−60F, 10 psi, with alarm contact, high visibility indicator pin, and suitable connector and cable. The device mounting location(s) shall provide visibility of the indicator pin from the ground.

4.14 Regulator Accessories

The voltage regulator shall be furnished with the following accessories:

1. Oil level gauge(s) with alarm and trip contacts
2. Oil temperature gauge with alarm and trip contacts
3. Mechanical position indicator with drag hands
4. External or internal metal oxide surge protection device connected across the series winding
5. Current and voltage transformers for compensator and voltage control relay. The current transformer shall be connected to sense phase 1 line current, and shall have 0.2 ampere secondary. The voltage transformer shall be connected to sense line to neutral voltage at terminal L1, and shall have voltage transformer taps or means of adjustment, or both, furnished to provide secondary control voltage in the range of 115–120 volts for operation at the nominal regulator system voltage rating and all other system voltages for which full capacity operation is specified.
6. Internal motor power supply
7. All other accessories normally furnished as basic regulator equipment.

4.15 Dimensions to External Ungrounded Parts

Minimum height to external ungrounded parts shall conform to the requirements of ANSI C2. An adjustable elevating structure shall be furnished if necessary to meet these requirements.

4.16 Center of Gravity

The voltage regulator centers of gravity, horizontal and vertical, both as prepared for shipment and as completely assembled for service, shall be clearly identified and marked on appropriate instruction plates mounted on the side and on the end of the tank wall.

4.17 Control and Metering

The regulator shall be furnished with a digital microprocessor control. The control shall be one of the following models approved by PacifiCorp: General Electric GE–2011C, Cooper CL–5E, or Siemens MJ–X.

The control panel shall be housed in a NEMA 3R control cabinet with provisions for padlocking. The regulator shall be shipped with the control cabinet mounted on the tank with the control cable connected. The cabinet shall be arranged for easy removal from the regulator for remote mounting or replacement; all electrical connections shall be incorporated in one polarized plug. The panel shall be vertically hinged for easy inspection, and shall be arranged for easy removal from the cabinet for replacement.

A visible means shall be furnished to disconnect the potential transformer from the control, and to short and disconnect the current transformer from the control, before disconnecting the polarized plug or testing or removing the control.

4.17.1 Control Features

The control shall include the following:

1. Provisions for setting the following control parameters:
   Voltage level setting
   Voltage bandwidth setting
   Time delay setting
   Line drop compensator settings
2. Internal–Off–External potential source selector switch
3. Terminals for connection of an external potential source
4. Automatic–Off–Manual control selector switch
5. Raise–Lower manual control switch
6. Provisions to allow supervisory indication and control of the Automatic–Off–Manual and Raise–Lower functions
7. Means to provide continuous indication showing whether the actual voltage level is within or outside the voltage band settings
8. Reset switch for position indicator drag hands
9. Tap changer neutral position indicating light
10. Operation counter
11. Password protection shall be furnished to prevent unauthorized changing of control settings
12. Voltage test terminals connected to the load side of the regulator
13. Separate motor and control panel fuses
14. Cabinet space heater, controlled by an On–Off switch and thermostat

4.18 Metering Capability

4.18.1 Real–Time Values

The control shall include a metering module that will provide real–time values of the following quantities.

1. Source–side voltage
2. Load–side voltage

3. Load–center voltage
4. Tap position
5. Percent regulation
6. Line current
7. Load kVA
8. Load kW
9. Load kvar
10. Power factor
11. Line frequency
12. Voltage harmonics
13. Current Harmonics

4.18.2 Stored Values

The metering module shall also provide stored values of the following quantities, with date and time marking. The demand time interval for these values shall be adjustable.

1. Load–side voltage
2. Load–center voltage
3. Maximum percent voltage boost
4. Maximum percent voltage buck
5. Line current
6. Load kVA
7. Load kW
8. Load kvar
9. Power factor at maximum load kVA
10. Power factor at minimum load kVA

4.19 Insulating Oil

The supplier shall furnish the necessary quantity of insulating oil in accordance with the requirements of PacifiCorp material specification ZS 061.

4.20 Rapid-Pressure-Rise Relay

One oil-space, rapid-pressure-rise relay shall be furnished on the voltage regulator tank, located near the control compartment approximately seven feet above the foundation level. The rapid-pressure-rise relay shall be:

- Qualitrol 900–009–03 type,
- vented,

- bolted–flange mounted,
- furnished with one normally open and one normally closed contact,
- furnished with provisions for testing relay operation without removing the relay from the voltage regulator,
- and furnished with a matching connector-and-cable assembly.

One seal-in relay Qualitrol 909–210–01 shall be furnished in the control compartment for the rapid-pressure-rise relay. A suitable two-inch ball valve shall be furnished for mounting the rapid-pressure-rise relay, to permit removing the relay without draining oil from the transformer tank. The valve shall have provisions for padlocking in both the fully opened and fully closed positions.

4.21 Finish Requirements

The voltage regulator tank exterior paint finish and all bushings shall be ANSI 70/Munsell 5.0 BG 7.0/0.4 light gray.

The voltage regulator tank interior shall be painted white.

5 Technical Documentation

All drawings shall be full size (not reduced). All values on drawings and other information shall be shown in US customary units only, or in both US customary and SI units.

5.1 Technical Documentation for Approval

If specified in Section 8.11, one disk of applicable drawings in AutoCAD (or in DXF file format if not available in AutoCAD) and two sets of prints of applicable drawings and other information from Section 5.3 shall be furnished for approval, and shall be sent to
PacifiCorp as specified in Section 9.

5.2 Final Technical Documentation

Applicable final drawings and other information from Section 5.3 shall be furnished as follows. Also, the PacifiCorp PM order number, PO number, equipment number, and installation location, all provided by PacifiCorp, shall be shown in the title block on all drawings and on all other informational documents.

1. One set of prints shall be shipped with each regulator in a weatherproof envelope or in the control cabinet.
2. Four additional sets of prints shall be sent to PacifiCorp as specified in Section 9. Note that if two or more regulators of a given rating are ordered for one substation, a total of only four additional sets for that rating are required for the substation.
3. If specified in Section 8.12, one additional set of applicable final drawings shall be furnished on a disk in AutoCAD (or in DXF file format if not available in Auto-

CAD), and shall be sent to PacifiCorp as specified in Section 9. Note that if two or more regulators of a given rating are ordered for one substation, a total of only one diskette for that rating is required for the substation.

5.3 Technical Documentation Description

5.3.1 Certification of Insulating Oil

The supplier shall furnish certification that the insulating oil used to fill the regulator contains less than 1.0 ppm polychlorinated biphenyl contamination.

5.3.2 Certified Test Report

The supplier shall furnish a complete certified test report.

5.3.3 Outline Drawing

The supplier shall furnish an assembled regulator outline drawing, including (1) the structural details of the regulator base, (2) the structural details of the elevating structure if applicable, (3) the weight and center of gravity of the oil–filled unit, (4) the dimensions of the unit, and (5) the foundation reactions produced by wind and seismic forces.

5.3.4 Nameplate Drawings

The supplier shall furnish a drawing of each nameplate, including potential and current transformer ratios and connections.

5.3.5 Winding Information

The supplier shall furnish identification of the type of winding construction and the conductor material used. This information shall be shown on the regulator nameplate drawing, outline drawing, or other documentation.

5.3.6 Bushing Outline Drawing

The supplier shall furnish detailed bushing outline drawings including line terminals.

5.3.7 Schematic and Wiring Diagrams

The supplier shall furnish schematic and wiring diagrams showing the load tap changing equipment control, alarm and relay connections, and potential transformer and current transformer connections.

5.3.8 Instruction Manuals

The supplier shall furnish instruction manuals covering receiving, handling, installation, operation, and maintenance of the regulator and all auxiliary equipment.

5.3.9 Renewal Parts

The supplier shall furnish complete lists of renewal parts for the regulator and all auxiliary equipment, including identification of each part by name and part number. The renewal parts list for the tap changing equipment shall be accompanied by detailed drawings and exploded views as required to facilitate complete maintenance by PacifiCorp. Parts lists and drawings shall relate specifically to the equipment covered by this specification; typical drawings are not acceptable.

6 Other Inspection Requirements

6.1 Design Review

If specified in Section 8.14 of this document, a design review will be conducted upon completion of the voltage regulator design. PacifiCorp may employ a consultant as its agent to oversee the review. The supplier shall include in the quoted schedule sufficient time for the review, and shall not order voltage regulator materials prior to completion of the review without the written approval of PacifiCorp.

If PacifiCorp, in its reasonable discretion, finds that the design does not conform to the contract requirements, then the supplier and PacifiCorp will confer regarding the nonconformity, and the supplier shall have the right to submit a corrected design to PacifiCorp. If PacifiCorp and the supplier can not reach an agreement on the voltage regulator design, PacifiCorp may reserve the right to cancel the order per the terms of the contract, Article 27, *Cancellation for Convenience*.

6.2 Quality Surveillance

A quality surveillance representative (QSR) may be employed by PacifiCorp to be present at the supplier's facility during the manufacturing and testing of the voltage regulator. If a QSR is employed, the QSR will comply with the supplier's safety and procedural requirements at all times while in the supplier's facility, and the following additional guidelines shall apply.

6.2.1 Cooperation with the Quality Surveillance Representative

The supplier shall cooperate with the QSR and arrange a reasonable and mutually agreeable schedule for the required inspections and witnessing of tests, consistent with maintaining scheduled progress of the voltage regulator through the supplier's facility. The supplier shall not pre-test voltage regulators prior to the QSR witnessing tests. PacifiCorp requires the QSR to witness all factory tests unless given written approval by PacifiCorp not to witness specific factory tests.

6.2.2 Authority of the Quality Surveillance Representative

The QSR will have full authority from PacifiCorp to make decisions to ensure that the complete voltage regulator equipment complies with all the requirements of

PacifiCorp's procurement documents, and to ensure that all required inspection and witness activities are carried out.

6.2.3 Disagreements

In the event of significant disagreement between the supplier and the QSR concerning scheduling of inspection or witness activities, or concerning interpretation of PacifiCorp's procurement documents, the supplier and the QSR shall promptly and jointly contact PacifiCorp to resolve the matter as described in the contract, Article 25, *Claim Notice and Resolutions Procedure*.

7 Bid Evaluation

7.1 Loss Evaluation

An Equivalent Total Owning Cost (ETOC) will be calculated from the bid price and the present value of the supplier's quoted losses as shown below. The ETOC will be used in determining bid awards.

$$ETOC = BID\ PRICE + (A \times NL) + (B \times LL) + (C \times AP)$$

where:

ETOC	=	*Equivalent total owning cost in dollars*
BID PRICE	=	*Supplier–quoted bid price in dollars*
A	=	*Loss cost multiplier for no–load losses in dollars per watt*
B	=	*Loss cost multiplier for load losses in dollars per watt*
C	=	*Cost multiplier for auxiliary power in dollars per watt*
NL	=	*No–load losses at 20°C in watts*
LL	=	*Load losses at 85°C in watts (at the self–cooled rating), excluding auxiliary power.*
AP	=	*Auxiliary power in watts (with all forced–cooling equipment in service)*

7.2 Loss Penalty

If the losses of the regulator shipped exceed the guaranteed losses stated on the vendor's bid, the supplier shall compensate PacifiCorp for those excess losses. PacifiCorp will calculate the cost and charge the supplier the cost of the evaluated excess losses.

7.3 Loss Cost Multipliers

The loss cost multipliers to be used in the loss evaluation method are specified in Section 8.10.

8 Additional Voltage Regulator-Specific Requirements

The voltage regulator information and specifications in this section are for the equipment referenced in Section 8.1, and shall be used in conjunction with the other requirements of this material specification.

8.1 Equipment Identification

PM Order number:___________________________________

PO number:____

REQ number:____

Equipment number(s):________________________________

Location:____

8.2 Commercial Issues

Correspondence regarding commercial issues shall be sent to the PacifiCorp purchasing department, with copies to:

Project engineer:_____________________________________
Address:____
City:___________________ State:_____ Zip:_____________
Telephone:______________

8.3 Technical Application Questions

Technical questions regarding this material specification, or notice of any other technical matters which arise during the proposal process or during equipment design, manufacture, or test, shall be directed to the project engineer (see Section 8.2).

8.4 Voltage and BIL Rating

The voltage regulator shall have the voltage and BIL ratings checked (✓) below:

13.2 kV, 110 kV BIL . . . . ❑

24.9 kV, 150 kV BIL . . . . ❑

34.5 kV, 200 kV BIL . . . . ❑

______ kV, ______ kV BIL . . . . ❑

8.5 Capacity Ratings

The voltage regulator shall have the following capacity ratings:
______ /______ /______ kVA ______ /______ /______ amperes

The voltage regulator shall be suitable for full capacity operation at a system voltage of ______ kV through ______ kV.

8.6 Regulation Range

The regulation range of the voltage regulator shall be as checked (✓) below:

±10 % in 5/8 % steps . . . . ❑

± ______ % in ______ % steps . . . . ❑

8.7 LTC Compartment

If checked (✓), the LTC shall be in a separate compartment . . . . ❑

8.8 Contaminated Environment Protection

If checked (✓), the regulator shall be furnished in accordance with the contaminated environment protection requirements of PacifiCorp material specification ZS 066 . . . . ❑

8.9 Maximum Height

The maximum overall height of the voltage regulator shall be as checked (✓):
_______ inches . . . . ❑

Supplier's Choice . . . . ❑

8.10 Loss Evaluation Factors

The loss cost multipliers are as follows (see Section 7.1):

No–load loss cost multiplier	(A) = $ _____ . _____ / watt
Load loss cost multiplier	(B) = $ _____ . _____ / watt
Auxiliary power cost multiplier	(C) = $ _____ . _____ / watt

8.11 Approval Drawings

If checked (✓), drawings and other information shall be furnished for approval. (See Section 5.1) . . . . ❑

Approval drawings on diskette shall be as checked (✓) below:

AutoCAD version . . . . ❑

DXF file format . . . . ❑

8.12 Final Drawings on Diskette

If checked (✓), one additional set of final drawings shall be furnished on a diskette as specified (see Section 5.2): . . . . ❑

Approval drawings on diskette shall be as checked (✓) below:

AutoCAD version . . . . ❑

DXF file format . . . . ❑

8.13 Elevation

The voltage regulator shall be designed for special high–elevation operation without derating, up to the specified elevation, if checked (✓) below.
__________ feet . . . . ❑

8.14 Design Review

If checked (✓), a design review will be conducted as specified in Section 6.1 of this document. . . . . ❑

9 Drawing Destination

All drawings and other information shall be mailed to:

Asset Management Document Control
825 NE Multnomah St., 1600 LCT
Portland, OR 97232

9.1 Notice of Shipment

The supplier shall notify the person named below:

Name:____________________________________
Address:____
City:_________________ State:_____ Zip:____________
Telephone:_____________

10 Issuing Department

The Asset Management Documentation Department of PacifiCorp is responsible for issuing this
material specification. Comments and suggestions are welcome. Submit comments or requests for additional copies of this document to:

PacifiCorp Asset Management Documentation
825 NE Multnomah Blvd., Suite 1600, Portland, OR 97232
telephone: (503) 813-5293, fax: (503) 813-6804

Technical questions regarding this material specification may be submitted to:

Staff Engineers, Standards Engineering
825 NE Multnomah Blvd., Suite 1600, Portland, OR 97232
telephone: (503) 813-6901, fax: (503) 813−6804

Standards Engineering Department

Substation Equipment—Power Circuit Breaker—Nominal 345 kV and Above

Project Issue Date: ___________

Specification Approval Date: 8 Feb 10

PacifiCorp Project Info

Attachment to Exhibit _____, Section _____, Attachment No. _____

Project Name: ____

Edited By: ____

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Contents

FIGURES PAGE

TABLES PAGE

Substation Equipment—Power Circuit Breaker—Nominal 345 kV and Above

1 Scope

This material specification states the requirements for substation circuit breakers with a nominal rating of 345 kV and above to be purchased by PacifiCorp.

2 Applicable Documents

Except as required otherwise by this material specification, the circuit breaker specified herein shall be furnished in complete accordance with the latest applicable industry codes, ANSI, IEEE, and NEMA standards, OSHA requirements, and PacifiCorp standards and material specifications in effect on the date of invitation to bid.

Test evidence shall be submitted to confirm that the circuit breaker offered has been fully type-tested to the relevant specifications in an independent test laboratory and/or witnessed by a third-party switchgear specialist. The test evidence shall satisfactorily cover all the requirements of this specification.

2.1 Industry Documents

Applicable industry documents may include, but shall not necessarily be limited to, those listed below.

ANSI C37.04, *Standard Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis*

ASME BPVC, *Boiler and Pressure Vessel Code*

ANSI/IEEE 100, *IEEE Standard Dictionary of Electrical and Electronics terms*

ANSI/NFPA 70, *National Electrical Code*

ANSI/IEEE C2, *National Electrical Safety Code*

ASTM D 2472, *Standard Specification for Sulfur Hexafluoride*

2.2 PacifiCorp Documents

Applicable PacifiCorp documents may include, but shall not necessarily be limited to, those listed below.

ZS 063, *Insulating Fluid—Sulfur Hexafluoride*

ZS 065, *Wind, Ice and Seismic Withstand*

ZS 066, *Contaminated-Environment Protection*

3 General

3.1 Application Information

This material specification states both the general requirements for circuit breakers, and the circuit-breaker-specific requirements that vary depending on installation and intended use (see section 8, *Additional Circuit-Breaker-Specific Requirements*).

3.2 Authorized Material Specification

This material specification is not considered valid until each page contains the approval signature (or initials) of the persons named in the title blocks, and section 8 has been completed.

4 Design and Manufacturing Requirements

4.1 Codes and Standards

Except as required otherwise by this material specification, the circuit breaker specified herein shall be furnished in complete accordance with the latest applicable industry codes; ANSI, IEEE, and NEMA standards; and PacifiCorp standards and material specifications in effect on the date of invitation to bid.

4.2 Type

The circuit breaker shall be sulfur hexafluoride (SF_6)-type with puffer or selfblast-puffer interrupters, outdoor, three-pole, 60-hertz, dead tank, with a separate or common supporting frame, and a separate SF_6 gas system for each pole. No other gas shall be mixed with the SF_6.

4.3 Elevation

Unless otherwise specified in 8.3, the circuit breaker shall be rated for an elevation up to 3300 feet. The IEEE altitude correction factors shall apply for elevations above 3300 feet.

4.4 Ambient Temperature

Unless otherwise specified in 8.4, the circuit breaker shall be rated for ambient temperature between –30°C and +40°C, as specified in IEEE Standard C37.04.

4.5 Operating Mechanisms, Control, and Wiring

4.5.1 Operating Mechanisms

The circuit breaker shall be furnished with three operating mechanisms, one per pole, and shall be suitable for single-pole and three-pole opening and closing operations.

4.5.2 Type of Operating Mechanisms

The operating mechanism shall be trip-free, antipumping, and of the stored-energy, pneumatic, spring, hydraulic type, or any combination of these.

4.5.3 Operating Mechanism Compartments

A NEMA 3R compartment shall be furnished to house each operating mechanism, including the associated charging motor, pump, or compressor. The supplier shall furnish all connections between each compartment and the control compartment.

4.5.4 Auxiliary Power and Control Wiring

The auxiliary power and control wiring shall consist of stranded copper conductor, 600-volt class, with insulation (or outer covering over the insulation) that is flame-retardant, heat-resistant, oil-resistant, and moisture-resistant. Both ends of all conductors and all terminal block points shall be clearly marked with the designation shown on the supplier's wiring diagrams.

Wiring runs outside of weatherproof enclosures shall be in rigid metallic or liquid-tight flexible metallic conduit,. All conduit and conduit connections shall be weatherproof, and all conduit connections to the enclosures shall be on the sides or bottom (not on the top) of the enclosures. For rigid conduit, a condulet outlet body (with an angled, domed cover) shall be furnished at each 90° change of direction; 90° bends in the conduit itself are not acceptable. Liquid-tight flexible metallic conduits shall be secured every 24" (or less), and shall be tightly and neatly routed.

The wiring materials and installation, including the conductor fill in all conduit and associated fittings and enclosures, shall comply with the requirements of NFPA 70. All exposed live parts in the control compartment or other auxiliary compartments operating above 150 V to ground shall be guarded as specified in IEEE C2.

All wires shall be terminated with uninsulated, seamless, ring–tongue compression terminals.

All PacifiCorp-interface terminal blocks shall be one-piece molded type, rated 600 volts and 30 amperes, equipped with #10–32 washer-head binder screws with slotted heads, and suitable for wire sizes #18 through #10 AWG. The terminal blocks shall be GE types EB–25 and EB–27, or Buchanan types 2B and 4B. Terminal blocks from other manufacturers that are functionally equivalent with GE and Buchanan can be used following review and approval by PacifiCorp. All non-PacifiCorp-interface terminations shall also be constructed on suitable weatherproof terminal blocks; no wires shall be spliced.

Auxiliary power and control wiring shall be factory installed as completely as possible. The supplier shall furnish all materials for wiring that must be installed in the field.

4.5.5 Control Compartment

A NEMA 3R control compartment shall be furnished on one breaker pole (may be combined with mechanism compartment) to house control equipment and terminal blocks for terminating all auxiliary wiring. PacifiCorp will bring all external auxiliary power and control wiring in conduit to the control compartment; the compartment shall be furnished with a removable bottom plate for drilling by PacifiCorp. The compartment door shall be vertically hinged, removable, and operated by a single handle.

The controls, terminal blocks, and other devices requiring access for operation and maintenance shall be mounted in the compartment at a height less than 6 feet above foundation level. The bottom of the compartment shall be not less than 2 feet above foundation level.

The compartment shall be furnished with two 240 VAC space heaters. One heater shall be connected to operate continuously. The second heater shall be controlled by a thermostat; the thermostat shall be adjustable, and the adjustment provisions shall include clear indication of a least three specific temperatures on the adjustment range.

The compartment shall be furnished with one 120 VAC, 20 amp, duplex convenience receptacle.

The PacifiCorp equipment number (see 8.1.1) shall be stenciled on the outside of the control compartment door.

4.5.6 Circuit Breaker Control Switch

A circuit breaker control switch shall be furnished in the control compartment for three-pole operation for maintenance purposes only, with associated red and green LED-type indicating lights with GE ET-16 bases, or bases that are fuctionally similar to, and interchangeable with, the GE ET-16 type. Indicating lights shall be as follows:

1. Two red lights, each wired in series with one of the two independent trip coils and a form-A contact
2. One green light wired in series with a form-B contact

Trip and close cycles shall be completed for momentary operation of the control switch. Provisions shall be made for the application of DC positive (from the control house) to enable the control switch to trip and close the circuit breaker (see Table 1, TB1). The control switch contacts shall be wired to the specified positions on the control cable terminal block (see Table 1, TB1).

4.5.7 Auxiliary Power and Control Voltages

The trip circuit and close circuit shall be DC. The compressor, pump, spring charching motor (if applicable), and heaters shall be AC.

The circuit breaker shall be equipped for operation with the AC and DC power supplies specified in 8.10. PacifiCorp will provide the AC and DC power supplies.

Separate auxiliary circuit breakers shall be furnished for motor and heater circuits.

Two unfused, 30-ampere minimum, 250-volt, double-pole, single-throw, knife-blade-type, gang-operated disconnect switches shall be furnished for isolating the two DC control power circuits (see 4.5.9) from the control power source during maintenance. The switches must provide a means of preventing the electrical operation of the circuit breaker by any trip or close input.

4.5.8 Included Equipment

Mechanism equipment including piping and linkages shall be factory installed as completely as possible. The supplier shall furnish all materials for connections which must be installed in the field.

4.5.9 Dual Trip Coils

Each operating mechanism shall be furnished with two separate and electrically independent DC trip coils. The two coils shall be arranged so that energization of either coil or of both coils simultaneously, or energization of either coil with the other coil shorted, will produce proper tripping. The primary trip coil and the close circuit shall be included in one control circuit. The secondary trip coil shall be included in a separate control circuit. The circuit breaker control switch (see 4.5.6) shall only operate the primary trip coil for trip operations.

4.5.10 Low-SF_6-Pressure Operation

Two alarms shall be furnished for each pole for low SF_6 pressure. The first stage alarm shall indicate abnormal but safe SF_6 pressure. The second stage alarm shall indicate a critical pressure. At the critical pressure each pole shall still have full current interrupting and overvoltage ratings.

Each mechanism shall be wired to allow PacifiCorp the option of having the mechanism remain in its current state for critical SF_6 pressure on any pole, or having the mechanism trip when the critical pressure occurs on any pole.

The circuit breaker shall have a minimum dielectric strength of 1.3 times rated voltage, both line-to-ground and across the open contacts, at one atmosphere of SF_6 pressure (zero psi gauge) on any pole.

4.5.11 Single-Pole and Independent-Pole Operation

Breaker control wiring shall be factory connected for single-pole operation (trip only the faulted pole for single-line-to-ground faults; trip all three poles for all other faults). Convenient arrangements shall be furnished for relocation of jumpers on terminal boards to reconnect breaker for independent-pole operation (trip all three poles for all faults). All control leads shall be wired to terminal blocks in the control compartment.

4.6 Functional Requirements

4.6.1 Remote Indication and Control

The circuit breaker shall be equipped with all the necessary terminal blocks, auxiliary switches, auxiliary relays, coils, contacts, and other auxiliary equipment connected to the circuit breaker control, to permit remote control and indication by PacifiCorp control equipment.

4.6.2 Interface Terminal Blocks

The PacifiCorp control cables shall terminate on independent, 12-position terminal blocks (see 4.5.4). These terminal blocks shall be furnished by the supplier in the control compartment for the exclusive use of PacifiCorp. The control cable, alarm cable, and auxiliary cable terminal blocks shall be wired per Table 1 for single-pole operation of the circuit breaker, and per Table 2 for independent-pole operation of the circuit breaker (see 8.9).

4.6.3 Pole Disagreement Timer

The circuit breaker shall be furnished with a pole disagreement timer. The timer shall start timing at the start of the pole disagreement condition and after the set time delay, the timer shall trigger a three-pole trip of the circuit breaker. The timer shall be field adjustable, and shall be factory set at 1.5 seconds.

Table 1 − Control Cable Terminal Blocks (TB1, TB2, TB3, and TB4), Single-Pole Operation

Terminal Position	Terminal Description	Explanation and Requirements
Control Terminal Block (TB1)		
1	Battery positive	+125 VDC station battery for close and trip coil 1
2	Battery negative	−125 VDC station battery for close and trip coil 1
3	Green light	All three-phase B contacts wired in series and to negative
4	Local control	Application of positive (from the control house) shall enable the control switch (located in the control compartment) to trip and close the circuit breaker.
5 and 6	52A	All three-phase A contacts wired in series and to terminal 5 and 6
7	Close control	Application of positive shall close the breaker.
8	52B	All three-phase B contacts wired in parallel and to positive
9	Trip control	Application of positive shall trip A phase of trip coil 1
10	Trip control	Application of positive shall trip B phase of trip coil 1
11	Trip control	Application of positive shall trip C phase of trip coil 1
12	52B	All three-phase B contacts wired in parallel and to negative
Alarm Cable Terminal Block (TB2)		
1	Alarm positive	PacifiCorp's annunciator positive with one side of all alarm contacts wired in common
2	Alarm 1	52A contact A phase, breaker trip indication
3	Alarm 2	Low SF_6 gas
4	Alarm 3	Critical low SF_6 gas
5	Alarm 4	Closing spring discharge
6	Alarm 5	52A contact B phase, breaker trip indication
7	Alarm 6	52A contact C phase, breaker trip indication
8	Alarm 7	Pole disagreement trip
9−12	Alarms 8−11	Additional alarms
Auxiliary Cable Terminal Block (TB3)		
1	52B	52B A phase contact wired to closing and trip coil 1 negative
2	52B	52B B phase contact wired to closing and trip coil 1 negative
3	52B	52B C phase contact wired to closing and trip coil 1 negative
4	52B	52B A phase contact wired to trip coil 2 negative
5	52B	52B B phase contact wired to trip coil 2 negative
6	52B	52B C phase contact wired to trip coil 2 positive

(Table 1, continued)

Terminal Position	Terminal Description	Explanation and Requirements
Auxiliary Cable Terminal Block (TB3)		
7–8	52B	52B three-phase contacts wired in series and to terminal 7 and 8
9–10	52B	52B three-phase contacts wired in series and to terminal 9 and 10
11–12	52B	52B three-phase contacts wired in series and to terminal 11 and 12
Control Cable Terminal Block (TB4)		
1	Trip coil 2 pos.	+125 VDC station battery for trip coil 2
2	Trip coil 2 neg.	−125 VDC station battery for trip coil 2
3	Trip control	Application of positive shall trip A phase of trip coil 2
4	Trip control	Application of positive shall trip B phase of trip coil 2
5	Trip control	Application of positive shall trip C phase of trip coil 2
6–7	Pole disagreement	52A contacts wired in parallel and in series with parallel 52B contacts and to terminals 6 and 7
8–9	Pole disagreement	52A contacts wired in parallel and in series with parallel 52B contacts and to terminals 8 and 9
10–11	52B	52B three-phase contacts wired in series and to terminals 10 and 11
12	52B	All three-phase B contacts wired in parallel and to negative

Table 2 – Control Cable Terminal Blocks (TB1, TB2, and TB3), Independent-Pole Operation

Terminal Position	Terminal Description	Explanation and Requirements
Control Terminal Block (TB1)		
1	Battery positive	+125 VDC station battery
2	Battery negative	−125 VDC station battery
3	Green light	Form-B contact wired to negative
4	Local control	Application of positive (from the control house) shall enable the control switch (located in the control compartment) to trip and close the circuit breaker.
5 and 6	Form A	Form-A contact wired between terminals 5 and 6
7	Close control	Application of positive shall close the circuit breaker.
8	Form B	Form-B contact wired to positive
9	Trip control	Application of positive shall trip the circuit breaker.
10	Spare	
11 and 12	Form A	Form-A contact wired between terminals 11 and 12
Alarm Cable Terminal Block (TB2)		
1	Alarm positive	PacifiCorp's annunciator positive with one side of all alarm contacts wired in common
2	Alarm 1	Form-A contact, breaker trip indication
3	Alarm 2	Low SF_6 gas
4	Alarm 3	Critical low SF_6 gas
5	Alarm 4	Closing spring discharge
6−12	Alarms 5−11	Additional alarms
Auxiliary Cable Terminal Block (TB3)		
1 and 2	Form A	Form-A contact wired between terminal 1 and 2
3 and 4	Form A	Form-A contact wired between terminal 3 and 4
5 and 6	Form A	Form-A contact wired between terminal 5 and 6
7 and 8	Form B	Form-B contact wired between terminal 7 and 8
9−12	Spares	

4.7 Bushings and Current Transformers

4.7.1 Approved Bushing Manufacturers and Color

Bushings shall be porcelain or composite, chosen from Appendix A of this specification, and colored ANSI 70 / Munsell 5.0 BG 7.0/0.4 light gray. Suppliers may propose other bushings; these must be reviewed and approved by PacifiCorp in writing.

4.7.2 Bushing Current Transformers

Bushing current transformers supplied shall be five-tap, multi-ratio, with full-winding ratios and accuracy indicated in 8.7, Table 4. Bushing current transformers shall also be capable of metering applications with an accuracy class not less than 0.3B–1.8 on the full winding at all standard burdens through the specified burden. This capability shall be noted on the bushing current transformer nameplate.

4.7.3 Bushing Current Transformer Secondary Leads

All bushing current transformer secondary leads shall be wired to six-point short-circuiting type terminal blocks in the control compartment as shown in Figure 1 and Figure 2. A separate terminal block, complete with shorting screws, shall be furnished for each bushing current transformer (see 4.5.4).

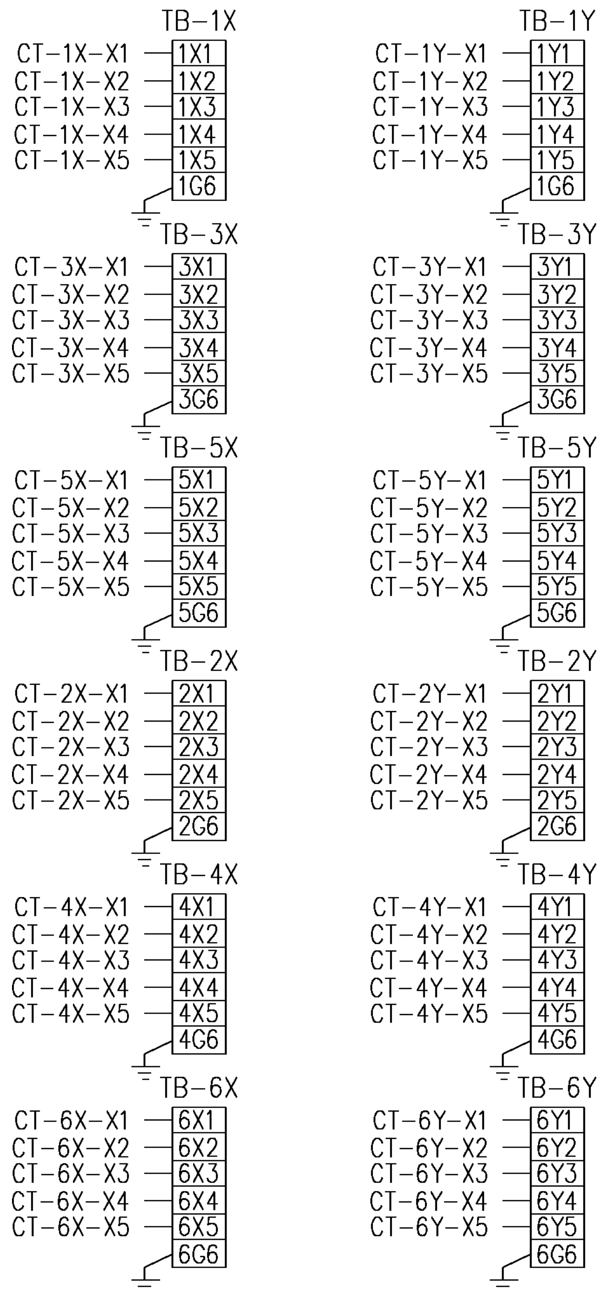

Figure 1 – Typical Connection Diagram for CT Terminal Blocks

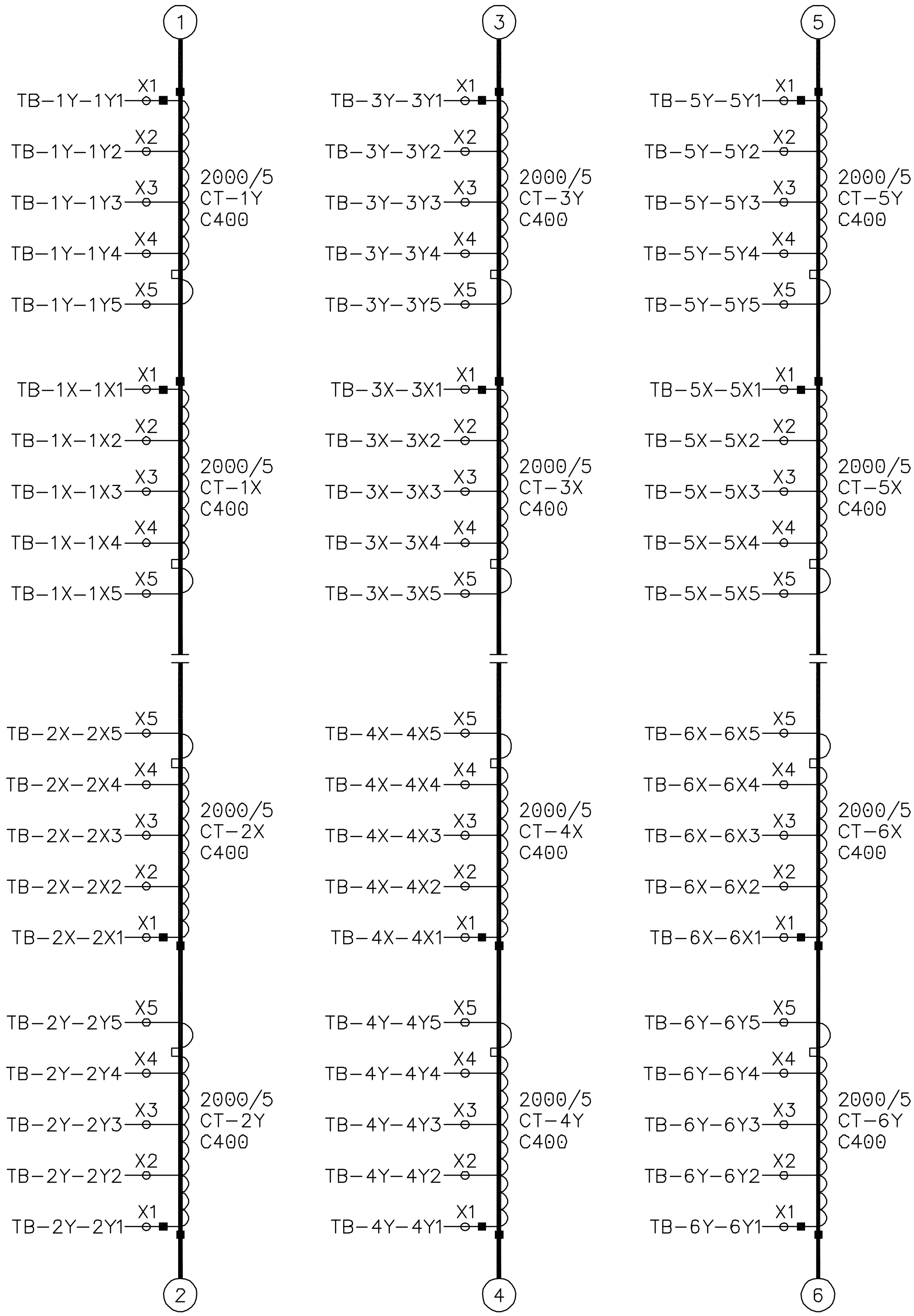

Figure 2 – Typical CT Location Diagram

4.8 Accessories

4.8.1 Auxiliary Switch Contacts

Auxiliary switch contacts will be used for indicating, interlocking, and alarming, and shall have current carrying capacity sufficient for the operation of the associated control circuits and indicating lights, as well as supervisory interposing relays.

Form-A and form-B contacts shall not be closed at the same time. If the circuit breaker is closed into a fault and trips open, the form-B contacts shall remain open for a minimum of 0.025 seconds.

In addition to all other auxiliary switch contacts (including those specified in Table 1, TB1, TB2, and TB3), each operating mechanism shall be furnished with 20 spare auxiliary switch contacts (10 form-A and 10 form-B) wired to a separate terminal block in the control compartment (see 4.5.4), for the exclusive use of PacifiCorp.

4.8.2 Alarm Contacts

The circuit breaker shall have alarm contacts wired to the alarm cable terminal block or the auxiliary cable terminal block for indication of failure of components critical to circuit breaker operation (see Table 1, TB2 and TB3). Contacts shall be isolated, normally open, dry, ungrounded contacts that close on alarm.

4.8.3 Operation Counter

Each operating mechanism shall have an operation counter arranged to count opening or closing operations, but not both.

4.8.4 Mechanical Position Indicator

Each operating mechanism shall have a visual mechanical position indicator effectively connected to the operating mechanism. Green shall indicate open, and red shall indicate closed.

4.8.5 Line Terminals

The circuit breaker shall have 4-inch by 4-inch flat pad line terminals with NEMA standard four-hole drilling.

4.8.6 Maintenance Closing Device and Tools

The circuit breaker shall have a maintenance closing device, if applicable, and any special tools required for installation and maintenance.

4.8.7 Latch Check Switch

Each operating mechanism shall have a latch check switch or hydraulic latch valve, if applicable.

4.8.8 Compressor or Pump Motor Meter

Each operating mechanism shall have a compressor or pump motor running time meter, if applicable.

4.8.9 Motion Analyzer

Each circuit breaker pole shall be furnished with provisions for installing a motion analysis transducer. A bracket for mounting the transducer to the circuit breaker shall be fitted or supplied. PacifiCorp is currently using Vanguard CT-7500 motion analysis instruments.

4.8.10 Alarm Monitor

If specified in 8.11, a 12-point alarm monitor shall be furnished. The monitor shall include the following for each point:

1. One input contact
2. An individual indicating long-life lamp and individual three-position switch (ON-OFF-TEST)
3. A blank nameplate for engraving by PacifiCorp
4. One transmitting auxiliary contact

The monitor shall be mounted in a NEMA 3R compartment in such a manner that the monitor will be readily visible when the compartment door is open. The monitor shall not be located behind a hinged panel or other concealment. The supplier shall furnish individual wiring of alarm circuits from dedicated alarm terminal blocks in the control compartment (see Table 1, TB2 and TB3) to the monitor, and individual wiring from the monitor transmitting auxiliary contacts to a separate terminal block in the control compartment for PacifiCorp's use (see 4.5.4).

4.9 Nameplate Information

Circuit breaker nameplates and instruction plates shall show all values in U. S. customary units only. The PacifiCorp equipment number specified in 8.1.1 shall be stamped or engraved on the nameplate and included in all drawings.

4.10 Paint and Color

The finish on painted metal parts shall be ANSI 70 / Munsell 5.0 BG 7.0/0.4 light gray. The supplier shall furnish one quart of touch-up paint per circuit breaker.

4.11 Wind and Seismic Withstand

The wind and seismic withstand capability of the circuit breaker shall be in accordance with the attached ZS 065.

4.12 External Fasteners and Hardware

With the exception of nuts and hardware used for support structures, all exposed fasteners and hardware (such as bolts, screws, washers, hinges, handles and brackets) shall be 300-series stainless steel, if not welded. If welded, 304L stainless steel shall be used. Other stainless steel grades will be considered if equivalence to USA grades can be demonstrated. All nuts shall be silicon-bronze to prevent galling. Hardware used for support structures can be galvanized steel.

4.13 Transient Overvoltage Factor

The circuit breaker shall be the definite-purpose type for capacitance current switching. For interruption of overhead line charging current, the breaker switching rating shall be 500 A rms, and the rated transient overvoltage factor shall be 2.0.

4.14 Preinsertion Closing Resistors

As specified in 8.6, the supplier shall furnish preinsertion closing resistors, or provisions for future addition of resistors, for control of line closing switching surge maximum voltage. Breaker design and provisions for adjustments shall be such that the specified values of resistor insertion time and breaker pole closing span can be readily obtained and maintained under actual conditions of operation and normal field maintenance.

If the supplier proposes a different method of controlling switching surges, their proposal shall be submitted with detailed studies and support material for review and approval by PacifiCorp's Standards Engineering Deparment.

4.15 Out-of-Phase Switching

The circuit breaker shall be suitable for switching under out-of-phase conditions with an opening angle of 180 degrees (full phase opposition) and a closing angle of 90 degrees; out-of-phase switching current rating shall be 25 percent of the rated symmetrical interrupting capability.

4.16 Interrupter Gas Temperature and Pressure Gauges

Gauges shall be furnished to provide indication of the temperature and pressure of the SF_6 gas in the interrupter housings. Gauges shall be furnished with alarm contacts (see 4.8.2).

A valve shall be furnished to isolate each gauge from the respective vessel to facilitate testing of the gauge.

4.17 Field Installation of SF_6 Gas

SF_6 gas required for field installation will be furnished by PacifiCorp; *the manufacturer shall not provide SF_6 gas with the circuit breaker.*

All SF_6 circuit breakers shall have a gas fill valve reserved for customer use and specifically dedicated to the filling/removal of SF_6 gas to/from the circuit breaker. The filling valve shall preferably be located near the existing gas pressure gauge for each SF_6 compartment, and shall be labeled as a filling valve. The use of the valve shall not reuqire the temporary fitting or removal of any other operating valves, gauges or fittings. The valve shall be permanently installed on each SF_6 compartment, with the customer interface specifications as follows:

1/2" #8 (34–16) JIC male end with a 1/2" #8 (34–16) JIC cap, or

Dilo DN20 or Dilo DN8 self-sealing male-to-Malmquist fitting (on the manufacturer's side)

All SF_6 gas circuit breakers shall have a pressure gauge installed on the circuit breaker. The pressure gauge shall be capable of providing an accurate display of the gas pressure in the circuit breaker installed at the factory prior to shipment. The manufacturer shall attach a conspicuous tag to the fill valve assembly to indicate the type of gas and pressure used to fill the breaker.

4.18 Pressure Vessel Requirements

The requirements of the latest ASME *Boiler and Pressure Vessel Code* shall be applied to the design, manufacture, testing, certification, and stamping of each pressure vessel 5 cubic feet or more in volume and operating at a gauge pressure of 15 psi or more, including interrupters as well as other vessels; the stamping of each specified vessel shall include the official "U" code symbol and associated required marking.

The supplier shall test the breaker tank to ensure zero SF_6 leakage for the warranty duration. The supplier shall also be responsible for applying suitable design and production criteria to all other pressure containing components.

5 Drawings and Other Information

If specified in 8.1.4, one disc of applicable drawings (in AutoCAD, or in DXF file format if not available in AutoCAD) and two sets of prints of applicable drawings and other information from this section shall be furnished for approval, and shall be sent to PacifiCorp as specified in 8.1.6.

Five sets of prints of applicable final drawings and other information from this section shall be furnished as follows: one set shall be attached and shipped with the circuit breaker in a weatherproof envelope or in the control compartment; the remaining four sets shall be sent to PacifiCorp as specified in 8.1.6.

If specified in 8.1.5, one additional set of applicable final drawings shall be furnished on a disc in AutoCad, or in DXF file format if not available in AutoCAD, and sent to PacifiCorp as specified in 8.1.6.

Drawings shall be full size (not reduced). All values on drawings and other information shall be shown in U.S. customary units only, or in both U.S. customary and SI units. The PacifiCorp equipment number specified in 8.1.1 shall be shown in the title block on all drawings.

1. Assembled circuit breaker outline drawing, including the following:
    a. Structural details of circuit breaker base
    b. Weight and center of gravity of installed unit and unit prepared for shipment
    c. Minimum shipping dimensions
    d. Foundation reactions produced by equipment operation, and by wind and seismic forces
2. Nameplate and instruction plate drawings
3. Pole unit assembly drawing
4. Bushing outline drawing
5. Terminal fitting drawing
6. Mechanism compartment and control compartment detail drawings
7. Schematic and wiring diagrams showing complete auxiliary equipment wiring, including customer connection points
8. Current transformer nameplate drawings (may be supplied separately or may be shown on the main circuit breaker nameplate drawing)
9. Current transformer information, including resistance per winding turn, the resistance of each lead, and curves showing ratio correction and secondary excitation for relaying, and ratio and phase angle correction for metering
10. Instruction manual, covering receiving, handling, installation, operation, and maintenance of the circuit breaker and all accessories

    The instruction manual shall also include the following:
    a. Maximum and normal values of circuit breaker contact resistance
    b. Complete lists of renewal parts for the circuit breaker and all accessories, including identification of each part by name and part number

        The parts lists and drawings shall relate specifically to the equipment covered by this specification; typical lists and drawings will not be acceptable.
    c. Pressure vessel certification reports
    d. Normal values of circuit breaker opening and closing times, with associated tolerances, and travel recorder chart
11. Certified test reports

6 Shipping Requirements

6.1 Dimensions and Weight

The supplier shall be responsible for checking the shipping dimensions and weight of the proposed design for suitability for shipment to the specified destination.

6.2 Notification of Shipment

The supplier shall notify PacifiCorp two weeks prior to the expected arrival of the circuit breaker. Additionally, the PacifiCorp contact person named in 8.1.7 shall be notified on the day of shipment and 48 hours prior to the delivery of the circuit breaker to ensure provisions for unloading.

7 Other Inspection Requirements

7.1 Quality Surveillance

A quality surveillance representative (QSR) may be employed by PacifiCorp to be present at the supplier's facility during the manufacturing and testing of the circuit breaker. If a QSR is employed, the QSR will comply with the supplier's safety and procedural requirements at all times while in the supplier's facility, and the following additional guidelines shall apply.

7.1.1 Cooperation with Quality Surveillance Representative

The supplier shall cooperate with the QSR and arrange a reasonable and mutually agreeable schedule for the required inspections and witnessing of tests, consistent with maintaining scheduled progress of the circuit breaker through the supplier's facility.

7.1.2 Authority of Quality Surveillance Representative

The QSR will have full authority from PacifiCorp to make whatever decisions are necessary to ensure that the complete circuit breaker equipment complies with all requirements of PacifiCorp's procurement documents, and to ensure that all required inspection and witness activities are carried out.

7.1.3 Disagreements

In the event of significant disagreement between the supplier and the QSR concerning scheduling of inspection or witness activities, or concerning interpretation of PacifiCorp's procurement documents, the supplier and the QSR shall promptly and jointly contact PacifiCorp to resolve the matter.

7.2 Field Engineer

Services of supplier's field engineer(s), if specified in 8.13, shall be furnished for supervision of field installation of all parts detached for shipment, and for complete pre-energization inspection of the circuit breaker. The field engineer(s) shall have a thorough working knowledge of the complete circuit breaker, including all internal and external components.

8 Additional Circuit-Breaker-Specific Requirements

The circuit breaker information and specifications in this section are for the equipment referenced in 8.1.1, and shall be used in conjunction with the other requirements of this material specification.

In this section, a box checked (✓) next to an item indicates that the item is required or applicable; a box not checked indicates that the item does not apply or is not acceptable.

8.1 Equipment Identification and Order Requirements

8.1.1 Equipment Identification

PM Order number: ____________________

REQ number: ____________________ PO number: ____________________

Equipment number(s): ____

Location: ____

8.1.2 Commercial Issues

Correspondence regarding commercial issues shall be sent to the PacifiCorp purchasing department, with copies to:

Project engineer: ____

Address: ____

City: ___________________________ State: __________ Zip: __________

Telephone: _______________________

8.1.3 Technical Application Questions

Technical questions regarding this material specification, or notice of any other technical matters which arise during the proposal process or during equipment design, manufacture, or test, shall be directed to the project engineer (see 8.1.2).

8.1.4 Approval Drawings

If checked (✓), drawings and other information shall be furnished for approval (see section 5). . . . . ❑

Approval drawings on disc shall be as checked (✓) below:

AutoCAD version ________ . . . . ❑

DXF file format . . . . ❑

8.1.5 Final Drawings on Disc

If checked (✓), one additional set of final drawings shall be furnished on a disc(s) as specified (see section 5):

AutoCAD version ________ . . . . ❑

DXF file format . . . . ❑

8.1.6 Drawing Destination

All drawings and other information specified in section 5 shall be mailed to the person in the department checked (✓) below:

❑ Portland Office
Asset Management Document Services
825 NE Multnomah St., 1600 LCT
Portland, OR 97232

8.1.7 Notice of Shipment

The supplier shall notify the person named below as specified in 6.2.

Name: ____

Address: ____

City: ______________________ State: _______ Zip: __________

Telephone: __________________________

8.2 Contaminated-Environment Protection

If checked (✓), the circuit breaker shall be furnished in accordance with the contaminated-environment protection requirements of the attached ZS 066. . . . . . . ❑

8.3 Elevation

The circuit breaker shall be designed for special high-elevation operation without de-rating, up to the specified elevation, if checked (✓) below:

________ feet . . . . ❑

8.4 Low Temperature Operation

The circuit breaker shall be designed for special low temperature operation, without de-rating, if checked (✓) below:

–50 °C daily minimum . . . . ❑

–40 °C daily minimum . . . . ❑

__________________ . . . . ❑

8.5 Ratings and Related Capabilities

The circuit breaker shall be rated as checked (✓) in Table 3.

Table 3 – Circuit Breaker Ratings

Maximum Voltage (kV_{rms})	BIL (kV)	Continuous Current (A)	Interrupting Current (kA)	Interrupting Time (Cycles)	(✓)
362	1300	2000	40	2	❑
550	1800	3000	40	2	❑
____	____	____	___	__	❑

8.6 Preinsertion Closing Resistors

Provisions shall be furnished for future addition of preinsertion closing resistors . . ❑

Preinsertion closing resistors shall be furnished with the circuit breaker as specified below. . . . . ❑

Resistor value: ________ ohms per pole

Minimum resistor insertion time (including tolerance): ________ milliseconds

Maximum breaker pole closing span time: ________ milliseconds

8.7 Bushing Current Transformers

Bushing current transformers supplied shall be furnished as indicated in Table 3 (see also 4.7.2 and 4.7.3).

Table 4 – Bushing Current Transformers

Bushing	Number per Bushing	Ampere Ratio	Relaying Accuracy
1, 3, 5			C800
1, 3, 5			C800
2, 4, 6			C800
2, 4, 6			C800

8.8 Minimum Height to External Ungrounded and Live Parts

The minimum height to external parts shall be as checked (✓) in Table 5.

Table 5 – Height To External Ungrounded and Live Parts

Operating Voltage (kV_{rms})	Minimum Height (inches) External Ungrounded Parts	External Live Parts	(✓)
345	102	216 inches	❑
500	102	252 inches	❑

8.9 Single-Pole or Independent-Pole Operation

The circuit breaker shall be factory connected for single-pole operation or independent-pole operation as checked (✓) below.

Single-pole operation (see 4.5.11) . . . . ❑

Independent-pole operation (see 4.5.11) . . . . ❑

8.10 Auxiliary Equipment Voltages

8.10.1 AC Voltage

The AC power supply will be as checked (✓) below. Supplier shall furnish auxiliary transformation on the circuit breaker as required.

120/240 VAC, single-phase, three-wire . . . . ❑

208 VAC, single-phase . . . . ❑

___ VAC, single-phase . . . . ❑

___ VAC, three-phase . . . . ❑

8.10.2 DC Voltage

The DC power supply will be as checked (✓) below:

48 VDC . . . . ❑

125 VDC . . . . ❑

8.11 Alarm Monitor

If checked (✓), the circuit breaker shall be equipped with the alarm monitor as specified in Section 4.8.10. Please provide the manufacturer and model number below.

________________________, 48 VDC . . . . ❑

________________________, 125 VDC . . . . ❑

8.12 Model

The circuit breaker model shall be as specified below:

____

8.13 Field Engineer

If checked (✓), the supplier's field engineer(s) shall furnish supervision for field installation as specified in 7.2 . . . . ❑

8.14 Capacitor Switching

If checked (✓), the circuit breaker shall be designed for capacitor bank switching with :

Synchronous closing control (zero voltage) . . . . ❑

Pre-insertion resistor . . . . ❑

8.15 Shunt Reactor Switching

If checked (✓), the circuit breaker shall be designed for shunt reactor switching with :

Synchronous closing control (peak voltage) . . . . ❑

Synchronous opening control (to prevent reignitions) . . . . ❑

9 Spare Parts

The supplier shall furnish a complete list of spare parts for the breaker and all auxiliary equipment, including identification of each part by name and part number. Parts list and drawings shall relate specifically to the equipment covered by this specification; typical drawings are not acceptable.

10 Issuing Department

The T &D Standards Engineering Documentation Department of PacifiCorp is responsible for issuing this material specification. Comments and suggestions are welcome. Submit comments or requests for additional copies of this document to:

PacifiCorp T & D Standards Engineering Documentation
825 NE Multnomah St., Suite 1600, Portland, OR 97232
telephone: (503) 813-5293; fax: (503) 813-6804

Technical questions regarding this material specification may be submitted to:

PacifiCorp T & D Standards Engineering
825 NE Multnomah St., Suite 1600, Portland, OR 97232
telephone: (503) 813-6883; fax: (503) 813–6804

Appendix A—Approved Bushing Suppliers

For power circuit breakers 345 kV and above, the PacifiCorp-approved bushing suppliers are:

1. ABB Power
2. NGK Locke
3. LAPP

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Substation Equipment—Flooded Lead-Acid Stationary Batteries

1 Scope

This material specification states the requirements for stationary batteries to be purchased by PacifiCorp for substation applications.

2 Applicable Documents

Except as required otherwise by this material specification, the battery specified herein shall be furnished in complete accordance with the latest applicable industry codes, ANSI, IEEE, and NEMA standards, OSHA requirements, and PacifiCorp standards and material specifications in effect on the date of invitation to bid.

ANSI/IEEE 100, *IEEE Standard Dictionary of Electrical and Electronics Terms*

ANSI/IEEE 450, *Recommended Practice for Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Generating Stations and Substations; Interpretation*

ANSI/IEEE 485, *Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations*

ASTM D 635, *Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.*

Uniform Building Code for Seismic Requirements

OSHA requirements for labeling and disposal of hazardous material

3 General

3.1 Application Information

This material specification states both the general requirements for stationary batteries, and the battery-specific requirements that vary depending on installation and intended use (see Section 7, Additional Battery-Specific Requirements). If the specific item's description states a different requirement from that specified in the general design and manufacturing requirements, the requirements in Section 7 shall prevail.

3.2 Authorized Material Specification

This material specification is not considered valid until each page contains the approval signature (or initials) of the persons named in the title blocks and Section 7 has been completed.

4 Design and Manufacturing Requirements

4.1 Ratings and Related Requirements

4.1.1 General Requirements

The battery will be housed indoors in a controlled environment. The battery shall be suitable for floating operation with an automatic voltage regulated charger.

The battery will provide critical power for switchgear operation, motor operated devices, protective relays, communication systems, and scada systems. The system shall have a 20-year operating life.

4.1.2 Ampere-Hour Capacity

The ampere-hour capacity shall be based on an 8-hour rate. The end of discharge voltage shall be 1.75 volts per cell at 77 °F. The battery shall supply the total load without assistance from the charging source.

4.1.3 Internal Resistance

The internal resistance is to be less than 0.002 ohms per cell.

4.1.4 Vent Plugs

Vent plugs shall be provided on each cell to effectively prevent acid spray from the cell and allow “gassing” during equalize charge. The vent caps shall be flame arrestor type.

4.1.5 Float Voltage

The battery cells shall be suitable for operation with a float voltage from 2.15 to 2.30 volts per cell.

4.1.6 Equalizing Voltage

The battery cells shall be suitable for operation with a equalizing voltage from 2.20 to 2.4 volts.

4.1.7 Open Circuit Voltage

The nominal open circuit voltage shall be 2.0 volts per cell.

4.1.8 Operating Temperature

The battery cells shall be suitable for operating temperature of +5 ° to +104 °F. Normally the battery cells will be in a controlled environment at 77 °F.

4.2 Unit Construction

The container and cover shall be of a high impact, transparent thermoplastic material. Each container and cover shall form a permanent impermeable and secure joint.

4.3 Separators

Each cell shall be provided with microporous plastic separators matched with fiberglass mats. Cell separators shall be incorporated to prevent shorting of the positive to negative plates.

4.4 Plate Grid

The positive plate grid alloy shall be lead planté, lead selenium, or lead calcium.

4.5 Electrolyte

The electrolyte shall be sulfuric acid. Cell shall have sufficient electrolyte to provide full capacity at all ratings. Minimum and maximum level marks (tolerance lines) shall be provided on each cell.

4.6 Number of Cells per Unit

Battery banks 200 AH and below shall have three cells per unit; otherwise, the maximum number of cells per unit shall be three.

4.7 Terminal Posts

Terminal posts are to be designed for bolted connections. The terminal post seals shall be designed to prevent acid from creeping up the posts and the venting of gases.

4.8 Sediment Space

Cells shall have sufficient sediment space below the plates to accommodate sediment for 20-year life expectancy.

4.9 Date Stamping and Numbering System

The manufactured date shall be stamped on each unit. Each unit shall be numbered differently or the manufacture shall supply the numbers and adhesive for applying to each unit. Manufacturer's label identifying the catalog type, and ampere-hour rating of the cell shall be visible on each cell.

4.10 Battery Accessories

The following items shall be supplied where applicable or appropriate with the battery system:

1. Interunit and intercell connections
2. Interstep and intertier connectors
3. Anticorrosive terminal grease
4. Terminal lugs

5. Two insulated connector bolt wrenches
6. One vent-mounted thermometer
7. One portable hydrometer syringe
8. Acid-resistant, self-adhering individual cell numbers
9. Stainless steel connector bolts, flat washers, and lock washers
10. Terminal cover system, clear PVC, with holes
11. Spill containment system, roll-mat type, including rails, liner, flame-retardant absorbtion pillows, and instructions

4.11 Battery Racks

Battery racks shall be fabricated from a steel angle iron or rectangular steel tubing, steel channel rails and flat steel braces. The battery racks shall support the batteries and withstand the shocks and motions as defined by the Uniform Building Codes for the seismic zone 4.

All racks shall be shipped assembled or be so designed as to allow for convenient assembly using conventional tools.

Racks shall be painted with a minimum of two coats of acid resisting paint. Color is to be the supplier's standard color or as approved by PacifiCorp. The channel rails supporting the battery containers must be covered with plastic, rubber or some other suitable acid resisting insulating material.

5 Drawings and Other Information

Two sets of applicable drawings and other information from the list below shall be furnished:

1. One set shall be attached and shipped with the equipment as specified in 6.1.
2. One set shall be submitted to the project engineer listed in 7.1.2.

Drawings shall be full size (not reduced). All values on drawings and other information shall be shown in U.S. customary units only, or in both U.S. customary units SI units.

5.1 Battery Outline Drawing and Data Sheets

The supplier shall provide an outline drawing, discharge characteristic curves and a data sheet at the time of bid.

5.2 Battery Rack Drawings

The supplier shall provide an outline drawing of the battery rack at the time of bid.

5.3 Instruction Manuals

The supplier shall provide one set of instruction manuals covering receiving, handling, installation operation, and maintenance of the battery system

5.4 Hazardous Material Handling Statement

The supplier shall provide a material safety data sheet as required by OSHA dealing with the handling, disposal and maintenance of the batteries.

5.5 Battery Recycling Program

The supplier shall provide details for recycling and conserving the resources of a spent battery. The supplier program should address a procedure for disposing of the battery or batteries.

5.6 Certified Test Reports

Supplier's completed test reports shall be mailed with the battery bank material shipping list.

5.7 Product Warranty or Guarantee or Both

The supplier guarantees that the battery system shall be free from defective materials and workmanship for a period of 18 months from the date of shipment or 12 months from the installation date.

Twenty year warranty shall guarantee that the batteries in float service will furnish 80% of their rated capacity for 20 years after the date of shipment.

6 Packing and Shipping Requirements

6.1 Installation Documentation

The supplier shall provide, with the shipped assembly, one set of installation drawings and an instruction book. These documents shall be packaged in a waterproof envelope and attached to the assembly. This set of documentation counts as one of the sets required in Section 5.

6.2 Shipment

The FOB point shall be as specified on the purchase order.

All cells shall be shipped at 90 percent to 100 percent capacity.

6.3 Notification of Shipment

The supplier shall notify PacifiCorp two weeks prior to expected arrival of the batteries and equipment. Additionally, the PacifiCorp contact person, named in 7.1.5, shall be notified on the day of shipment and 48 hours prior to the delivery of the equipment to ensure provisions for unloading.

7 Additional Battery-Specific Requirements

The stationary battery information and specifications in this section are for the item in the General Purpose Requisition (GPR) stated in 7.1, and shall be used in conjunction with the other requirements of this material specification.

In this section, a box checked (✓) by an item indicates that the item is required or applicable; a box not checked indicates that the item does not apply or is not acceptable.

7.1 Equipment Identification and Order Requirements

7.1.1 Equipment Identification

GPR number: ________________________________ Item number:____________

Location:____

Project number: ____

7.1.2 Commercial Issues

Correspondence regarding commercial issues shall be sent to the PacifiCorp Purchasing Department with copies to:

Project engineer:____

Address:____

City:____________________ State: _________________ Zip: _______________

Telephone:______________________

7.1.3 Technical Application Questions

Technical questions regarding this material specification, or notice of any other technical matters which arise during the proposal process or during equipment design, manufacture, or test, shall be directed to the project engineer (see 7.1.2).

7.1.4 Drawing Destination

All drawings and other information specified in Section 5 shall be mailed to the department below:

PacifiCorp Substation Engineering
825 NE Multnomah St., Suite 1600
Portland, OR 97232

7.1.5 Notice of Shipment

The supplier shall notify the person named below as specified in 6.3.

Name:____

Address:____

City: ________________State: _______________ Zip: _______

Telephone:________________

7.2 Nominal Output Voltage

The batteries shall be suitable for operation on a system with the voltage rating checked (✓) below:

48 Vdc . . . . ❑
(based on 24 cells per bank)

125 Vdc . . . . ❑
(based on 60 cells per bank)

7.3 Battery Sizing Data

The ampere-hour rating of the assembly shall be_______ampere-hours at the 8-hour rate.

The temperature of the electrolyte shall be based on 77 °F.

The design margin factor shall be 115 percent.

The aging factor shall be 125 percent.

7.4 Mounting Requirements

The mounting requirements of the assembly shall be as checked (✓) below:

Suppliers standard . . . . ❑

Special application (as specified below) . . . . ❑

Floor-mounted single-tier rack . . . . ❑

Floor-mounted two-step rack . . . . ❑

The battery rack with batteries installed for all the checked options shall not exceed the following dimensions:

Depth (in inches): . . . . _______

Length (in inches): . . . . _______

Height (in inches): . . . . _______

8 Issuing Department

The Asset Management Documentation Department of PacifiCorp is responsible for issuing this
material specification. Comments and suggestions are welcome. Submit comments or requests for additional copies of this document to:

PacifiCorp Asset Management
825 NE Multnomah St., Suite 1600, Portland, OR 97232
telephone: (503) 813-5293, fax: (503) 813-6804

Technical questions regarding this material specification may be submitted to:

Staff Engineers, PacifiCorp Asset Management
825 NE Multnomah St., Suite 1600, Portland, OR 97232
telephone: (503) 813-6896, fax: (503) 813–6804

PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY

ZS 019−2006

Material Specification

Substation Equipment—Battery Charger

Standards Engineering Department

Date: 13 Jul 06

PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY

Contents

Substation Equipment—Battery Charger

1 Scope

This material specification states the requirements for battery chargers to be purchased by PacifiCorp for substation applications.

2 Applicable Documents

Except as required otherwise by this material specification, the battery charger specified herein shall be furnished in complete accordance with the latest applicable industry codes, ANSI, IEEE, and NEMA standards, OSHA requirements, and PacifiCorp standards and material specifications in effect on the date of invitation to bid.

ANSI/IEEE 100, *IEEE Standard Dictionary of Electrical and Electronics Terms*

ANSI/IEEE C37.90.1, *Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems*

ANSI/NFPA 70, National Electrical Code, Article, *Voltage Ratings, Wire Tagging and Identification*, and Article 480, *Storage Batteries*.

NEMA PE5, *Utility Type Battery Chargers*

NEMA PE7, *Communication Type Battery Chargers*

UL-1236, *UL Standard for Safety—Battery Chargers*

3 General

3.1 Application Information

This material specification states both the general requirements for battery chargers, and the battery-charger-specific requirements that vary depending on installation and intended use (see Section 7, Additional Battery-Charger-Specific Requirements). If the specific item's description states a different requirement from that specified in the general design and manufacturing requirements, the requirements in Section 7 shall prevail.

3.2 Authorized Material Specification

This material specification is not considered valid until each page contains the approval signature (or initials) of the persons named in the title blocks and Section 7 has been completed.

4 Design and Manufacturing Requirements

4.1 Type

The type of unit shall be as specified below.

1. The unit shall be designed, manufactured, and tested according to the latest applicable codes and standards.
2. The unit shall be designed for expected life of 20 years.
3. The charger shall be of the solid-state, controlled ferroresonance, constant-voltage type.
4. The unit shall provide for charging of batteries and for the equalization of the batteries after discharge.
5. The charger shall be equipped to allow the removal of the batteries from the circuit while the charger serves as a regulated, steady state source to the load (battery eliminator feature).

4.2 Ambient Temperature

The unit shall be capable of continuously operating at 110% of the rated dc output over temperatures from 0 °C to 50 °C (32 °F to 122 °F) under all considerations of temperature and frequency. The charger's dc output voltage regulation shall be within 0.5% at any load from no load to full load.

4.3 Input Power and Surge Protection

The charger's surge withstand capability shall meet the requirements of standards listed in Section 2.

If selected in 7.3, a RFI input filter shall be provided to reduce the electromagnetic inference (EMI) on the ac input and dc output. The unit so equipped shall meet FCC part 15, subparagraph J for Class A compliance. Electrical voice band noise shall be less than 32 dBrnC using C-message weighing network.

The input voltage shall be 120 Vac or 240 Vac single-phase type. All units shall be 60 hertz with 5% line variation. Input voltage may vary from a +6% to –12%.

4.4 Input and Output Breaker Protection

Breakers shall be provided for protection of the ac input and dc output. These breakers shall be in addition to any internal fuses.

4.5 Output Voltage, Output Surge Protection, Reverse Current Polarity

The output voltage, output surge protection, and reverse current polarity shall be as specified below.

1. The output voltage shall be as stated in Section 7.
2. The automatic current limiting circuit shall be adjustable down to 90% and up to 120% of the rated output dc current.
3. A high-voltage shutdown circuit shall be provided if the dc output exceeds safe battery limits.
4. A dc surge suppressor (MOV type) shall be provided on the output of the charger.
5. A back-feed blocking diode shall be provided to prevent the battery from discharging back though the charger.
6. A dc output protection diode shall be provided to prevent damage to the charger or the batteries, or both, due to reversed polarity connections.
7. As noted in Section 7, some chargers will require load sharing features. Load sharing shall be required for chargers operating in parallel and proportionately share the load.

4.6 Output Filter Section

An output filter shall be provided to limit the ripple voltage to 30 mV_{rms} or 0.06% of nominal output voltage whichever is higher without the battery connected. The electrical noise level shall be less than 32 dBrnC when operating as a battery eliminator (battery disconnected).

4.7 Float and Equalization Functions

The float and equalization functions shall be as specified below.

1. The battery charger shall float the station battery continuously at a selected voltage between 2.15 to 2.30 volts per cell. Internal or external adjustments of this voltage shall be provided.
2. The unit shall provide an equalize charge from 2.2 to 2.4 volts per cell. Internal or external adjustments of this voltage shall be provided.
3. The unit shall act as battery eliminator for the capacity stated in Section 7.
4. An equalizing timer shall be provided, with the range of 0 to 72 hours.
5. Float and equalize charging shall be selectable.

4.8 Standard Accessories

The standards accessories shall be as follows.

1. Dc output ammeter and voltmeter shall be provided with a minimum accuracy of 2%.
2. Ac pilot light shall be provided.

4.9 Battery Ground Detection System

Ground detection system for both positive and negative terminals to ground shall be provided. Indicating lights and a ground test switch shall be provided. A lamp test switch shall be provided to test the indicating lights.

A ground detection system alarm relay with form-C contacts wired to a terminal board for customer's termination shall be provided. The contact shall be rated 125 volts dc. A time delay shall be provided.

4.10 Alarm Auxiliary Contacts

The alarm auxiliary contacts shall include the following:

1. A charger failure alarm and relay with form-C contacts wired to a terminal board for customer's termination shall be provided. A time delay shall be provided.
2. A input ac voltage alarm and relay with form-C contacts wired to a terminal board for customer's termination shall be provided. A time delay shall be provided.
3. A high and low dc voltage alarm and relay with form-C contacts wired to a terminal board for customer's termination shall be provided. A time delay shall be provided.
4. Each alarm shall operate an LED-indicating light mounted on the battery charger.
5. The alarms shall be capable of being paralleled on a pair of charger terminals to provide a single charger alarm to PacifiCorp's annunciator. Contacts shall be rated 125 volts dc.

4.11 Labeling and Marking

The supplier shall provide precautionary labeling and symbols for *Danger*, *Warning* and *Caution,* as required by nationally recognized standards, laws, or regulations.

All operating controls and alarms shall be identified with permanently affixed legends. Letters shall be so place on the battery charger so that they are readily visible

The following minimum information shall be given on the nameplate of the battery charger:

1. Supplier's name, model number, and serial number
2. Rated dc output voltage
3. Rated dc output current
4. Nominal ac supply input voltages
5. Nominal ac supply frequency
6. Number of supply phases
7. Ac input current

5 Drawings and Other Information

Two sets of applicable drawings and other information from the list below shall be furnished:

1. One set shall be attached and shipped with the equipment as specified in 6.1.
2. One set shall be submitted to the project engineer listed in 7.1.2.

Drawings shall be full size (not reduced). All values on drawings and other information shall be shown in U.S. customary units only, or in both U.S. customary units SI units.

5.1 Outline Drawings

The supplier shall provide an outline drawing of the unit within two weeks after receipt of the purchase order.

5.2 Wiring Diagrams

Wiring diagrams shall be provided within two weeks after receipt of purchase order.

5.3 Instruction Manuals

The supplier shall provide instruction manuals covering receiving, handling, installation, operation, and maintenance of the battery charger.

5.4 Renewal Parts

The supplier shall provide a complete list of renewal parts for the battery charger.

5.5 Certified Test Reports

The supplier's completed certified test reports shall be mailed with the final documentation.

5.6 Product Warranty or Guarantee or Both

The supplier guarantees that the battery charger shall be free from defective materials and workmanship for a period of eighteen months from the date of shipment or twelve months from date of installation.

6 Packing Shipping Requirements

6.1 Installation Documentation

The supplier shall provide, with the shipped unit, one set of installation drawings and an instruction book. These documents shall be packaged in a waterproof envelope and attached to the unit. This set of documentation counts as one of the sets required in Section 5.

6.2 Shipment

The f.o.b. point shall be as specified on the purchase order.

6.3 Notification of Shipment

The supplier shall notify PacifiCorp two weeks prior to expected arrival of the batteries and equipment. Additionally, the PacifiCorp contact person, named in 7.1.5, shall be notified on the day of shipment and 48 hours prior to the delivery of the equipment to ensure provisions for unloading.

7 Additional Battery-Charger-Specific Requirements

The battery charger information and specifications in this section are for the equipment referenced in 7.1.1, and shall be used in conjunction with the other requirements of this material specification.

In this section, a box checked (✓) by an item indicates that the item is required or applicable; a box not checked indicates that the item does not apply or is not acceptable.

7.1 Equipment Identification and Order Requirements

7.1.1 Equipment Identification

PM Order number: ________________________

REQ number: __________________ PO number: __________________

Location: ____

7.1.2 Commercial Issues

Correspondence regarding commercial issues shall be sent to the PacifiCorp Purchasing Department with copies to:

Project engineer: ____

Address: ____

City: ______________________________ State: __________ Zip: ______________

Telephone: ___________________________

7.1.3 Technical Application Questions

Technical questions regarding this material specification, or notice of any other technical matters which arise during the proposal process or during equipment design, manufacture, or test, shall be directed to the project engineer (see 7.1.2).

7.1.4 Drawing Destination

All drawings and other information specified in Section 5 shall be mailed to the person in the department checked (✓) below:

❑ Portland Office
Attention: ______________________________
Substation Engineering
825 NE Multnomah Blvd, Suite 1600
Portland, OR 97232

7.1.5 Notice of Shipment

The supplier shall notify the person named below as specified in 6.3.

Name: ____________________

Address: ____________________

City: ____________________ State: __________ Zip: __________

Telephone: ____________________

7.2 Nominal Output Voltage

The battery charger shall be suitable for operation on a system with the output voltage rating checked (✓) below:

48 Vdc . . . . ❑

130 Vdc . . . . ❑

7.3 Input Filter (RFI) Required

The input filter is required as checked (✓) below (see 4.3):

Supplied with filter . . . . ❑

Supplied with extra low-noise rating 22 dBrnC instead of 32 dBrnC standard (reference 4.6) . . . . ❑

7.4 Proportional Load Sharing

Supplied with load share feature for operating chargers in parallel (reference 4.5) . ❑

7.5 Output Capacity

The charger shall be rated to deliver _____ amperes, or with sufficient capacity to charge the battery cells in 12 hours while supplying normal station load of 15 amperes. The battery cells are rated _____ ampere-hours. (*Note to originator: Complete at least one of the blanks.)*

The output capacity shall be suitable for locations lower that 3,300 feet elevation, higher elevations are as noted _____ feet above sea level. *(Note to originator: Complete the blank, if applicable.)*

8 Issuing Department

The Asset Management Documentation Department of PacifiCorp is responsible for issuing this material specification. Comments and suggestions are welcome. Submit comments or requests for additional copies of this document to:

PacifiCorp Asset Management
825 NE Multnomah St., Suite 1600, Portland, OR 97232
telephone: (503) 813-5293, fax: (503) 813-6804

Technical questions regarding this material specification may be submitted to:

Staff Engineers, PacifiCorp Asset Management
825 NE Multnomah St., Suite 1600, Portland, OR 97232
telephone: (503) 813-6896, fax: (503) 813-6804

Substation Equipment—Coupling Capacitor Voltage Transformer—Nominal 46 kV and Above

1 Scope

This material specification states the requirements for coupling capacitor voltage transformers (CCVTs) with a nominal rating of 46 kV and above to be purchased by PacifiCorp.

2 References

The following publications shall be used in conjunction with this material specification, and form a part of this material specification to the extent specified herein. When a referenced publication is superseded by an approved revision, the revision shall apply.

2.1 Industry Publications

Referenced industry publications are:

ANSI C93.1, *American National Standard for Power-Line Carrier Coupling Capacitors and Coupling Capacitor Voltage Transformers (CCVT)—Requirements*

ANSI C93.2, *American National Standard Requirements for Power-line Coupling Capacitor Voltage Transformers (CCVT)*

IEEE 57.13, *Standard Requirements for Instrument Transformers*

2.2 PacifiCorp Publications

Referenced PacifiCorp publications are:

PacifiCorp Material Specification ZS 061, *Electrical Equipment—Insulating Oil*

PacifiCorp Material Specification ZS 065, *Wind, Ice, and Seismic Withstand*

PacifiCorp Material Specification ZS 066, *Contaminated-Environment Protection*

3 General

3.1 Application Information

This material specification states the general requirements for CCVTs within the specified range of ratings.

3.2 Authorized Material Specification

This material specification is not considered valid until each page contains the approval signature (or initials) of the persons named in the title blocks.

4 Basic Design and Manufacturing Requirements

4.1 Codes and Standards

Except as required otherwise by this material specification, the CCVT specified herein shall be furnished in complete accordance with the latest applicable industry codes; ANSI, IEEE, and NEMA standards; and PacifiCorp standards and material specifications in effect on the date of invitation to bid.

4.2 Type

Unless specified in the purchase order, the CCVT shall be outdoor, 60-hertz, with oil-filled capacitor unit(s), porcelain capacitor-unit housing(s), and oil- or air-filled base housing. The CCVT shall be rated for line-to-ground connection.

4.3 Elevation

Unless checked (✓) below, the CCVT shall be rated for elevations up to 7,000 feet above sea level.

3,300 feet above sea level . . . . ☐
5,000 feet above sea level . . . . ☐

For elevations above 3,300 feet, any required de-rating of the dielectric strength shall not exceed the IEEE correction factor of 1.0% for each 330 feet of elevation increase.

4.4 Ambient Temperature

Unless checked (✓) below, the CCVT shall be rated for the ambient temperature between –40°C to +45°C, as specified in IEEE Standard C93.1.

–50°C to +45°C . . . . ☐

4.5 Wind, Ice and Seismic Withstand

The wind, ice and seismic withstand capability of the CCVT shall be in accordance with PacifiCorp Material Specification ZS 065.

4.6 Contaminated Environment Protection

If specified in the purchase order, the CCVT shall be furnished in accordance with the contaminated environment protection requirements of PacifiCorp Material Specification ZS 066. (Note that the exposed fasteners and hardware on *all* CCVTs shall meet the requirements of Section 4.9 of this document.)

4.7 Standard Features and Accessories

The CCVT shall be furnished with the following standard features and accessories:

1. Capacitor unit porcelain housing
2. Two tapped transformer secondary windings
3. Potential grounding switch, and protective gap or surge arrester
4. Space heater for air-filled base housing
5. Flat-pad type line terminal with NEMA standard 4-hole drilling
6. Clamp-type ground connector suitable for 1/0 to 4/0 AWG copper conductor
7. All other standard features and accessories

4.8 Base Housing and Other Compartments

The base housing and any other compartments shall be weatherproof, and oil tight if applicable. The housing or compartment material shall be aluminum, stainless steel, galvanized steel, or painted steel.

4.9 Exposed Fasteners and Hardware

With the exception of nuts, all exposed fasteners and hardware (such as bolts, screws, washers, hinges, handles and brackets) shall be 300–series stainless steel, if not welded. If welded, 304L stainless steel shall be used. All nuts shall be silicon-bronze to prevent galling. Other stainless steel grades will be considered if equivalence to USA grades can be demonstrated.

4.10 Exterior Finish and Porcelain Color

The finish on exposed painted metal parts, and all capacitor unit porcelain housings, shall be ANSI 70 / Munsell 5.0 BG 7.0/0.4 light gray.

4.11 Nameplate Information

The CCVT nameplates and instruction plates shall show all values in U.S. customary units. In addition to the ANSI/NEMA standard information required on the CCVT nameplate, the suppliers shall include:

1. PacifiCorp equipment number provided by PacifiCorp
2. Nominal line-to-ground voltage (instead of the maximum rated voltage as specified by ANSI)
3. Nominal secondary voltage
4. Rated elevation
5. Rated daily minimum and daily peak ambient temperatures
6. CCVT winding and polarity marks

7. Weight of CCVT
8. Rated capacitance (C_1 and C_2)
9. Rated for high seismic zone

4.12 Factory Calibration

The CCVT shall be permanently factory calibrated for the specified accuracy class. No field adjustment shall be required to maintain the accuracy throughout the burden range.

4.13 Optional Accessories

4.13.1 Carrier Accessories

Carrier accessories, if specified in the purchase order, shall include the following equipment mounted in the base housing or in a weatherproof compartment attached to the base housing:

1. Carrier grounding switch
2. Choke coil
3. Carrier drain coil, and protective gap or surge arrester (A gas tube-type protective gap is not acceptable.)
4. Space heater for air-filled compartment
5. Carrier entrance bushing
6. All other standard carrier accessories

If carrier accessories are not specified, provisions and space shall be furnished for future installation of this equipment; except that any component which must be mounted under oil shall be furnished initially, factory-installed.

4.13.2 Line Tuner

If specified in the purchase order, line tuner shall be housed in a separate weatherproof compartment suitable for mounting on the CCVT base housing, or on a separate PacifiCorp structure. All standard accessories, including a space heater, shall be furnished. A single insulated conductor shall be furnished for connection from the line tuner to the CCVT; this conductor shall be 5 kV, No. 8 AWG, and 20 feet in length.

The nominal equipment-side matching transformer impedances shall be 50 ohms; line-side matching impedances shall be adjustable from 200 to 750 ohms.

Line tuner protection shall include a safety ground switch, a blocking capacitor, and a spark gap or arrestor for surge protection.

At carrier frequencies and/or bandwidth, specified in the purchase order, the line tuner shall have a return loss of greater than 12 dB and a power rating of 100W.

The specific line tuner optional requirements shall be specified in the purchase order and are as follows:

1. Line tuner type:
   Acceptable line tuner types are:
   a. Single-Frequency Resonant Tuner
   b. Dual-Frequency Resonant Tuner
   c. Broadband Tuner using a bandpass filter design. A broadband high-pass filter design is not acceptable.
2. Type of coupling:
   a. Phase to Ground
   b. Phase to Phase using a two coax/two tuner design with a balanced transformer.

5 Technical Documentation

All drawings shall be full-size (not reduced). All values on drawings, and other information, shall be shown in US customary units only, or in both US customary and SI units.

The PacifiCorp PM order number, PO number, PacifiCorp equipment number, and installation location, all provided by PacifiCorp, shall be shown in the title block on all drawings and on all transmittal and shipping documents.

All drawings and other information to be sent to PacifiCorp shall be mailed to the following address:

PacifiCorp Standards Engineering Documentation
Lloyd Center Tower
825 NE Multnomah St., Suite 1600
Portland, OR 97232

Electronic copies shall be emailed to *ManufacturerDrawings@PacifiCorp.com*.

“Review drawings” are those submitted to PacifiCorp to check for general conformance with the contract and/or specification documents. Exceptions or comments made on the drawings do not constitute approval of the document or an amendment of the contract between PacifiCorp and the parties producing the document. The drawing review does not relieve such parties from compliance with the requirements of the plans and specifications, accuracy of dimensions and quantities indicated, suitability of construction materials or fabrication and installation techniques.

“Final for manufacturing” drawings are those that have been reviewed by PacifiCorp and with which the equipment will be manufactured. PacifiCorp will use these drawings for engineering design and if there are any changes made to the drawings after these are issued, penalties may be incurred. Manufacturing tolerances listed on these drawings shall be at an absolute minimum due to the implications this may have on the engineering design work.

"As-built drawings" are those issued after the equipment has been manufactured and shall reflect the exact condition of the equipment at the time of shipment. There shall be no manufacturing tolerances listed on these drawings as they should be a direct representation of the equipment dimensions and the accessory locations.

5.1 Review Drawings

If specified in the purchase order, the following shall be furnished for approval and shall be sent to PacifiCorp as specified in Section 5 of this document:

1. One set of electronic copies submitted via email of applicable drawings and other information from Section 5.4 of this document.
2. The document for seismic qualification prepared per ZS 065 which was checked, stamped and signed by a Professional Engineer licensed in the United States shall be submitted by the equipment manufacturer at the same time as the review drawings.

5.2 Final for Manufacturing Drawings

Applicable final for manufacturing drawings and all other information from Section 5.4 of this document shall be furnished as specified in the following list as specified in Section 5 of this document after the review period has occurred for the review drawings.

1. One set of electronic copies submitted via email of applicable drawings and other information from Section 5.4 of this document.
2. One compact disc (CD) of applicable drawings in AutoCAD, or in DXF file format if not available in AutoCAD.

5.3 As-Built Drawings

Applicable as-built drawings, instruction manuals, test reports, and all other information from Section 5.4 shall be furnished as specified in the following list.

1. One set of as-built drawings, instruction manuals, test reports and all other information specified in Section 5.4 shall be shipped with the CCVT in a weatherproof envelope or in a compartment.
2. Five additional sets of as-built drawings, instruction manuals, test reports, and all other information specified in Section 5.4 shall be sent to PacifiCorp as specified in Section 5 of this document.
3. Two additional sets of as-built drawings in AutoCAD (or in DXF file format if not available in AutoCAD), instruction manuals, test reports, and all other information specified in Section 5.4 shall be sent to PacifiCorp as specified in Section 5 of this document.

5.4 Technical Documentation Description

5.4.1 Certified Test Report

The supplier shall furnish a complete certified test report.

5.4.2 Outline Drawings

The supplier shall furnish an assembled CCVT outline drawing, including:

1. The dimension of the CCVT.
2. Structural details of the CCVT base housing including mounting details.
3. Weight and center of gravity of the CCVT filled with insulation medium.

5.4.3 Nameplate and Instruction Plate Drawing

The supplier shall furnish a drawing of each nameplate and instruction plate. (See nameplate-specific requirements in Section 4.11).

5.4.4 Schematic and Wiring Diagram

The supplier shall furnish a schematic and wiring diagram showing the complete base housing wiring, including customer connection points.

5.4.5 Instruction Manuals

The supplier shall furnish an instruction manual covering receiving, handling, installation, operation, and maintenance of the CCVT and all accessories.

5.4.6 Terminal Fitting Drawing

The supplier shall furnish detail terminal fitting drawings.

6 Shipping Requirements

6.1 Shipping Dimensions and Weight

The supplier shall be responsible for checking the shipping dimensions and weight of the proposed design for suitability for shipment to the specified destination.

6.2 Notification of Shipment

The supplier shall notify PacifiCorp two weeks prior to the expected arrival of the CCVT. Additionally, the PacifiCorp contact named below shall be notified on the day of shipment and 48 hours prior to the delivery of the CCVT to ensure provisions for unloading.

PacifiCorp Project Services Dept. – Attn: Maridee Dearing
825 NE Multnomah, Suite 1500
Portland, OR 97232
Telephone: (503) 813-7061; Fax: (503) 813-6596

7 Ratings and Related Capabilities

The CCVT rating shall be one of those listed in Table 1, as specified in the purchase order. Unless checked (✓) below, the CCVT shall be designed to the 0.3 / Z accuracy class/burden.

0.3 / ZZ . . . . ❏

Table 1 – CCVT Ratings

Nominal System Voltage BIL ($kV_{L—L, rms}$)	BIL (kV)	Nominal Line-to-Ground Voltage ($kV_{L-G,rms}$)	Marked Ratio	Nominal Secondary Voltage (V_{rms})		Capacitance Minimum (pF)	
46	250	26.56	240/400:1	110.7/66.4	■	15000	❏
69	350	39.84	350/600:1	113.8/66.4	■	12000	❏
115	550	66.40	600/1000:1	110.7/66.4	■	7500	❏
138	650	79.67	700/1200:1	113.8/66.4	■	6200	❏
161	750	92.95	800/1400:1	116.2/66.4	■	6200	❏
230	900	132.79	1200/2000:1	110.7/66.4		5000	❏
345	1300	199.19	1800/3000:1	110.7/66.4	■	5000	❏
525	1800	303.11	2500/4500:1	115.5/64.2		5000	❏

**supplier's choice

8 Material Specification Issuing Department

The Standards Engineering Documentation Department of PacifiCorp is responsible for issuing this standard material specification. Comments and suggestions are welcome. Please submit comments or requests for additional copies of this material specification to:

PacifiCorp Standards Engineering Documentation
825 NE Multnomah Blvd., Suite 1600, Portland, OR 97232
telephone: (503) 813-5293 fax: (503) 813-6804

Technical application questions regarding this material specification may be submitted to:

Staff Engineers, PacifiCorp Engineering and Technology Development
825 NE Multnomah Blvd., Suite 1600, Portland, OR 97232
telephone: (503) 813-6883 fax: (503) 813-6804

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Standards Engineering Department

Substation Equipment—Group-Operated Air Switch

Project Issue Date: ___________

Specification Approval Date: 9 Mar 11

PacifiCorp Project Info

Attachment to Exhibit _____, Section _____, Attachment No. _____

Project Name: ____

Edited By: ____

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Contents

Substation Equipment—Group-Operated Air Switch

1 Scope

This material specification states the requirements for group-operated air switches and grounding switches to be purchased by PacifiCorp for application in substations of 15 kV through 500 kV.

2 Applicable Documents

Except as required otherwise by this material specification, the air switch and associated grounding switch, if specified in 7.14, specified herein shall be furnished in complete accordance with the latest applicable industry codes, ANSI, IEEE, and NEMA standards, OSHA requirements, and PacifiCorp standards and material specifications in effect on the date of the invitation to bid.

2.1 Industry Documents

Applicable industry documents may include, but shall not necessarily be limited to, those listed below.

ANSI/IEEE C37.30, *Definitions and Requirements for High Voltage Air Switches, Insulators, and Bus Supports*

ANSI/IEEE C37.34, *Test Code for High Voltage Air Switches*

2.2 PacifiCorp Documents

Applicable PacifiCorp documents may include, but shall not necessarily be limited to, those listed below.

ZS 065, *Wind, Ice, and Seismic Withstand*

ZS 066, *Contaminated-Environment Protection.*

3 General

3.1 Application Information

This material specification states both the general requirements for group-operated air switches and the switch-specific requirements that vary depending on installation and intended use (see section 7, *Additional Air Switch-Specific Requirements*.)

3.2 Authorized Material Specification

This material specification is not considered valid until each page contains the approval signature of the persons named in the title blocks, and section 7 has been completed.

4 Design and Manufacturing Requirements

4.1 Type

The air switch and associated grounding switch, if specified in 7.14, shall be three-pole, single-throw, group-operated devices.

4.2 Temperature and Elevation Requirements

The air switch shall be suitable for full rated operation in ambient temperatures up to +40°C and at elevations up to 3300 feet, without exceeding the allowable maximum temperature of any switch component. For elevations above 3300 feet, any required derating shall not exceed the derating determined by the IEEE C37.30 correction factors.

4.3 Terminals

The air switch shall be equipped to accept a 4-inch by 4-inch NEMA-standard four-hole terminal pad at both hinge and jaw ends, suitable for terminal connectors on both pad surfaces. All copper terminal pads shall be tin plated to 0.001 inch.

4.4 Arcing Horns

Each air switch shall be furnished with arcing horns and tips.

4.5 Blade Operation

Closing operation of each air switch shall end with the contact portion of the blade perpendicular to the contact faces of the jaw to insure high contact pressure.

4.6 Rated Ice Breaking Ability

The air switch shall be designed and constructed so that a 3/4-inch (20 mm) thickness of ice deposited on the device will not interfere with the successful opening or closing of the device, in accordance with ANSI/IEEE C37.30 Supplement C, paragraph 4.16.

4.7 Hinge Current-Carrying Assemblies

The air switch hinge current-carrying assemblies shall use a high-pressure, braidless design. The grounding switch may have a braided cable across the hinge.

4.8 Contacts

Vertical break and grounding switches shall be equipped with high-pressure, reverse-loop, silver contacts backed by a stainless steel coil spring and silver blade contacts.

4.9 Insulators

4.9.1 Approved Insulator Suppliers and Color

Unless specified, the switch supplier shall furnish all insulators. Only insulators approved by PacifiCorp shall be used. The approved insulators are Lapp, NGK Locke, PPC Insulators, or Newell with Munsell 5.0 BG 7.0/0.4 light gray color.

4.9.2 Insulator Strength

All insulators supplied shall be standard strength unless stronger insulators are specified or required by supplier's design.

4.9.3 Rotating Stacks

All rotating insulator stacks shall have stainless steel or stainless-and-bronze bearing assemblies and a means to prevent the entrance of contaminants.

4.10 Adjustable Air Gaps

Adjustable air gaps (spill gaps), if specified in 7.3, shall be provided on the jaw end of each air switch.

4.11 Mounting Hardware and Other Equipment

The switch shall be shipped complete with mounting hardware, operating linkage, and all other parts required for installation and successful operation on the structure shown on the attached drawing specified in 7.5. The mounting hardware, leveling method and operating linkage shall be designed so they can be easily bolted (not welded) to the steel structure. The leveling method shall be designed to use a screw-jack principle or shims to provide accurate leveling of the installed air switch. If a motor operator is specified in 7.7, the switch supplier shall provide all mounting hardware for the switch and the specified motor operator as required to insure proper switch operation and alignment of the operating mechanism.

4.12 Operating Mechanism

The operating mechanism shall be a swing-handle type for operating voltages of 15 kV to 115 kV, and gear-operated for operating voltages of 138 kV and higher. The operating linkage shall be of sufficient strength and size to limit the maximum deflection of the blade during operation to one-half inch. Maximum operating force required to open or close the air switch shall be limited to 50 foot pounds applied at the air switch operator, including allowance for interrupters, if specified in 7.9. The operating linkage on a vertical air switch shall "over-toggle" in the switch-open and switch-closed positions to prevent accidental closing and opening.

The operating mechanism shall be located approximately 42 inches from the top of the foundation level.

4.13 Locking Provision

Provision shall be made for padlocking the air switch and grounding switch in the open and in the closed positions.

4.14 Switch Interlocks

If specified in 7.14.2, air switch mechanical interlocking (non-key interlock) shall be supplied between the grounding switch and the air switch.

4.15 Auxiliary Switch Contacts

4.15.1 Air Switch Contacts: If specified in 7.6, auxiliary contacts shall be provided for monitoring the position of the air switch. The auxiliary contacts shall include six normally-open and six normally-closed contacts suitable for use in protective relay schemes. The contacts shall be mounted in such a way that they cannot be decoupled from the air switch.

4.15.2 Motor Contacts: If specified in 7.6, auxiliary contacts shall be provided for monitoring the position of the motor operator. The auxiliary contacts shall include four normally-open and four normally-closed contacts for use with the auto–sectionalizing scheme.

4.16 Identification

A nameplate shall be mounted on the air switch.

5 Drawings and Other Information

The supplier shall provide to the engineering document control person named in 7.1.6, within six weeks from date of purchase order, five sets of installation drawings showing mounting and operating details on the typical structure specified in 7.5 and five instruction books for each type of air switch delivered. One additional set of installation drawings and an instruction book shall be attached to the air switch in a waterproof envelope.

6 Packing and Shipping Requirements

6.1 Dimensions and Weight

The supplier shall be responsible for checking the shipping dimensions and weight of the proposed design for suitability for the method of shipment specified on the purchase order.

6.2 Shipment

The f.o.b. point shall be as specified on the purchase order.

6.3 Notification of shipment

The supplier shall notify PacifiCorp two weeks prior to the expected arrival of the air switch. Additionally, the PacifiCorp contact person named in 7.1.7 shall be notified on the day of shipment and 48 hours prior to the delivery of the air switch to ensure provisions for unloading.

6.4 Packing

Prior to shipment, the group operated switch shall be preassembled and adjusted to insure that all components are properly aligned and that the switch operates properly. Switches 161 kV and below, shall be shipped as one unit consisting of three (3) fully assembled poles. The associated operating mechanism and mounting hardware shall be packaged together and shipped separately or shipped within the crate containing the three pole units. Switches 230 kV and above shall be disassembled and shipped with their live parts secured to the switch base and their insulators shipped separately.

The supplier shall code all shipping containers and crates in such a manner that all mounting and operating hardware can be readily identified as belonging to the particular switch for which it was designed. At a minimum, all containers and crates shall also be identified with PacifiCorp's name, the PacifiCorp purchase order number, and the name of the substation for which the switch is intended.

7 Additional Air Switch-Specific Requirements

The air switch information and specifications in this section are for the item in the General Purpose Requisition (GPR) stated in 7.1, and shall be used in conjunction with the other requirements of this material specification.

In this section, a box checked (✓) next to an item indicates that the item is required or applicable; a box not checked indicates that the item does not apply or is not acceptable.

7.1 Equipment Identification and Order Requirements

7.1.1 Equipment Identification

GPR number: ____________________ Item number: ____________________

Equipment number(s): ____________

Location: ____

Project number: _________________

7.1.2 Commercial Issues

Correspondence regarding commercial issues shall be sent to the PacifiCorp Purchasing Department with copies to:

Project Engineer: ____

Address: ____

City: ___________________________ State: ___________ Zip: _______________

Telephone: ______________________

7.1.3 Technical Application Questions

Technical questions regarding this material specification, or notice of any other technical matters which arise during the proposal process or during equipment design, manufacture, or test shall be directed to the project engineer (see 7.1.2).

7.1.4 Approval Drawings

If checked (✓), three sets of drawings and other information specified in section 5 shall be furnished for approval. . . . . ☐

7.1.5 Drawings on Diskettes

If checked (✓), final drawings shall be furnished on diskettes as specified:

AutoCAD version _________ . . . . ☐

DXF file format . . . . ☐

7.1.6 Drawing Destination

All drawings and other information specified in section 5 shall be mailed to the person in the office checked (✓) below:

❑ Portland Office

Attention: ____________________________

Substation Engineering

825 NE Multnomah St., Suite 1600 LCT

Portland, OR 97232

❑ Salt Lake City Office

Attention: ____________________________

Substation Engineering

1407 West North Temple, NTO310

Salt Lake City, UT 84140

❑ Generation Engineering

Attention: ____________________________

Engineering Document Control Services

1407 West North Temple, NTO210

Salt Lake City, UT 84140

7.1.7 Notice of Shipment

The supplier shall notify the person named below as specified in 6.3.

Name: ____

Address: ____

City: ___________________________ State: __________ Zip: ______________

Telephone: ______________________

7.2 Action Type

The air switch action type shall be provided as checked (✓) below:

Vertical break . . . . ❑

Double side break . . . . ❑

Center side break . . . . ❑

V switch . . . . ❑

Other: ____________________________ . . . . ❑

7.3 Adjustable Air Gaps

If checked (✓), adjustable air gaps (spill gaps) shall be provided on the air switch as specified in 4.10. Air gap spacing is ____________ . . . . ❑

7.4 Mounting Position

The mounting position for the air switch shall be provided as checked (✓) below:

Horizontal . . . . ❑

Vertical . . . . ❑

Other: ______________________________ . . . . ❑

7.5 Typical Structure

The following typical structure drawing is attached:

Drawing number: _____________________

7.6 Auxiliary Switch Contacts

If checked (✓), the air switch shall be equipped with auxiliary switch contacts as described below:

Air switch contacts (Section 4.14.1) . . . . ❑

Motor contacts (Section 4.14.2) . . . . ❑

7.7 Motor Operator Mechanism

A motor operator mechanism shall be supplied as checked (✓) below:

By supplier, per attached motor operator specification . . . . ❑

By PacifiCorp . . . . ❑

Not required . . . . ❑

7.8 Contaminated Environments

If checked (✓), the air switch shall also be equipped in accordance with the contaminated-environment protection requirements of the attached material specification ZS 066. . . . . ❑

7.9 Interrupter Supplier

Interrupters shall be supplied and installed as checked (✓) below:

By PacifiCorp . . . . ❑

By switch supplier . . . . ❑

7.10 Interrupter Type

The interrupter type to be supported by either PacifiCorp or the supplier shall be as checked (✓) below:

	Loop-Opening	Line Dropping	Combination
Joslyn	❑	❑	❑
Pascor		❑	
Turner	❑	❑	❑
Other ________	❑	❑	❑

7.11 Voltage and BIL Ratings

The air switch shall have the voltage and BIL ratings checked (✓) below:

15 kV, 110 kV BIL . . . . ❑

25 kV, 150 kV BIL . . . . ❑

34.5 kV, 200 kV BIL . . . . ❑

46 kV, 250 kV BIL . . . . ❑

69 kV, 350 kV BIL . . . . ❑

115 kV, 550 kV BIL . . . . ❑

138 kV, 650 kV BIL . . . . ❑

161 kV, 750 kV BIL . . . . ❑

230 kV, 900 kV BIL . . . . ❑

345 kV, 1300 kV BIL . . . . ❑

500 kV, 1800 kV BIL . . . . ❑

_____ kV, _____ kV BIL . . . . ❑

7.12 Phase Spacing

The spacing between phases shall be as checked (✓) below:

3 feet . . . . ☐
5 feet . . . . ☐
7 feet . . . . ☐
10 feet . . . . ☐
12 feet . . . . ☐
14 feet . . . . ☐
15 feet . . . . ☐
_____ feet . . . . ☐

7.13 Air Switch Continuous and Momentary Current Ratings

The continuous and momentary current ratings of the air switch shall be as checked (✓) below:

1200 continuous amperes; 61000 momentary amperes . . . . ☐
2000 continuous amperes; 100000 momentary amperes . . . . ☐
_____ continuous amperes; ________ momentary amperes . . . . ☐

7.14 Grounding Switch

If checked (✓), a grounding switch shall be provided with the air switch and the requirements in 7.14.1 through 7.14.3 shall apply. ☐

7.14.1 Location

The location of the grounding switch on the air switch shall be as checked (✓):

Jaw end . . . . ☐
Hinge end . . . . ☐

7.14.2 Interlock

If checked (✓), interlocking shall be provided as described in 4.14. . . . . ☐

7.14.3 Momentary Rating

The minimum rated momentary current of the grounding switch contacts shall be as checked (✓) below:

40000 amperes . . . . ☐
61000 amperes . . . . ☐
70000 amperes . . . . ☐

7.15 Special Height Requirement

If checked (✓), the switch height, as measured from the bottom of the switch base to the top of the switch terminal pad, shall be as indicated below:

__________ inches . . . . ❑

7.16 Seismic Design Requirement

If checked (✓), the wind and seismic withstand capability of the switch shall be in accordance with the attached material specification ZS 065. . . . . ❑

7.17 Corona Shielding

If checked (✓), corona shielding of the conductor terminals shall be provided by the switch manufacturer. Visual corona shall be eliminated, or any portion of the switch in either the open or closed position, for an applied test voltage of 318 kV line-to-ground. . . . . ❑

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Material Specification

Electrical Equipment—Insulating Oil

T & D Standards Engineering Department

Date: 29 May 09

Contents

Electrical Equipment—Insulating Oil

1 Scope

This material specification states the requirements for insulating oil to be purchased by PacifiCorp.

2 Applicable Documents

The following publications shall be used in conjunction with this material specification, and form a part of this material specification to the extent specified herein. When a referenced publication is superseded by an approved revision, the revision shall apply.

2.1 Industry Publications

Referenced industry publications are:

OSHA 29 CFR 1910, 1200, *Hazard Communication Standard*

ASTM D 117, *Standard Guide to Tests Methods and Specifications for Electrical Insulating Oils of Petroleum Origin*

ASTM D 877, *Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes*

ASTM D 923, *Standard Test Method for Sampling Electrical Insulating Liquids*

IEC WG–35, *Covered Conductor Deposition Test*

3 General

3.1 Application Information

This material specification states the general requirements for insulating oil for energized electrical equipment. The insulating-oil-specific requirements that vary depending on the project shall be stated in the purchase order.

3.2 Authorized Material Specification

This material specification is not considered valid until each page contains the approval signature (or initials) of the persons named in the title blocks.

4 Manufacturing Requirements

4.1 Codes and Standards

Except as required otherwise by this material specification, electrical equipment insulating oil requirements shall be in complete accordance with the latest applicable industry codes, ANSI, IEEE and NEMA standards, and PacifiCorp Construction Standards and Material Specifications in effect on the date of invitation to bid.

4.2 Type

The insulating oil supplied under this specification shall be non-corrosive, light mineral insulating oil for use as a dielectric medium in an energized electrical apparatus. The oil shall also be naphthenic and inhibited, as specified in Sections 4.3 and 4.5.

4.3 Raw Material and Processing

The insulating oil shall be manufactured from predominantly naphthenate base crudes. Distillates from these crudes may be acid refined, hydrogen treated, solvent extracted, or processed by other industry accepted methods that will yield mineral insulating oil that meets the testing requirements in Section 5 of this specification at the point of delivery to PacifiCorp. No changes in the approved crude used or the approved refining methods shall be made without prior written acceptance by PacifiCorp.

4.4 Impurities

Insulating oil shall be clear and free from all injurious impurities, such as metallic or nonmetallic particles or other foreign substances.

4.5 Additives

Insulating oil shall contain no additives other than the oxidation inhibitor. Certification stating that the additive Dibenzyl Disulfide (DBDS) is not contained in the insulating oil shall be provided.

4.6 Oil Sampling

Oil samples shall be taken in accordance with ASTM D 923 and shall be taken such that they represent the oil at the point of delivery to PacifiCorp.

5 Testing and Certification

The supplier shall provide a certificate or Material Safety Data Sheet stating that the insulating oil provided is not required to carry a cancer warning label in accordance with OSHA 29 CFR 1910, 1200. The supplier shall guarantee conformity to this specification at the point of delivery. Each individual container shall be accompanied by a certificate showing that the insulating oil in that container conforms to this specification at the point of loading, and giving all results of tests made on the oil. A copy of all documentation shall be submitted to PacifiCorp as specified in Section 6 of this document. The certificates shall include the results of the following tests, made on bottom samples taken after filling of each container of oil prior to shipment to PacifiCorp:

1. PCB analysis
2. Dielectric breakdown voltage (ASTM D 877)
3. Flash point
4. Dissipation (power) factor
5. Color
6. Visual examination
7. Neutralization number
8. Water content
9. Corrosive sulfur

The certificate shall also include the results of the tests specified in Table 1, made on samples from the manufacturing batch from which the shipment is drawn, and the following shipment identification information:

1. PacifiCorp purchase order number
2. Supplier's order number
3. Consignee
4. Date of shipment
5. Destination
6. Refinery lot number
7. Trailer or equipment serial number
8. Filling date
9. Volume of oil shipped

All insulating oil that does not conform to this specification at the point of delivery will be returned to the supplier collect. PacifiCorp shall be kept fully informed by the supplier as to the method and frequency of quality control employed for certification of these properties.

Table 1 specifies the properties to be tested, the test methods to be employed, and the test criteria for acceptance. The ASTM test methods listed in Table 1 may be found in abbreviated form in ASTM D 117.

Table 1 – Test Requirements

Electrical Properties	Test Method	Test Criteria
Dielectric breakdown at 60 Hz:		
Disc electrodes 0.100-inch gap	ASTM D 877	30 kV min.
VDE electrodes 0.040-inch gap	ASTM D 1816	28 kV min.
Dielectric breakdown voltage impulse at 25 °C needle-to-sphere ground 1-inch gap	ASTM D 3300	145 kV min.
Dissipation (power) factor		
at 25 °C	ASTM D 924	0.05% max.
at 100 °C	ASTM D 924	0.30% max.
Gassing tendency		
Procedure A	ASTM D 2300	+15 μl/minute max.
Procedure B	ASTM D 2300	+30 μl/minute max.
(use either procedure A or B)		
Physical Properties		
Aniline point	ASTM D 611	63–80 °C
Color	ASTM D 1500	0.5 max.
Flash point	ASTM D 92	145 C
Interfacial tension at 25 °C	ASTM D 971	40 dynes/cm min
Pour point	ASTM D 97	–40 °C max.
Specific gravity at 15/15 °C	ASTM D 1298	0.865–0.910
Viscosity		
at 100 °C	ASTM D 445	3.0/36 cST/SUS max.
at 40 °C	ASTM D 445	12.0/66 cST/SUS max.
at 0 °C	ASTM D 445	76.0/350 cST/SUS max
Visual examination	ASTM D 1524	Clear and Bright
Chemical Properties		
Corrosive Sulfur	ASTM D 1275B ASTM D 2668 IEC WG–35	Noncorrosive
Inorganic chloride ion	ASTM D 878	0.10 ppm
Inorganic sulfate ion	ASTM D 878	None
Neutralization number	ASTM D 974	0.03 mg KOH/g max.
Oxidation inhibitor content % by weight	ASTM D 1473 ASTM D 2668	0.3% max.

Electrical Properties	Test Method	Test Criteria
Chemical Properties		
Oxidation stability testing		
72 hour test: Sludge weight %	ASTM D 2440	0.10% max.
Neutralization number		0.30 mg KOH/g max.
164 hour test: Sludge weight %	ASTM D 2440	0.20% max.
Neutralization number		0.40 mg KOH/g max.
Rotating bomb test, minutes	ASTM D 2112	195 min.
Polychlorinated biphenyl (PCB)	ASTM D 4059	Not detectable
Total sulfur, weight %	ASTM D 989	0.15 % max.
Water Content, ppm	ASTM D 1315 ASTM D 1533	30 ppm max. before processing

6 Technical Documentation

All values in documentation shall be shown in US customary units only, or in both US customary and SI units.

The PacifiCorp PM order number, PO number, PacifiCorp equipment number, and installation location, all provided by PacifiCorp, shall be shown in the title block on all documents, including all transmittal and shipping documents.

All documents and other information sent to PacifiCorp shall be mailed to the following address:

PacifiCorp Asset Management Documentation
825 NE Multnomah St., Suite 1600
Portland, OR 97232
Telephone: (503) 813–6975; Fax: (503) 813–6804

7 Shipping Requirements

All insulating oil shall be shipped via common-carrier truck or factory-filled electrical apparatus purchased by PacifiCorp. All insulating oil shipped by any other means will be returned to the supplier collect. The supplier shall carefully inspect each container to assure that it is free of injurious foreign matter. The inspection shall include, but shall not be limited to, a visual internal inspection of the container, valves, and piping. Inspection shall occur immediately prior to loading of the insulating oil.

7.1 Notification of Shipment

The supplier shall notify PacifiCorp two weeks prior to expected arrival of insulating oil. Additionally, the PacifiCorp contact person named in the purchase order shall be notified on the day of shipment and 48 hours prior to the delivery of the insulating oil to ensure provisions for unloading.

8 Supplier Approval

All suppliers must be approved by PacifiCorp prior to receiving an order. Approval is issued to a supplier for a given crude source, refining process, conformity to the requirements of this specification, and performance deemed essential by PacifiCorp. Suppliers may be required to submit a one-gallon sample, for independent testing, and test certificates representing the quality of insulating oil to be delivered. The test certificates shall include the test requirements found in Section 5. The test sample submitted to PacifiCorp shall be clearly marked with the refinery name, refinery location, crude source, and refining process.

9 Issuing Department

The T &D Standards Engineering Documentation Department of PacifiCorp is responsible for issuing this material specification. Comments and suggestions are welcome. Submit comments or requests for additional copies of this document to:

PacifiCorp T & D Standards Engineering Documentation
825 NE Multnomah St., Suite 1600, Portland, OR 97232
telephone: (503) 813-5293; fax: (503) 813-6804

Technical questions regarding this material specification may be submitted to:

PacifiCorp T & D Standards Engineering
825 NE Multnomah St., Suite 1600, Portland, OR 97232
telephone: (503) 813-6883; fax: (503) 813–6804

Wind, Ice, and Seismic Withstand

1 Scope

This material specification states the requirements for wind, ice, and seismic withstand capability of substation equipment to be purchased by PacifiCorp.

2 Applicable Documents

The following publications shall be used in conjunction with this material specification, and form a part of this material specification to the extent specified herein. When a referenced publication is superseded by an approved revision, the revision shall apply.

2.1 Industry Publications

Referenced industry publications are:

IEEE 693, *Recommended Practices for Seismic Design of Substations*
ASCE 7, *Minimum Design Loads for Buildings and Other Structures*
ACI 318, *Building Code Requirements for Structural Concrete*

3 General

3.1 Application Information

This material specification states the general requirements for wind, ice and seismic withstand capability of substation equipment. The equipment-specific requirements that vary depending on the particular equipment and application shall be stated in the purchase order. This material specification must accompany a PacifiCorp material specification for specific substation equipment identified in the purchase order.

3.2 Authorized Material Specification

This material specification is not considered valid until each page contains the approval signature (or initials) of the persons named in the title blocks.

4 General Wind, Ice and Seismic Withstand Requirements

4.1 Codes and Standards

Except as required otherwise by this material specification, the general wind, ice and seismic withstand requirements shall be in accordance with the latest applicable industry codes, ANSI, IEEE, ASCE, ACI and NEMA standards, and PacifiCorp Construction Standards and Material Specifications in effect on the date of invitation to bid.

4.2 Seismic Performance Criteria

Substation power equipment and supporting structures shall meet the requirements of IEEE 693 and, unless checked (✓) below, shall be qualified for the "high seismic qualification level".

Low seismic qualification level . . . . ☐

Moderate seismic qualification level . . . . ☐

The equipment's nameplate shall indicate the seismic qualification level to which the equipment was designed and built.

4.3 Wind and Ice Performance Criteria

Substation power equipment and supporting structures shall be designed for wind and ice loadings in accordance with the application of ASCE 7, Chapter 6, *Wind Loads,* and Chapter 10, *Ice Loads—Atmospheric Icing*. The basic wind speed (for a three-second gust) shall be 100 mph (as opposed to the values given in Figures 6–1, 6–1a, 6–1b and 6–1c of ASCE 7, Chapter 6). The nominal ice thickness and simultaneous wind speed shall be based on the values shown in ASCE 7, Chapter 10, Figures 10–2 through 10–5, except the nominal ice thickness shall not be less than 1/4", and the nominal wind speed shall be no less than 40 mph. The "importance factor" shall be 1.15, and shall be in accordance with ASCE 7 for an occupancy category IV.

4.4 Anchor Requirements

Equipment or supporting stands shall include holes for anchoring the equipment to a concrete foundation using steel rods, bolts or special anchors (henceforth "anchors"). Selection of the number, positions and diameters of anchors shall be included in the engineering analysis and calculations for qualification of the equipment. Contrary to IEEE 693, selection of anchor diameter shall be based on the design procedure in ACI 318, Appendix D, and not on the ASCE Substation Structure Design Guide. For purposes of this design, anchor material shall be assumed to be steel meeting ASTM F1554.

Design shall facilitate the installation of post–installed anchors, i.e. adhesive, expansion or undercut anchors installed after placing equipment on foundation. The minimum clearance space required to install this type of anchor in concrete is 9 inches between the equipment face and the anchor, 15 inches to either side of the anchor, 14 inches in front of the anchor bolts, and 78 inches above the anchor (see Figure 1). Also, in accordance with ACI 318, Appendix D, anchors positioned in groups shall have a minimum center–to–center spacing of six times the diameter of the anchor.

Finally, holes more than 1/4" larger in diameter than the proposed anchors are considered oversized. Oversized holes may result in shear forces being distributed unevenly amongst anchors. Oversized holes are permitted if this uneven shear distribution is considered in the engineering analysis and qualification.

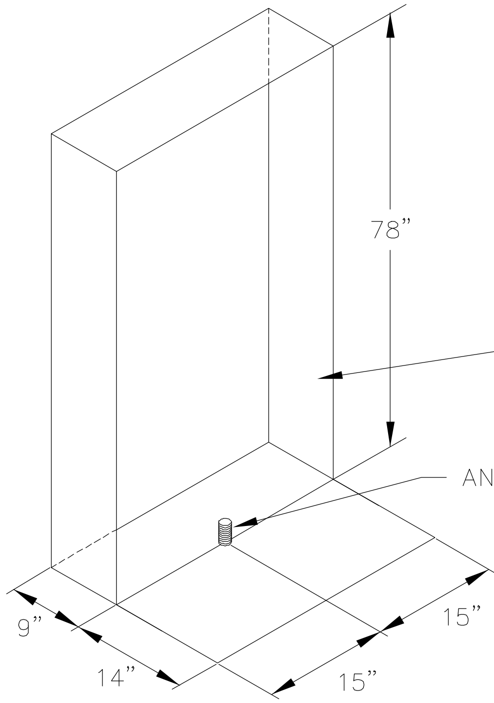

Figure 1 – Anchor Clearance Zone

4.5 Required Documentation

- Documentation for seismic qualification shall be prepared per IEEE 693 Annex S and Annex T for analysis and test reports.
- If the qualification is by analysis, the report shall be submitted on a mutually-agreed-upon date after the award of contract.
- If the qualification is by testing, the test plan and test report shall be submitted on a mutually-agreed-upon date.
- Documentation for the wind and ice calculations shall be submitted on the same date as the final seismic report.
- Calculations for anchorage design shall be included.
- Drawings shall indicate the maximum forces at each anchorage location (tension, shear, compression).
- Drawings shall indicate forces to be used for designing foundations (shear, overturning moments, axial forces).
- All calculations, test results and drawings shall be checked, stamped and signed by a Professional Engineer licensed in the United States.

4.6 Copies of Wind, Ice and Seismic Analyses

The supplier shall furnish one hard copy and two PDF copies (on two CDs) of the analyses of wind and ice loading and seismic effect, including all calculations and drawings. Copies shall be sent with equipment approval drawings.

5 Issuing Department

The T &D Standards Engineering Documentation Department of PacifiCorp is responsible for issuing this material specification. Comments and suggestions are welcome. Submit comments or requests for additional copies of this document to:

PacifiCorp T & D Standards Engineering Documentation
825 NE Multnomah St., Suite 1600, Portland, OR 97232
telephone: (503) 813-5293; fax: (503) 813-6804

Technical questions regarding this material specification may be submitted to:

PacifiCorp T & D Standards Engineering
825 NE Multnomah St., Suite 1600, Portland, OR 97232
telephone: (503) 813-6883; fax: (503) 813–6804

Contaminated-Environment Protection

1 Scope

This material specification states the requirements for contaminated-environment protection of substation equipment to be purchased by PacifiCorp.

2 Applicable Documents

The following publications shall be used in conjunction with this material specification and form a part of this material specification to the extent specified herein. When a referenced publication is superseded by an approved revision, the revision shall apply.

2.1 Industry Publications

Referenced industry publications include:

ANSI/NFPA 70, *National Electrical Code*

ASTM B 117, *Standard Method of Salt Spray (Fog) Testing*

ASTM D 1654, *Standard Method of Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments*

ASTM D 2247, *Standard Method for Testing Coated Metal Specimens at 100% Relative Humidity*

ASTM D 2794, *Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)*

ASTM D 3359, *Standard Methods for Measuring Adhesion by Tape Test*

ASTM G 53, *Standard Recommended Practice for Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials*

3 General

3.1 Application Information

This material specification states the general requirements for contaminated-environment protection of substation equipment. The equipment-specific requirements, which may vary depending on the particular equipment and application, shall be stated in the purchase order. This material specification must accompany the PacifiCorp material specification for specific substation equipment identified in the purchase order. The purchase order shall specify whether the equipment shall be designed to withstand a marine or sulfur–contaminated environment.

3.2 Authorized Material Specification

This material specification is not considered valid until each page contains the approval signature (or initials) of the persons named in the title blocks.

4 General Contaminated-Environment Protection Requirements

4.1 Codes and Standards

Except as required otherwise by this material specification, the general contaminated–environment protection requirements shall be in accordance with the latest applicable industry codes, including ANSI, IEEE, and NEMA standards, as well as any PacifiCorp Construction Standards and Material Specifications in effect on the date of invitation to bid.

4.2 Bushing and Insulator Creep Distance

Unless checked (✓) below, a heavy contamination level of 44 mm/kV per IEEE C57.19.100, based on nominal line-to-ground kV, shall be the minimum bushing and insulator creep distance.

Extra Heavy Contamination (54 mm/kV or greater per IEEE C57.19.100) . . . . ❑

4.3 Accessory Compartment(s)

Control compartment and other accessory compartment(s) shall be NEMA 4X (instead of the specified 3R).

4.4 Corrosion Resistance of Exposed Metal Parts

4.4.1 Required Metals and Coatings

All exposed, bronze and copper parts shall be galvanized, or plated with tin or cadmium to a minimum plating thickness of 0.001 inch. All other exposed, unpainted metal parts shall be aluminum, stainless steel, or galvanized steel. All exposed, painted metal parts shall have a minimum total coating thickness of 5 mils.

4.4.2 Additional Requirements for Painted Parts

To verify the capability of the paint coating to withstand corrosive environments, the supplier shall certify that painted test specimens have passed the tests specified in sections 4.4.2.1 through 4.4.2.3 of this document.

4.4.2.1 Marine or Sulfur Environment Tests

For either marine or sulfur environment, applicable tests shall include the following:

1. ASTM D 2247, Humidity Test: 1000 hours with no blisters
2. ASTM D 2794, Impact Test:
    a. 2 inch-pound reverse impact, without cracking or losing adhesion

b. 160 inch-pound direct impact, without cracking or losing adhesion

3. ASTM D 3359, Adhesion Test: no peeling or removal
4. ASTM G 53, Light and Condensation Test: 500 hours with no more than 50% loss of gloss

4.4.2.2 Salt Spray Test

If suitability for marine environment is specified in the purchase order, painted test specimens shall also pass ASTM B 117, Salt Spray Test, for a minimum of 1000 hours with the following results:

1. For an unscribed specimen, there shall be no blisters or corrosion of specimen.
2. For a scribed specimen, loss of adhesion shall not be more than 1/8 inch from scribe, and the underfilm corrosion shall not be more than 1/16 inch from scribe.

4.4.2.3 High Sulfur Environment Protection

If suitability for sulfur environment is specified in the purchase order, manufacturer shall submit documentation showing corrosion resistance of all exposed materials used in the equipment to be reviewed and approved by PacifiCorp.

Exposed metal not suitable for a sulfur environment shall be protected using a sulfur-resistant epoxy coating. Manufacturer shall submit their proposed coating and coating-application system in writing to be approved by PacifiCorp.

5 Issuing Department

The T &D Standards Engineering Documentation Department of PacifiCorp is responsible for issuing this material specification. Comments and suggestions are welcome. Submit comments or requests for additional copies of this document to:

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PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY
Engineering Handbook

6B.5—Fence Application and Construction

Standards Engineering Documentation

Date: 17 Apr 08

Contents

FIGURES PAGE

TABLE PAGE

TABLE PAGE

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6B.5—Fence Application and Construction

1 Scope

This standard covers the construction requirements for permanent fencing around PacifiCorp substations or substation equipment. This standard shall also be used as an attachment to construction contracts for fence installation. The design considerations covered by this fencing application and construction standard are as follows:

1. Fence safety clearances
2. Curbed fence installations
3. Fence isolation
4. Removable fence subsection
5. Fence relocation

2 References

ANSI/IEEE C2-1987, *National Electrical Safety Code*

ANSI/IEEE 1119-1988, *Guide for Fence Safety Clearances in Electric-Supply Stations*

ASTM A90-1981, *Standard Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles* (Reaff 1991)

ASTM A121 E1-1986, *Standard Specification for Zinc-Coated (Galvanized) Steel Barbed Wire*

ASTM A392, Rev B-1991, *Standard Specifications for Zinc-Coated Steel Chain-Link Fence Fabric*

ASTM A446/A446M-1991, *Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality*

ASTM A569/A569M Rev A-1991, *Standard Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip Commercial Quality*

ASTM A824-1991, *Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence*

ASTM F626-1990, *Standard Specification for Fence Fittings*

ASTM F669-1991, *Standard Specifications for Strength Requirements of Metal Post and Rails for Industrial Chain Link Fence*

ASTM F1083-1991, *Standard Specifications for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures*

ASTM F1234 Rev A-1990, *Standard Specification for Protective Coatings on Steel Framework for Fences*

PacifiCorp Construction Standard SF 001, *Substation Grounding*

3 General

Fences are required to be installed around electrical equipment to minimize the possibility of entrance by unauthorized persons. This requirement includes platform mounted transformers and regulators which do not meet above ground equipment clearances.

3.1 Compliance with NESC

The construction of the fence must comply with NESC. This fencing standard is divided into the following subsections:

1. Fence Construction Standard
2. Fence Material Specifications
3. Fence Isolation Sections
4. Removable Fence Section
5. Curbed Fence Standards
6. Fence Safety Clearances
7. Fence Relocation

3.2 Grounding Requirements

Fences installed at electrical facilities typically must be grounded. All fencing shall be installed per 6B.6, Substation Grounding.

3.3 Locked Entrance

Entrances through fences not under observation of an authorized attendant shall be kept locked.

3.4 Isolation of Fences

PacifiCorp substation fences shall not be connected to any other fence. See subsection 6, *Fence Isolation Sections*, for additional information.

3.5 Clearances from Structures

The minimum distance that the fence should be installed from any substation structure supporting a live part shall be based on section 9 of this standard. Any objects inside or outside the substation should not be located within a restricted zone. The minimum restricted zone shall be ±5 feet wide and 16 feet high; see Figure 10. If the minimum 5 feet distance cannot be met, measures should be taken to prevent the likelihood of a person using the object to gain access to the substation. The restricted zone outside the substation fence may be used for the planting of screening vegetation, as long as it is not climbable by a person.

3.6 Curbing at Fence Line

Curbing at the fence line should be installed around new substations that are being constructed in residential areas. The purpose of the curbed fences is to prevent entrance under substation fences. Curbing at the fence line can also be installed to provide oil containment in rural areas if cost effective (see subsection 8, *Curbed Fence Standards*).

4 Fence Construction

The fence shall be constructed of chain link and shall be installed in strict compliance with furnished plans and these standards. Installation shall use good workmanship by skilled craftsmen, experienced in erection of this type of fencing. The fence shall be erected on the lines and to the grade as provided by PacifiCorp. For more detail refer to Figure 3 through Figure 6 of this guideline.

4.1 Post Spacing Location and Selection

Posts shall be spaced not more than 10 feet on centers in the line of the fence (adjust to even spaces). They shall be plumb with tops properly graded and aligned. Corner posts shall be located at all angles of 20° or greater. Pull posts shall be placed not over 1500 feet apart in each line of fence or when a grade change of more than 20° (slope ratio of 10 to 3.5) occurs.

4.2 Fence and Barbed Wire Height

Fence shall stand eight feet above grade with a fabric height of 7 feet and 3 strands of barbed wire 1 foot high on brackets 45° outbound.

4.3 Excavation and Concrete Work

Curbs and all foundations for posts and gate catches shall be concrete with the top 6 inches formed. Minimum concrete dimensions appear on Figure 3 and Figure 5 of this standard.

4.3.1 Concrete Mix

Ready mix concrete shall have a minimum 28 day compressive strength of 3000 psi, maximum slump of 4 inches, air content of 4.5% to 7.5%, and water to cement ratio at time of placement of 5.3:10 by weight. Site mixed concrete shall be a 1:2:3 mix (1 cement, 2 sand, and 3 gravel). Maximum slump for site mixed concrete shall be 4 inches.

4.3.2 Finish

The top exposed surface of the concrete shall be crowned to shed water and troweled smooth. Top of concrete shall be formed in line with sides of hole to avoid ”mushrooming” of the concrete. Top of exposed surface of concrete shall be crowned 1 inch above subgrade.

4.3.3 Installation in Rocky Ground

Where solid rock is encountered, a hole 2 inches larger than the post diameter may be drilled and the post grouted into the hole with a fine mix of concrete. Minimum depth of holes in solid rock shall be 12 inches for line posts and 18 inches for end, corner, gate, and pull posts. Where solid rock is covered with an overburden of soil, the posts shall be set in the solid rock to the depth as listed above and the upper portion of the hole shall be completed as a standard concrete footing.

4.4 Extension Arms and Barbed Wire

All extension arms shall be firmly seated on the top of the posts with the blade portion of the arm slanting outward at 45°. Three strands of barbed wire shall be installed with sufficient tension to maintain tautness during temperature changes and shall be securely fastened to extension arms.

4.5 Top Rail

The top rail shall pass through the base of the line post tops and shall be securely fastened to terminal posts. Every fifth coupling in sections 100 feet or longer shall have an internal spring to compensate for contraction and expansion.

4.6 Bracing

Braces shall be installed midway between the grade line and the top rail on all corner, pull, terminal, and gate posts. Bracing shall extend from these brace posts to the adjacent line posts, and diagonally trussed from its line post end back to the base of these posts. The 3/8-inch diameter truss rod shall be tensioned properly.

4.7 Tension Wire

The tension wire shall be installed with sufficient tension to maintain tautness during temperature changes and installed at 2 inches above finish grade. It shall be secured to the fabic and each line post, and terminated at each corner, gate, terminal, and pull posts.

4.8 Fabric

The fabric shall be installed only after the concrete has sufficiently cured (normally 7 days after placing), and all framework and braces have been installed. The fabric shall be stretched taut with its lower edge 1.5 inches above rough grade or subgrade. Panels of fabric shall be stretched between all terminal posts and terminated on stretcher bars which are held by fabric bands spaced not to exceed 15 inches. Portions of fabric shall be attached to the fence structure with the galvanized fastening types and maximum spacings specified below:

1. Top of fabric to top rail: Wire ties #9 gauge galvanized steel, 24-inch spacing
2. Center of fabric to bracing: Wire ties #9 gauge galvanized steel, 18-inch spacing
3. Width of fabric to line posts: Wire ties #9 gauge galvanized steel, 15-inch spacing
4. Bottom of fabric to tension: Wire ties or #11 gauge galvanized steel wire hog rings, 24-inch spacing

4.9 Gates

The normal drive gate should be a double-swing 24-foot 0-inch gate. A 4-foot 0-inch walk gate should also be installed, at a convenient location, but not as a part of the drive gate. Gates shall be erected so as to provide free and easy operation. Gate posts will not be used as corner posts for gates, nor located closer than 10 feet from a corner. However, gate posts may be used as corner posts for removable fence sections, if necessary (see subsection 7, Removable Fence Section). Braces shall be installed on each side of all gates. The top of the gate frame and the barbed wire shall be aligned vertically. Horizontal brackets and 2 strands of barbed wire shall be mounted as shown on Figure 3 so as to clear the gate posts. The lower edge of the bottom rail shall be no more than 2 inches above finished grade.

4.10 Warning Signs

Warning signs shall be placed on all gates and sides of fences with the distance between signs not to exceed 150 feet. The "Danger—High Voltage" sign shall be placed at eye level, 5 feet above ground level. The "No Trespassing" sign shall be placed immediately below it. Approved signs are listed below:

- Danger—High Voltage: SI# 7992686. For Spanish use: SI# 7992687.
- No Trespassing: SI# 8252306.

4.11 Inward-Opening Gate

In substations where there is limited property, such that the ground grid cannot be extended 3 feet out from the gate swing radius, the gate shall be limited to opening inward only, with gate catches installed as shown in Figure 1. Gates so designated shall be equipped with 180° hinges to restrict gate opening.

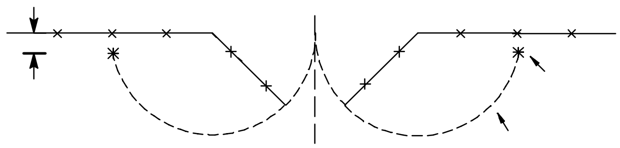


Figure 1 – Inward Gate Swing

In substations where the ground grid has been extended outside the gate swing radius, gate catches shall be installed as shown in Figure 2.

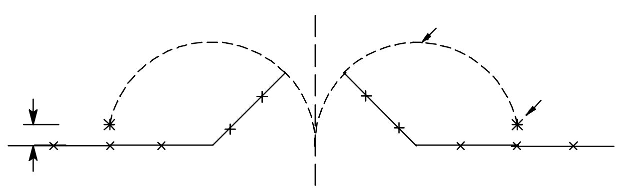


Figure 2 – Outward Gate Swing

4.12 Cleanup

Pieces of fencing or other scrap materials shall be removed. Dirt from excavations and left over concrete shall be removed or deposited as instructed by PacifiCorp representative and the area shall be left clean and orderly.

*See subsection E for material requirements, post and framework dimensions. These vary depending on steel type and usage (see Table 1).

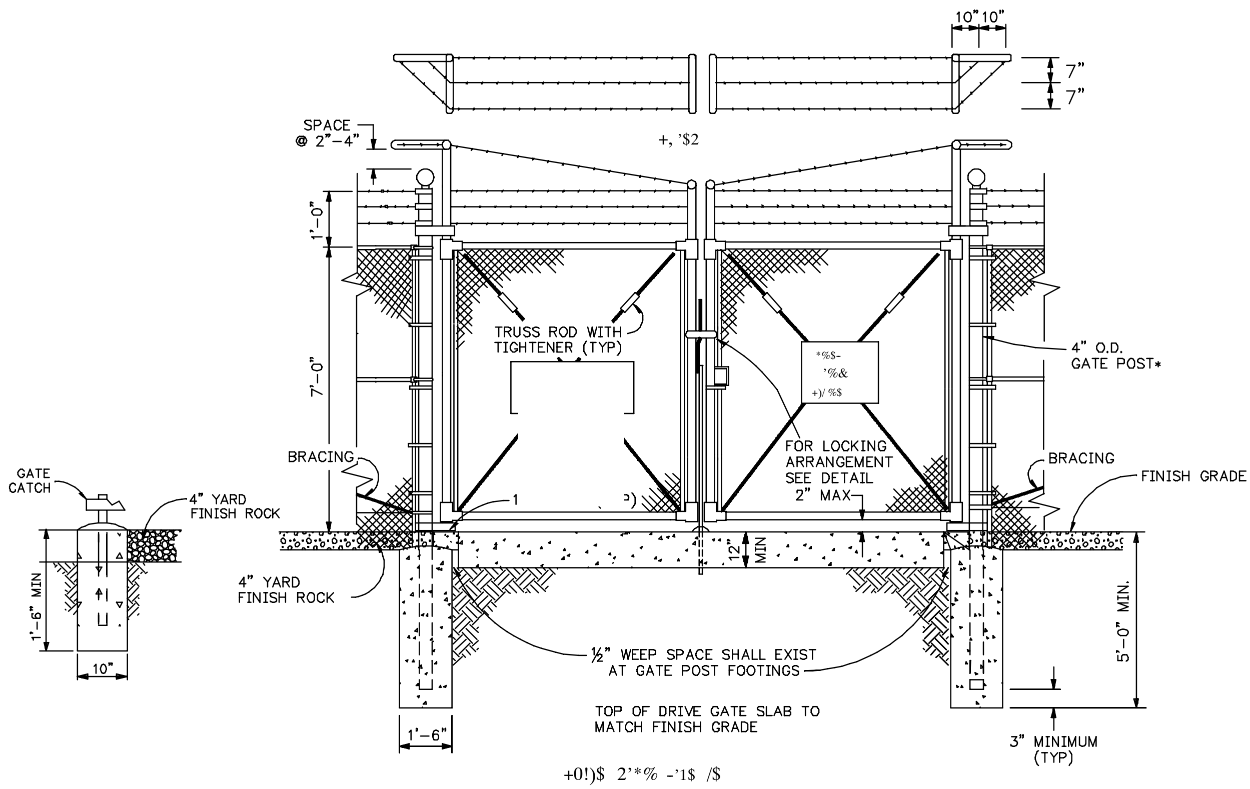


Figure 3 – Standard Gate Construction

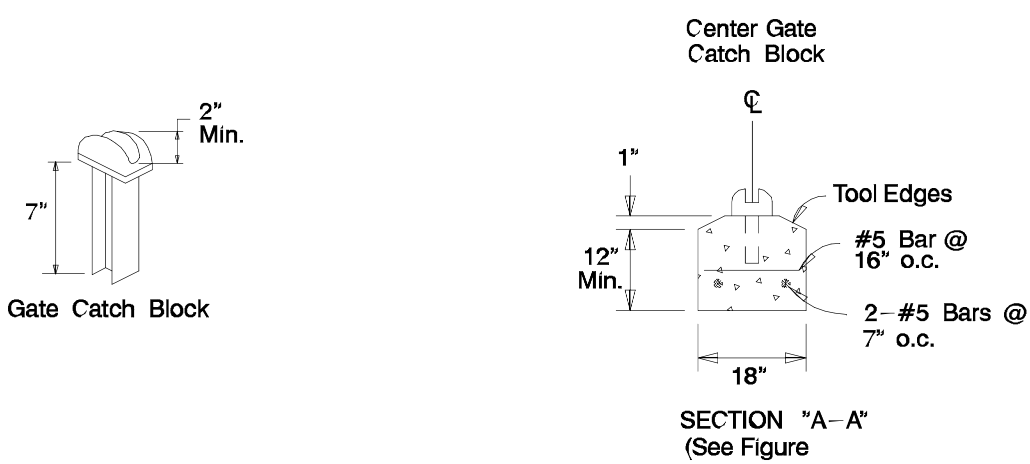


Figure 4 – Gate Catch Details

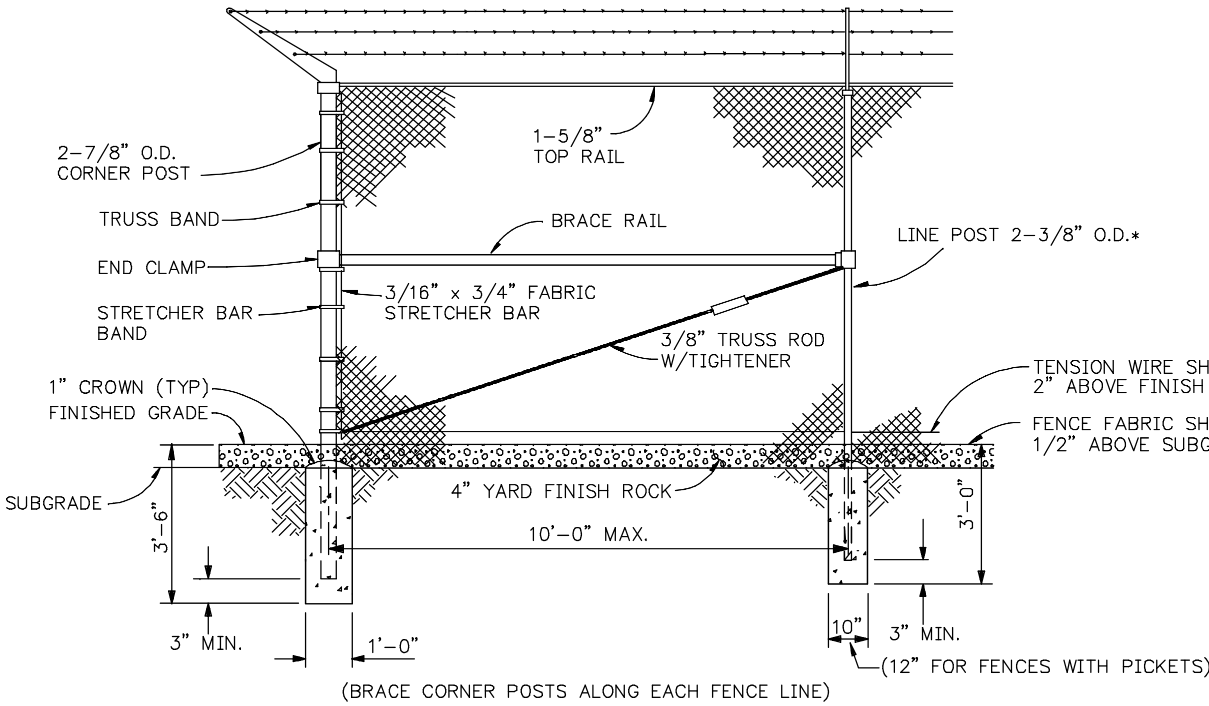


Figure 5 – Standard Fence Corner Construction

*See subsection E for material requirements, post and framework dimensions. These vary depending on steel type and usage (see Table 1).

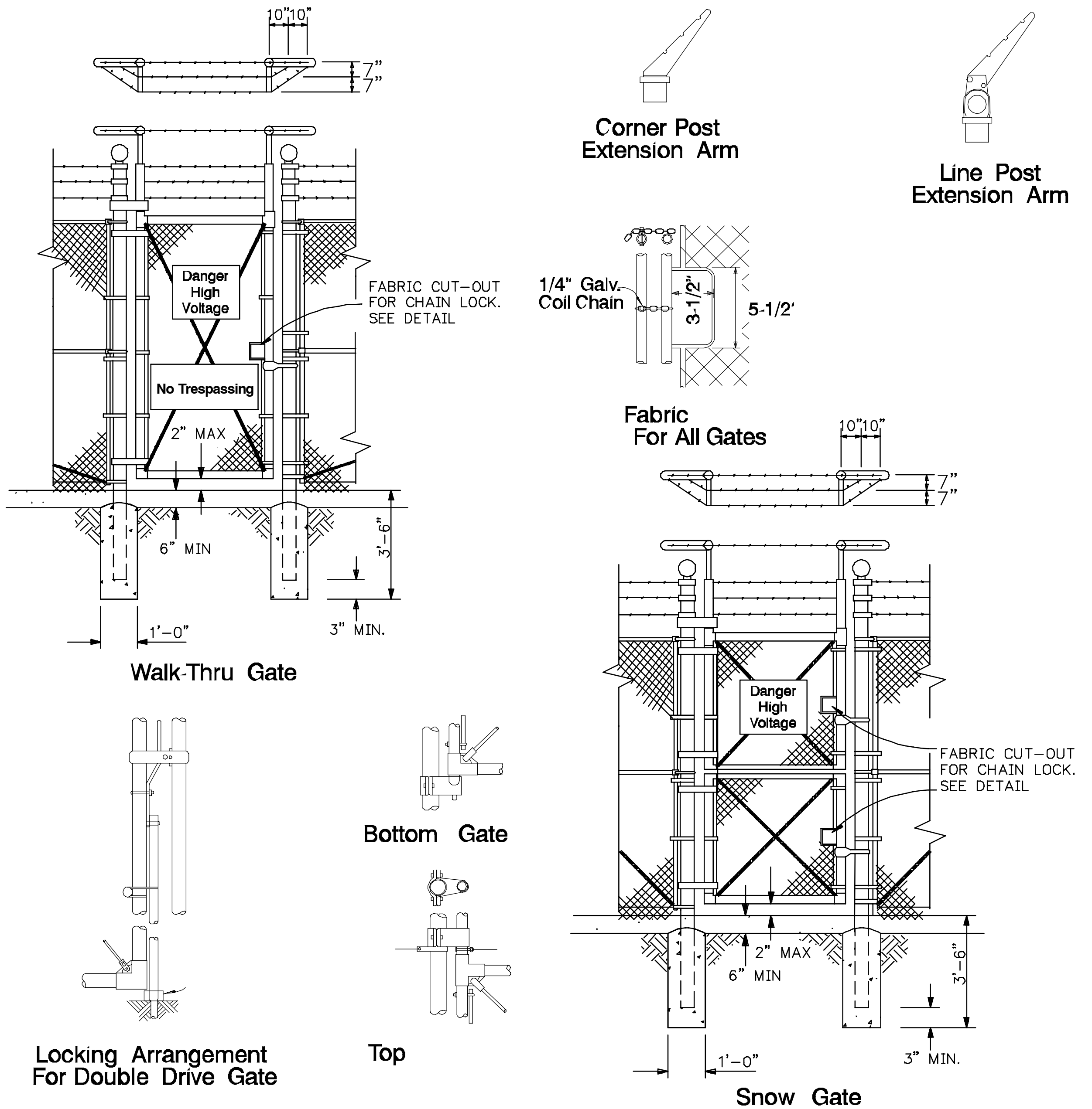


Figure 6 – Standard Fence and Gate Construction Details

5 Fence Material Specifications

5.1 Fabric

Fence fabric shall be 7 feet and shall conform to ASTM A392 latest revision. Fabric shall be made from #9 galvanized wire helically wound and interwoven into a 2-inch diamond mesh with twisted and barbed selvage at top and bottom. Minimum tensile strength of the wire shall be 90000 psi before zinc coating and 80000 psi after zinc coating. Wire shall be galvanized with a minimum weight of 1.20 ounces of zinc per square foot of uncoated wire surface. Fabric shall withstand a test of galvanizing according to ASTM A90 latest revision.

5.2 Framework

Post and framework dimensions may vary depending on steel type and application (see Table 1 for details). Fence frame work shall conform to ASTM F669. Framework shall be group IA, group IC, or group II, as defined below. Size tolerances shall be ± 5% on weights. Lengths shall be sufficient for depth of required concrete embedment and barbed wire attachment. Use of rerolled, regalvanized or open seam posts or rails is not allowed.

Group IA pipe shall have 1.8 oz minimum hot-dipped zinc per square foot of surface. Schedule 40 pipe shall conform to ASTM F1083.

Group IC pipe shall be made from steel complying with ASTM A446 grade D or ASTM A569 with minimum yield strength of 50 000 psi. The pipe exterior shall conform to ASTM F1234, type B hot-dipped galvanized, 0.9 oz minimum hot-dipped zinc per square foot of surface. The exterior chromate coating shall be 30 ±15 micrograms per square inch and polymer coating shall be 0.5 ±0.2 mils thick. The interior shall conform to ASTM F1234, type B hot-dip galvanized 0.9 oz per square foot zinc.

Table 2 – Fencing Framework Sizes

Description	Size (Diameter)	Weight (lb/ft)
Line Posts (without pickets)		
Group IA	2 3/8”	3.65
Group IC	2 3/8”	3.12
Line Posts (with pickets)		
Group IA	4”	9.10
Group IC	2 7/8”	4.64
Terminal Post—End, Corner & Pull Posts (without pickets)		
Group IA	2 7/8”	5.79
Group IC	2 7/8”	4.64
Terminal Post—End, Corner & Pull Posts (with pickets)		
Group IA	4”	9.10
Group IC	2 7/8”	4.64
Top Rails and Braces (with or without pickets)		
Group IA	1 5/8”	2.27
	1 5/8”	1.84
Gate Frames (with or without pickets)		
Group IA	1 7/8”	2.72
Group IC	1 7/8”	2.28
Gate Posts, for Nominal Width of Gate Leaf (with or without pickets)		
5 feet and less		
Group IA	2 7/8”	5.79
Group IC	2 7/8”	4.64
6—12 feet		
Group IA	4”	9.10
Group IC	4”	6.56

5.3 Fittings

All fence fitting shall comply with ASTM F626. Fittings shall be from malleable or pressed steel. No aluminum fittings are allowed.

5.3.1 Post Tops

All intermediate or line posts shall be fitted with 45° barbed wire support arms with wire positioned outside the fence. Arms shall be 14 gauge pressed steel or malleable iron designed to hold the top rail and three strands of barbed wire with the top strand located 12 inches above the fabric. Arms having projections to be bent down over barbed wire may not be used. Tubular posts shall be equipped with tops designed to exclude moisture from the posts.

5.3.2 Rail and Brace Ends

Rail and brace ends shall be provided where top and brace rails are required. Rail and brace ends shall be fabricated from pressed steel or cast iron and shall be galvanized.

Top rail sleeves shall be fabricated from pressed steel, 0.051-inch wall thickness, and galvanized. Sleeves shall be not less than 6 inches long with expansion sleeves provided at every fifth sleeve.

5.3.3 Tie Wires

Tie wires shall be 9 gauge, galvanized steel, class 3.

5.3.4 Hog Rings

Hog rings shall be 11 gauge galvanized steel, class 3.

5.3.5 Fabric Stretcher Bars

Fabric stretcher bars shall be 3/4 inch wide and 1/4 inch thick, minimum.

5.3.6 Tension, Brace, and Top Rail Band

Tension, brace, and top rail bands shall be 1 inch wide and 1/8 inch thick, minimum.

5.3.7 Bolts, Nuts, Truss, and Turnbuckles

Bolts, nuts, truss, and turnbuckles shall be 3/8-inch, minimum, galvanized steel.

5.3.8 Gate Fittings

Corners, padlock fittings, hinges and latches shall be of heavy malleable castings or pressed steel. hinges shall be of ball and socket type. Hinges which pivot on pins and bolts are not acceptable. Gate stops and catches for each leaf of drive gates will be furnished and installed.

5.3.9 Barbed Wire

Barbed Wire: Barbed wire shall be made of two strands of galvanized twisted 12 1/2 gauge carbon steel wire per ASTM A121, class III. Barbs shall be four-point pattern on approximately 5-inch centers. Barbs shall be 14 gauge carbon steel wire. Aluminum alloy 5052-H38 may be substituted in lieu of carbon steel wire.

5.3.10 Tension Wire

Tension Wire: Tension wire shall be #7 gauge spring coil wire with type II, class 2 galvanized coating per ASTM A824, latest revision.

5.4 Pickets

Pickets shall be manufactured from virgin high-density polyethylene and shall be unaffected by prolonged exposure to ultraviolet light. The picket system shall include means to lock pickets in place. Pickets shall be sized for 2-inch diamond mesh fabric as called for in subsection 55.1. Use of factory installed pickets with a 3-inch by 5-inch diamond mesh fabric is not allowed unless approved by PacifiCorp.

6 Fence Isolation Sections

When a PacifiCorp substation fence is to be adjacent to any other fence, the intermediate section of fence must isolate the two sections of fence as shown in Figure 7.

6.1 Existing Terminal Post

The existing customer's terminal post must be extended to the height of the company's fence. A barb wire barrier may need to be constructed to insure that barbed wire extends to the top of the terminal post.

6.2 Insulation From the Isolation Section Of Fence

This isolated section of fence shall be completely insulated from the grounding system.

6.3 Terminal Post

The terminal posts of the isolated fence section shall be grouted in 6-inch PVC conduit type EB after PVC is placed in cement footings. PVC end caps shall be placed at the bottom of the conduit.

6.4 Additional Information

For further information about isolating a fence section, contact the Substation Engineering Department.

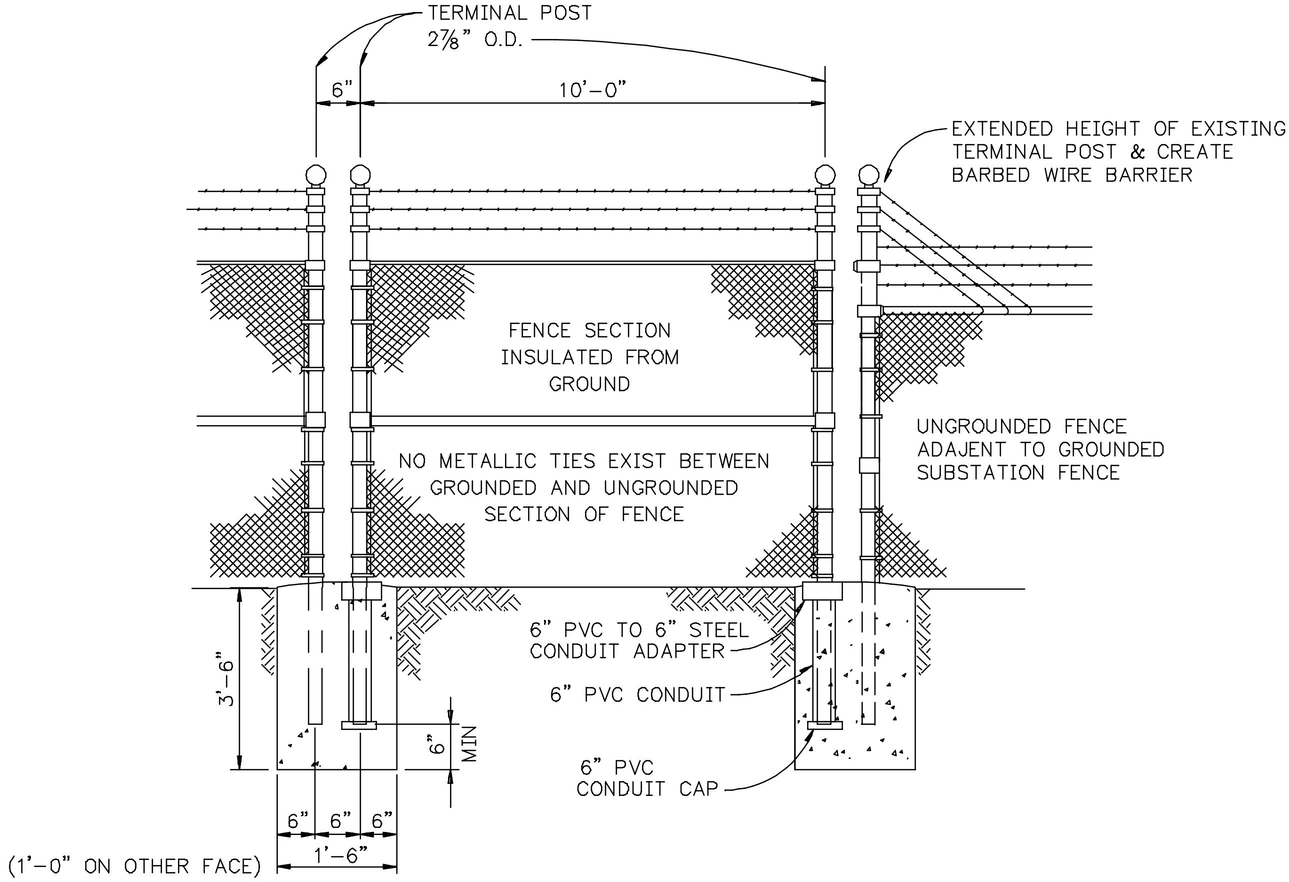


Figure 7 – Insulated Fence Panel

7 Removable Fence Section

A removable fence section may be required in substations with limited property to facilitate the removal of station equipment. A gate should be installed instead of a removal section, if possible. The removable section shall be constructed as shown in Figure 8 and per material specifications detailed in subsection 5, *Fence Material Specifications*. Gate posts are used for removable fence sections, which may be located at a corner (see 4.9).

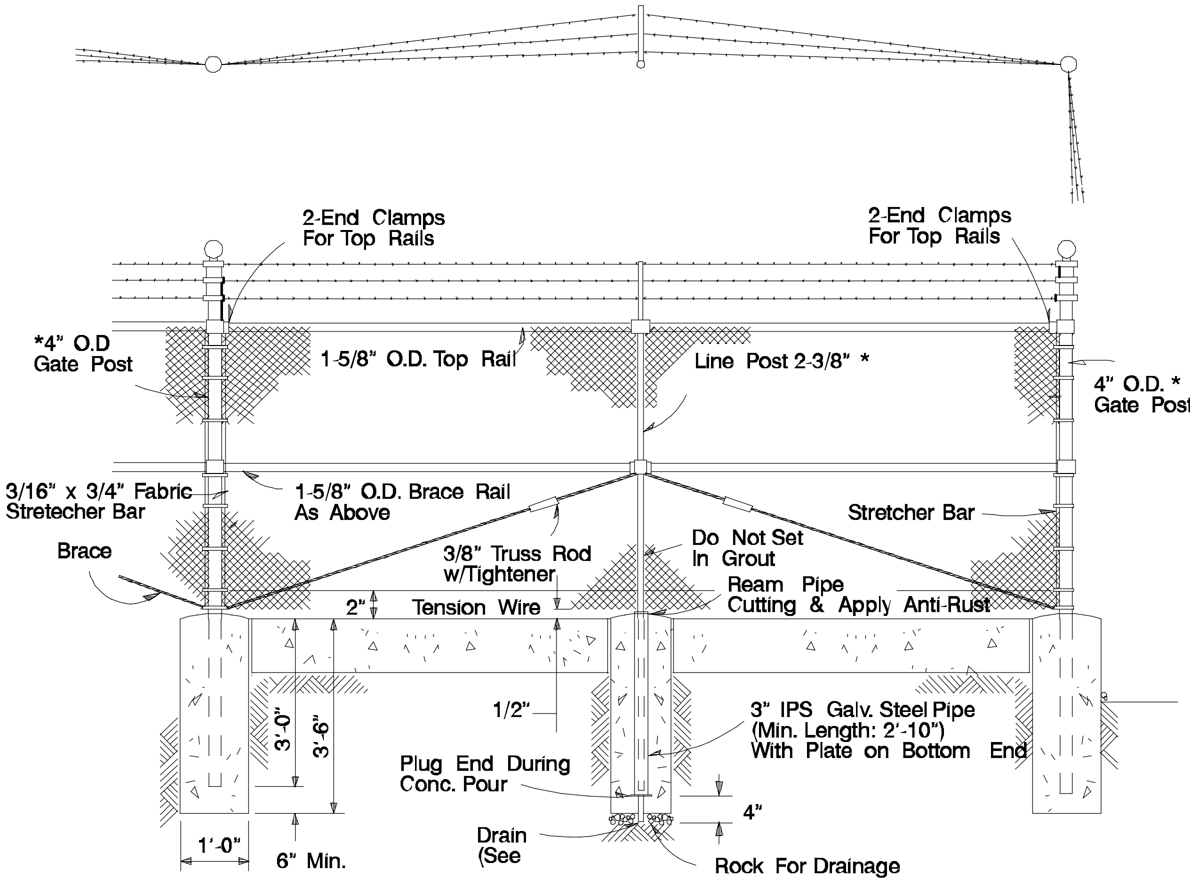


Figure 8 – Removable Fence Section, 16-foot

*See subsection 5 for material requirements for fences with pickets.

8 Curbed Fence Standards

Curbed fences shall be installed in strict compliance with furnished plans and PacifiCorp standards. Curbed fences shall only be installed in substations located in urban residential areas or in substations where curbing the perimeter is the most cost effective way to install oil containment. A minimum of a 6-inch x 6-inch concrete curb shall be installed, except at drive gate locations. Curbing shall be installed so top of concrete is flush, or slightly above finish rock surface. The fence fabric shall be 1/2 inches above top of concrete and tension wire shall be 2 inches above top of concrete. Refer to Figure 9 for details for a curbed fence. Fence material specifications are specified in subsection 5, *Fence Material Specifications.* If curbing is used for oil containment, the expansion joint material should be used in the weep space.

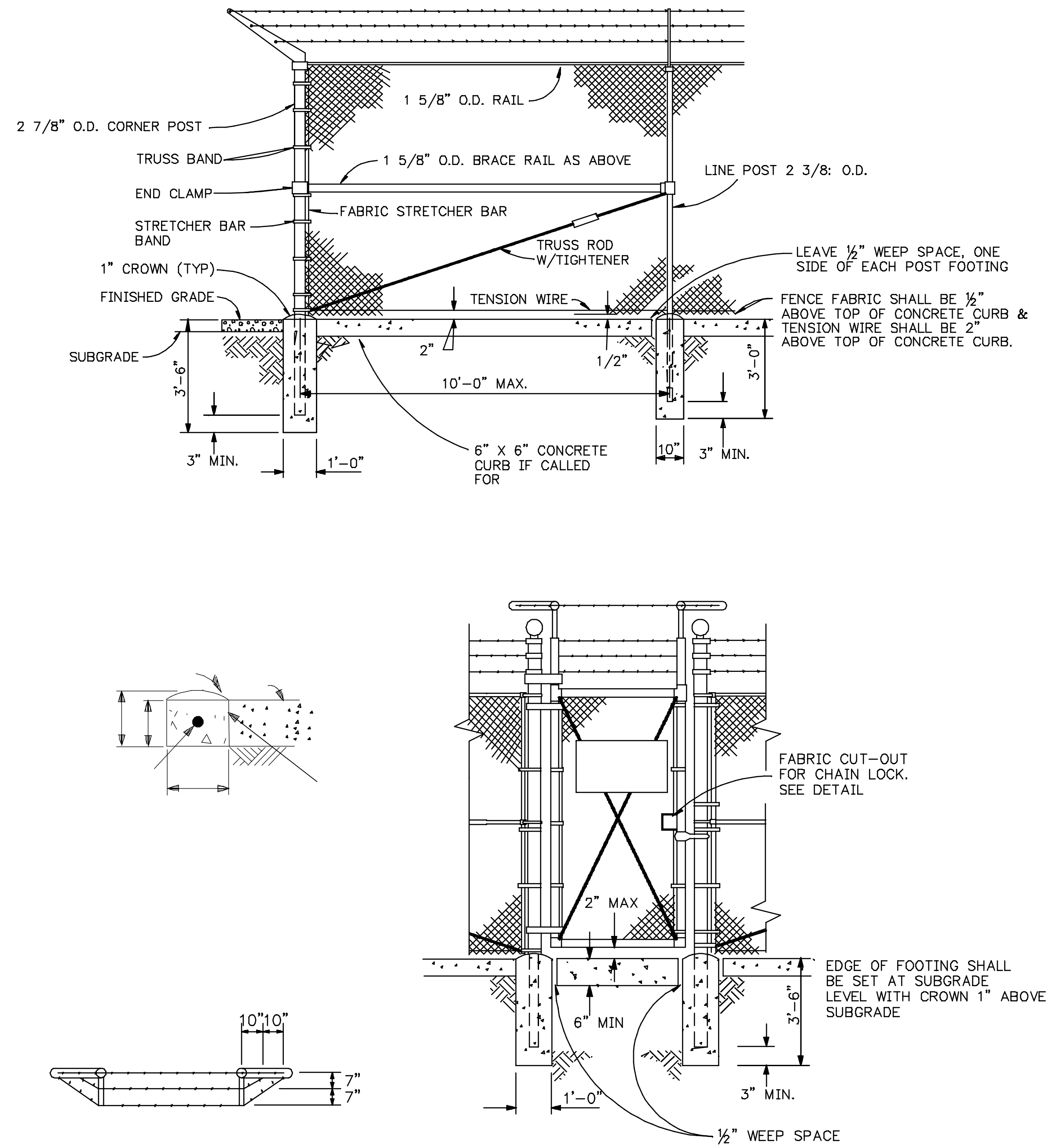


Figure 9 – Curbed Fence Standard

9 Fence Safety Clearances

Table 2 and Table 3, respectively, show safety and operating clearance zones that should be maintained when designing the substation fence location. This safety zone is designed to prevent contact with live parts by a person inserting an object through the substation fence. The fence should be located such that all live parts are outside the safety zone. The operating clearance zone is designed to allow adequate room between the fence and equipment for operation and maintenance purposes. The most stringent of the two requirements shall govern when designing the fence location. See Figure 10 for an example of a 12.5 kV substation.

Table 3 – Fence Safety Clearances
(Dimensions for use with Figure 10)

Nominal Voltage (between phases)	Dimensions “A” (Vertical)		Dimension “B” (Horizontal)	
(volts)	(feet)	(meters)	(feet)	(meters)
151–34500	15.0	4.6	10.0	3.1
46000–69000	16.0	4.9	12.0	3.7
115000	16.7	5.1	13.0	4.0
138000	17.1	5.2	14.0	4.3
161000	17.6	5.4	14.0	4.3
230000	19.0	5.8	16.0	4.0
345000	21.3	6.5	18.0	5.5
500000	24.9	7.6	21.0	6.4

Table 4 – Fence Operating Clearances
(Dimensions for use with Figure 10)

Equipment Type	Dimension “B” (Horizontal)
Fuse Structure of Disconnect Switches	20 feet
Operation Handles of Airbreak Switches	15 feet
Structures where there is no equipment	10 feet

NOTES:

1. Dimension A is equal to the vertical clearance of wires, conductors, and cables above spaces and ways subject to pedestrians or restricted traffic only (ANSI C2–1987 [1], rules 232A and 232B, and table 232–1, 5) for the voltage considered.
2. The B dimension was established after considering the horizontal clearance of unguarded live parts in electric–supply stations (ANSI C2–1987 [1], rule 124 A and table 124–1), plus

the effective length of a rod or pole that could be inserted through the electric-supply station fence. The horizontal clearances used for the extra-high voltages are based on BIL factors fence. (ANSI C2-1987 [1], table 124-1, part C).

3. The values shown for dimension A for nominal voltages between phases of 115 kV and above should be increased 3% for each 1000 feet (300 m) in excess of 3300 feet (1000 m) above mean sea level.

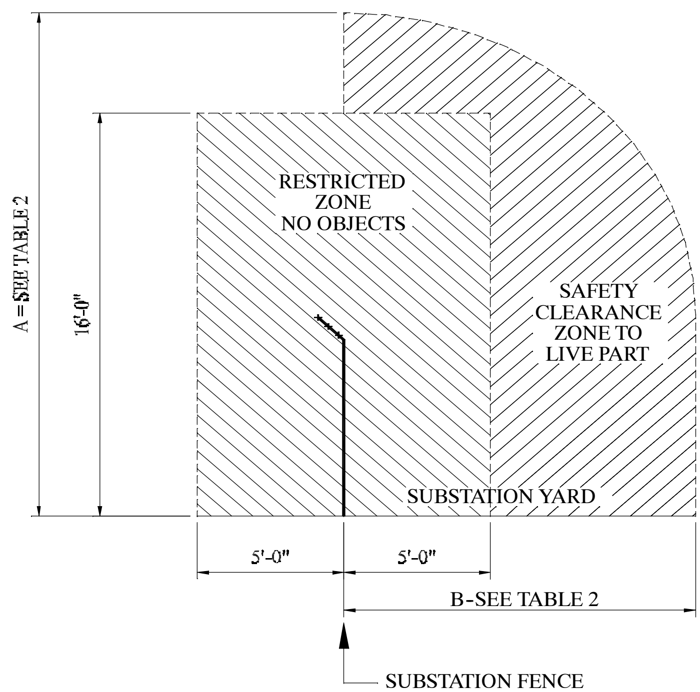


Figure 10 – Safety Clearance for Substation Fence

10 Fence Relocation

10.1 Expansion of Substations

When so specified in the contract documents, portions of an existing fence shall be removed and relocated (only if existing fence meets current 8-foot 0-inch height requirements), in accordance with these specifications and drawings furnished. The following fence materials shall be reused: Fabric, bracing and top railing. Reused fence materials shall be removed and handled with care so as not to damage them. New bottom tension wire must be installed and fence posts shall not be reused. All fence materials which are not rein-stalled shall be returned to the nearest PacifiCorp warehouse unless stated differently in contract.

When relocating an existing fence, the contractor shall coordinate the work so that security is maintained at all times.

10.2 New Fence to Existing Fence

When enlarging a substation by installing a new fence to an existing substation, the new fence shall meet the current fence height standard of 8 feet 0 inches (including barb wire). Figure 11 shows how to join the unequal height fence sections.

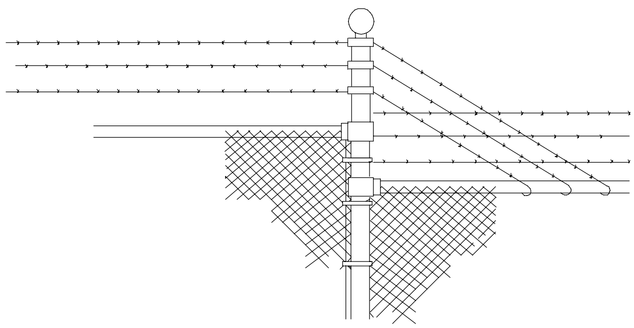


Figure 11 – Joint Unequal Height Fence Section

11 Handbook Issuing Department

The Asset Management Document Services Department of PacifiCorp is responsible for issuing this document. Comments and suggestions are welcome. Additional copies may be obtained from:

Asset Management Document Services, Lloyd Center Tower
825 NE Multnomah St., Suite 1600, Portland, Oregon 97232
Telephone: (503) 813-5293 Fax: (503) 813-6804

Technical questions regarding the content of this document may be directed to PacifiCorp Standards Engineering, (503) 813-6883. Publication and use of this document is authorized by the Manager of Standards Engineering when the block below has been signed.

Approved: ______________________________
Sikhiu Huynh, Engineer
Technology Development

Approved: ______________________________
Greg Lyons, Manager
Standards Engineering and Technology Development

APPENDIX G

PACIFICORP EQUIPMENT, MATERIAL AND PROCESS SPECIFICATIONS/STANDARDS

PLANT DESIGN

APPENDIX G

PacifiCorp Equipment, Material and Process Specifications/Standards

Plant Design

Specifications/Standards

The following PacifiCorp specifications/standards are included to assist the Contractor in development of the Scope of Work. The Contractor shall be responsible for providing design, procurement and installation of the facilities for the Currant Creek Block 2 Facility in accordance with these specifications/standards and Exhibit A of these documents.

ZS 071 – Control Cable – 600 Volt, Shielded

ZS 072 – Control Cable – 600 Volt, Nonshielded

Protective Relaying Standard – GEN-ENG-RELAY-0001

Arc Flash Hazard Standard – GEN-ENG-RELAY-0002

Piping, Equipment and Valve Labeling Standard – CUR-OPS-ADMIN-002

Infrared Thermography Requirements for Electrical Equipment

New AC Induction Electric motor Specifications

Vibration Analysis and Acceptance Standard

Precision Balance Specification for Rotating Machinery

Precision Alignment Specification-Rotating Machinery Shaft Alignment

Lubrication Standard for New Construction

Data and Voice Network Infrastructure Wiring Guidelines, 8B.3.1

Material Specification

Control Cable—600 Volt, Shielded

Asset Management Department

Date: 29 Sep 06

Contents

Control Cable—600 Volt, Shielded

1 Scope

This specification states the requirements for control cable to be purchased by PacifiCorp for substation applications.

2 Applicable Codes and Standards

The latest revisions of the following documents in effect on the date of invitation to bid apply to the extent specified herein.

American Society for Testing and Materials (ASTM)

ASTM B8, *Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft*

Insulated Cable Engineers Association, Inc. (ICEA)

ICEA T-30-520, *Vertical Cable Tray Flame Tests @ 70 000 Btu*

National Electrical Manufacturers Association (NEMA)

NEMA WC 7, *Cross-Linked-Thermosetting-Polyethylene-Insulated wire and Cable for the Transmission and Distribution of Electrical Energy* (ICEA S-66-524)

NEMA WC 8, *Ethylene-Propylene- Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy* (ICEA S-68-516)

NEMA WC 26, *Wire and Cable Packaging*

Underwriters Laboratories Inc. (UL)

UL 1581, *Reference Standard for Electrical Wires, Cable and Flexible Cords*

3 General

3.1 Application Information

This material specification states both the general requirements for control cable and the cable-specific requirements, which vary depending on installation and intended use (see Section 7). If the cable-specific item description states a different requirement from that specified in the general design and manufacturing requirements, the requirements in Section 7 shall prevail.

3.2 Authorized Material Specification

This material specification is not considered valid until each page contains the approval signature of the persons named in the title blocks, and Section 7 has been completed and approved.

4 Design and Manufacturing Requirements

4.1 Codes and Standards

The control cable specified herein shall be designed, manufactured, and tested in accordance with the latest applicable revisions of NEMA WC 8, except as required otherwise by this specification.

4.2 Cable Type

The control cable supplied shall meet the requirements for NEMA WC 8, 600-volt shielded, outdoor cable, and shall be capable of continuous operation at a conductor temperature of 90 ° C wet or dry.

4.3 Ambient Temperature

The control cable shall be rated for ambient temperature between −40 °C and +49 °C.

4.4 Cable Application

The cable shall be suitable for outdoor use, for direct burial without auxiliary mechanical protection, and for operation under water.

4.5 Conductors

The conductors shall be class C stranded, annealed copper wire with concentric lay in accordance with ASTM B8. If insulation is sulfinated, the conductors shall be protected with a coating of tin, lead or lead alloy. The conductor size shall be as specified in 7.1.

4.6 Insulation

The conductor insulation shall be a tightly fitting, free-stripping, ozone-resistant, homogeneous, ethylene propylene rubber (epr), or cross-linked polyethylene (xlpe) compound. For cross-linked polyethylene, the insulation thickness shall be that listed in NEMA WC 7, table 3-1A, column B (the pertinent information is given in Table 1 of this material specification). For ethylene propylene rubber the insulation thickness shall be that listed in Nema WC 8, table 3−1A, column B (the pertinent information is given in Table 1 of this material specification), and the conductor insulation may be either jacketed (type-I) or unjacketed (type-II).

4.6.1 Type-I

Type-I insulation thickness shall be as specified for this voltage class in NEMA WC 8, section 3.6. Type I insulation shall have a jacket as described in 4.10. The jacket shall not be considered part of the required insulation thickness.

4.6.2 Type-II

Type-II insulation thickness shall be as specified for this voltage class in NEMA WC 8, section 3.7. Type-II insulation shall be colorable, and shall be VW-1 flame-resistant per UL 1581.

Table 1 – Cables—Conductor Sizes and Insulation Thicknesses
(Source: Table 3-1A, WC 7 and Table 3-1A, WC 8)

Rated Circuit Voltage	Conductor Size	Insulation Thickness*	
($V_{Phase-to-Phase}$)†	(AWG or kcmil)‡	(mils)	(mm)
0–600	14–9‡	30	0.76
	8–2	45	1.14
	1–4/0	55	1.40
	225–500	65	1.65
	525–1000	80	2.03
	1025–2000	100	2.54
601–2000	14–9‡	45	1.14
	8–2	55	1.40
	1–4/0	65	1.65
	225–500	75	1.90
	525–1000	90	2.29
	1025–2000	115	2.92

* These insulation thicknesses (2000 volts or less) apply to multiple-conductor cables with an outer covering and to single-conductor cables with an outer covering.

These insulation thicknesses are considered adequate for electrical purposes and may be specified for single-conductor cables employing sunlight-resistant, carbon black pigmented insulation without further covering. These cables may be used in applications where installation and service conditions are such that the additional thickness for mechanical protection is not considered necessary for satisfactory operation.

Insulation thickness in this table is adequate for both 100 percent and 133 percent levels. For 173 percent insulation level, consult the manufacturer.

† The actual operating voltage shall not exceed the rated circuit voltage by more than (a) 5 percent during continuous operation or (b) 10 percent during emergencies lasting not more than 15 minutes.

‡ Single-conductor cables in sizes 9 AWG and smaller shall not be used for direct earth burial.

4.7 Cabling, Belting, and Fillers

Cabling, belting, and fillers shall be composed of nonhygroscopic thermoplastic or rubber materials.

4.8 Cable Shielding

The cable shall be designed to provide good electrostatic shielding, initially and after normal flexing and bending. The cable shall be provided with a helically wrapped, 30% minimum-overlapped, 5 mil or heavier, bare copper tape electrostatic shield.

4.9 Overall Jacket

The complete cable shall be jacketed with chlorinated polyethylene. The jacket thickness shall be as specified in NEMA WC 8, table 7.5–2; and in all cases, the maximum jacket average thickness shall be no more than 10% higher than the specified values to aid in flexibility and installation. The jacket shall be resistant to weathering, sunlight (uv), oils, chemicals, acids, alkalies, flame, and moisture. The jacket shall be black in color.

4.10 Conductor Insulation Jacket (Type-I)

The type-I insulators shall be jacketed either with chlorosulfonated polyethylene meeting NEMA WC 8 section 4.4.10, or chlorinated polyethylene meeting NEMA WC 8 section 4.4.7. The jacket thickness shall be 15 mils, minimum. The jacket shall be resistant to weathering, sunlight (uv), oils, chemicals, acids, alkalies flame, and moisture. The jackets shall be colored in accordance with 4.11.

4.11 Color Coding and Sequence

The insulation or jacketing of the conductors shall be color coded in accordance with NEMA WC 8, appendix K method 1. The color sequence shall be in accordance with NEMA WC 8, table K-2. The supplier shall state in writing that method 1 was used. Color-coding jackets shall meet the requirements of 4.10.

5 Completed Cable Tests

The completed cable shall meet requirements of the tests specified herein.

5.1 Cold Bend Test

The cable shall meet the requirements in NEMA WC 8 section 6.18 table 6.7 at –40 °C with no cracking of the jacket or insulation.

5.2 Heat Shock Test

The cable shall meet the requirements in NEMA WC 8 section 6.16 at 120 °C

5.3 Vertical Flame Test

The cable shall pass ICEA T-30-520 vertical flame test.

6 Preparation for Shipping and Storage

6.1 General

6.1.1 Loss or Damage

The supplier shall prepare the reels of cable to protect them from loss and damage. The supplier shall be responsible for any loss or damage in transit.

6.1.2 Storage

The supplier shall provide instructions for handling, storage (including long-term storage), and periodic inspection and maintenance to assure that deterioration will be minimal during storage. Instructions shall be fastened securely to the shipping unit.

6.2 Reels and Lengths

6.2.1 Reels

Cable shall be shipped on nonreturnable wood reels. These reels, while using the most economical construction, must withstand shipping, normal handling in the field, and outdoor storage up to three years in all weather conditions. The reels shall then withstand normal handling and installation of the cables without damage to the cable or reel itself. *Plywood flange reels are not acceptable.* The nonreturnable wood reels shall meet the requirements of NEMA WC 26. Reel drums must be large enough that cable will not be bent beyond the minimum recommended bending radius.

Reels of cable shall be covered with wood lags of suitable strength to provide physical protection for the cables during transit, storage, and normal handling operations. Each reel of cable shall be protected by a weather resistance covering of suitable grade to meet the requirements for class 4, extra-heavy-duty physical protector, in accordance with NEMA WC 26.

6.2.2 Cable Lengths

The cable lengths specified in the PacifiCorp purchase order are the minimum lengths that will be acceptable. Each reel shall contain only one continuous length of cable, with no splices. Cable shall be placed on reels such that both ends are accessible for inspecting and testing upon receipt at the jobsite.

6.2.3 Cable Pulling Eye

Each reel of cable, 4/0 AWG and above, shall be supplied with a pulling eye installed on the cable. The supplier shall provide detailed procedures for PacifiCorp to install pulling eyes at the jobsite.

6.3 Reel Marking

Each cable reel shall be marked on both sides with indelible lettering (Paper tags are unacceptable.) with the information specified below:

1. Reel number

   The reel number shall be 2 inches high, minimum. The number shall consist of the cable code and reel number. For example, for cable code 81M and reel number 2, the reel number would be 81M/02.

2. Purchase order number
3. Cable voltage rating, number and size of conductors
4. Reel length in feet
5. Warning as follows: "STAND REEL ON RIM ONLY. DO NOT LAY ON SIDE."

6.4 Cable Marking

Completed cable to be furnished under this specification shall be identified by a printed marking applied to the outside surface of the jacket including information listed below:

1. Manufacturer's name
2. Number of conductors or pairs
3. Shield (copper)
4. Size of conductors
5. Insulation material (epr)
6. Voltage rating

7 Additional Cable-Specific Requirements

This material specification is not considered valid until each page of this section is approved and signed by the manager of Substation Engineering.

In this section, a box checked (✓) indicates that the item is required or applicable; a box not checked indicates that the item does not apply or is not acceptable.

7.1 Conductor Size

The size and number of conductors shall be as checked (✓) below.

Cable, no. 2/0 AWG, 2-conductor . . . . ☐

Cable, no. 4 AWG, 4-conductor . . . . ☐

Cable, no. 10 AWG, 4-conductor . . . . ☐

Cable, no. 10 AWG, 12-conductor . . . . ☐

7.2 Shipment Notice

The supplier shall notify the person named below 48 hours prior to delivery of the cable.

Name: ______________________________

Address: ______________________________

City: ____________, State: __________, ZIP: ________

Telephone: ________________

7.3 Correspondence

7.3.1 Technical Application Questions

Direct any technical application questions regarding this material specification to the project engineer (see 7.3.2).

7.3.2 Specification or Bid

Correspondence regarding this specification or the bid shall be sent to the PacifiCorp purchasing department, with copies to:

Project Engineer: ______________________________

Address: ______________________________

City: ____________, State: ________, ZIP: ________

Telephone: ____________

______

8 Issuing Department

The Asset Management Documentation Department of PacifiCorp is responsible for issuing this material specification. Comments and suggestions are welcome. Submit comments or requests for additional copies of this document to:

PacifiCorp Asset Management Documentation
825 NE Multnomah St., Suite 1600, Portland, OR 97232
telephone: (503) 813-5293; fax: (503) 813-6804

Technical questions regarding this material specification may be submitted to:

PacifiCorp Standards Engineering
825 NE Multnomah St., Suite 1600, Portland, OR 97232
telephone: (503) 813-6970; fax: (503) 813-6804

PACIFICORP
PACIFIC POWER UTAH POWER

PacifiCorp
ZS 072–1997

Material Specification

Control Cable—600 Volt, Nonshielded

ENGINEERING
Standards and Technical Support Department

Date: 30 Jul 97

Contents

Control Cable—600 Volt, Nonshielded

1 Scope

This specification states the requirements for control cable to be purchased by PacifiCorp for substation applications.

2 Applicable Codes and Standards

The latest revisions of the following documents in effect on the date of invitation to bid apply to the extent specified herein.

American Society for Testing & Materials (ASTM)

ASTM B3, *Standard Specification for Soft or Annealed Copper Wire*

ASTM B8, *Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft*

ASTM B33, *Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes*

ASTM B189, *Standard Specification for Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes*

Insulated Cable Engineers Association Inc. (ICEA)

ICEA T-30-520, *Vertical Cable Tray Flame Tests @ 70,000 Btu*

National Electrical Manufacturers Association (NEMA)

NEMA WC 7, *Cross-Linked-Thermosetting-Polyethylene-Insulated wire and Cable for the Transmission and Distribution of Electrical Energy* (ICEA S-66-524)

NEMA WC 8, *Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA S-68-516)*

NEMA WC 26, *Wire and Cable Packaging*

NEMA WC 57, *Control Cables (ICEA No. S-73-532)*

Underwriters Laboratories Inc. (UL)

UL 1581, *UL Standard for Safety—Reference Standard for Electrical Wires, Cables, and Flexible Cords*

3 General

3.1 Application Information

This material specification states both the general requirements for control cable and the cable-specific requirements, which vary depending on installation and intended use (see Section 7). If the cable-specific item description states a different requirement from that specified in the general design and manufacturing requirements, the requirements in Section 7 shall prevail.

3.2 Authorized Material Specification

This material specification is not considered valid until each page contains the approval signature of the persons named in the title blocks, and Section 7 has been completed and approved.

4 Design and Manufacturing Requirements

4.1 Codes and Standards

The control cable specified herein shall be designed, manufactured, and tested in accordance with the latest applicable revisions of NEMA WC 8, except as otherwise required by this specification.

4.2 Cable Type

The control cable supplied shall meet the requirements for NEMA WC 8, 600-volt unshielded, outdoor cable, and shall be capable of continuous operation [at a conductor temperature] of 90 °C wet or dry.

4.3 Ambient Temperature

The control cable shall be rated for ambient temperature between –40 °C and + 49 °C.

4.4 Cable Application

The cable shall be suitable for outdoor use, for direct burial without auxiliary mechanical protection, and for operation under water.

4.5 Conductors

The conductors shall be class C stranded, annealed copper wire with concentric lay in accordance with ASTM B8. If insulation is sulfonated, the conductors shall be protected with a coating of tin, lead or lead alloy per ASTM B33, B189 respectively. The conductor size shall be specified in 7.1.

4.6 Insulation

The conductor insulation shall be a tight-fitting, free-stripping, ozone-resistant, homogeneous, ethylene propylene rubber (epr), or cross-linked polyethylene (xlpe) compound. For cross-linked polyethylene, the insulation thickness shall be that listed in NEMA WC 7 table 3–1A, column B (the pertinent information is given in Table 1 of this material specification). For ethylene propylene rubber the insulation thickness shall be that listed in NEMA WC 8, table 3–1A, column B (the pertinent information is given in Table 1 of this material specification), and the conductor insulation may be either jacketed (type-I) or unjacketed (type-II).

Table 1 – Cables—Conductor Sizes and Insulation Thicknesses
(Source: Table 3-1A, WC 7 and Table 3-1A, WC 8)

Rated Circuit Voltage ($V_{Phase\text{-}to\text{-}Phase}$)†	Conductor Size (AWG or kcmil)‡	Insulation Thickness* (mils)	Insulation Thickness* (mm)
0–600	14–9‡	30	0.76
	8–2	45	1.14
	1–4/0	55	1.40
	225–500	65	1.65
	525–1000	80	2.03
	1025–2000	100	2.54
601–2000	14–9‡	45	1.14
	8–2	55	1.40
	1–4/0	65	1.65
	225–500	75	1.90
	525–1000	90	2.29
	1025–2000	115	2.92

* These insulation thicknesses (2000 volts or less) apply to multiple-conductor cables with an outer covering and to single-conductor cables with an outer covering.

These insulation thicknesses are considered adequate for electrical purposes and may be specified for single-conductor cables employing sunlight-resistant, carbon black pigmented insulation without further covering. These cables may be used in applications where installation and service conditions are such that the additional thickness for mechanical protection is not considered necessary for satisfactory operation.

Insulation thickness in this table is adequate for both 100 percent and 133 percent levels. For 173 percent insulation level, consult the manufacturer.

† The actual operating voltage shall not exceed the rated circuit voltage by more than (a) 5 percent during continuous operation or (b) 10 percent during emergencies lasting not more than 15 minutes.

‡ Single-conductor cables in sizes 9 AWG and smaller shall not be used for direct earth burial.

4.6.1 Type-I

Type-I insulation thickness shall be as specified for this voltage class in NEMA WC 8, section 3.6. Type-I insulation shall have a jacket as described in 4.9. The jacket shall not be considered part of the required insulation thickness.

4.6.2 Type-II

Type-II insulation thickness shall be as specified for this voltage class in NEMA WC 8, section 3.7. Type-II insulation shall be colorable, and shall be VW-1 flame-resistant per UL 1581.

4.7 Cabling, Belting , and Fillers

Cabling, belting, and fillers shall be composed of nonhygroscopic thermoplastic or rubber materials.

4.8 Overall Jacket

The complete cable shall be jacketed either with chlorosulfonated polyethylene or chlorinated polyethylene. The jacket thickness shall be specified in NEMA WC 57, table 4–5. The jacket shall be resistant to weathering, sunlight (uv), oils, chemicals, acids, alkalies, flame, and moisture. The jackets shall be black in color.

4.9 Conductor Insulation Jacket (Type-I)

The type-I insulation shall be jacketed chlorosulfonated polyethylene meeting NEMA WC 8, section 4.4.10 or chlorinated polyethylene meeting NEMA WC 8, section 4.4.7. The jacket thickness shall be 15 mils minimum. The jacket shall be resistant to weathering, sunlight (uv), oils, chemicals, acids, alkalies, flame, and moisture. The jackets shall be colored in accordance with 4.10.

4.10 Color Coding and Sequence

The insulation or jacketing of the conductors shall be color coded in accordance with NEMA WC 57, appendix E method 1. The color sequence shall be in accordance with NEMA WC 57, table E–2. The supplier shall state in writing that method 1 was used. Color-coding jackets shall meet the requirements of 4.9.

5 Completed Cable Tests

The completed cable shall meet requirements of the tests specified herein.

5.1 Cold Bend Test

The cable shall meet the requirements of NEMA WC 8, section 6.18, table 6.7 at –40 °C with no cracking of the jacket or insulation.

5.2 Heat Shock Test

The cable shall meet the requirements in NEMA WC 8, section 6.16 at 120 °C.

5.3 Vertical Flame Test

The cables shall pass ICEA T-30-520 vertical flame test.

6 Preparation for Shipping and Storage

6.1 General

6.1.1 Loss or Damage

The supplier shall prepare the reels of cable to protect them from loss and damage. The supplier shall be responsible for any loss or damage in transit.

6.1.2 Storage

The supplier shall provide instructions for handling, storage (including long-term storage), and periodic inspection and maintenance to assure that deterioration will be minimal during storage. Instructions shall be fastened securely to the shipping unit.

6.2 Reels and Lengths

6.2.1 Reels

Cable shall be shipped on nonreturnable wood reels. These reels, while using the most economical construction, must withstand shipping, normal handling in the field, and outdoor storage up to three years in all weather conditions. The reels shall then withstand normal handling and installation of the cables without damage to the cable or reel itself. *Plywood flange reels are not acceptable.* The nonreturnable wood reels shall meet the requirements of NEMA WC 26. Reel drums must be large enough that cable will not be bent beyond the minimum recommended bending radius.

Reels of cable shall be covered with wood lags of suitable strength to provide physical protection for the cables during transit, storage, and normal handling operations. Each reel of cable shall be protected by a weather-resistant covering of suitable grade to meet the requirements for class 4, extra-heavy-duty physical protection in accordance with NEMA WC 26.

6.2.2 Cable Lengths

The cable lengths specified in the PacifiCorp purchase order are the minimum lengths that will be acceptable. Each reel shall contain only one continuous length of cable, with no splices. Cable shall be placed on reels such that both ends are accessible for inspecting and testing upon receipt at the job site.

6.2.3 Cable Pulling Eye

Each reel of cable 4/0 AWG and above, shall be supplied with a pulling eye installed on the cable. The supplier shall provide detailed procedures for PacifiCorp to install pulling eyes at the job site.

6.3 Reel Marking

Each cable reel shall be marked on both sides with indelible lettering (paper tags are unacceptable) with the information specified below:

1. Reel number

   The reel number shall be a minimum of 2 inches high. The number shall consist of the cable code and reel number. For example, for cable code 81M and reel number 2, the reel number would be 81M/02.
2. Purchase order number
3. Cable voltage rating, number, and size of conductors
4. Reel length in feet
5. Warning as follows: "STAND REEL ON RIM ONLY. DO NOT LAY ON SIDE"

6.4 Cable Marking

Completed cable to be furnished under this specification shall be identified by a printed marking applied to the outside surface of the jacket including information listed below:

1. Manufacturer's name
2. Number of conductors
3. Size of conductors
4. Insulation material (epr)
5. Voltage rating

7 Additional Cable-Specific Requirements

This material specification is not considered valid until each page of this section is approved and signed by the manager of Substation Engineering.

In this section, a box checked (✓) indicates that the item is required or applicable; a box not checked indicates that the item does not apply or is not acceptable.

7.1 Conductor Size

The size and number of conductors shall be checked (✓) below.

Cable, no. 10 AWG, 2-conductor ❑

Cable, no. 14 AWG, 2-conductor ❑

Cable, no. 14 AWG, 4-conductor ❑

Cable, no. 14 AWG, 12-conductor ❑

7.2 Shipment Notice

The supplier shall notify the person named below 48 hours prior to delivery of the cable.

Name: ____

Address: ____

City: ____________________, State: _______________, ZIP: _____________

Telephone: _____________________________

7.3 Correspondence

7.3.1 Technical Application Questions

Direct any technical questions regarding this material specification to the project engineer (see 7.3.2).

7.3.2 Specification or Bid

Correspondence regarding this specification or the bid shall be sent to the PacifiCorp purchasing department, with copies to:

Project Engineer: ____

Address: ____

City: ________________________, State: ___________, ZIP: _____________

Telephone: _________________

____

8 Issuing Department

The Standards Services department of PacifiCorp Engineering is responsible for issuing this material specification. Comments and suggestions are welcome. Submit comments or requests for additional uncompleted copies of this material specification to:

1407 West North Temple, OUC 2000
Salt Lake City, Utah 84140–0020
telephone: (801) 220-2034
fax: (801) 220-2258

PACIFICORP ENERGY
A DIVISION OF PACIFICORP

Generation

Engineering

Document Type:	New Generation Plant Construction Standard			Document ID Number:	GEN-ENG-RELAY-0001	
Unit(s):				Review Date:	10/13/2010	
SUBJECT:	Protective Relaying Standard			Reviewed By:	Mike Collins	
Written By:	**Mike Collins**	**Date:**	**04/14/08**	**Approved By:**	**Mike Collins**	**Date:** **04/14/08**

Revision Number	Reason for Revision	Date	MOC #
0			

THERMAL PLANT PROTECTIVE RELAYING REQUIREMENTS

Protection design, settings and hardware for electrical equipment must be approved by the PacifiCorp Protective Relaying Department and will meet all recommendations contained within the PacifiCorp FACILITY CONNECTION REQUIREMENTS FOR TRANSMISSION SYSTEMS, IEEE Std. 666-1991 IEEE Design Guide for Electric Power Service Systems for Generating Stations, IEEE Std. C37.102 IEEE Guide for AC Generator Protection and IEEE Std. C37.110 IEEE Guide for Application of Current Transformers Used for Protective Relaying Purposes.

Protection drawing packages shall conform to PacifiCorp drawing standards. Separate 1-lines, 3-lines, DC control schematics, and wiring diagrams are required. All protection drawings must be provided with the standard PacifiCorp drawing border.

Part numbers for relays, test switches, lockout relays must be approved by the PacifiCorp Relay Department.

All voltage, current and digital inputs and outputs for each relay must be connected to a test switch. Protective relays and lockout relays must be electrically isolated via test switches for testing purposes.

Relay settings reports are required and must contain all data required to review the settings including 1-lines, narrative philosophy, relay set points, calculations, coordination curves, protected equipment data, and system data. The relay settings report must cover all the protective relays in the plant. A paper copy and an electronic copy must be provided to the PacifiCorp Relay Department.

All protective relaying DC control circuits must be 125 VDC.

Remote communication via modem must be provided to all generator, generator step-up, and auxiliary transformer protective relays. All plant relay must support the IEC 61850 communication protocol.

The final protective relaying drawing package and report must be submitted to the PacifiCorp Relay Department for approval prior to ordering the equipment. PacifiCorp shall review and provide comments within two (2) weeks from submittal by Contractor.

Plant protection systems must meet the PacifiCorp Standard 139 – Facility Interconnection Requirements for Xmsn Systems. The most current version of this document is posted at http://idoc.pacificorp.us/Article/Article23187.html.

PACIFICORP ENERGY
A DIVISION OF PACIFICORP

Generation Engineering

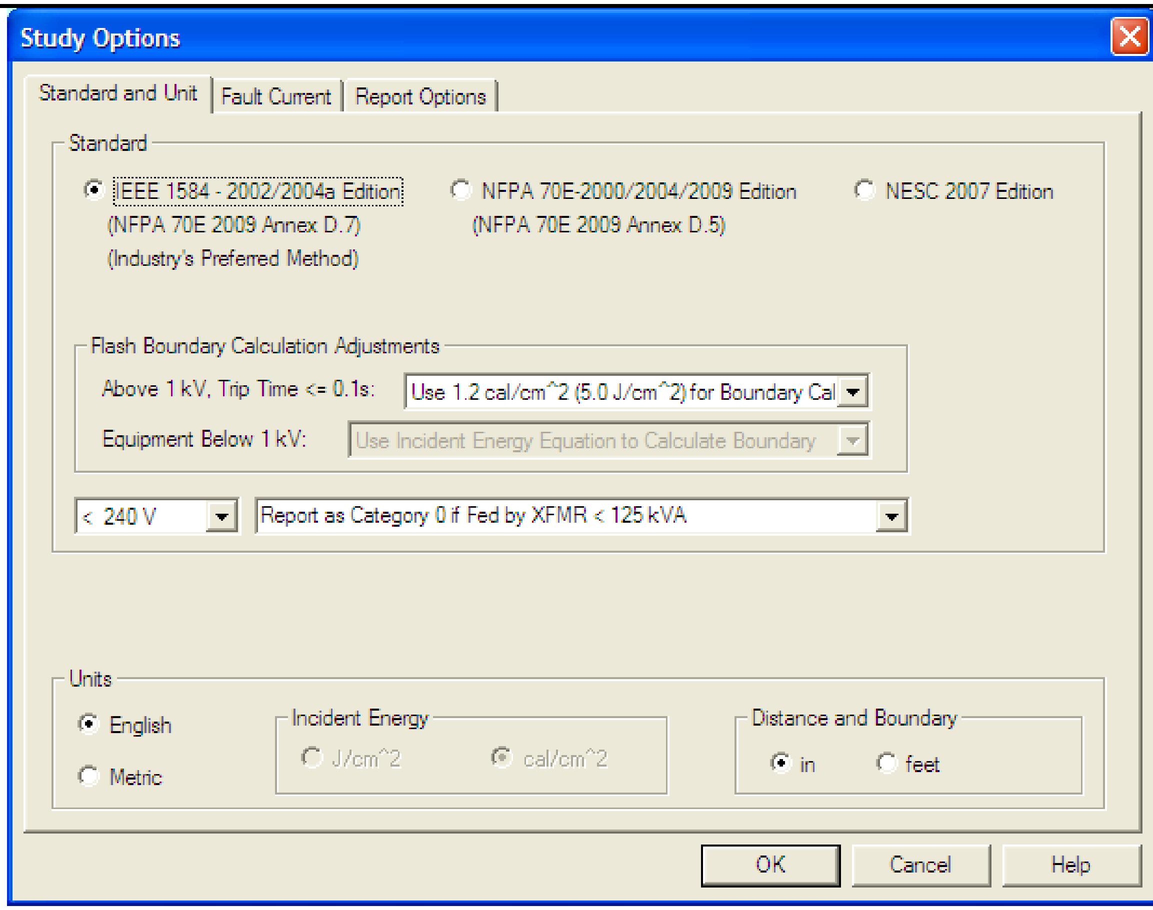
Document Type	**New Generation Plant Construction Standard**				Document Number	**GEN-ENG-RELAY-0002**
					Revision Number	5
SUBJECT:	**Arc Flash Hazard Standard**					
Written By:	Justin Rosenkrantz	Date:	5/10/2010		Review Date:	**5/10/2010**
Approved By:	Mike Collins				Reviewed By:	Mike Collins
Title of Approver	Relay Department Manager	Date:	5/10/2010			

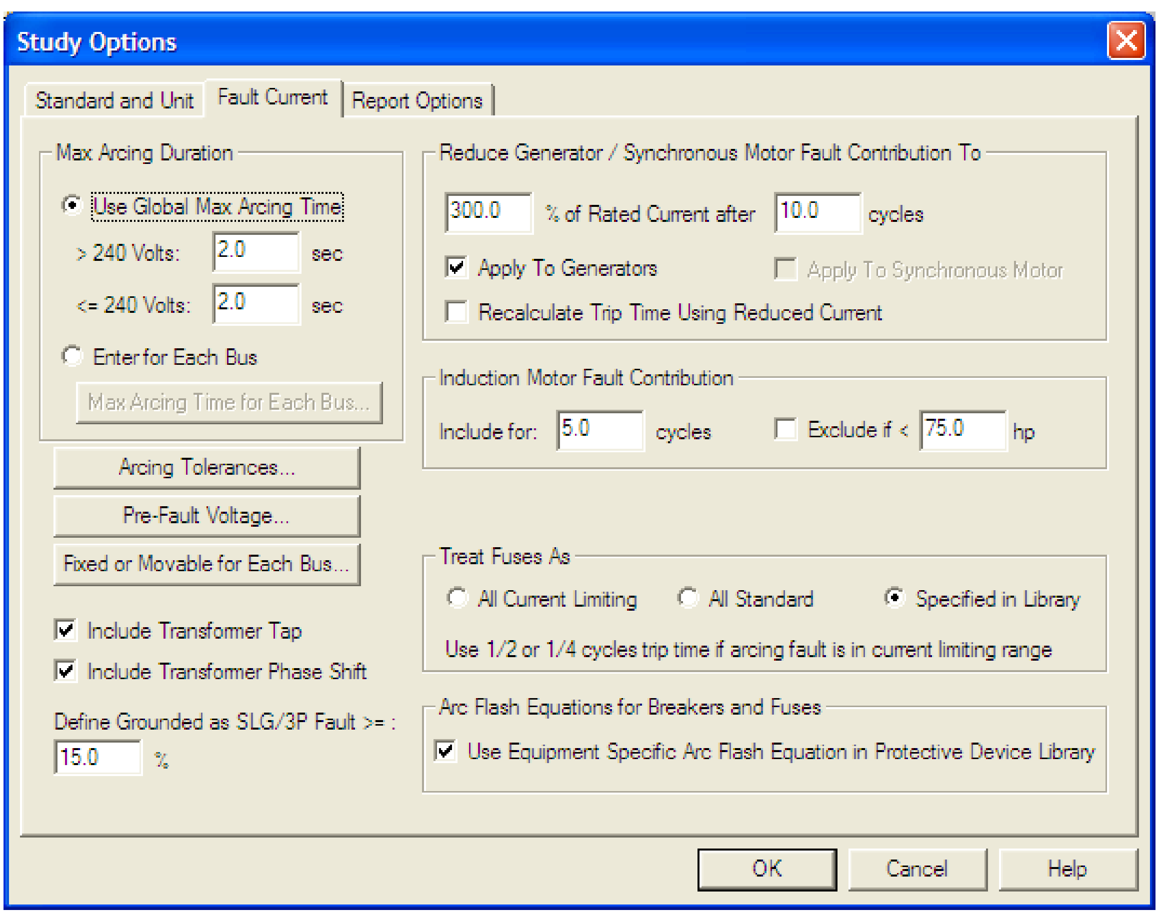
SCOPE and DEFINITION

This standard covers the arc flash safety requirements for new generation plant construction. This standard is designed to protect personnel from serious injury or death in the event of an arcing fault.

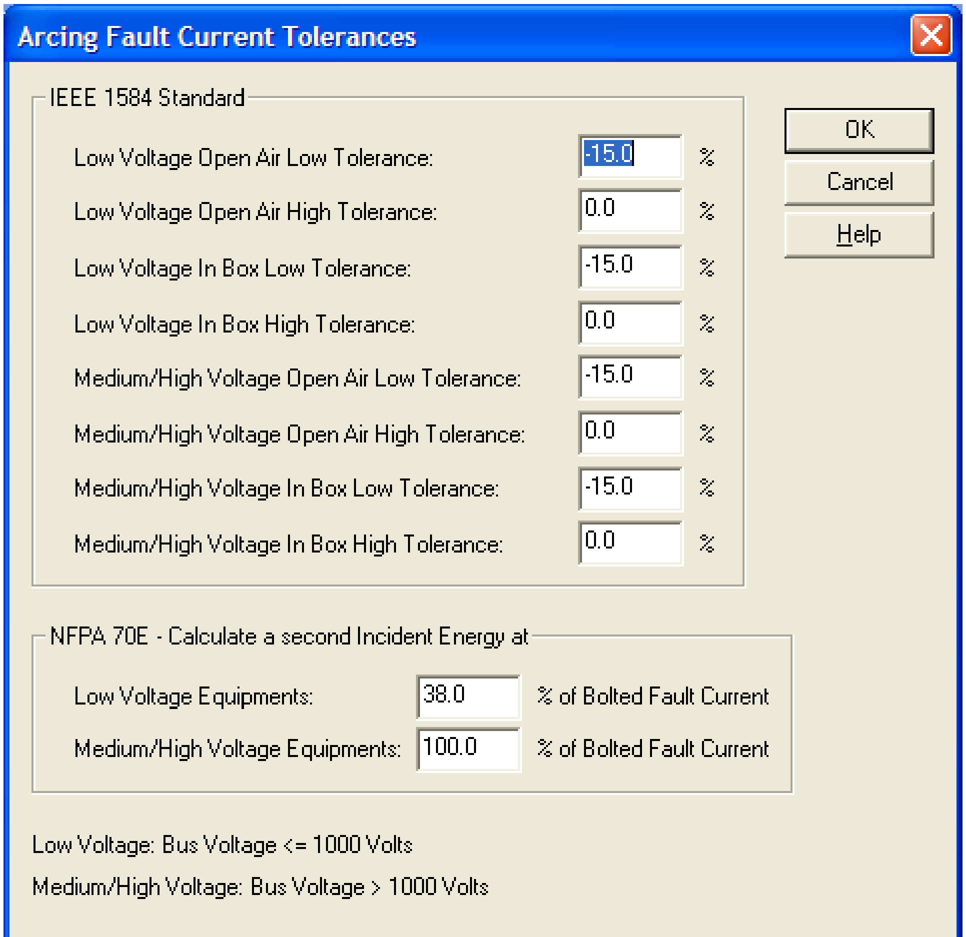
CONSTRUCTION REQUIREMENTS

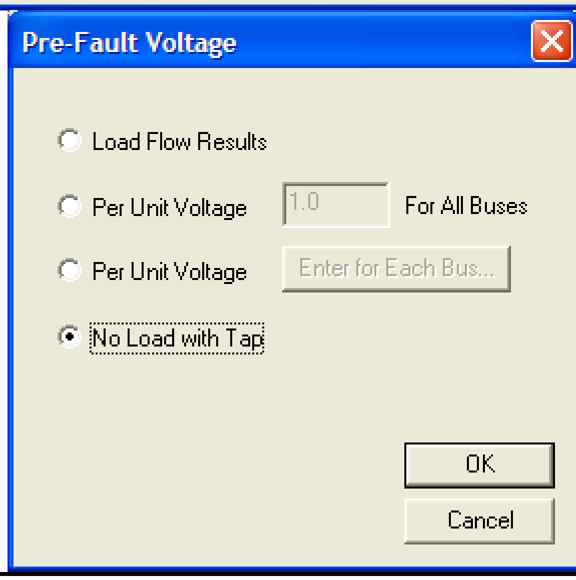
1. An arc flash study shall be performed based on the current version of IEEE standard 1584 and using SKM Power*Tools for Windows (PTW) software.
2. All electrical equipment shall be designed such that the incident energy levels from arc flash events shall be limited to 25 cal/cm^2 (a hazard category of 3). Where this is deemed infeasible, PacifiCorp Energy's protective relaying group shall be consulted.
3. Type 2B medium voltage arc resistant switchgear tested per the latest revision of IEEE Std C37.20.7 shall be installed for all applicable medium voltage locations.
4. The PTW model shall be based on the following (PacifiCorp Energy's protective relaying group should be consulted when any questions arise):
   a. A two second arc flash duration shall be assumed for all locations where deemed feasible. Where location constraints or other concerns make this assumption invalid, the arc flash calculations shall be appropriately modified.
   b. For 4160 VAC and above, the working distance shall be 36 inches. For all other voltages the working distance shall be 36 inches for drawout type breakers and 18 inches for all other equipment.
   c. SKM Parameters should be consistent with the following screenshots:

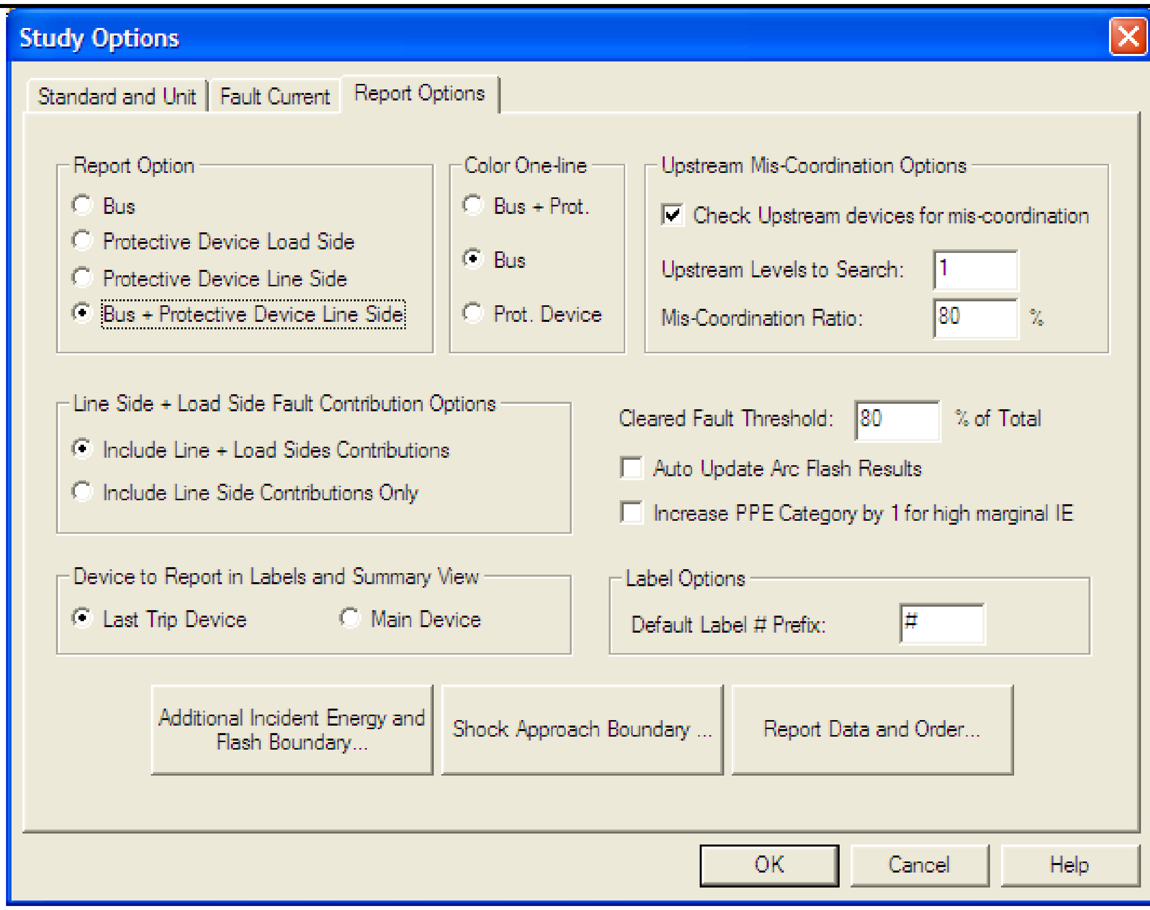

Study Options
Standard and Unit
Fault Current
Report Options
Standard
IEEE 1584 - 2002/2004a Edition
(NFPA 70E 2009 Annex D.7)
(Industry's Preferred Method)
NFPA 70E-2000/2004/2009 Edition
(NFPA 70E 2009 Annex D.5)
NESC 2007 Edition
Flash Boundary Calculation Adjustments
Above 1 kV, Trip Time <= 0.1s:
Use 1.2 cal/cm^2 (5.0 J/cm^2) for Boundary Cal
Equipment Below 1 kV:
Use Incident Energy Equation to Calculate Boundary
< 240 V
Report as Category 0 if Fed by XFMR < 125 kVA
Units
English
Metric
Incident Energy
J/cm^2
cal/cm^2
Distance and Boundary
in
feet
OK
Cancel
Help


Study Options
Standard and Unit
Fault Current
Report Options
Max Arcing Duration
Use Global Max Arcing Time
> 240 Volts: 2.0 sec
<= 240 Volts: 2.0 sec
Enter for Each Bus
Max Arcing Time for Each Bus...
Arcing Tolerances...
Pre-Fault Voltage...
Fixed or Movable for Each Bus...
Include Transformer Tap
Include Transformer Phase Shift
Define Grounded as SLG/3P Fault >= :
15.0 %
Reduce Generator / Synchronous Motor Fault Contribution To
300.0 % of Rated Current after 10.0 cycles
Apply To Generators
Apply To Synchronous Motor
Recalculate Trip Time Using Reduced Current
Induction Motor Fault Contribution
Include for: 5.0 cycles
Exclude if < 75.0 hp
Treat Fuses As
All Current Limiting
All Standard
Specified in Library
Use 1/2 or 1/4 cycles trip time if arcing fault is in current limiting range
Arc Flash Equations for Breakers and Fuses
Use Equipment Specific Arc Flash Equation in Protective Device Library
OK
Cancel
Help

*Although grounded is defined as 15% as shown in the options above, that is mainly to help SKM complete the calculations. Field verification should be made and anything that is resistively grounded or ungrounded should be marked as ungrounded in the study, per IEEE 1584.







The PPE Table for SKM should be requested by Consultant from Company and the latest revision will be provided for loading into SKM.

5. Create a detailed report to include the topics in order as listed below. Two printed copies in three ring binders with section dividers shall be provided, along with a CD in each binder which should include electronic copies of report documentation and the SKM model project files (including PTW library file used for the study). Before the report is printed and any labels are created, the study results shall be discussed with Company. Any changes discussed shall be included in the final report.
    a. Title Page (should include name of Consultant responsible for the arc flash review and the date the review was completed)
    b. Table of Contents
    c. Report summary (include a copy of the AF Summary results from SKM)
    d. Description of different system operating configurations used for SKM scenarios
    e. List of any assumptions
    f. Screenshots of SKM options and Help -> About screen showing SKM version used.
    g. SKM one-line diagram
    h. List of all data used in the arc flash study (i.e. transformer, motor, and generator data, cable information, and protective device settings)
    i. Any other documentation the Consultant deems appropriate to include
6. All applicable equipment shall be labeled with weather-resistant (and UV resistant where exposed to sunlight) arc flash labels using the following design as an example:

WARNING

Arc Flash and Shock Hazard

Appropriate PPE Required

36 inches	Flash Hazard Boundary
3.6 cal/cm^2	Flash Hazard at 18 inches
Category 1	Cotton Underwear + FR Shirt & Pants + Face Shield + Std PPE(inc. hearing)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
42 inches	Limited Approach
12 inches	Restricted Approach
1 inches	Prohibited Approach

Location: MCC-A1-3

10-28-09 UPDATE

CURRANT CREEK

Document Type:	**OPERATIONS ADMINISTRATIVE POLICY**				Document ID Number:	**CUR-OPS-ADMIN-002**	
Unit(s):	**ALL**				Review Date:		
SUBJECT:	**PIPE, EQUIPMENT AND VALVE LABELING STANDARD**				Reviewed By:		
Written By:	**Jared Kissell**	**Date:**	**1-14-11**		**Approved By:**		**Date:**

Revision Number	Reason for Revision	Date	MOC #
0	New Policy regarding consistency in labeling	1-14-11	

SCOPE and DEFINITION

This Standard establishes a common system for plant pipe, equipment and valve labeling. The intent of this standard is to provide uniformity, reduce hazards and to prevent operational errors. Pipe identification and labeling should conform to the American National Standards Institute (ANSI) Standard A13.1-2007 and will be consistent with any specific items identified in PacifiCorp's Accident Prevention Manual and/or Safety & Operating Rules Handbook.

PIPE, EQUIPMENT and VALVE LABELING STANDARD

Equipment and Valve Labeling

1. All plant equipment, valves and instruments will be labeled and meet PacifiCorp Energy Standard 21: *Conduct of Operations - Section N: Equipment Labeling.*

2. All Plant equipment, valves and instruments contained in the P&ID's will be labeled synchronized to the current P&ID. Equipment should be labeled by equipment number and function. Valves should be labeled with a number and/or text description, consistent with plant drawings.

3. Electrical breakers and panels are labeled so as to designate which circuit they are fed from and what devices they feed. Labeling of electrical breakers and panels will be consistent with plant electrical drawings.

4. All labels will be durable, heat/chemical resistant and large enough to be easily located and read.

5. All labels will be visible from the point of normal approach.

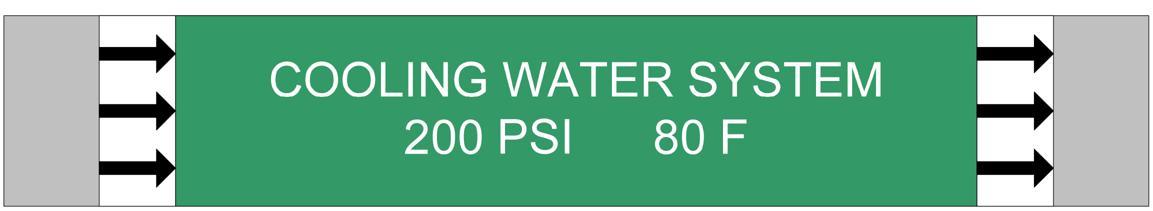
6. Currant Creek MOC procedure ensures all new equipment receives the appropriate labels as per this procedure.

7. Completion of the "Job Closeout" section of the Pre-Job Brief ensures all equipment replaced and/or removed from service has its' label properly restored as per this procedure.

Pipe Labeling

1. All plant pipe labeling should conform to ANSI Standard 13.1-2007 (See Appendix 3)
2. All plant piping contained in the P&ID's will be labeled and synchronized to the current P&ID nomenclature.
3. All labels will be durable, heat/chemical resistant and large enough to be easily located and read.
4. Where pipelines are located above or below the normal line of vision, the lettering shall be placed above or below the horizontal centerline of the pipe. (See appendix 3 ANSI Standard 13.1-2007 – Figure 1)
5. All labels will be visible from the point of normal approach. (See appendix 3 ANSI Standard 13.1-2007 – Figure 1)
6. All labels will include the normal working temperature and pressure of the piping systems contents.
7. All labels will have flow arrow indication bands at each end of the label. (See Pipe Label Example-page #2)
8. Labels will be placed near valves, changes in pipe direction; at both sides of ceiling, wall or floor penetrations and at frequent intervals on straight pipe runs every 50' at a minimum. (See appendix 2)
9. To insure adequate visibility, the length of the labeling color band and the size of the descriptive text will be appropriate to the size of the pipe. (See ANSI Standard 13.1-2007 – Table 3)
10. When the piping layout is of extreme complexity or accessibility is limited, substitute labeling techniques may be used to achieve positive identification, providing there is no deviation from the concept of identification described in ANSI Standard 13.1-2007
11. In high heat applications, some labels may need to be attached to a separate mounting plate.
12. Re-check all piping & labels prior to labeling to ensure the correct label is being attached.
13. Currant Creek MOC procedure ensures all new piping receives the appropriate label as per this procedure.
14. Completion of the "Job Closeout" section of the Pre-Job Brief ensures all equipment replaced and/or removed from service has its' label properly restored as per this procedure.

PIPE LABELING EXAMPLE



Appendix 1 - Plant Identification Table (Suggested label test & background)

Equipment	Legend (letters)	Background
HRSG Equipment	White	Black
HP Drum	Black	Yellow
HP Economizer	Black	Yellow
HP Evaporator	Black	Yellow
HP Superheater	Black	Yellow
Reheater	Black	Yellow
IP Drum	Black	Yellow
IP Economizer	Black	Yellow
IP Evaporator	Black	Yellow
Superheater	Black	Yellow
IP Steam	Black	Yellow
LP Drum	Black	Yellow
Feedwater Preheater	Black	Yellow
LP Evaporator	Black	Yellow
LP Superheater	Black	Yellow
HRSG Blowdown Tank	Black	Yellow
HRSG Drains	Black	Yellow
CEMS Equipment	Black	White
Ammonia Tank	Black	Orange
Ammonia	Black	Orange
SCR Blower Piping	Black	Orange
Aux Boiler Feedwater	Black	Yellow
Aux Boiler Steam	Black	Yellow
Aux Boiler FGR	Black	Yellow
CT Accessory Module	Black	Yellow
CT Lube Oil	Black	Yellow
CT Trip Oil	Black	Yellow
CT Gas Fuel	Black	Yellow
CT Hydraulic Oil	Black	Yellow
CT Lift Oil	Black	Yellow
Cooling and Sealing Air	Black	Yellow
Cooling Water	White	Green
Atomizing Air	Black	Yellow
Fire Protection	White	Red
Inlet Air Heating	Black	Yellow
Heating and Ventilation	White	Blue
Water Wash	White	Green
CT Generator	Black	Yellow
Load Commutated Inverter	Black	Yellow
Seal Oil	Black	Yellow
Generator CO2	Black	White
Generator Hydrogen	Black	Yellow
Isolation Transformer	Black	Yellow
Air Processing Unit	Black	Yellow

Inlet Air System	White	Blue
Water Wash	White	Green
Water Wash Pump	White	Green
ST-HP Turbine	White	Yellow
ST-IP Turbine	White	Yellow
ST-LP Turbine	White	Yellow
ST-Hydraulic Oil	White	Yellow
ST Generator	White	Yellow
ST Lube Oil	White	Yellow
ST- Gland Steam	White	Yellow
ST- Gland Steam Condenser	White	Yellow
Steam Drains	White	Yellow
Internal Drains Tank	White	Yellow
External Drains Tank	White	Yellow
HP Steam	White	Yellow
LP Steam	White	Yellow
Hot Reheat Steam	White	Yellow
Cold Reheat Steam	White	Yellow
Air Cooled Condenser	White	Green
Condenser Air Removal	White	Yellow
Hogging Ejector	White	Yellow
Holding Air Ejector	White	Yellow
Air Ejector Condenser	White	Yellow
Hogging Vacuum Pump Separator	White	Green
Holding Vacuum Pump Separator	White	Green
Closed Cooling Water	White	Green
Closed Cooling Water Expansion Tank	White	Green
Closed Cooling Water Cooler	White	Green
Condensate	White	Yellow
Condensate Drum	White	Yellow
Deaerator	White	Yellow
Feedwater	White	Yellow
HP Feedwater	White	Yellow
IP Feedwater	White	Yellow
Raw Water	White	Green
Raw Water Tank	White	Green
Multimedia Filter	White	Green
Reverse Osmosis	Black	Yellow
Deionization	White	Green
Clean in Place Skid	Black	Orange
Cycle Make-Up	White	Green

Demin Water Storage Tank	White	Green
Demin Water	White	Green
Cycle Chemical Feed	Black	Orange
Amine or Ammonia	Black	Orange
Oxygen Scavenger	Black	Orange
Sampling & Analysis	Black	Yellow
Sample System Panel	Black	Yellow
Temperature Control Unit	Black	Yellow
Waste Water	White	Green
Storage Area Sump	White	Green
CT Area Sump	White	Green
Plant Drains Sump	White	Green
Service Building Sump	White	Green
Oil/Water Separator	Black	Yellow
Waste Water Storage Tank	White	Green
CT Water Wash Drains Tank	Black	Orange
Compressed Air	White	Blue
Air Receiver Tank	White	Blue
Compressed Air Dryer	White	Blue
Instrument Air	White	Blue
Service Air	White	Blue
CO2 Tank	Black	White
CO2	Black	White
Nitrogen Tank	Black	White
Nitrogen	Black	White
Hydrogen Trailer	Black	Yellow
Hydrogen	Black	Yellow
Fuel Gas	Black	Yellow
Inlet Gas Scrubber	Black	Yellow
Inlet Gas Drain Tank	Black	Yellow
Fuel Gas Dew Point Heater	Black	Yellow
Fuel Gas Filter/Separator	Black	Yellow
Fire Protection	White	Red
Potable Water	White	Green
Potable Water Storage Tank	White	Green
Sanitary Waste	Black	Orange
Isolated Bus Duct	Black	Yellow
Non-Segregated Bus Duct	Black	Yellow
Generator Breakers	Black	Yellow
Step Up Transformers	Black	Yellow
Unit Auxiliary Transformers	Black	Yellow

6.9kv MCC	Black	Yellow
Excitation Transformer	Black	Yellow
Isolation Transformer	Black	Yellow
480v MCC	Black	Yellow
Unit Substation Transformer	Black	Yellow
DC Power System	Black	Yellow
UPS System	Black	Yellow
DCS	Black	Yellow

APPENDIX 2 VALVE & EQUIPMENT LABELING

BFP 101A HP DISCHARGE VALVE
1FWS-V138
P&ID 100545-DJ-0601C
Normally Open

UNIT #	DESCRIPTION	POWER TRAIN	DESIGNATION
0	Power Block(s) Common	0	Common
1	Power Block One	1A	Block One South CT/HRSG
2	Power Block two	1B	Block One North CT/HRSG
3	Steam Turbine Generator	2A	Block Two South CT/HRSG
		2B	Block Two North CT/HRSG

SYSTEM ABREVIATION	SYSTEM NAME	EQUIPMENT ABBREVIATION	EQUIPMENT NAME
ABH	AUXILIARY BOILER REAGENTS	ACC	AIR COOLED CONDENSER
ABS	AUXILIARY BOILER SYSTEM	ACU	AIR CONDITIONING UNIT
ACW	AIR CHILLED WATER	AOV	AIR OPERATED VALVE
AFS	AQUEOUS AMMONIA STORAGE AND TRANSFER	ARV	AIR RELIEF VALVE
AIC	INLET AIR CHILLING	AUX	AUXILIARY
ARC	CONDENSER AIR REMOVAL	BFP	BOILER FEED PUMP
ASF	AUXILIARY STEAM	BOP	BALANCE OF PLANT
BMS	BURNER MANAGEMENT SYSTEM	BLR	BOILER
CCW	COMPONENT COOLING WATER	BLDG	BUILDING
CDO	CARBON DIOXIDE	BKR	BREAKER
CDS	CHILLED WATER CARBON DIOXIDE	COND	CONDENSATE
CEM	CONTINUOUS EMISSIONS MONITORING	COMP	COMPRESSOR
CFS	CHEMICAL FEED SUPPLY	CHL	CHILLER

CLO	CHEMICAL CLEANING	CLC	COOLING COIL
CNM	CONDENSATE	CLR	CLARIFIER
CNS	CONDENSATE MAKEUP & DRAW OFF	CND	CONDENSER
CRS	COLD REHEAT STEAM	CNDT	CONDITIONER
CTG	COMBUSTION TURBINE GENERATOR	COOL	COOLER
CWS	CIRCULATING WATER	CRV	COMBINED REHEAT VALVE
DCS	DISTRIBUTED CONTROL SYSTEM	CTG	COMBUSTION TURBINE GENERATOR
DEM	EQUIPMENT DRAINS	CT	COMBUSTION TURBINE
DWS	POTABLE WATER	DRM	DRUM
FGS	FUEL GAS	DA	DEAERATOR
FOA	AUXILIARY BOILER/DIESEL FUEL	DBD	DAMPER BACKDRAFT
FOM	FUEL OIL	DEHC	DIGITAL ELECTRO HYDRAULIC CONTROL
FPL	FIRE PROTECTION CO2	DEMN	DEMINERALIZER
FPS	FIRE PROTECTION	DESH	DESUPERHEATER
FWS	FEEDWATER	DH	DUCT HEATER
GCH	COMBUSTION TURBINE HYDROGEN	DIFF	DIFFUSER
GCO	COMBUSTION TURBINE SEAL OIL	DISC	DISCHARGE
GSC	TURBINE GENERATOR	DMP	DAMPER
GTA	GAS TURBINE AUX & SERVICES	DRY	AIR DRYER
HRS	HOT REHEAT STEAM	EFN	EXHAUST FAN
HVA	HEATING & VENTILATION SYSTEM	EJ	EXPANSION JOINT
HVC	CONTROL BUILDING HVAC SYSTEM	EJECT	EJECTOR
IAS	INSTRUMENT AIR	EVAP	EVAPORATIVE or EVAPORATOR
IPS	INTERMEDIATE PRESSURE STEAM	EXC	EXCITER
LOS	LUBRICATION SYSTEMS	FLT	FILTER
LPS	LOW PRESSURE STEAM	FN	FAN/EXHAUSTER/BLOWER
MBB	BOILER MAIN BURNER CONTROL	FW	FEED WATER
MBH	BOILER CHEMICAL FEED	GEN	GENERATOR
MBL	BOILER BLOWDOWN & VENTS	GSSC	GLAND SEALING STEAM CONDENSER
MBS	MAIN BOILER SYSTEM (HRSG)	GSU	GENERATOR STEP UP TRANSFORMER
MSE	MAIN TURBINE EXHAUST	HTR	HEATER
MSS	MAIN STEAM	HEX	HEAT EXCHANGER
MWS	WATER	HRSG	HEAT RECOVERY STEAM GENERATOR
NBS	NITROGEN BLANKETING	HUM	HUMIDIFIER
PBS	SANITARY DRAINS & DISPOSAL	IF	INSULATING FLANGE/DIELECTRIC
RAW	RAW WATER	IV	INTERCEPT VALVE (TURBINE)
SAS	SERVICE AIR	LCI	LOAD CENTER

SDS	STEAM DRAINS/DRAINS TO CONDENSER	LCI	LOAD COMUTATIVE INVERTER
SLB	TEMPORARY STEAM BLOW PIPING	LO	LUBE OIL
SSS	STEAM SAMPLING SYSTEM	KD	KNOCKDOWN DRUM
STA	STEAM TURBINE AUXILIARY	MCC	MOTOR CONTROL CENTER
STG	STEAM TURBINE GENERATOR	MTR	MOTOR
SVS	STEAM VENTS-STEAM	MOV	MOTOR OPERATED VALVE
SVV	STEAM VENTS-SAFETY VALVES	MSV	MAIN STOP VALVE (TURBINE)
SWS	SERVICE WATER	NG	NATURAL GAS
TCH	CTG HYDRAULIC CONTROL OIL	PDC	POWER DISTRIBUTION CENTER
TCL	CTG LUBE OIL	PMP	PUMP
TCS	GAS TURBINE SYSTEM	PNL	PANEL
TSH	CTG HYDRAULIC CONTROL	RECIRC	RECIRCULATION
TME	STG GLAND SEAL & EXHAUST STEAM	RAK	SAMPLE CONDITIONING RACK
TML	STG LUBE OIL	SCR	SELECTIVE CATALYTIC REDUCTION
TSW	SANITARY WASTE SYSTEM	SJAE	STEAM JET AIR EJECTOR
VPS	VACUUM PRIMING	SL	SILENCER
WTC	CHEMICAL FEED COOLING TOWERS	SKID	SKID
WTD	DEMINERALIZED WATER	SP	SPECIALTY PIPING
WTS	WATER TREATMENT - RAW WATER	STG	STEAM TURBINE GENERATOR
WTU	WASTE WATER TREATMENT - STATION	STR	STRAINER
WTW	STORM WATER	SUMP	SUMP
WWT	WASTE WATER TREATMENT	SWG	SWITCHGEAR
		TURB	TURBINE
		TG	TURNING GEAR
		TK	TANK
		TWR	TOWER
		VFD	VARIABLE SPEED DRIVE
		VTV	AIR / VACUUM
		XFRMR	TRANSFORMER

Appendix 3 - ANSI Standard 13.1-2007

This Standard is intended to establish a common system to assist in identification of hazardous materials conveyed in piping systems and their hazards when released in the environment.

This scheme concerns identification of contents of piping systems. It is recommended for the identification of piping systems used in industrial, commercial and institutional installations, and in buildings used for public assembly. It does not apply to buried pipelines or to electrical conduits.

Existing schemes for identification shall be considered as meeting the requirements of this Standard if:

(a) Such schemes are described in writing
(b) Employees are trained as to the operation and hazards of the piping systems

2 DEFINITIONS AND REFERENCES

2.1 Piping Systems

For the purpose of this Standard, piping systems shall include piping of any kind including fittings, valves, and pipe coverings. Supports, brackets, or other accessories are specifically excluded from applications of this Standard. Piping is defined as conduits used to convey, distribute, mix, separate, discharge, meter, control, or snub fluid flows.

2.2 Materials

2.2.1 Flammable. This classification includes fluids, which under ambient or expected operating conditions, are a vapor or produce vapors that can be ignited and continue to burn in air. The term thus may apply, depending on service conditions, to fluids defined for other purposes as *flammable* or *combustible.*

2.2.2 Combustible. This classification includes fluids that can burn, but are not flammable.

2.2.3 Toxic and Corrosive. This classification includes fluids that are corrosive or toxic, or will produce corrosive or toxic substances when released.

2.2.4 Fire Quenching. This classification includes water, foam, and CO2 used in sprinkler systems and fire fighting piping systems.

2.3 References

The latest edition of the following standard shall, to the extent specified herein, form a part of this Standard.

Table 1 - Example of Content Descriptions Appearing in a Legend

“CONDENSATE”
“HP STEAM”
“GLAND STEAM”
“RAW WATER”
“FUEL GAS”
“INSTRUMENT AIR”

3 METHOD OF IDENTIFICATION

3.1 legends

This Standard considers a legend to be primary and explicit for identification of contents. Positive identification of the contents of a piping system shall be by lettered legend, giving the name of the contents in full or abbreviated form (see Table 1). Arrows shall be used to indicate direction of flow. Where flow can be in both directions, arrows in both directions shall be displayed. Contents shall be identified by a legend with sufficient additional details such as temperature, pressure, etc., as are necessary to identify the hazard.

Legends shall be brief, informative, pointed, and simple for greatest effectiveness. Legends shall be applied close to valves or flanges and adjacent to changes in direction, branches, and where pipes pass through walls or floors; and at intervals on straight pipe runs sufficient for identification. Identification may be accomplished by stenciling, the use of tape, or markers. In any situation, the number and location of identification markers shall be based on the particular piping system.

3.2 Color

Color should be used to identify the characteristic hazards of the contents. Color should be displayed on or contiguous to, the piping by any physical means, but its use shall be in combination with legend. Color may be used in continuous, total length coverage or in intermittent displays. Colors preceded by the word "Safety" shall meet the requirements of ANSI Z535.1. See Table 2.

3.3 Visibility

Attention shall be given to visibility with reference to pipe markings. Where pipelines are located above or below the normal line of vision, the lettering shall be placed below or above the horizontal centerline of the pipe. See Fig. 1.

3.4 Type and Size of Letters – Table 2 – Color

Fluid Service	Background Color	Letter Color	Color and Letter Sample
Fire quenching fluids	Safety Red	White	Letters
Hazardous liquids	Safety Orange	Black	Letters
Flammable fluids, High temperature/High Pressure fluids, Electrical hazard	Safety Yellow	Black	Letters
Combustible fluids	Safety Brown	White	Letters
Non-hazardous fluids	Safety Green	White	Letters
Compressed Air	Safety Blue	White	Letters
Hazardous Gas	Safety White	Black	Letters

Contrast shall be provided between color field and legend for readability. Use of letters of standard style} in sizes ~ in. (13 mm) and larger, is recommended. See Table 3 for specific size recommendations. For identification of materials in pipes of less than %in.

(19 mm) in diameter, and for valve and fitting identification, the use of a permanently legible tag is recommended.

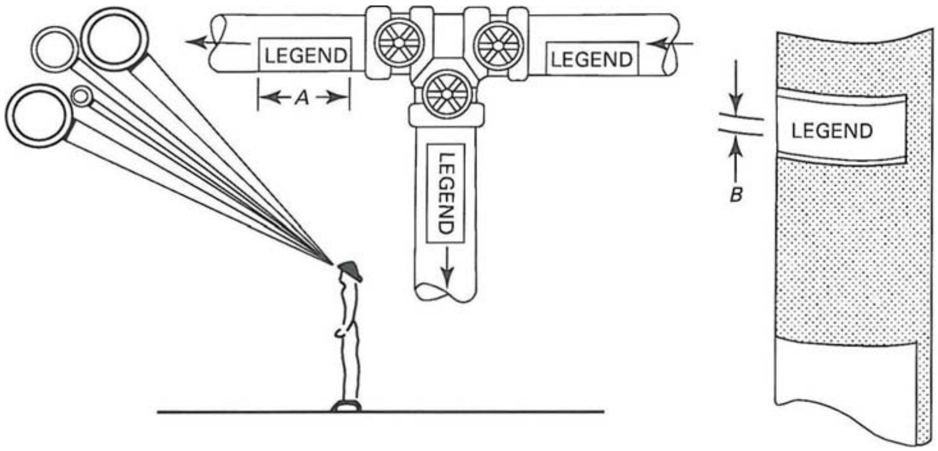
3.5 Unusual or Extreme Situations

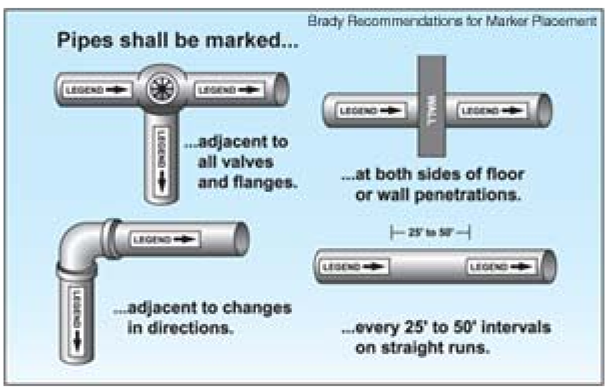
When the piping layout creates or occurs in a limited area of inaccessibility or of extreme complexity, such segments of layouts may require substitute techniques to achieve positive identification. Use of substitute techniques shall be limited to such segments and shall not deviate from the concept of identification described in paragraphs. 3.1, 3.2, and 3.3.

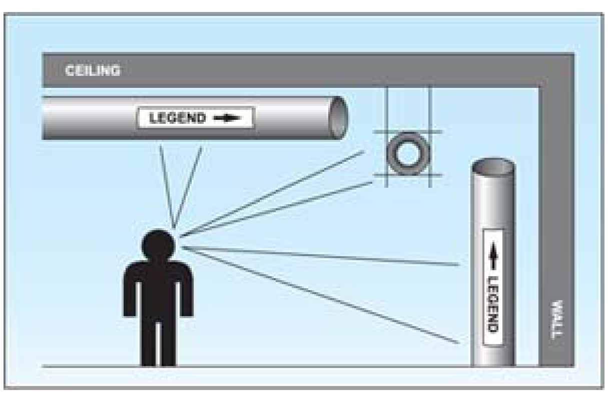
Table 3 Size of Legend Letters

Outside Diameter of Pipe Covering (in.)	Length of Color Field (in.)	Size of Letters (in.)
¾ to 1 ¼	8”	½”
1 ½ to 2	8”	¾”
2 ½ to 6	12”	1 ¼”
8 to 10	24”	2 ½”
Over 10	32”	3 ½”

Figure 1


LEGEND
LEGEND
A
LEGEND
B
LEGEND


Brady Recommendations for Marker Placement
Pipes shall be marked...
...adjacent to all valves and flanges.
WALL
...at both sides of floor or wall penetrations.
25' to 50'
...adjacent to changes in directions.
...every 25' to 50' intervals on straight runs.


CEILING
LEGEND
LEGEND
WALL

1.0 PURPOSE

The purpose of this standard is to provide minimum specifications for new installation of Switchgear, Load Centers, and Motor Control Centers to incorporate safe and effective infrared data collection methods within the PacifiCorp generation fleet.

2.0 SAFETY

Safety is the number one priority. All safety precautions and procedures must be stringently followed. Be alert and move slowly, deliberately, and cautiously when working around high energy electrical equipment. Proper Personal Protective Equipment (PPE) must be worn at all times while performing work on energize equipment. When in doubt, treat all electrical equipment as energized until the equipment is confirmed de-energized.

3.0 BACKGROUND

3.1. Hereafter in this specification, any changes in the scope of the original Purchase Order or deviations from this specification must be confirmed through PacifiCorp Purchasing Department. Decisions of a technical nature may be referred to the PacifiCorp Engineering Department, but this does not relieve the vendor of confirming these decisions with the PacifiCorp Purchasing Department or PacifiCorp Representative.

3.2. Current industrial standards referred to in the document shall be followed unless otherwise specified by the PacifiCorp Purchase Order and confirmed by the PacifiCorp Purchasing Department or PacifiCorp Representative.

3.3. References to manufacturer's names or to identify quality. Alternate makes are permissible, but the approval must be obtained from the PacifiCorp Representative.

4.0 APPLICABLE INDUSTRIAL STANDARDS

4.1. National Electric Code

4.2. NFPA 70E – Standard for Electrical Safety in the Workplace

4.3. OSHA 29-CFR Part 1910 – Occupational Safety and Health Standards

4.4. IEEE 1584 – Guide for Performing Are-Flash Hazard Calculations

4.5. PacifiCorp Energy Generation – Electrical Safety Program

5.0 STANDARD

5.1. Arc Flash Hazard Analysis

5.1.1. In compliance with an a PacifiCorp approved Arch Flash Hazard Analysis Study, a PacifiCorp approved Arc Flash Warning Label shall be applied as described in the PacifiCorp Electrical Safety Program.

5.2. Installation of Viewports

5.2.1. For equipment with calculated PPE requirements greater than 2, Mikron Spyglass viewports (Mikron part number 20110-3) or other PacifiCorp approved viewport will be installed such that:

5.2.1.1. Connections to the bus can be easily viewed utilizing a spyglass lens. In most cases, to view all phases, multiple viewports will be required

5.2.1.2. Wires to equipment down line or to breakers, fuses, or overloads can easily been seen at or near the termination.

5.2.1.3. A label identifying the equipment to be view is placed above the viewport in order to capture a visual image identifier of the equipment while collecting the infrared image.

5.2.2. Consistent and symmetric placement of required viewport installation should be observed.

5.3. Installation Location

5.3.1. The equipment shall be installed such that all connections to the main bus can be easily seen by opening hinged doors or access panels. Excessive efforts to view connections to the main bus that could potentially put a person at risk of electrical shock will not be accepted.

5.3.2. The equipment shall be installed such that no other equipment, walls, or items lie within the calculated restricted approach boundary plus one linear foot.

5.4. Access

5.4.1. All access panels or doors shall be self supporting hinge type.

6.0 GUARANTEE

6.1. The manufacture shall guarantee the final product against defective workmanship and materials for a minimal period of one year after the installation of the motor. This period may be extended as defined by the Purchase Order.

6.2. Any defects in materials or workmanship will be repaired by the vendor at the vendor's expense.

7.0 SUPPLEMENT

7.1. Any questions regarding this standard can be directed to the PacifiCorp Generation Support Predictive Maintenance Group at:

PacifiCorp Generation Support
Attn: Predictive Maintenance Group
1407 W. North Temple Room 330
Salt Lake City, Ut. 84116

1.0 PURPOSE

The purpose of this standard is to provide minimum specifications for new installation motors to be used within the PacifiCorp generation fleet. This standard will detail the requirements for all three phase motor applications.

2.0 SAFETY

Safety is the number one priority. All safety precautions and procedures must be stringently followed. Be alert and move slowly, deliberately and cautiously when working around rotating equipment.

3.0 BACKGROUND

3.1. Hereafter in this specification, any changes in the scope of the original Purchase Order or deviations from this specification must be confirmed through PacifiCorp Purchasing Department. Decisions of a technical nature may be referred to the PacifiCorp Engineering Department, but this does not relieve the vendor of confirming these decisions with the PacifiCorp Purchasing Department or PacifiCorp Representative.

3.2. Current industrial standards referred to in the document shall be followed unless otherwise specified by the PacifiCorp Purchase Order and confirmed by the PacifiCorp Purchasing Department or PacifiCorp Representative.

3.3. Any motors exceeding the ratings described in the applicable industrial standards or this standard will be addressed on a case-by-case basis or be specified within the Purchase Order.

4.0 APPLICABLE INDUSTRIAL STANDARDS

4.1. NEMA MG-1 – Motors and Generators

4.2. NEMA MG-2 – Safety Standard and Guide for Selection, Installation, and Use of Electrical Motors and Generators

4.3. National Electric Code

4.4. IEEE 112 – IEEE Standard Test Procedure for Polyphase Induction Motors and Generators

4.5. IEEE 841 – IEEE Standard for Petroleum and Chemical Industry – Premium-Efficiency, Severe-Duty, Totally Enclosed Fan-Cooled (TEFC) Squirrel Case Induction Motors – Up to and Including 370 kW (500 hp)

4.6. AFBMA – Antifriction Bearing Manufacturer Associate Standards, As Related to Boundary Dimension Tolerances and Load Ratings for Electric Motor Applications

4.7. NEMA MW 1000 – Magnetic Wire

5.0 STANDARD

5.1. Enclosure

5.1.1. All motors will be designed for industrial application and conform to the NEMA MG-1 industrial standard. Other specifications will be implied by the Purchase Order.

5.2. Starting Duty

5.2.1. All motors will be rated for full voltage starting.

5.3. Winding and Insulation

5.3.1. Motor windings will be constructed using copper wire. The motor insulation system must have at least a Class B rating.

5.3.2. VFD motor insulation system must be at least class H rating.

5.4. Bearings

5.4.1. All lifetime lubrication bearings shall have rubber seals on both sides of the bearing. Bearings shall be rated over 200 degree Fahrenheit.

5.4.2. Motors with greasable antifriction bearings shall have grease fitting extended above the top of the motor frame. A 2.5 pound relief plug will be installed in the purge port of the motor. On the endbell side of the motor fitting shall extend above and below the endbell.

5.4.3. Antifriction bearings shall be SKF unless otherwise approved by PacifiCorp.

5.4.4. For straight-bore bearings a “C-3” fit or equivalent is required.

5.5. Shaft

5.5.1. The run-out of the shaft shall not exceed 0.001 TIR.

5.6. Terminal Boxes

5.6.1. All motor lead terminal boxes on motors below 200 horsepower shall be one size larger than standard NEMA MG-1. On motors 200 horsepower and larger, oversized terminal boxes will provide a pliable seal for motor leads and a pliable seal for terminal box cover. Terminal box must be the same NEMA rating as the motor enclosure and contain a grounding lug.

5.7. Vibration – AC Motor Analysis and Acceptance

5.7.1. Alternating current motors will be tested at rated voltage and frequency, and no load. Single speed alternating current motors will be tested at synchronous (running) speed. A multi-speed alternating current motor will be tested at all its rated synchronous (running) speeds.

5.7.2. Method of Motor Isolation for Measuring Vibration

5.7.2.1. Place the motor on an elastic mounting so proportioned that the up and down natural frequency shall be at least as low as 25 percent of the test speed of the motor. To accomplish this it is required that the elastic mounting be deflected downwards at least by the amounts shown in the following table due to the weight of the motor. When a flexible pad is used the compression shall in no case be more than 50 percent of the original thickness of the flexible pad; otherwise the supports may be too stiff.

MOTOR SYNCHRONOUS SPEED (RPM)	ISOLATION PAD COMPRESSION (INCHES)
600	2-1/4
900	1
1200	9/16
1800	1/4
3600	1/16
7200	1/64
Note: The required deflection is inversely proportional to the speed squared.	

Table 1

Completely assembled motors shall have a percentage separation between the rotor shaft first actual critical speed and the rated motor speed as specified:

ROTOR DESIGN	FIRST ACTUAL CRITICAL SPEED LOCATION
Rigid Shaft	At least 25% Above Rated Motor Speed
Flexible Shaft	Maximum of 85% of Motor Speed

Table2

MAXIMUM ALLOWABLE VIBRATION LEVELS FOR ELECTRIC MOTORS			
BAND	FREQUENCY RANGE	VELOCITY LINE AMPLITUDE BAND LIMITS (INCH/SEC PEAK)	ACCELERATION BAND LIMITED OVERALL AMPLITUDE LIMITS (g's PEAK)
1	0.3 x RPM 0.8 x RPM	0.04	0.5
2	0.8 x RPM 1.2 x RPM	0.075	0.5
3	1.2 x RPM 3.5 x RPM	0.04	0.5
4	3.5 x RPM 8.5 x RPM	0.03	0.5
5	8.5 x RPM 60,000 CPM	0.03	0.5
6	60,000 CPM 120,000 CPM	0.03	0.5

Table 3

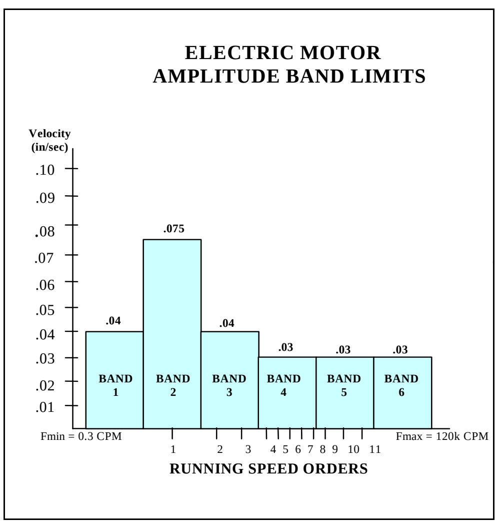


Figure 1

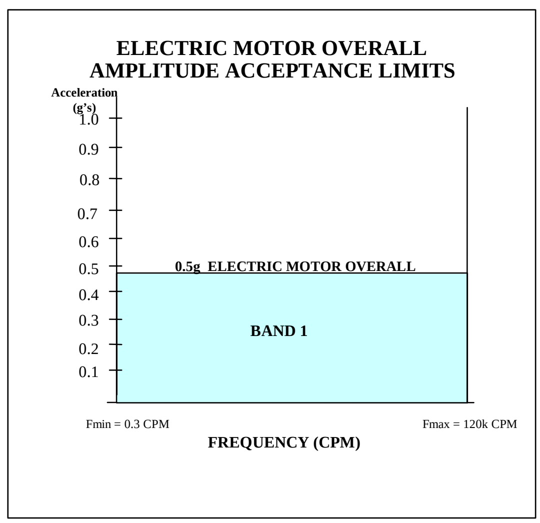


Figure 2

5.7.3. Running speed vibration amplitudes must be within the API 684 4W/N tolerance.

5.8. Efficiency

5.8.1. Motors will have a guaranteed minimum efficiency at full load greater than or equal to the values listed in the table below. If efficiency is not listed below, the manufacture shall use the efficiency defined by the Purchase Order. Motor with efficiencies below the value listed can be penalized as defined by the Purchase Order. All testing will be done in accordance with IEEE 112 method B.

			2-Pole		4-Pole		6-Pole		8-Pole	
kW	hp	Voltage class	Nom. effic. %	Min. effic. %	Nom. effic. %	Min. effic. %	Nom. effic. %	Min. effic. %	Nom. effic. %	Min. effic. %
0.75	1	600 V	77.0	74.0	85.5	82.5	82.5	80.0	75.5	72.0
1.1	1.5	600 V	84.0	81.5	86.5	84.0	87.5	85.5	78.5	75.5
1.5	2	600 V	85.5	82.5	86.5	84.0	88.5	86.5	84.0	81.5
2.2	3	600 V	86.5	84.0	89.5	87.5	89.5	87.5	85.5	82.5
3.7	5	600 V	88.5	86.5	89.5	87.5	89.5	87.5	86.5	84.0
5.5	7.5	600 V	89.5	87.5	91.7	90.2	91.0	89.5	86.5	84.0
7.5	10	600 V	90.2	88.5	91.7	90.2	91.0	89.5	89.5	87.5
11	15	600 V	91.0	89.5	92.4	91.0	91.7	90.2	89.5	87.5
15	20	600 V	91.0	89.5	93.0	91.7	91.7	90.2	90.2	88.5
19	25	600 V	91.7	90.2	93.6	92.4	93.0	91.7	90.2	88.5
22	30	600 V	91.7	90.2	93.6	92.4	93.0	91.7	91.7	90.2
30	40	600 V	92.4	91.0	94.1	93.0	94.1	93.0	91.7	90.2
37	50	600 V	93.0	91.7	94.5	93.6	94.1	93.0	92.4	91.0
45	60	600 V	93.6	92.4	95.0	94.1	94.5	93.6	92.4	91.0
55	75	600 V	93.6	92.4	95.4	94.5	94.5	93.6	93.6	92.4
75	100	600 V	94.1	93.0	95.4	94.5	95.0	94.1	93.6	92.4
95	125	600 V	95.0	94.1	95.4	94.5	95.0	94.1	94.1	93.0
110	150	600 V	95.0	94.1	95.8	95.0	95.8	95.0	94.1	93.0
150	200	600 V	95.4	94.5	96.2	95.4	95.8	95.0	94.5	93.6
190	250	600 V	95.8	95.0	96.2	95.4	95.8	95.0	94.5	93.6
		2300/4000 V	95.0	94.1	95.0	94.1	95.0	94.1	95.0	94.1
220	300	600 V	95.8	95.0	96.2	95.4	95.8	95.0	–	–
		2300/4000 V	95.0	94.1	95.0	94.1	95.0	94.1	95.0	94.1
260	350	600 V	95.8	95.0	96.2	95.4	95.8	95.0	–	–
		2300/4000 V	95.0	94.1	95.0	94.1	95.0	94.1	95.0	94.1
300	400	600 V	95.8	95.0	96.2	95.4	95.8	95.0	–	–
		2300/4000 V	95.0	94.1	95.0	94.1	95.0	94.1	95.0	94.1
340	450	600 V	95.8	95.0	96.2	95.4	95.8	95.0	–	–
		2300/4000 V	95.0	94.1	95.0	94.1	95.0	94.1	95.0	94.1
370	500	600 V	95.8	95.0	96.2	95.4	95.8	95.0	–	–
		2300/4000 V	95.0	94.1	95.0	94.1	95.0	94.1	95.0	94.1

Table 4- IEEE 840-2009 - Minimum full load efficiency of enclosed motors

6.0 MOTOR RATINGS

6.1. Service Factor/Winding Temperature

6.1.1. Motors will have a service factor of 1.15 with a class B (90°C) winding temperature rise measured by stator resistance operating under conditions of:

a) 40°C ambient temperature
b) elevation of 6600 feet above sea level
c) rated voltage
d) rated frequency
e) service factor of 1.0

Temperature rise at full load will be determined by using IEEE 112. If testing is performed at sea level, temperature rise will be corrected as indicated by the IEEE 112-2004 note in section 5.8.5.

6.2. Duty

6.2.1. Motors will be rated for continuous duty unless otherwise specified in the Purchase Order.

7.0 MOTOR TESTING

7.1. Testing methods

7.1.1. All required testing as indicated on the Purchase Order or by this standard will be perform in accordance to the IEEE 112 standard test procedures.

7.2. Test Witness

7.2.1. PacifiCorp reserves the right to witness any required testing performed.

7.3. Required testing

7.3.1. All testing defined in Appendix A and B

7.3.2. Efficiency

7.3.3. Any additional testing as defined by the Purchase Order

8.0 NAMEPLATE DATA

8.1. Motor nameplate data must include data as required by NEMA GM-1. This information must be metal stamped in the nameplate. No painted nameplate information will be allowed. Additional information, including drive end and opposite end bearings identified by "bearing manufacturer's" numbers, minimum guaranteed operating efficiency, temperature rise at specified elevation and specified service factor, and purchase order number are to be included on a readily visible stainless steel nameplate which is permanently attached. Adhesive-type nameplates are not acceptable.

9.0 DOCUMENTATION

9.1. Dimensional Drawings

9.1.1. Two copies of an accurate dimensional drawing will be provided by the manufacturer for any motor supplied. One copy of the drawings is to accompany the motor delivered to the PacifiCorp facility; the other copy shall be sent via email to the Project Manager and/or PacifiCorp Buyer and shall include the PacifiCorp Purchase Order Number for reference.

9.2. Predictive Maintenance Tools Data

9.2.1. Two copies of data to support predictive maintenance analysis are to be provided by the manufacturer for any motor supplied. One copy of the data is to accompany the motor delivered to the PacifiCorp facility; the other copy shall be sent via email to the Predictive Maintenance Corporate group, the Project Manager, and the PacifiCorp Buyer and shall include the PacifiCorp Purchase Order Number. The information to be supplied must include but not limited to:

9.2.1.1.Appendix A – Shop Precision Balance Certificate

9.2.1.2.Appendix B – Required PacifiCorp Test Results

9.2.1.3.Appendix C – Required Motor Data

10.0 GUARANTEE

10.1. The manufacture shall guarantee the final product against defective workmanship and materials for a minimal period of one year after the installation of the motor. This period may be extended as defined by the Purchase Order.

10.2. Any defects in materials or workmanship will be repaired by the vendor at the vendor’s expense.

11.0 SHIPPING

11.1. Each electric motor assembly shall be shipped in a separate shipping crate plainly marked on four sides, by a means not affected by weather or handling, with PacifiCorp Electric Operations’ purchase order number, stock item number, and material commodity code numbers.

11.2. Motors will be shipped via the most expeditious route possible, using commercial transportation or individual company delivery methods. Any motor needed on an emergency status will be routed and trafficked through PacifiCorp Electric Operations' traffic department traffic number which is available upon request.

12.0 ATTACHMENTS

12.1. Appendix A – Shop Precision Balance Certificate

12.2. Appendix B – Required PacifiCorp Test Results

12.3. Appendix C – Required Motor Data

13.0 SUPPLEMENT

13.1. Any questions regarding this standard can be directed to the PacifiCorp Generation Support Predictive Maintenance Group at:

PacifiCorp Generation Support
Attn: Predictive Maintenance GroupAlb
1407 W. North Temple Room 330
Salt Lake City, Ut. 84116

Appendix A - Shop Precision Balance Certificate

BALANCE INFORMATION	
PacifiCorp Plant:	
Vendor Name:	
PO Number:	
Machine Name:	
Equipment ID:	
Serial Number:	
Work Order Number:	
Date Balancing Completed:	
Approximate Rotor Weight (lbs):	
Natural Frequencies:	
Balance Speed:	
Rotation (looking driver to driven):	
Location of Phase Reference:	
Final Balance Vectors:	
Stack Balance Required (y/n):	
PacifiCorp Witness (y/n):	
Type key used:	
Balance Machine Type (circle one):	Hard Bearing / Soft Bearing

Note: A maximum of five (5) balance correction runs shall be performed to achieve the specified tolerances. If specified tolerances cannot be accomplished in five (5) runs Vendor is to contact PacifiCorp personnel for further direction.

BALANCE JOB DATA, TOLERANCE and CALCULATIONS					
Plane 1			**Plane 2**		
Allowable Unbalance Tolerance: 4(W)/N			***Allowable Unbalance Tolerance: 4(W)/N***		
W (Rotor Weight) =			W (Rotor Weight) =		
W x 4 =			W x 4 =		
Divide by N (Service RPM) =			Divide by N (Service RPM) =		
Divide by 2 for two planes =			Divide by 2 for two planes =		
Allowable Unbalance (Oz-In) =			Allowable Unbalance (Oz-In) =		
Balance Achieved (Oz-In) =			Balance Achieved (Oz-In) =		
Final Weight (w, radius, Ang) =			Final Weight (w, radius, Ang) =		
Initial Run (Amp, Phase) =			Initial Run (Amp, Phase) =		
Final Run (Amp, Phase) =			Final Run (Amp, Phase) =		
Final Weight (w, radius) =			Final Weight (w, radius) =		
Influence Cf. (mil/w-in, phase)			Influence Cf. (mil/w-in, phase)		
Rotor Sns. (w-in/mil, phase)			Rotor Sns. (w-in/mil, phase)		

Example (Umax = 4W/N): Rotor weight = 1500 lbs, RPM = 3600

Umax = 4 x 1500 = 6000, 6000/3600 = 1.67, 1.67/2 => 0.83 oz-in (per plane)

Notes

Name: Signature:

Appendix B – Required PacifiCorp Test Results

Manufacturer:	
PacifiCorp Purchase Order:	
Motor Serial Number:	

Winding Tests

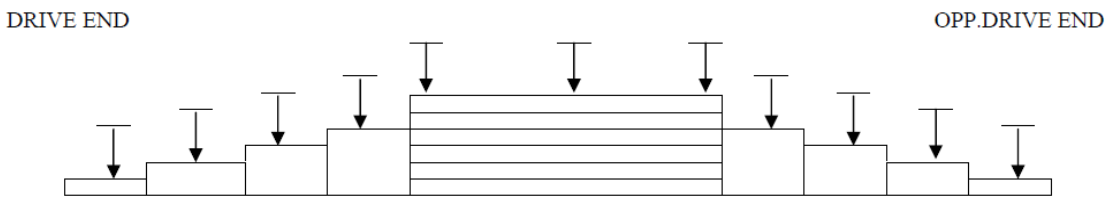
Type of Test	Stator					Wound Rotor				
	Ambient Air Temp °C °F (Circle one)			OK	Not Ok	Ambient Air Temp °C °F (Circle One)			OK	Not Ok
Winding Resistance	ϕ1-2	ϕ2-3	ϕ3-1			ϕ1-2	ϕ2-3	ϕ3-1		
Insulation Resistance	MΩ at VDC					MΩ at VDC				
Surge Test	VAC					VAC				
Polarization Index	at VDC					at VDC				
High Pot	VAC VDC					VAC VDC				
	Minutes µA					Minutes µA				
Tested By:						Date:				

Appendix B – Required PacifiCorp Test Results (Cont.)

Vibration Tests (indication in peak inches per second)

RPM		Horizontal	Vertical	Axial
Total Test Time:				
Vibration Readings - Band 1	Drive End			
	Non-Drive End			
Vibration Readings - Band 2	Drive End			
	Non-Drive End			
Vibration Readings - Band 3	Drive End			
	Non-Drive End			
Vibration Readings - Band 4	Drive End			
	Non-Drive End			
Vibration Readings - Band 5	Drive End			
	Non-Drive End			
Vibration Readings - Band 6	Drive End			
	Non-Drive End			
Overall Vibration Readings	Drive End			
	Non-Drive End			
Drive End Bearing Temp		°F		
Non-Drive End Bearing Temp		°F		

Rotor Runout (TIR)



Test By:	
Date:	

Appendix C – Required Motor Data

Manufacturer:	
PacifiCorp Purchase Order:	
Motor Serial Number:	

Motor Speed	
# of Poles	
# of Rotor Bars	
#of Stator Slots	
Shaft Diameter	

Item	Drive End	Non-Drive End	Other
Bearing Manufacturer			
Bearing Type			
Bearing Number			

1.0 PURPOSE

The purpose of this standard is to describe the methods for the development, implementation, and management of the PacifiCorp Generation routine vibration analysis program. This standard provides engineering performance guidelines for new/rebuilt equipment acceptance and continued operation parameters of rotating equipment use by the PacifiCorp Generation fleet. The vibration limits establish a common goal of acceptability and the methods required for data acquisition excluding on-line data acquisition systems, turbines and generators.

This standard does not limit the analyst with required instrumentation or methods. Rather, it defines the final orientation, outcome, and documentation required for equipment history.

2.0 SAFETY

Safety is the number one priority. Be alert and move slowly, deliberately, and cautiously when working around rotating equipment. Common sense is the greatest safety tool that can be used. At a minimum, follow guidelines set forth in the PacifiCorp Accident Prevention Manuals and manufacturers written recommendations.

Ensure that cables, probes, clothing, and hands are kept clear of moving parts. When testing is being performed under fluorescent lighting or using a strobe light, exercise caution, because rotating machinery sometimes appears to be stopped or rotating slowly when actually rotating at normal speeds.

Placing probes on some machines could be hazardous when the machine is running. In such cases, the probes should be placed with long lead wires while the machine is not running.

3.0 BACKGROUND

Vibration analysis is a nondestructive, diagnostic activity that encompasses the acquisition and interpretation of the dynamic response of operating rotating machinery in the form of vibration data samples to determine machine condition.

The rewards of accurate and precise vibration analysis will:

- **a.** Reduce PacifiCorp Generation's operating costs by establishing acceptable vibration levels for plant rotating equipment.
- **b.** Improve the life and performance of the Generation fleet's rotating equipment.
- **c.** Provide a uniform procedure for evaluating the vibration characteristics of the Generation fleet's rotating equipment.
- **d.** Provides incipient fault and failure detection.
- **e.** Reduces maintenance costs due to minimizing equipment damage.

f. Provides advanced maintenance planning opportunities.

4.0 SCOPE

4.1. This standard establishes acceptable limits for vibration levels and is to be used to establish a new database, machine specifications, machine acceptance and continuous machine operations.

4.2. This standard establishes measurement procedures--including standardized measurement axis directions and locations, calibration and performance requirements of instrumentation, and procedures for reporting vibration data for machine acceptance.

5.0 STANDARD

5.1. **Instrumentation Requirements for Portable Vibration Analyzers**

5.1.1. FFT Analyzer shall meet or exceed the minimum specifications outlined below.

5.1.1.1. The FFT analyzer shall be capable of acquiring 6,400 Lines of Resolution.

5.1.1.2. The FFT analyzer shall be capable of acquiring 20,000 Hz.

5.1.1.3. The FFT analyzer shall be capable of acquiring a Dynamic Range 72 dB.

5.1.1.4. The FFT analyzer shall be capable of applying a Hanning window for analyzing vibration and Uniform window for impact testing.

5.1.1.5. The FFT analyzer shall be capable of linear non-overlap averaging.

5.1.1.6. The FFT analyzer shall have anti-aliasing filters.

5.1.2. **Portable Vibration Analyzer Measurement System Accuracy** - The measurement system (FFT analyzer, cables, transducer and mounting) used to take vibration measurements shall have a measurement system Amplitude accuracy over the linear frequency range of ±5% for Displacement, Velocity and Acceleration.

5.1.3. **Amplitude Uncertainty**: Uniform or Rectangular (impact testing) 56.5%; Hanning (fault analysis) 18.8%; Flat Top (condition evaluation) 1.0%.

5.1.4. **Shaft Relative Proximity Probe Glitch***:* All glitch (electrical or mechanical) shall be 0.5 mils peak-peak or less as measured in-situ at 100 RPMs.

5.1.5. **Measurement System Calibration** - Vibration equipment used to take vibration measurements must be calibrated by a qualified instrumentation laboratory within a one (1) year prior. Calibration shall be traceable to the National Institute of Standards and Technology (NIST).

5.1.6. **Machine Information for Developing Routes** – Detailed machine design and historical information is required to establish an advanced vibration analysis program. This information should be gathered during machine design, installation and repairs (see attachments).

5.1.7. **Vibration Measurement Locations, Directions and Conventions**

5.1.7.1. Identification of Sampling Locations Vibration Data Collection

Number each bearing in sequence from the non-driven (NDE) end bearing of the driver (typically a motor or turbine), through the power train (in the direction of power flow), through to the non-driven (NDE) end bearing of the ultimately driven component following table below. Understanding the power flow sequencing of the machine train is vital to the diagnostic evaluation of vibration spectral data. For vertical pumps horizontal reading should be indentified 90° perpendicular to the plane of discharge flow.

Equipment ID-ABC							
Identifier "A"			Identifier "B"			Identifier "C"	
M	Motor		I	Inboard		H	Horizontal
T	Turbine		O	Outboard		V	Vertical
E	Engine		A	Axial		A	Axial
P	Pump					X	Radial-X (Horizontal)
F	Fan					Y	Radial-Y (Vertical)
C	Compressor					P	PeakVue
G	Gearbox						

5.1.7.2. Physical Marking of Measurement Points

Each point where vibration data will be periodically collected shall have 1-1/8 in diameter by 1/8 in thick (minimum) cold-rolled ferrous stainless steel disk attached as a data collection target. Each target shall be stamped with the appropriate identifier (example: Motor Outboard Horizontal = MOH).

5.1.7.3. Displacement Probes

When X & Y displacement probes are used, use the appropriate letter to designate the sensor position, i.e., A, B, C, D, E, etc., for bearings 1, 2, 3, 5, etc. The letters for horizontal and vertical (H & V) can be substituted for X & Y if desired (optional). However, when substituting H &

V for X & Y, one must adopt a convention for determining which probes correspond to horizontal and vertical as X/Y probes often do not correspond to true horizontal and vertical. In general, a horizontal (X axis) displacement probe mounted in the top half of a bearing should be located on the right side of the vertical centerline (clockwise from vertical) when viewed from the driver end regardless of direction of shaft rotation.

5.1.8. **Vibration Measurement Units**

5.1.8.1.Displacement - Mils, Peak-Peak

5.1.8.2.Velocity – in/sec, Peak

5.1.8.3.Acceleration - g's, Peak

5.1.9. **Frequency Maximum (Fmax), Low Frequency Cutoffs**

Application	**Low Frequency Cutoffs**	**Frequency Maximum**	**Lines of Resolution**	**Averages**	**Window Type**
Sleeve Bearings for machines w/o vanes	120 CPM	20xRPM	1600	8	Hanning
Sleeve Bearing machine with Vanes (or Blades)	120 CPM	20xRPM or 1.2BPF	1600	8	Hanning
Gear Box, Unknown # of Teeth	120 CPM	200xGMF	3200	8	Hanning
Gear Box, known # of Teeth	120 CPM	3.2xRPM	3200	8	Hanning
Electric Motor, Rotor Pass	120 CPM	360,000 CPM	3200	8	Hanning
Electric Motor	120 CPM	12,000 CPM	1600	8	Hanning
Tapered or Spherical Roller Bearings	120 CPM	50xRPM	1600	8	Hanning
Roller Bearings machines > 1700 RPM	120 CPM	40xRPM	1600	8	Hanning
Roller Bearings machines 1400 - 1700 RPM	120 CPM	50xRPM	1600	8	Hanning
Roller Bearings machines 1100 - 1400 RPM	120 CPM	60xRPM	1600	8	Hanning
Roller Bearings machines 800 - 1100 RPM	120 CPM	80xRPM	1600	8	Hanning
Roller Bearings machines 600 - 800 RPM	120 CPM	100xRPM	1600	8	Hanning

5.1.10. Vibration Analysis and Acceptance Limits

Criteria for Overall Vibration Condition Rating (Peak Overall, Velocity, In/Sec)

1 Assuming machine speed = 600 - 60,000 RPM
2 Assuming measurements by accelerometer or velocity pickup securely mounted as close as possible to bearing housing.
3 Assuming machine is not mounted on vibration isolators (For isolated machinery - Set Alarms 30%-50% higher).
4 Set motor Alarms the same as that for the particular machine type unless otherwise noted.
5 Set Alarms on individual external gearbox positions about 25% higher than that for a particular machine type.

Machine Type	Good	Fair	Alarm 1 (Warning)	Alarm 2 (Fault)
Cooling Tower Drives				
a) Long, hollow drive shaft	0 - 0.4	0.4 - 0.6	0.6	0.9
b) Close coupled belt drive	0 - 0.3	0.3 - 0.4	0.4	0.7
c) Close coupled direct drive	0 - 0.2	0.2 - 0.3	0.3	0.5
Compressors				
a) Reciprocating	0 - 0.3	0.3 - 0.5	0.5	0.8
b) Rotary Screw	0 - 0.3	0.3 - 0.5	0.5	0.7
c) Centrifugal - with or W/O external gearbox	0 - 0.2	0.2 - 0.3	0.3	0.5
d) Centrifugal - Integrated gear (axial meas.)	0 - 0.2	0.2 - 0.3	0.3	0.5
e) Centrifugal - Integrated gear (radial meas.)	0 - 0.2	0.2 - 0.3	0.3	0.4
Fans/Blowers				
a) Lobe-type rotary	0 - 0.3	0.3 - 0.5	0.5	0.7
b) Belt driven blower	0 - 0.3	0.3 - 0.5	0.5	0.7
c) General direct drive fans (with coupling)	0 - 0.3	0.3 - 0.4	0.4	0.6
d) Primary air fans	0 - 0.3	0.3 - 0.4	0.4	0.6
e) Forced draft fans	0 - 0.2	0.2 - 0.3	0.3	0.5
f) Induced draft fans	0 - 0.2	0.2 - 0.3	0.3	0.4
g) Shaft mounted integral fans	0 - 0.2	0.2 - 0.3	0.3	0.4
h) Vane-Axial fans	0 - 0.2	0.2 - 0.3	0.3	0.4
Turbine/Generators				
a) 3600 RPM Turbine/Generators	Refer to OEM Specifications			
b) 1800 RPM Turbine/Generators	Refer to OEM Specifications			
Centrifugal Vertical Pumps				
a) Vertical pumps (12'-20' high)	0 - 0.3	0.3 - 0.5	0.5	0.8
b) Vertical pumps (8'-12' high)	0 - 0.3	0.3 - 0.4	0.4	0.6
c) Vertical pumps (5'-8' high)	0 - 0.2	0.2 - 0.4	0.4	0.5
d) Vertical pumps (0'-5' high)	0 - 0.2	0.2 - 0.3	0.3	0.5
Centrifugal Horizontal Pumps				
a) General purpose, direct coupled	0 - 0.2	0.2 - 0.3	0.3	0.5
b) Boiler feed pumps	0 - 0.2	0.2 - 0.3	0.3	0.5
c) Hydraulic Pumps	0 - 0.1	0.1 - 0.2	0.2	0.3

* Note: the "Alarm1" and "Alarm2" overall levels given above apply only to in-service machinery which has been operating for some time after initial installation and/or overhaul. See section 5.7.2 for Acceptance Criteria for New and Rebuilt Machinery.

5.1.11. **Vibration Monitoring Spectral Band Alarm Limits**

SPECTRAL BAND ALARM LIMITS			
a) General Sleeve Bearing Machines (without vanes)			
Band	Frequency Range	Alarm Setting	
1	[0.2 → 0.8] x RPM	20% Overall Alarm	
2	[0.8 → 1.8] x RPM	90% Overall Alarm	
3	[1.8 → 2.8] x RPM	40% Overall Alarm	
4	[2.8 → 3.8] x RPM	30% Overall Alarm	
5	[3.8 → 10.2] x RPM	25% Overall Alarm	
6	[10.2 → 20] x RPM	20% Overall Alarm	
b) Gearbox (known number of teeth)			
Band	Frequency Range	Alarm Setting	
1	[0.25 → 0.75] x GMF	25% Overall Alarm	
2	[0.75 → 1.25] x GMF	70% Overall Alarm	
3	[1.25 → 1.75] x GMF	25% Overall Alarm	
4	[1.75 → 2.25] x GMF	50% Overall Alarm	
5	[2.25 → 2.75] x GMF	25% Overall Alarm	
6	[2.75 → 3.25] x GMF	40% Overall Alarm	
c) Gearbox (unknown number of teeth)			
Band	Frequency Range	Alarm Setting	
1	[20 → 50] x RPM	60% Overall Alarm	
2	[50 → 80] x RPM	60% Overall Alarm	
3	[80 → 110] x RPM	50% Overall Alarm	
4	[110 → 140] x RPM	50% Overall Alarm	
5	[140 → 170] x RPM	40% Overall Alarm	
6	[170 → 200] x RPM	40% Overall Alarm	
d) Electric Motor Rotor Bar (measured at motor outboard bearing horizontal)			
Band	Frequency Range	Alarm Setting	
1	[30k → 85k] x CPM	0.06 in/sec	
2	[85k → 140k] x CPM	0.06 in/sec	
3	[104k → 195k] x CPM	0.05 in/sec	
4	[195k → 250k] x CPM	0.045 in/sec	
5	[205k → 305k] x CPM	0.04 in/sec	
6	[305k → 360k] x CPM	0.035 in/sec	
e) Electric Motor (measured at motor inboard bearing horizontal)			
Band	Frequency Range	Alarm (600-2k) RPM	Alarm (2k-4k) RPM
1	[240 → 2k] x CPM	90% OA Alarm	30% OA Alarm
2	[2k → 4k] x CPM	40% OA Alarm	90% OA Alarm
3	[4k → 6k] x CPM	40% OA Alarm	40% OA Alarm
4	[6k → 8k] x CPM	35% OA Alarm	35% OA Alarm
5	[8k → 10k] x CPM	30% OA Alarm	30% OA Alarm
6	[10k → 12k] x CPM	25% OA Alarm	25% OA Alarm
f) Tapered or Spherical Roller Element Bearing Machines (without vanes)			

Band	Frequency Range	Alarm Setting
1	[0.4 → 1.2] x RPM	90% Overall Alarm
2	[1.2 → 2.2] x RPM	40% Overall Alarm
3	[2.2 → 3.2] x RPM	30% Overall Alarm
4	[3.2 → 12.2] x RPM	25% Overall Alarm
5	[12.2 → 20] x RPM	20% Overall Alarm
6	[20 → 50] x RPM	15% Overall Alarm
g) General Roller Element Bearing Machines (without vanes)		
Band	Frequency Range	Alarm Setting
1	[0.4 → 1.2] x RPM	90% Overall Alarm
2	[1.2 → 2.2] x RPM	40% Overall Alarm
3	[2.2 → 3.2] x RPM	30% Overall Alarm
4	[3.2 → 12.2] x RPM	25% Overall Alarm
5	[12.2 → 20] x RPM	20% Overall Alarm
6	[20 → Fmax] x RPM	15% Overall Alarm
h) Centrifugal Machines (known number of vanes or blades & roller bearings)		
Band	Frequency Range	Alarm Settings
1	[0.4 → 1.2] x RPM	90% Overall Alarm
2	[1.2 → 2.2] x RPM	40% Overall Alarm
3	[2.2 → (BPF-1.2)] x RPM	35% Overall Alarm
4	[(BPF-1.2) → (BPF+1.2)] x RPM	60% Overall Alarm
5	[(BPF+1.2) → 20] x RPM	35% Overall Alarm
6	[20 → Fmax] x RPM	20% Overall Alarm
i) Centrifugal Machines (unknown number of vanes or blades & roller bearings)		
Band	Frequency Range	Alarm Settings
1	[0.4 → 1.2] x RPM	90% Overall Alarm
2	[1.2 → 2.2] x RPM	40% Overall Alarm
3	[2.2 → 3.2] x RPM	30% Overall Alarm
4	[3.2 → 6.8] x RPM	60% Overall Alarm
5	[6.8 → 20] x RPM	35% Overall Alarm
6	[20 → Fmax] x RPM	20% Overall Alarm
j) Centrifugal Machines (known number of vanes or blades & sleeve bearings)		
Band	Frequency Range	Alarm Settings
1	[0.2 → 0.8] x RPM	20% Overall Alarm
2	[0.8 → 1.8] x RPM	90% Overall Alarm
3	[1.8 → 3.8] x RPM	40% Overall Alarm
4	[3.8 → (BPF-1.2)] x RPM	30% Overall Alarm
5	[(BPF-1.2) → (BPF+1.2)] x RPM	70% Overall Alarm
6	[(BPF+1.2) → 20] x RPM	35% Overall Alarm
k) Centrifugal Machines (unknown number of vanes or blades & sleeve bearings)		
Band	Frequency Range	Alarm Settings
1	[0.2 → 0.8] x RPM	20% Overall Alarm
2	[0.8 → 1.8] x RPM	90% Overall Alarm
3	[1.8 → 3.8] x RPM	40% Overall Alarm
4	[3.8 → 7.8] x RPM	70% Overall Alarm
5	[7.8 → 9.8] x RPM	25% Overall Alarm

6	[9.8 → 20] x RPM	35% Overall Alarm

5.2. **Routine Data Collection –** Requirements for regular data collection of vibration data.

5.2.1. **Collecting Vibration Samples of Equipment Operating at a Limited Capacity.** Process variable must be collected to reflect any changes in vibration analysis spectrum.

5.2.2. **Collecting Vibration Samples for Comparative Data to On-Line Systems.** Online vibration data collection shall be collected as route data if the online system is not capable of condition assessment.

5.3. **Continuous Diagnostic Monitoring**

5.3.1. All turbo machinery, boiler feed pump, forced draft and induced draft shall include Bently Nevada System 1 diagnostic platform.

5.3.2. Continuous diagnostic monitoring of critical equipment shall include the ability to perform advanced vibration analysis functions included, but not limited to: Orbit, Bode, Time Wave, Spectrum, Polar, Centerline, Waterfall Plots, and Transient Events storage.

5.3.3. **Measurement Point Setup** – Refer to condition monitoring OEM recommendations, administer modify as necessary.

5.3.4. **Data Storage** – Startups and Shutdowns, monthly auto archiving are required for all critical equipment monitored.

5.4. **Data Reduction and Analysis**

5.4.1. Initial baselines shall be established when the machine component is first monitored after acceptance criteria has been met and running under normal operational condition. Baseline data shall form the reference base for vibration trending.

5.4.2. New baselines are to be established following any maintenance activities which would improve established baseline data.

5.4.3. Collected vibration data shall be compared to component baselines during every monitoring period to identify adverse trends or abnormal equipment conditions.

5.4.4. Collected vibration data shall be reviewed for the identification of any alert, warning, or alarm conditions. Any readings which are indicative of degrading equipment condition shall be reported and a plan developed to resolve the problem.

5.5. **Reporting and Notification**

5.5.1. Develop, maintain, and publish a "vibration route problem report" to process owners, planners, and plant management.

5.5.2. Report equipment problem to person(s) responsible for maintenance of equipment in failure mode and ensure notification is written.

5.5.3. Report equipment condition on new or rebuilt equipment to person responsible for maintenance on that piece of equipment and maintain history.

5.5.4. Record in "History" section of vibration software relevant data of failure, repairs required, complete repairs, rebuilds, etc.

5.5.5. Maintain and report required vibration analysis performance indicators.

5.6. **Equipment Analysis, Acceptance and Verification**

5.6.1. **Machinery Vibration System Verification** – Prior to release for service, vibration systems shall be verified for proper installation and accuracy.

SECTION 5.7.2

5.6.2. **AC MOTORS ANALYSIS AND ACCEPTANCE**

5.6.2.1. Alternating current motors will be tested at rated voltage and frequency, and no load. Single speed alternating current motors will be tested at synchronous (running) speed. A multi-speed alternating current motor will be tested at all its rated synchronous (running) speeds. Direct current motors will be tested at their highest rated speed. Series and universal motors will be tested at operating speed.

5.6.2.2. Method of Motor Isolation for Measuring Vibration
Place the motor on an elastic mounting so proportioned that the up and down natural frequency shall be at least as low as 25 percent of the test speed of the motor. To accomplish this it is required that the elastic mounting be deflected downwards at least by the amounts shown in the following table due to the weight of the motor. When a flexible pad is used the compression shall in no case be more than 50 percent of the original thickness of the flexible pad; otherwise the supports may be too stiff.

MOTOR SYNCHRONOUS SPEED (RPM)	ISOLATION PAD COMPRESSION (INCHES)
600	2-1/4
900	1
1200	9/16
1800	1/4
3600	1/16
7200	1/64
Note: The required deflection is inversely proportional to the speed squared.	

Table 1

Completely assembled motors shall have a percentage separation between the rotor shaft first actual critical speed and the rated motor speed as specified:

ROTOR DESIGN	**FIRST ACTUAL CRITICAL SPEED LOCATION**
Rigid Shaft	At least 25% Above Rated Motor Speed
Flexible Shaft	Maximum of 85% of Motor Speed

Table2

MAXIMUM ALLOWABLE VIBRATION LEVELS FOR ELECTRIC MOTORS			
BAND	FREQUENCY RANGE	VELOCITY LINE AMPLITUDE BAND LIMITS (INCH/SEC PEAK)	ACCELERATION BAND LIMITED OVERALL AMPLITUDE LIMITS (g's PEAK)
1	0.3 x RPM 0.8 x RPM	0.04	0.5
2	0.8 x RPM 1.2 x RPM	0.075	0.5
3	1.2 x RPM 3.5 x RPM	0.04	0.5
4	3.5 x RPM 8.5 x RPM	0.03	0.5
5	8.5 x RPM 60,000 CPM	0.03	0.5
6	60,000 CPM 120,000 CPM	0.03	0.5

Table 3

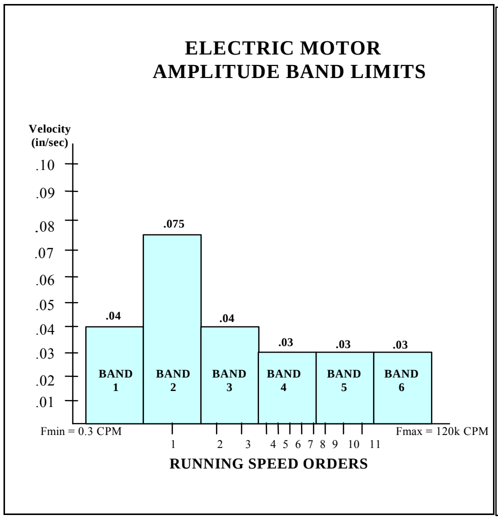


Figure 1

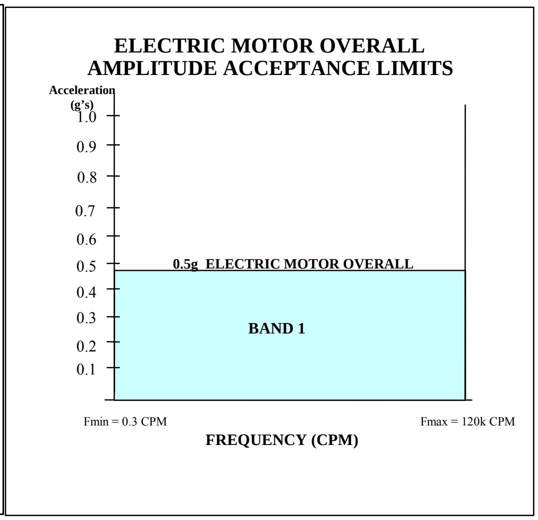


Figure 2

SECTION 5.7.3

5.6.3. FANS ANALYSIS and ACCEPTANCE

5.6.3.1. **Fans are defined as:**
All non-positive displacement air handling units including Induced Draft (ID) Fans, Forced Draft (FD) Fans, Overhung Fans, Centerhung Fans, Centrifugal, Vaneaxial, Tubeaxial, Blowers, etc.

5.6.3.2. **Shaft Tolerance**
Fan shaft diameter shall meet bearing manufacturer specifications for shaft tolerances.

5.6.3.3. **Resonance**
Natural frequencies of the completely assembled fan unit shall not be excited at the operating speed. (Running speed should be at least 25% removed from a natural frequency of the system.)

5.6.3.4. **Limits**
New and Rebuilt/Repaired Fans shall conform to the vibration limits specified in Table 4 when operating at specified system CFM and Fan Static Pressure.

The frequency range for fan certification shall be from F_{min} = 0.3 X Running Speed of Fan to 60,000 cpm for velocity and to 120,000 cpm for acceleration.

For fan speeds up to 3600 RPM, the maximum velocity amplitude (inch/sec-Peak) of vibration at bearing locations in any direction shall not exceed the Line Amplitude Band Limit values specified in Table 4 and graphed in Figure 3.

For fan speeds up to 3600 RPM, the Band-Limited Overall vibration level of acceleration (g's Peak) at bearing locations in any direction shall not exceed the Band-Limited Overall Amplitude Acceptance Limit values specified in Table 4 and graphed in Figure 4.

Acceptance limits for fans running over 3600 RPM shall be specified by the purchaser.

MAXIMUM ALLOWABLE VIBRATION LEVELS FOR FANS		
BAND	FREQUENCY RANGE	VELOCITY LINE AMPLITUDE BAND LIMITS (INCH/SEC PEAK)
1	0.3 x RPMmin 0.8 x RPM fan	0.04 DIRECT COUPLED 0.075 BELT DRIVE
2	0.8 x RPM fan 1.2 x RPM fan/motor	0.075
3	1.2 x RPM fan/motor 3.5 x RPM fan/motor	0.04
4	3.5 x RPM fan/motor to Fmax = 60,000 CPM	0.03
		ACCELERATION BAND LIMITED OVERALL AMPLITUDE LIMITS (g's PEAK)
1	0.3 x RPMmin to Fmax = 120,000 CPM	0.5
RPMmin = Lowest system speed (e.g. Belt speed if Belt Driven, Fan speed if direct drive coupled RPM fan/motor = Fan or motor speed whichever is greater (IN/SEC)		

Table 4

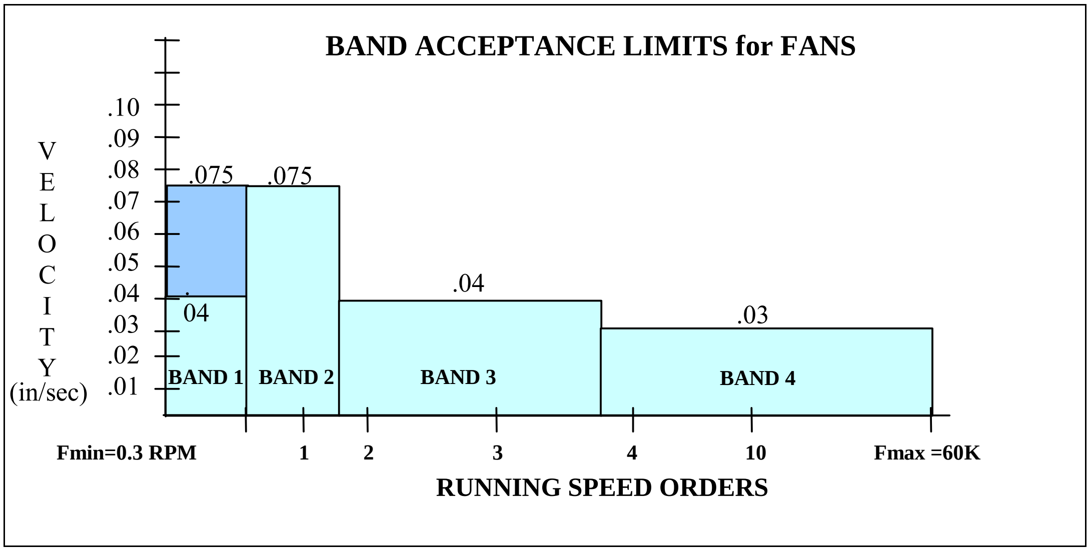


Figure 3

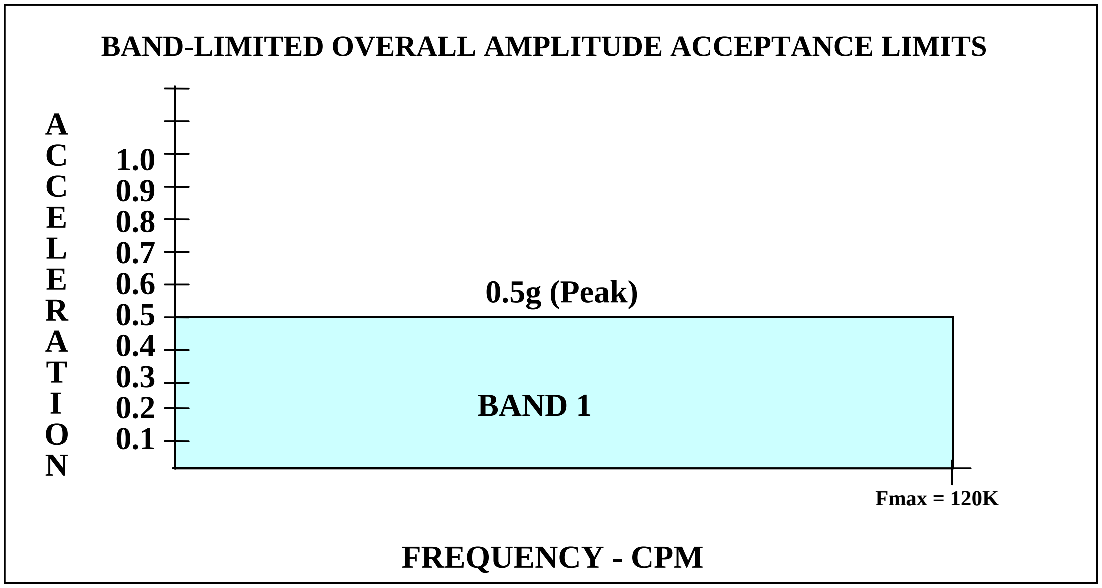


Figure 4

5.6.3.5. **Other Requirements**

Variable speed or adjustable sheaves shall not be used in the final installation.

Drive sheave and driven sheave should differ in size by 20 % or more to avoid "beat" vibration

SECTION 5.7.4

5.6.4. **PUMPS ANALYSIS and ACCEPTANCE**

5.6.4.1.Pumps shall be defined in two (2) categories:

- Positive Displacement --including, but not limited to Piston, Gear, and Vane.
- Centrifugal

5.6.4.2.Operating Conditions

- Non-cavitating non-separating condition.
- No piping strain.
- Shaft coupling aligned.
- Straight suction pipe to pump. (Reference Hydraulic Institute Standard)
- Certification shall be performed while pumps are operating within design specifications.

5.6.4.3.**Limits For Positive Displacement & Centrifugal Pumps**

For purposes of Line Amplitude evaluations a "PUMPING FREQUENCY" (PF) band will be established. The PF Band will be centered on the Pumping Frequency (Number of pumping elements X Pump RPM). The band will extend + 2 lines of resolution on either side of the line of resolution containing the Pumping Frequency. (i.e. Bandwidth = 5 lines of resolution)

Excluding the lines of resolution contained in the Pumping Frequency (PF) Band, the Velocity Amplitude (Inch/sec-Peak) of any line of resolution, measured at bearing locations in any direction shall not exceed the Line-Amplitude Band Limit values specified in Table 5 and graphed in Figure 5.

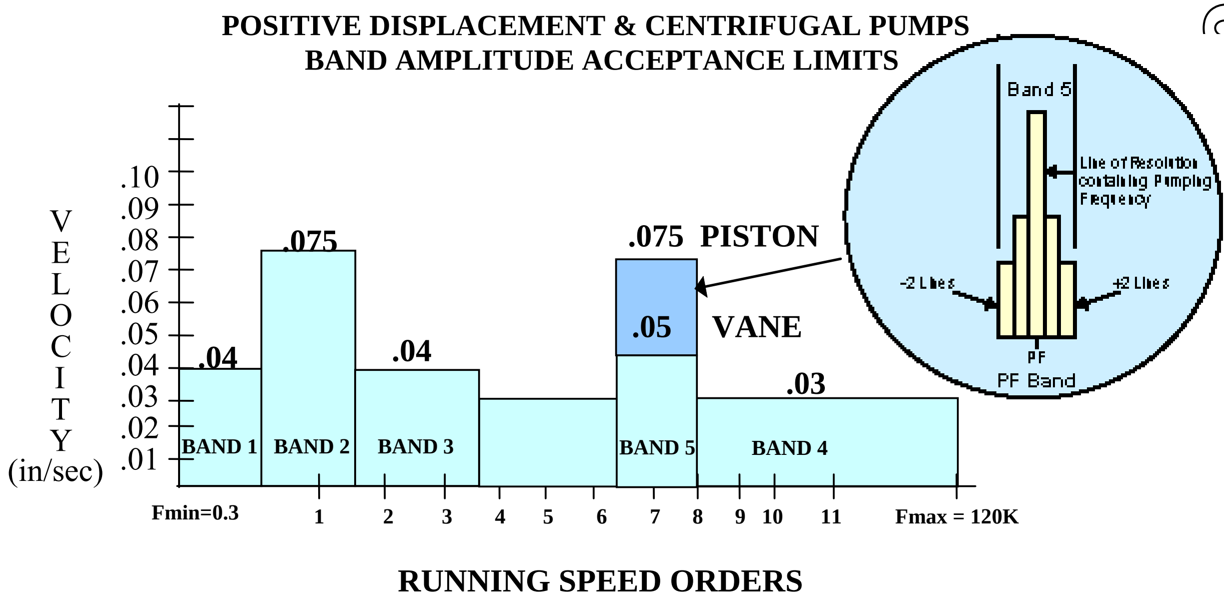
The Velocity Band-Limited Overall Amplitude (Inch/sec - Peak) at bearing locations in any direction shall not exceed the Pumping Frequency Band Limited Overall Amplitude Acceptance Limit value specified in Table 5 and graphed in Figure 5.

The Acceleration Band-Limited Overall Amplitude (g's Peak) at bearing locations in any direction shall not exceed the Band-Limited Overall Amplitude Acceptance Limit values specified in Table 5 and graphed in Figure 6.

MAXIMUM ALLOWABLE VIBRATION LEVELS FOR POSITIVE DISPLACEMENT AND CENTRIFUGAL PUMPS		
LINE-AMPLITUDE BAND LIMITS		
BAND	FREQUENCY RANGE (CPM)	VELOCITY (INCH/SEC - PEAK)
1	0.3 x RPM 0.8 x RPM	0.04
2	0.8 x RPM 1.2 x RPM	0.075
3	1.2 x RPM 3.5 x RPM	0.04
4	3.5 x RPM 120,000 CPM	0.03
BAND-LIMITED OVERALL AMPLITUDE LIMITS		
BAND	FREQUENCY RANGE (CPM)	ACCELERATION (g's PEAK)
1	0.3 x RPM - 300K CPM	1.5g - POSITIVE DISPLACEMENT 1.0g - NON-POSITIVE DISPLACEMENT
PUMPING FREQ. BAND (PF)	FREQUENCY RANGE (CPM)	VELOCITY (INCH/SEC - PEAK)
BAND 5	5 Lines of resolution centered on PF.	0.075 PISTON 0.05 VANE

Table 5

POSITIVE DISPLACEMENT & CENTRIFUGAL PUMPS
BAND AMPLITUDE ACCEPTANCE LIMITS



NOTE: Band 5 is a floating band width of the pumping frequency ± 2 lines of resolution acceptance limits for band 5 are line amplitude vibration levels

Figure 5

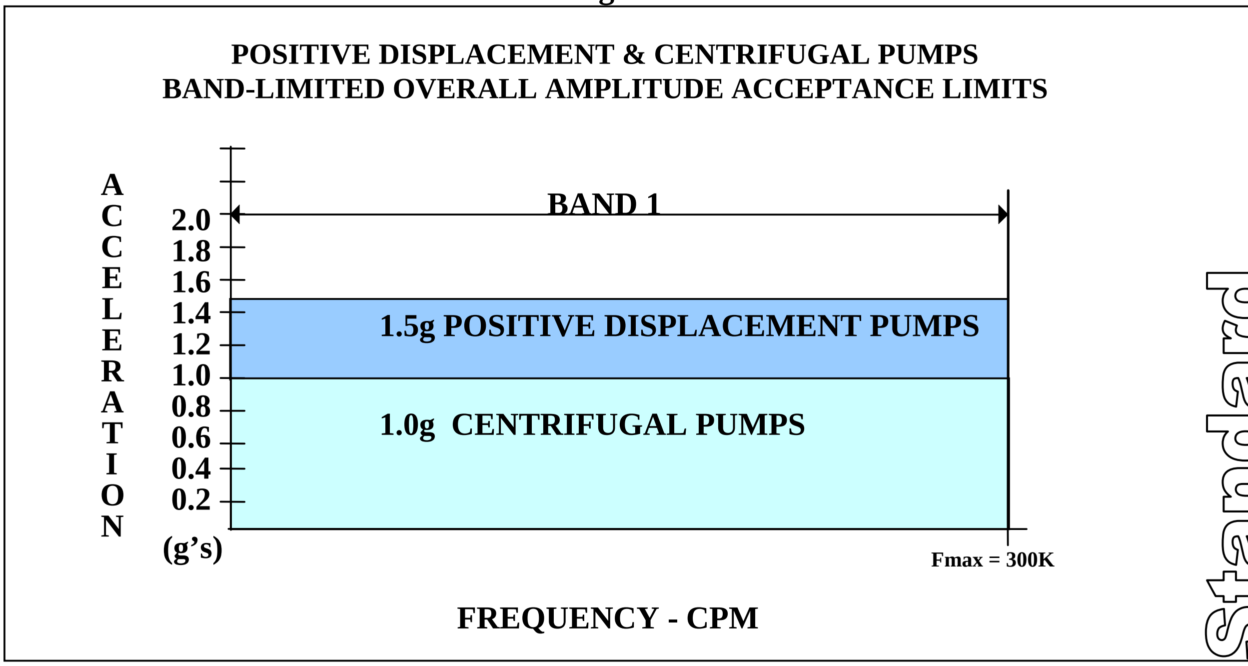


Figure 6

5.6.4.4.**Vertical Mounted Pumps**

Vertically mounted pump systems with a "Vertical Mount Height" greater than 5 feet will have an allowable increase in Velocity Amplitude Acceptance Limits in Bands 1, 2, and 3 of 5% per foot of "Vertical Mount Height" greater than 5 feet. (e.g. A 7 foot Vertical Mount Height would yield a 10% increase [(7 ft - 5 ft) x 5%/ft] in the Table 9.4A Velocity Amplitude Acceptance Limits specified for Bands 1, 2, and 3. Therefore the limit for Band 1 would be [0.4 Inch/sec + (0.4 Inch/sec x 0.1)] = 0.44 Inch/sec-Peak.

Vertical Mount Height is defined as the furthest measurable distance from the machine mounting to the end of the driver or the end of the pump, which ever is greater.

SECTION 5.7.5

5.6.5. GEARBOXES ANALYSIS and ACCEPTANCE

Gearboxes shall not exceed the Vibration Limits specified table 6 and in Figures 7 and 8.

MAXIMUM ALLOWABLE VIBRATION LEVELS FOR GEARBOXES		
LINE-AMPLITUDE BAND LIMITS		
BAND	FREQUENCY RANGE (CPM)	VELOCITY (INCH/SEC - PEAK)
1	0.3 x RPM 0.8 x RPM	0.04
2	0.8 x RPM 1.2 x RPM	0.075
3	1.2 x RPM 3.5 x RPM	0.04
4	3.5 x RPM 120,000 CPM	0.03
BAND-LIMITED OVERALL AMPLITUDE LIMITS		
BAND	FREQUENCY RANGE (CPM)	ACCELERATION (g's PEAK)
1	0.3 x RPM – 3.5 x GMF or 600K CPM	1.0

Table 6

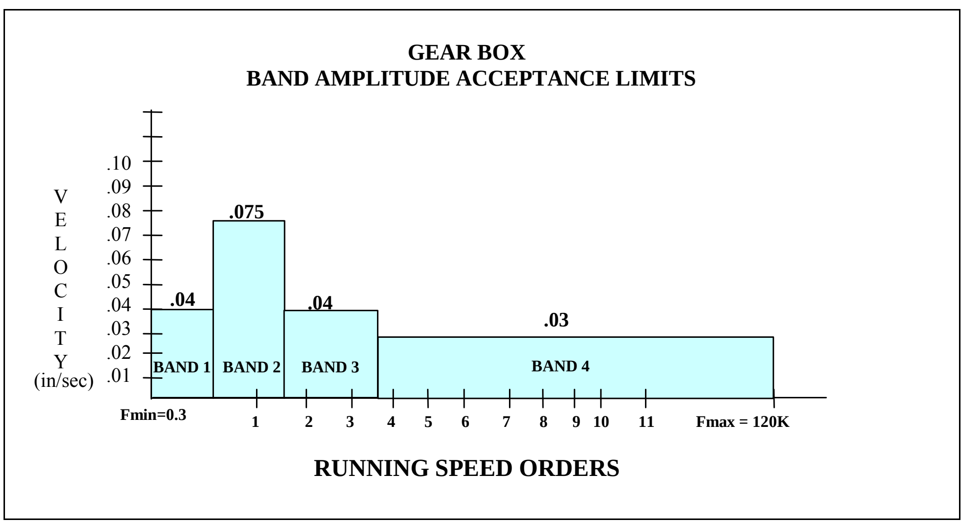
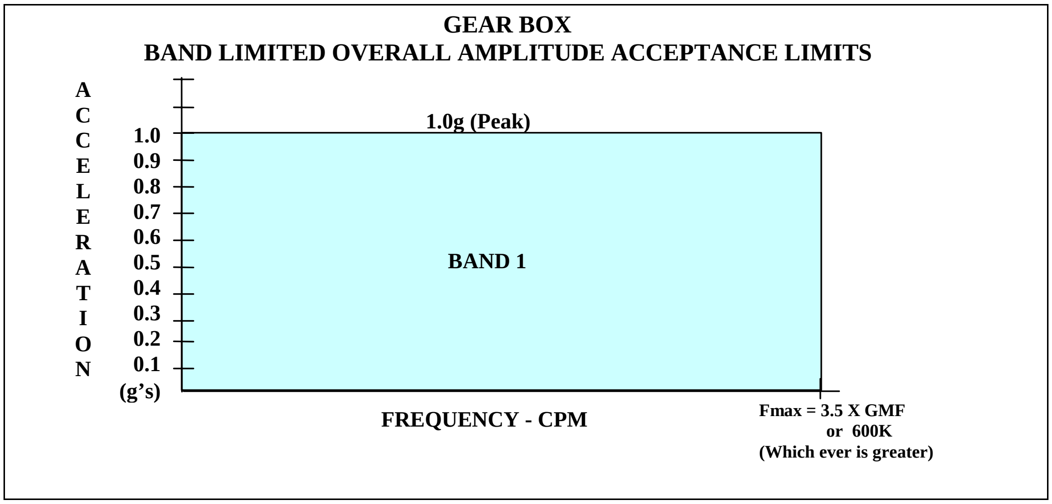


Figure 7



GEAR BOX
BAND LIMITED OVERALL AMPLITUDE ACCEPTANCE LIMITS
ACCELERATION (g's)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
1.0g (Peak)
BAND 1
FREQUENCY - CPM
Fmax = 3.5 X GMF
or 600K
(Which ever is greater)

Figure 8

SECTION 5.7.6

5.6.6. COMPRESSOR ANALYSIS and ACCEPTANCE

5.6.6.1. Centrifugal Compressors

Centrifugal compressors shall not exceed the Vibration Limits specified in Table 7 and Figures 8 and 9.

5.6.6.2. Positive Displacement

Positive displacement compressors shall not exceed the Vibration Limits specified in Table 7 and Figures 8 and 9.

MAXIMUM ALLOWABLE VIBRATION LEVELS FOR POSITIVE DISPLACEMENT AND CENTRIFUGAL COMPRESSORS		
LINE-AMPLITUDE BAND LIMITS		
BAND	FREQUENCY RANGE (CPM)	VELOCITY (INCH/SEC - PEAK)
1	0.3 x RPM 0.8 x RPM	0.04
2	0.8 x RPM 1.2 x RPM	0.075
3	1.2 x RPM 3.5 x RPM	0.04
4	3.5 x RPM 120,000 CPM	0.03
BAND-LIMITED OVERALL AMPLITUDE LIMITS		
BAND	FREQUENCY RANGE (CPM)	ACCELERATION (g's PEAK)
1	0.3 x RPM - 300K CPM	1.5g - POSITIVE DISPLACEMENT 1.0g - NON-POSITIVE DISPLACEMENT

Table 7

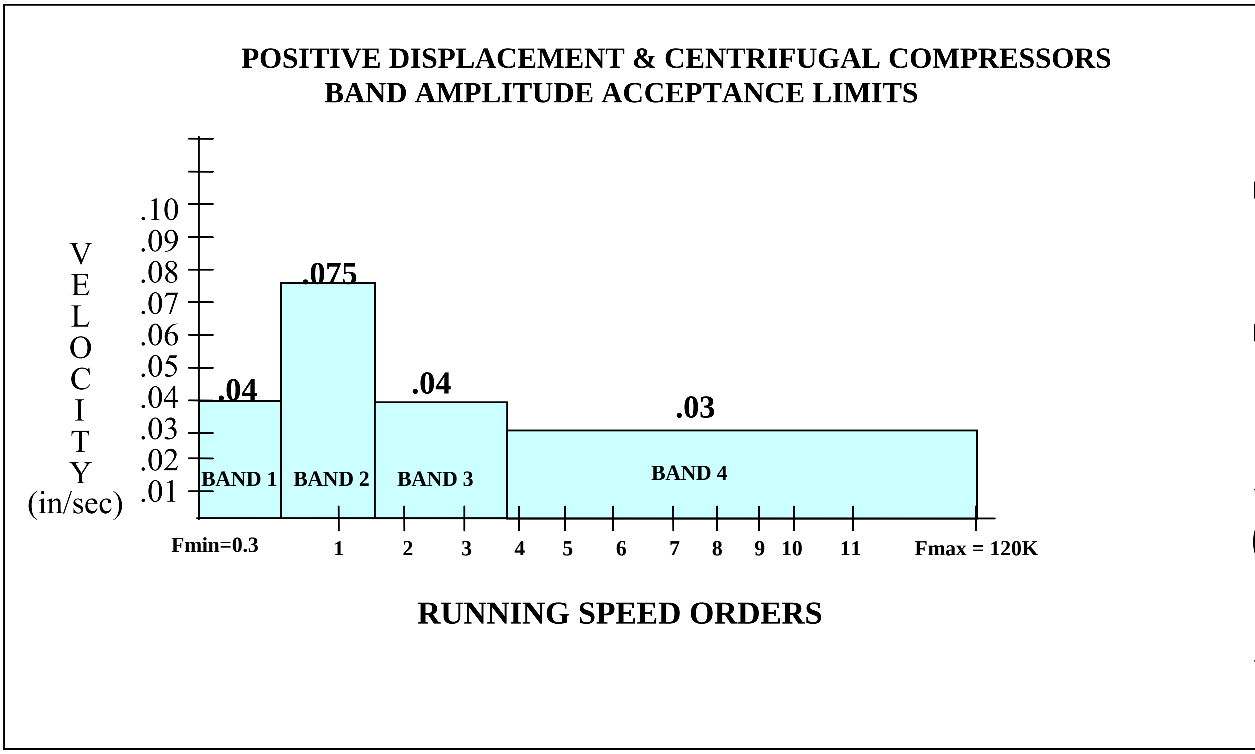

POSITIVE DISPLACEMENT & CENTRIFUGAL COMPRESSORS
BAND AMPLITUDE ACCEPTANCE LIMITS
VELOCITY (in/sec)
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
.04
.075
.04
.03
BAND 1
BAND 2
BAND 3
BAND 4
Fmin=0.3
1
2
3
4
5
6
7
8
9
10
11
Fmax = 120K
RUNNING SPEED ORDERS

Figure 8

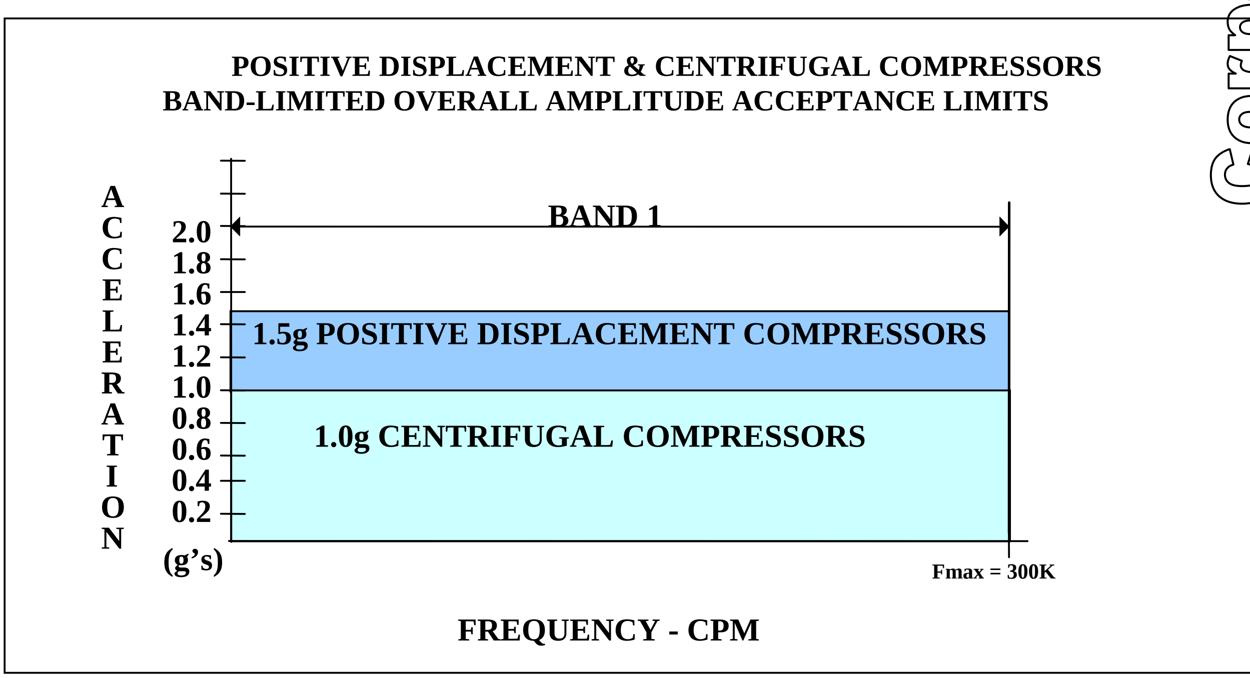

POSITIVE DISPLACEMENT & CENTRIFUGAL COMPRESSORS
BAND-LIMITED OVERALL AMPLITUDE ACCEPTANCE LIMITS
ACCELERATION (g's)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
BAND 1
1.5g POSITIVE DISPLACEMENT COMPRESSORS
1.0g CENTRIFUGAL COMPRESSORS
Fmax = 300K
FREQUENCY - CPM

Figure 9

6.0 REFERENCES

6.1. "PacifiCorp Employees". *A special thanks to the dedicated plant employees for their insight and input.*

6.2. "General Motors Corporation". *Specification No. V1.0a, GM_1761: Vibration Standard for the Purchase of New and Rebuilt Machinery and Equipment..*

6.3. "EPRI". *Project 2817-01, TR103374: Predictive Maintenance Guidelines.*

6.4. "Technical Associates of Charlotte". *Level II Vibration Analysis Handbook.*

1.0 PURPOSE

The purpose of this standard is to provide minimum specifications for precision equipment balance on rotating equipment when first placed into service and after major repairs throughout the PacifiCorp Energy Business Unit.

Balancing is a procedure by which the mass distribution of a rotor is checked, and if necessary, adjusted to ensure that the residual unbalance or the vibration at the journals and/or the forces at the bearings at the frequency corresponding to service speed are within specified limits thus minimizing wear.

This standard does not limit the balancer with required instrumentation or methods. Rather, it defines the final orientation, outcome and documentation required for equipment history. The balancer is free to use whatever equipment is most suitable for the task at hand. For corporate approved vibration analysis equipment and pricing see Corporate Approved Equipment List for details.

2.0 SAFETY

Safety is the number one priority. Proper tag out and/or lock out procedures must be followed. All personnel must be in a safe location during the balance job. At a minimum follow guidelines set forth in the PacifiCorp Accident Prevention Manuals and manufacturers written recommendations.

Be alert and move slowly, deliberately and cautiously when working around rotating equipment. Above all, it cannot be sufficiently stressed that balancing should be predictable from run up to run up. If it is not, stop because it is not a balance problem. Common sense is the greatest safety tool that can be used.

3.0 BACKGROUND

Precision equipment balancing is the procedure of measuring vibration and adding or removing weight to adjust the mass distribution, thus reducing equipment vibrations. A vibration reduction program can save a plant a considerable amount of money, reduce downtime and increase availability. Accurate and precise equipment balance will:

- **a.** Minimizes equipment and ambient noise.
- **b.** Lower radial and axial forces, thus increasing bearing life.
- **c.** Decreases operating stress, thus lowering cyclic fatigue and the probability of fatigue related failures.
- **d.** Reduce power consumption.
- **e.** Lower vibration levels in machine casings, bearing housings and rotors.
- **f.** Extend equipment life cycle.

4.0 SCOPE

4.1. This standard establishes acceptable balance quality for new and rebuilt rotating machinery and equipment purchased.

4.2. This standard applies to all persons involved in the performance or specification of rotating equipment precision balancing.

4.3. This standard is required when describing accepted good engineering practice used throughout the PacifiCorp Energy Business Unit. It should be used as a model for establishing best practices when performing rotating equipment precision balancing.

4.4. This standard does NOT apply to turbo machinery. Please refer to the Original Manufacture's balance standards and procedures.

4.5. This standard only applies to "rigid" rotors and shafts that do not bend or deflect due to forces caused by unbalance. A rotor is considered flexible when its speed is more than 75% of its lowest natural frequency in bending.

A determination of the actual type of the rotor in question must be made because rotors which operate above 70% of their critical speed will actually bend or flex due to the forces of unbalance. These flexible rotors must be treated with extreme care when choosing the correction planes.

Most rotors encountered will be rigid (fans, electric motors, pumps, etc) and are covered by this standard, with high-speed turbo-machinery being the exception. Flexible rotors are to be identified by the manufacturer and appropriate information on balancing made available from them.

5.0 STANDARD

5.1. Balancing Equipment Requirements

The system used to take vibration measurements for machine balance acceptance shall be calibrated by a qualified instrumentation laboratory within the past 12-months, have 1x running speed filtering capability and have a ±5% Amplitude accuracy over the selected frequency range.

5.2. Minimum Requirements

This standard should be used as a minimum requirement for all rotating equipment balance. If the tolerances or criteria become unobtainable for individual balance jobs, appropriate documentation shall be provided detailing the conditions causing the shortcoming and a plan developed to resolve these issues.

5.3. Rotating Equipment Balance Specifications

5.3.1. This standard provides direction to the acceptable vibration levels in field and shop balancing and applies to all rotating equipment in the facility. This standard also provides direction for purchase of rotating equipment.

5.3.2. This standard should be applied whenever repairing (field or shop) or specifying for the purchase of new rotating equipment. The vibration criteria are amplitudes at the fundamental rotational frequency (1x turning speed). This is a narrowband limit and an overall amplitude value is NOT acceptable.

5.3.3. *Field Balancing:* Absent of more precise tolerances specified by the machine manufacturer or by plant engineer for special applications, all equipment shall be balanced within the tolerances specified in Table 1. This standard is roughly equal to an API 4W/N standard.

5.3.4. *Shop Balancing:* Absent of more precise tolerances specified by the machine manufacturer or by the purchasing engineer for special applications, when specifying equipment for new and rebuild shop balance applications the API tolerance for unbalance of 4W/N shall be used (as specified in Table 2). Upon notification by the vendor, PacifiCorp will, at its discretion, witness final balance results.

5.3.5. *Special Applications*: When equipment is specified as "special application" by the machine manufacturer or by plant engineering, such as multi-stage and vertical rotating elements, the machine manufacturer tolerances for acceptable balance shall override the tolerances outlined in this document.

5.3.6. Before beginning any balance job, other possibilities for the problem should be eliminated. A complete vibration analysis and equipment inspection should be carried out to assure that mass unbalance is the problem.

5.3.7. Keys and keyway clearances are areas that are often overlooked and yet critical to a precision balance job. As a rule of thumb keyways should have a top clearance of 4-6 mils. Excessive top key clearance will allow the key to move radially outward during operation, resulting in a change in unbalance.

When a key is not provided, shop balance will be performed using a standard one-half key in key seat. (see Key Length Calculation illustration for final in service key length).

When couplings are assembled, the keyways are to be placed 180° apart between the drive and driven couple.

5.3.8. Permanently attached balancing weights must be secured by welding, bolting, riveting, or of a "clip-on" design.

5.3.8.1. If bolted, a hardened bolt (minimum of Grade VIII) must be used in conjunction with a mechanical locking device (e.g. lock washer or lock nut).

5.3.8.2. "Clip-on" balancing weights can only be used on centrifugal type fans and must be located and attached on the ID pitch of the blades such that the rotational motion of the fan creates a positive seating of the “clip-on” weight against the fan blade.

5.3.8.3. Balancing weights and methods of attachment must be stable at equipment operating temperature and of a material compatible with the parent material of the equipment to which the balancing weight is attached. Moreover, all attachments shall be in accordance with the manufactures recommendations.

5.3.8.4. The use of stick-on lead weights is NOT acceptable.

5.3.8.5. The use of DYNAWEIGHT or any other “temporary” weight attachment is NOT acceptable.

5.3.8.6. Any parent metal removed to achieve balance shall be removed in a manner which will maintain the structural integrity and required clearances of the rotor or sheave.

5.3.8.7. Access for field balancing shall be designed into the initial system design or any redesign of the system.

5.3.9. Balancing measurements and applications shall be performed by technically qualified persons who are trained and experienced in machinery balancing.

5.3.10. For new and shop rebuilt equipment, authorization for acceptance based on the balance quality of this specification requires a signature by the purchaser or authorized representative.

6.0 DOCUMENTATION

This section provides direction to the type of information that should be kept on file for equipment balance history (see appendix for templates). The intent is to supply as much information as possible for equipment history records.

6.1. All plants should use the forms shown in the appendix as part of any equipment balance work order. A reasonable effort should be made to collect as much of this information as possible. All balance documentation shall be attached to the completed work order and history added to SAP in accordance with normal plant practices.

7.0 DEFINITIONS & FIGURES

Precision Balance Standards		
Default Balance Specifications *Field Applications*		
RPM	**Max Vibration (in/sec, $_{Peak}$)**	**Max Vibration (mils, $_{Peak-to-Peak}$)**
Less then 600	0.05	1.5
600 to 1500	0.05	1.0
1800	0.05	0.5
3600	0.05	0.5
Above 3600	See Manufactures Recommendations	

Table 1

Notes: If the above tolerances become unobtainable for individual Precision Balance jobs, appropriate documentation shall be provided detailing the conditions causing this shortcoming and a plan developed to resolve this shortcoming.

Balance Specification *Shop Applications*
New and Rebuild Applications
$U_{max} = 4W/N$

Table 2

Notes: Umax = Maximum acceptable unbalance (Oz-In), W = Static Journal Loads (lbs), N = Maximum Continuous In –Service Rotor Speed (RPM).

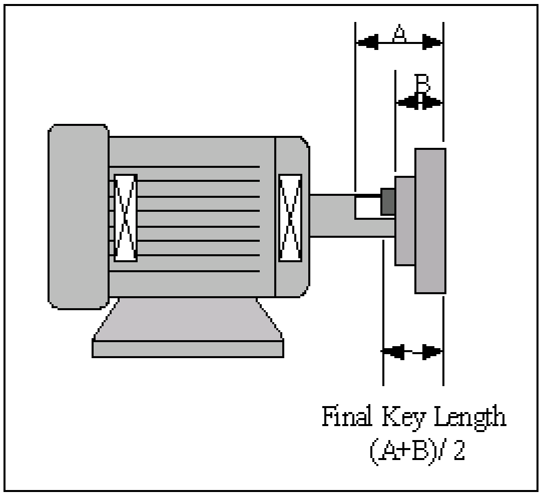


Figure 1

Amount of Unbalance: Product of the unbalance mass and the distance (radius) of its center of mass from the shaft axis.

Amplitude: A measure of the severity of vibration.

API: American Petroleum Institute

Balance: When a mass centerline and rotational centerline of a rotor are coincident.

Balancing: A procedure for adjusting the radial mass distortion of a rotor by adding or removing weight, so that the mass centerline approaches the rotor geometric centerline achieving less vibration amplitude at rotational speed.

Displacement: The distance traveled by a moving object, measured in Peak-to-Peak amplitude and expressed in engineering units of mils (1 mil = 0.001 inch).

Field Balance: The process of balancing a rotor in its own bearings and supporting structure rather than a balancing machine.

Flexible Rotor: A rotor that deforms significantly at running speed. This term is used for rotors that operate close to or above their first critical speed. A rotor is considered flexible when its speed is more than 75% of its lowest natural frequency in bending.

N: The Maximum Continuous Rotor Speed (RPM).

Peak-to-Peak: Refers to the displacement from one travel extreme to the other, measured in mils (1 mil = 0.001 inch).

Residual Unbalance: Unbalance of any kind that remains after balancing.

Rigid Rotor: A rotor that does not deform significantly at running speed. A rotor is considered rigid when its speed is less than 75% of its lowest natural frequency in bending.

RMS: (Root mean squared) equal to 0.707 times the peak of a sinusoidal wave.

Tolerance: Maximum allowable deviation from the desired values, whether such values are zero or non-zero.

Two Plane Balancing: A procedure by which the mass distribution of a rigid rotor is adjusted in order to ensure that the residual unbalance in two arbitrary planes is within specified limit referred to those planes.

U_{max}: Maximum unbalance (oz-in).

Unbalance: Condition which exists in a rotor when vibration force or motion is imparted to its bearings as a result of centrifugal forces.

Velocity: The time rate of change of displacement with respect to some reference position, measured in inches-per-second Peak.

W: Static Journal Loads (lbs).

8.0 REFERENCES

8.1. "PacifiCorp Employees". *A special thanks to the dedicated plant employees for their insight and input.*

8.2. "National Aeronautics and Space Administration"; *Reliability Centered Maintenance Guide for Facilities and Collateral Equipment*. February 2000.

8.3. "American Petroleum Institute", *API Technical Publication 684, 2003*

8.4. EPRI, *Predictive Maintenance Development and Implementation TR-108936*. 1998

8.5. Wowk, Victor, *Machinery Vibration: Balancing, 1995.*

8.6. Universal Technologies, Inc.; *Reliability Toolbox*. 2001.

8.7. International Standard Organization, *ISO1940-1, 2003*

9.0 ATTACHMENTS

9.1. Field Balance Data Sheet

9.2. Shop Balance Data Sheet

Field Precision Balance Data Sheet

BALANCE INFORMATION	
PacifiCorp Plant:	
Machine Name:	
Equipment ID:	
Work Order Number:	
Date Balancing Completed:	
Approximate Rotor Weight (lbs):	
Natural Frequencies:	
Balance Speed:	
Rotation (looking driver to driven):	
Final Balance Vectors:	
Location of Phase Reference:	
Special conditions used to balance this rotor (i.e., dampers open, etc):	

BALANCE JOB DATA					
Plane 1			Plane 2		
Initial Run Vibration (Amp, Phase)			Initial Run vibration (Amp, Phase)		
Trial (Weight, Location)			Trial (Weight, Location)		
Trial Run (Amp, Phase)			Trial Run (Amp, Phase)		
Final Run Vibration (Amp, Phase)			Final Run Vibration (Amp, Phase)		
Final Weight (w, radius)			Final Weight (w, radius)		
Desired Unbalance (Amp, mils)			Desired Unbalance (Amp, mils)		
Balance Quality Achieved (Amp, Phase)			Balance Quality Achieved (Amp, Phase)		
Influence Coefficient (mil/w-in, phase)			Influence Coefficient (mil/w-in, phase)		
Rotor Sensitivity (mil/w-in, phase)			Rotor Sensitivity (mil/w-in, phase)		

Notes

Shop Precision Balance Data Sheet

BALANCE INFORMATION	
PacifiCorp Plant:	
Vendor Name:	
PO Number:	
Machine Name:	
Equipment ID:	
Serial Number:	
Work Order Number:	
Date Balancing Completed:	
Approximate Rotor Weight (lbs):	
Natural Frequencies:	
Balance Speed:	
Rotation (looking driver to driven):	
Location of Phase Reference:	
Final Balance Vectors:	
Stack Balance Required (y/n):	
PacifiCorp Witness (y/n):	
Type key used:	
Balance Machine Type (circle one):	Hard Bearing / Soft Bearing
Note: A maximum of five (5) balance correction runs shall be performed to achieve the specified tolerances. If specified tolerances cannot be accomplished in five (5) runs Vendor is to contact PacifiCorp personnel for further direction.	

BALANCE JOB DATA, TOLERANCE and CALCULATIONS					
Plane 1			**Plane 2**		
Allowable Unbalance Tolerance: 4(W)/N			***Allowable Unbalance Tolerance: 4(W)/N***		
W (Rotor Weight) =			W (Rotor Weight) =		
W x 4 =			W x 4 =		
Divide by N (Service RPM) =			Divide by N (Service RPM) =		
Divide by 2 for two planes =			Divide by 2 for two planes =		
Allowable Unbalance (Oz-In) =			Allowable Unbalance (Oz-In) =		
Balance Achieved (Oz-In) =			Balance Achieved (Oz-In) =		
Final Weight (w, radius, Ang) =			Final Weight (w, radius, Ang) =		
Initial Run (Amp, Phase) =			Initial Run (Amp, Phase) =		
Final Run (Amp, Phase) =			Final Run (Amp, Phase) =		
Final Weight (w, radius) =			Final Weight (w, radius) =		
Influence Cf. (mil/w-in, phase)			Influence Cf. (mil/w-in, phase)		
Rotor Sns. (w-in/mil, phase)			Rotor Sns. (w-in/mil, phase)		

Example (Umax = 4W/N): Rotor weight = 1500 lbs, RPM = 3600

Umax = 4 x 1500 = 6000, 6000/3600 = 1.67, 1.67/2 => 0.83 oz-in (per plane)

Notes

Name: Signature:

1.0 PURPOSE

The purpose of this standard is to provide minimum specifications for accurate shaft alignment on mechanical rotating equipment when first placed into service and after major repair throughout the PacifiCorp Energy Business Unit. It specifies the alignment condition of components to reduce vibration and minimize wear.

This standard does not limit the aligner with required instrumentation or methods. Rather, it defines the final orientation, outcome and documentation required for equipment history. The aligner is free to use the alignment equipment most suitable for the task at hand.

2.0 SAFETY

Safety is the number one priority. Proper tag out and/or lock out procedures must be followed. All sources of energy to the machine system that pose a hazard to the aligner shall be de-energized. At a minimum, when aligning rotating equipment, follow guidelines set forth in the PacifiCorp Accident Prevention Manuals and manufacturer’s written recommendations.

Be alert, move slowly, deliberately and cautiously when working around rotating equipment. Common sense is the greatest safety tool that can be used.

3.0 BACKGROUND

Shaft to shaft alignment is the positioning of two or more machines so that the rotational centerlines of their shafts are collinear at the coupling center under operating conditions. Accurate and precise shaft to shaft alignment will:

a. Lower radial and axial forces on bearings.
b. Lower the probability of shaft failure from cyclic fatigue.
c. Minimize the amount of wear in the coupling components.
d. Minimize the amount of shaft bending from the point of power transmission in the coupling to the coupling end bearing.
e. Maintain proper rotor internal clearances.
f. Lower vibration levels in machine casings, bearing housings, and rotors.
g. Studies have shown, for roller element bearings, that if the equipment is offset misaligned by 10 percent of the coupling manufacturer's allowable offset a 10 percent reduction in inboard bearing life is expected.

4.0 SCOPE

4.1. This standard defines acceptable limits for shaft-to-shaft alignment of coupled machines. The limits are defined in terms of maximum offset and angularity.

4.2. This standard applies to all persons involved in the performance or specification of rotating equipment shaft alignments.

4.3. This standard should be used as a guide for best practices when performing rotating equipment shaft alignments.

4.4. This standard is required when describing accepted good engineering practice used throughout the PacifiCorp Energy Business Unit. It should be used as a model for establishing best practices when performing rotating equipment shaft alignment.

4.5. This standard does NOT apply to gas/steam turbines or generator.

5.0 STANDARD

5.1. Alignment System Requirements

The measurement system is required to provide repeatable readings when exercised through one rotation of the shaft(s). Repeatability is the significant characteristic that guarantees adherence to the specification.

5.2. Minimum Requirements

This standard should be used as a minimum requirement for all rotating equipment alignment. If the tolerances or criteria become unobtainable for individual alignment jobs, appropriate documentation shall be provided detailing the conditions causing the shortcoming and a plan developed to resolve these issues.

5.3. Shaft Alignment Specifications

All shaft-to-shaft centerline alignments shall be within the tolerances specified in Table 1. The tolerances shown are the maximum allowable deviations from desired values (targets), whether such values are zero or nonzero. A nonzero target is an intentional offset or angular misalignment to compensate for events such as thermal growth, dynamic loads, etc. If more precise tolerances are specified by the machine manufacturer or by the purchasing engineer for special applications, these will be used in lieu of the values in Table 1.

5.4. Soft Foot

Soft foot is a condition that exists when the bottom of all feet of a machine are not in the same plane (i.e. not coplanar). Soft foot is present if the machine frame distorts when a foot bolt is loosened or tightened. It shall be corrected before the machine is actually aligned. Soft foot tolerance is 0.002 inch, measured at the machine foot. (Table 2).

5.5. Shaft Spacers can be treated as a continuation of the shaft from either the driver or driven machine. The aligner can use either coupling flange to establish the center of the coupling. Spacer shafts can be dealt with in this manner because alignments are shaft to shaft.

5.6. Foot Centerline Deformations

The stiffness of the machine base shall be sufficient that no foot at the centerline shall deformation or deflect more than 0.001” over the operating range from alignment conditions to full load conditions (Table 2).

Precision Alignment Standards

Shaft Tolerances		
	Offset	**Angularity** (mils/inch of couple dia.)
RPM	**(mils)**	**(mils/inch)**
600	5.0	1.0
900	3.0	0.7
1200	2.5	0.5
1800	2.0	0.3
3600	1.0	0.2
7200	0.5	0.1

Table 1.

Notes: (1) The above standard shall be established at the cold alignment position. (2) If the above tolerances become unobtainable for individual alignment jobs, appropriate documentation shall be provided detailing the conditions causing this shortcoming and a plan developed to resolve this shortcoming. (3) If more precise tolerances are specified by the machine manufacturer or by the purchasing engineer for special applications, these will be used in lieu of the values in Table 1.

Parameter	Tolerance
Soft Foot (measured at the machine foot)	0.002” max
Foot Centerline Deformation (No load to full load)	0.001” max
Foot Movement Caused By Pipe Flange Tightening	0.002” max
Maximum Total Shim Pack (including the spacer block)	4 max

Table 2.

5.7. Bases and Foundations

The base and foundation shall be visually inspected for cracks and uneven mating surfaces. Grossly uneven mating surfaces shall be corrected by grinding, machining or grouting. Footprint areas on the baseplate will be checked with machinist level and will be corrected.

For machines consisting of a single steel plate, plate thickness must equal or exceed the thickness of the machine foot, but no less than the values in Table 3.

Minimum Baseplate Thickness for Single Steel Plates	
0 to 25 HP	¾ inch Single Steel Plate
25 to 75 HP	1 inch Single Steel Plate
75 to 150 HP	1-1/2 inch Single Steel Plate
150 HP and Above	2 inch Single Steel Plate

Table 3.

5.8. Base Tolerances

Rotating Equipment Shaft Leveling: Assembled equipment shafts shall be set level to 0.001 inches per foot of shaft length (± 0.005 inches) up to a maximum of 0.001 inches for any length shaft unless otherwise noted in the equipment specifications. Use the machine surfaces on which the equipment sets for the base/mounting frame leveling plane. Use the machined shaft surface for equipment leveling plane.

Bases should be of sufficient rigidity not to distort when hold-down bolts are tightened. In addition, the surfaces under all of the machines' feet should be in the same plane and flat within 0.001 inch.

5.9. Base Grout

Grout: Use only high performance expansive, non-shrink, epoxy grout.

Grout Space: Grout Space: Use blocks and shims under base for support at anchor bolts and midway between bolts, to position base approximately 1" above the concrete foundation, with studs extending through holes in the base plate. Grout shall cover shims (Sole plates) at least ½".

Anchoring: Tighten anchors avoiding thread damage. For expandable concrete anchors, use methods specified by anchor manufacturer.

Level Check: Final level check shall be held for inspection and approval by authorized PacifiCorp Representative before proceeding.

Anchor Bolts: Fill anchor bolt holes with grout, after bolt alignment is proven, and prior to placing grout under equipment bases.

Surface Preparation: Roughen surface by chipping, removing laitance and unsound concrete. Clean area of all foreign material such as oil, grease and excess water ponds.

Application: Place grout after the equipment base has been set and its alignment and level have been approved. Form around the base, mix grout and place in accordance with grout manufactures published instructions.

Finishing: Point the edges of the grout to form a smooth 45° slope.

Coating: After grout has cured (not before 3 days after placement) paint exposed surfaces of grout with shellac.

5.10. Pipe Strain

Piping should be fitted, supported, and sufficiently flexible such that soft foot due to movement caused by tightening pipe flanges does not exceed 0.002 inch (measured at the machine foot). On new installations, pipe stress exceeding the allowable tolerance shall be corrected before the machine is aligned.

On existing installations, pipe stress exceeding the allowable tolerance shall be corrected before the machine is aligned whenever feasible.

5.11. Thermal Growth

Thermal growth refers to the expansion of materials with temperature rise. For alignment purposes, thermal growth means the movement of shaft centerlines associated with the change in temperature from conditions at time of alignment to operating conditions. This change in temperature can produce changes in alignment that may affect offset and/or angularity. Alignment parameters shall be measured and adjusted for thermal growth.

5.12. Shims

Shims shall meet the following specifications:

a. Commercially die-cut.
b. Made of corrosion and crush resistant stainless steel, which is dimensionally stable when subjected to high compression over long periods of time.
c. Consistent over the whole shim area without seams or folds from bending.

d. All shims shall be measured to verify actual thickness. This measurement is to be taken in the throat of the shim.
e. Clean, free from burrs, bumps, nicks and dents of any kind. Remove all machining burrs or thread pulls in female holes on mating surfaces of mounting frame and machine feet. Mounting feet of machines and mounting base pads and frames must be free of all grease, rust, paint, and dirt before assembly and/or shipping.
f. For shims 10 mils or greater, size numbers shall be etched into the shim, not printed or stamped.
g. The overall shim pack shall not exceed a total of five (5) shims.
h. Shims must rest on bare metal, not paint or other coatings.

5.13. Axial Shaft Play

Shaft axial movement along the machine centerline caused by axial forces, thermal expansion/contraction, is permitted by journal bearings and/or looseness, but should be reduced as much as possible. For rolling element bearings, if minimum end play tolerances are not provided on motor drawings a value of 0.003 inch should be used.

5.14. Machinery Movements

Machines shall be adjusted with small, precise movements. Excessive force that could cause internal or excessive damage is to be avoided. Steel-hammer blows on bare steel or an iron machine housing is unacceptable. Hammering on wooden blocks is acceptable. Jackbolts are the preferred movement method.

Horizontal, coarse threaded jackbolts shall be installed at each mounting foot on both sides of the driver machine.

Jackbolts shall be positioned in line with the mounting bolts at each foot on both sides of the driver machine.

Jackbolt diameter shall be equal to or greater than the diameter of the largest bolt that will fit the driver frame mounting bolt hole.

The jackbolt guide shall be fixed to the machine base and will be either a nut sized for the jackbolt or a braced flat plate with through tapped threads equal to the thickness of the nut.

"Bolt bound" conditions can be handled in various ways, depending on the situation at the job site. The following methods are acceptable:
a. Moving both machines.
b. Undercutting of the bolts outer diameter down to the minor diameter is permitted, but the bolt should not be decreased in diameter more than 10%.
c. Enlarging the hole is acceptable if structural integrity is not compromised.

Upon completion of all movement, the machine is to be secured by tightening the hold down bolts to the manufactures recommended torque specifications. Upon completion of torquing, final shaft-to-shaft readings shall be taken and reported as the final orientation. All jack bolts will be left loose upon completion of alignment.

Doweling of machines in place will not be done unless the installation instructions specifically require it.

6.0 DOCUMENTATION

This section provides direction to the type of information that should be kept on file for equipment alignment history (see appendix for templates). The intent is to supply as much information as possible for equipment history records.

6.1. All plants should use the forms shown in the appendix as part of any equipment alignment work order. A reasonable effort should be made to collect as much of this information as possible. These sheets should be made available in the SAP system and attached to all equipment alignment work orders. It is the responsibility of each facility to enter completed equipment alignment information and history into each SAP record.

6.2. All alignment documentation shall be attached to the completed work order and history added to SAP in accordance with normal plant practices.

7.0 DEFINITIONS & FIGURES

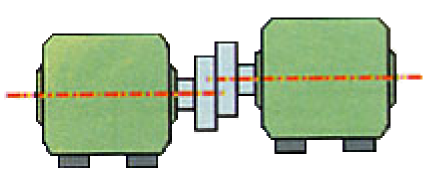


Figure 1. Vertical Offset (Plan View)

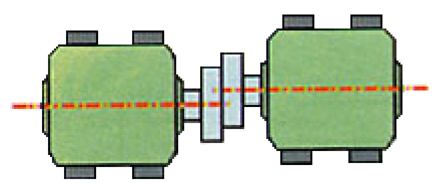


Figure 2. Horizontal Offset (Top View)

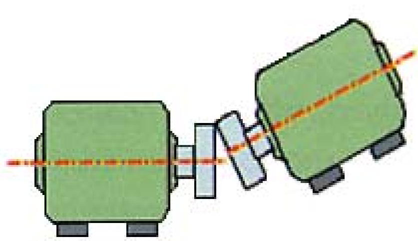


Figure 3. Vertical Angularity (Plan View)

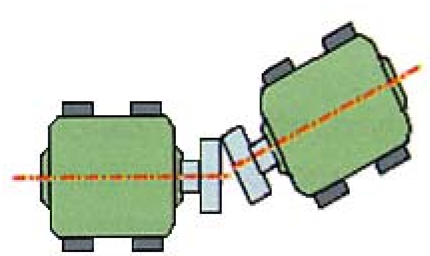


Figure 4. Horizontal Angularity (Top View)

Source for Figures 1 – 4: PRÜFTECHNIK LTD

Bolt bound: When it becomes impossible to move either the stationary machine or the machine to be moved, because either their mounting holes or the machine base holes don't physically allow movement due to interference between the bolt and bolt hole. Common solutions range from enlarging or elongating mounting holes of the machine or machine base, plugged and drilled the machine baseplate, or reducing the diameter of the mounting bolt or by moving the target machine to allow room for horizontal movement of the sight machine.

Cold alignment: An alignment performed when machines have cooled to ambient temperature.

Collinear: Collinear means two lines that are positioned as if they were one line. Collinear as used in alignment means two or more centerlines of rotation with no offset or angularity between them. Two or more lines are co-linear when there is no offset or angularity between them (i.e. they follow the same path).

Concentric: Having a common center.

Displacement: A distance traveled from an at rest position, usually measured in mils.

Eccentricity (mechanical): The variation of the outer diameter of a shaft's surface when referenced to the true geometric centerline of the shaft. Also referred to as "out-of-roundness".

Hot alignment check: An alignment check performed after machines are brought up to operating temperature.

Machine to be moved (site machine): When aligning two rotating machines, usually a "driver" and "driven" combination, one is determined as the "site", or "machine to be moved" usually based upon the relative ease of moving it. In most cases this is the "driver", many times a motor. In the case of turbine driven equipment, such as pumps, the "machine to be moved" or "site machine" can be the "driven" piece of equipment. Under most conditions, once the site machine is chosen all moves are made to that piece of equipment.

Magnetic center: When an electric motor operates, the magnetic field between the stator and rotor tend to hold the rotor in a stationary position relative to the rotor shaft's axis. This position is called "magnetic center". Motors with sleeve bearings will require verifying that the rotor is setting on magnetic center before, during and after completion of alignment.

Soft foot: A condition that exists when the bottom of all of the feet of the machinery components are not on the same plane (can be compared to a chair with one short leg). Soft foot is present if the machine frame distorts when a foot bolt is loosened or tightened. It must be corrected before the machine is actually aligned;

- **Parallel soft foot:** A parallel gap between the machine foot and its support surface.
- **Angular soft foot:** An angled gap between the machine foot and its support surface.
- **Induced soft foot:** A type of soft foot that is caused by external forces, (pipe strain,

- coupling strain, shim distortion etc.,) acting on a machine independent of the foot to base plate relationship.
- **"Squishy" soft foot:** A type of soft foot characterized by material, (could be Shims, paint, rust, grease, oil, dirt, etc.) acting, like a spring between the underside of the machine foot and the base plate contact area.

Shim stack: Refers to the group of shims under each foot.

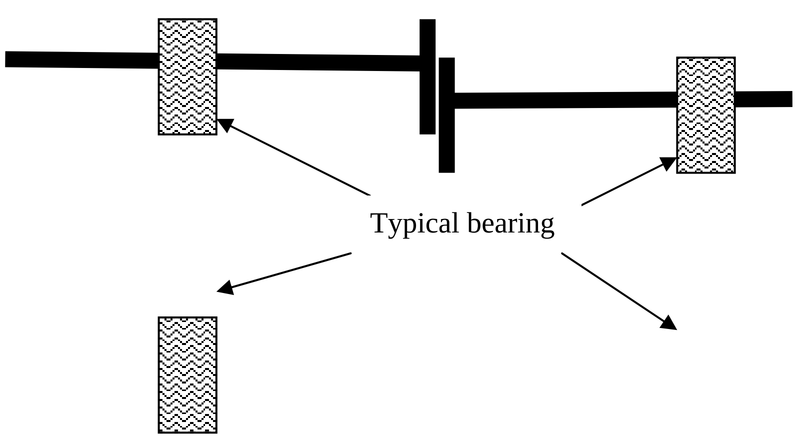
Shouldered bolt: A bolt that has been decreased in diameter due to the machine being bolt bound. The bolt should not be decreased in diameter more than 10 % of its original diameter.

Static or Stationary feet: Feet that will not be used during a shim change.

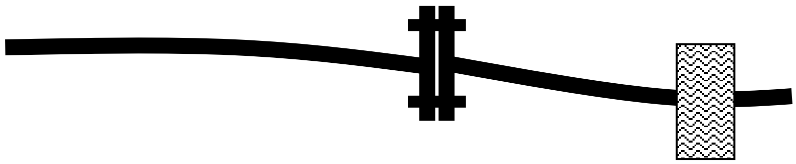
Stationary machine (target machine): When aligning two rotating machines, usually a "driver" and "driven" combination, one is determined as the "target", or "stationary machine" usually based upon the relative difficulty of moving it. Usually this is the "driven" machine, often a pump, gearbox, etc. Difficulty of movement can be based upon piping in the case of pumps and blowers, or output shafts in the case of gearboxes, etc. Under most conditions once one machine is determined to be the "target", or "stationary machine" all moves to bring both machine's shafts into alignment are made to the "site", or "machine to be moved".

Thermal growth: When metal gets hot it expands. Almost every piece of rotating equipment is subject to "thermal growth" based upon the temperature of the case and feet. A piece of machinery can grow in almost any direction usually based upon differential temperatures in it's case. When attempting to achieve alignment between two shafts, usually in a "cool" shut down state, the thermal growth of each piece of machinery must be factored to achieve alignment during the "hot" running state.

Tolerance: "Tolerance", when used in conjunction with shaft to shaft alignment, will refer to the maximum amount of misalignment allowable between the axial centerlines of the two aligned shafts. The most often misunderstood aspect of tolerance is that it only refers to the misalignment capabilities of the coupling. The maximum amount of misalignment any given coupling can tolerate is usually many times the maximum amount of misalignment a typical bearing can tolerate. In the vast majority of applications, bearings become the fulcrum points for any coupling misalignment, and the misalignment at the coupling is transmitted to the bearings.



While a coupling may have a given tolerance and be able to withstand a given misalignment, the stress transmitted from coupling misalignment to the bearings may exceed their tolerances, and decrease bearing life.



8.0 REFERENCES

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8.4. "National Aeronautics and Space Administration"; *Reliability Centered Maintenance Guide for Facilities and Collateral Equipment*. February 2000.

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9.0 ATTACHMENTS

9.1. Alignment Datasheet

Rotating Machinery Shaft Alignment Data Sheet

Equipment ID:		Date:	
Performed By:		Work Order #:	

Machine Information			
Stationary Machine		**Moveable Machine**	
Type		Type	
Model		Model	
Speed		Speed	

Soft Foot (Offline/Online)				**Thermal Growth**			
Stationary Machine		**Moveable Machine**		**Stationary Machine**		**Moveable Machine**	
Outboard	Inboard	Outboard	Inboard	Outboard	Inboard	Outboard	Inboard

Final Alignment Data			
Vertical Offset:		Horizontal Offset:	
Vertical Angularity:		Horizontal Angularity:	

Shaft Runout			
Stationary Machine		**Moveable Machine**	

Total Shim Packs Used							
Machine:	Location:	# Shims Used	Total Thickness	Machine:	Location:	# Shims Used	Total Thickness
Stationary:	IB			Movable:	IB		
	IB				IB		
	OB				OB		
	OB				OB		

Base Plate Thickness		**Axial Shaft Play**	
Movement Caused by Pipe Strain		**Coupling Gap**	

Notes:

1.0 PURPOSE

Lubrications Standards for Industrial Equipment is issued by PacifiCorp with the intent to provide PacifiCorp with safe, well designed, reliable and productive industrial equipment which consistently produce cost competitive high quality products. This standard is to be used by PacifiCorp as well as industrial equipment builders as an engineering guide in developing the lubrication systems. The mission of the standard is to:

a. Enhance PacifiCorp health and safety.
b. Improve equipment reliability, maintainability and efficiency while eliminating the housekeeping problems associated with improper amounts of lubricant.
c. This standard is not intended to inhibit new technology in any manner. Consequently, PacifiCorp would expect and encourage all industrial equipment builders to call to the attention of the Corporation any situation, which inhibits the application of new technology.
d. PacifiCorp believes that the standards described in this document provide a sound basis for safe, reliable and productive industrial equipment in all PacifiCorp Facilities.

In the event of a conflict between the text of this specification document and the references cited herein, please contact PacifiCorp Energy PdM Department. Nothing in this document supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.0 DEFINITIONS

2.1. Industrial Equipment. Industrial Equipment is any new, used and/or refurbished equipment used in process of producing electricity.
2.2. Lubrication Points. Lubrication points are points where lubricant is delivered to the moving elements of the equipment.
2.3. Fill Openings. Fill openings are designated points on equipment, machinery, or conveyors designed to accept a quantity of lubricant sufficient to maintain the equipment for a specified time.
2.4. Grease Points. Grease points are those designated lubrication points requiring grease as the lubricant.
2.5. Receiving Facility. Specific Facility where the equipment, machinery or equipment is installed, operated, and maintained.
2.6. The use of the word "shall" is understood to be a requirement; use of the word "should" is understood to be a recommendation.

3.0 SAFETY

3.1. Safety is the number one priority. When applicable, proper tag out and/or lock out procedures must be followed. At a minimum follow guidelines set forth in the PacifiCorp Accident Prevention Manuals and manufacturers written recommendations.

3.2. Be alert and move slowly, deliberately and cautiously when working around rotating equipment. Common sense is the greatest safety tool that can be used. Lubricants may be hot and volatile during sampling routines, at a minimum, proper safety and environmental procedures should be followed.

3.3. Personnel shall not be required to climb over or reach past revolving spindles, shafts, moving tools or equipment elements to service or fill lubricated components.

3.4. The placement of reservoirs, fill openings, grease points and the like, shall consider the machine work envelope. Accordingly, they shall be located in such a manner as to provide access from working height without the need to remove machine guarding or barriers and be clear of the machinery work envelope.

3.5. Integral reservoirs (worm gear drives, cone drives, transmissions, drill ads etc.) are by necessity located to suit machine design. Accordingly, fill points and drains for integral reservoirs shall be located or piped to working height and external to guarding or barriers and be clear of the machinery work envelope.

3.6. To prevent slipping, remove spilled and leaking lubricants from floors

3.7. Oily rags should be placed in tightly closed safety containers and dispose of regularly

3.8. Keep storage tank vents open

3.9. Smoking is prohibited

3.10. Vent light oils and solvents to prevent excessive inhalation of fumes by personnel

3.11. Avoid skin contact with hot oil

3.12. When adding lubricants to running equipment, the level may appear deceptively low due to lubricant that is either suspended or splashed above the static level use caution to prevent overfilling.

3.13. Do not use kerosene to clean bearings; it is dangerous as kerosene will not evaporate and will reduce the lubricating ability of the oil or grease that is reapplied to the bearing. Its use also increases the fire hazard.

3.14. When shutting down a machine, try to wipe it clean; and oil all bearings that are manually lubricated. When a machine is oiled at the beginning of a shutdown period, the bearings are protected

4.0 BACKGROUND

4.1. Lubrications Standards for Industrial Equipment is an effort to improve the overall health of operating rotating machinery and reduce equipment failure due to lubrication related issues.

4.2. Technological advancements in the field of power generation have raised the level of importance for maintaining system cleanliness during all phases of manufacturing, installation and operation. Each improvement to efficiency and reduction in emissions require a further tightening in clearances and reduction in the margins for error. The level of cleanliness control which the new power plant installations demand, require a change in the approach to maintaining system cleanliness.

4.3. System cleanliness must be a plant lifetime approach ranging from design to plant operations and maintenance. Strict, in-process controls to prevent contamination and to maintain the system cleanliness level are essential to the successful installation and long term reliability.

4.4. The best practices learned during installations have decreased the average amount of time required to deliver a cleaner, more robust system. Applying these practices is important to obtaining expected performance and equipment life.

4.5. The rewards of improved lubrication:

- 4.5.1. Reduce operating costs.
- 4.5.2. Improve the life and performance of rotating equipment.
- 4.5.3. Reduces maintenance costs due to minimizing equipment damage.

5.0 STANDARD

5.1. Approval Requirements

- 5.1.1. Lubrication designs, including component stock list shall be approved in writing by PacifiCorp prior to the purchase of any components.
- 5.1.2. The following documentation is required for approval and shall be submitted as a complete package at the time of approval request:
  - 5.1.2.1. Lubrication Instructions including layout diagram.
  - 5.1.2.2. System Graphical Schematic Diagram(s) including design data.
  - 5.1.2.3. Complete stock list per ISO 1219-1
- 5.1.3. The following items are to be submitted with the request for approval of any lubrication design:
  - 5.1.3.1. All diagrams, charts, and schematics are to be drawn using AutoCAD. Ver. 12 or later, or as approved by PacifiCorp.
  - 5.1.3.2. Approval Request Review Time. A minimum of thirty (30) working days shall be allowed for the PacifiCorp to review all diagrams, charts, and schematics.

5.2. Lubrication Points

- 5.2.1. Each component lubrication point and device shall be identified with its individual reference letter, symbol or number.

5.2.2. A lubrication application chart shall be furnished for each piece of equipment. The chart shall contain the applicable information. The chart shall consist of Digital Images of the equipment identifying all lubrication action points. The Lubrication System Schematic Drawing shall clearly show (but shall not be limited to) the following:

5.2.2.1. All components of the system including the Manufacturer name, size and catalog number of filter assemblies and filter elements.

5.2.2.2. Conductor sizes, material and connector types and manufacturer.

5.2.2.3. Pumps, Distribution and feeder blocks

5.2.2.4. Pump displacement.

5.2.2.5. Reservoir capacity.

5.2.2.6. Cycling frequency and cycling time.

5.2.2.7. Detail letters, numbers and symbols for cross-reference.

5.2.2.8. Complete stock lists, which shall include the original component manufacturer's name, part number, description, quantity and detail number.

5.2.2.9. Motor hp, rpm and voltage

5.2.2.10. The Lubrication chart shall contain supplier's recommendations for lubricants for all fill points, as selected from the PacifiCorp approved lubricants, which are available on request. Designations by Brand Names are not acceptable.

5.2.2.11. Lubrication instructions that shall form part of the general instruction manual and shall be available on the machine or equipment.

5.2.2.12. Specific frequency of service for each lubrication point. In this regard, the terms "As Needed" and or "As Required" or similar reference are Unacceptable.

5.2.2.13. Lubrication instructions. Lubrication instructions shall be provided on all industrial equipment and shall be located on the equipment where the operator can readily obtain them. The lubrication instructions provided on the industrial equipment shall be the same as the lubrication instructions appearing in the general instruction manual.

5.2.2.14. NOTE: The Lubrication Application Chart, Shall be provided As outlined in ISO-5169 when specified by the receiving facility.

5.2.2.15. All lubrication charts and diagrams shall comply with appropriate PacifiCorp drawing specification.

5.2.2.16. All moving parts shall be lubricated to minimize wear and insure the accuracy and efficiency of the machine or equipment. It shall be the responsibility of the Supplier to insure that all Lubrication Points have been initially lubricated with the PacifiCorp approved lubricant, prior to equipment commissioning.

5.2.2.17. All industrial equipment fill point shall be properly labeled/Tag. The label/Tag shall use the NORIA Lubrication Identification System (LIS) for oil or an equivalent. The tag will contain the following information ISO 6743(Class L) Lubricant Classification, ISO VG, Base oil Type, Base Oil type Classification, Special Properties/Special Properties.

5.2.2.18. Lubrication points shall be accessible at working height or a service platform without the removal of guards, sheet metal panels, covers, etc.

5.2.2.19. The reservoir fill points for all centralized lubrication systems shall be located at the Central Service Area.

5.3. Lubricants

5.3.1. Oil shall be the preferred medium for lubrication, except where leakage and contamination from the oil will create an environmental concern. If oil lubrication is not practicable, then grease /fluid grease lubrication shall be utilized.

5.3.2. Industrial equipment, turbo machinery and conveyor suppliers shall be required to have written approval from PacifiCorp for all fluids and greases used. All lubricants shall be PacifiCorp approved.

5.4. Service Frequency

5.4.1. All industrial equipment shall be capable of operation for a minimum of 200 hours without the attention of lubrication personnel.

5.5. Fittings

5.5.1. Any one-pressure Grease fitting or Grease metering valve outlet shall serve no more than one lubrication point.

5.5.2. The metering valve was grease metering with an automatic grease lubrication system.

5.5.3. Manifolds and drilled passages shall be used wherever possible to reduce tubing use and complexity. Manifolds and drilled passage flow paths shall be shown on the layout drawings submitted for written approval.

5.6. Shields and Seals

5.6.1. Shields and/or seals shall be used where required to prevent leakage and/or to exclude contaminants.

5.7. Separated Fluid Systems

5.7.1. The lubrication and hydraulic systems shall be separated unless approved otherwise by PacifiCorp when approved as combined, the following conditions shall exist:

5.7.1.1. Both the lubrication and the hydraulic system shall be capable of performing their required functions with the common fluid.

5.7.1.2. Comprehensive hydraulic and lubrication information for every hydraulic and lubrication system(s) shall be provided.

5.8. Lubrication Devices

5.8.1. Lubrication devices shall be located so as to prevent damage to other machine components as well as the devices themselves. Lubrication devices shall be located in such a way as to prevent contamination or temperature extremes from deteriorating the lubricant and from causing malfunctioning of the devices.

5.8.2. Lubricating devices including all internally mounted nozzles, tips, extensions, etc. used for dispensing lubricants shall be securely mounted and in no case shall the conductor support devices.

5.9. Port Threads

5.9.1. All tapped holes for installing oil or grease fittings/conductors shall conform to BSPP, Metric or SAE Straight Thread Standards as specified by the receiving facility. The minimum BSPP Thread size shall be 1/8 –28. The minimum Metric Thread size shall be 6mm x 0.75. The minimum SAE Straight Thread size shall be 5/16-24. NPT or BSPT Threads may be used with written approval from the receiving facility “Drive-In” type fittings are not acceptable under any circumstance.

5.10. Painting

5.10.1. No paint shall be applied over nameplates, legend plates, grease fittings, gages, tubing, instruments, metering blocks or lubrication identification tags.

5.11. Manual Single Point Lubrication

5.11.1. Manual single point lubrication shall have no more than one lube point per oil or grease fitting.

5.12. Fittings

5.12.1. Hydraulic grease fittings with “ball-checks” in accordance with DIN 71412 for metric or ANSI/SAE J534 shall be used for individual point greasing.

5.12.2. Individual Grease points shall be serviceable with a standard grease gun and coupler.

5.12.3. Grease and hydraulic oil fittings shall be located so as to provide a 40-degree cone of accessibility extending outward from the fitting for at least two feet. In locations where this clearance cannot be provided, the fitting shall be piped to a central service area or another accessible area.

5.12.4. Zerk caps and Tags shall be provided on all grease fittings .The tag shall use the NORIA Lubrication Identification System (LIS) for Grease or an equivalent. Tag shall contain the following information Thickener, Grease Consistency NLGI Grade Number, Base Oil ISO VG, Base Oil Type, Base Oil type Classification, Special Properties, Special Properties.

5.12.5. Leak proof button head fittings shall be used for the pressure application of oil.

5.13. Location of Routine Maintenance Devices

5.13.1. Lubrication personnel shall not be required to use portable ladders, or be required to shut down the machinery equipment or conveyor while adding lubricant. In addition, lubrication personnel shall not be required to break any safety light screens while adding lubricant(s). Acceptable working height shall be determined by PacifiCorp.

5.13.2. All centralized lubrication system metering devices shall be accessible for replacement without the removal of any conductors, conduit, or other components. They shall also be accessible for inspection and/or adjustment during equipment operation.

5.14. Centralized Lubrication Systems

5.14.1. The equipment supplier shall properly adjust all centralized lubrication systems before the equipment is accepted by PacifiCorp.

5.14.2. Centralized lubrication systems shall not contain components from more than a single lubrication system manufacturer. The lubrication system shall include (but shall not be limited to) all necessary Filters, Distribution/Metering devices, diagnostic devices, lubricant conductors, clamps, and lubricant dispensing Pump(s).

5.14.3. Centralized lubrication system metering devices shall not be internally cross-ported to combine output from several metering valves. External cross-porting bars or doublers shall be used for this purpose.

5.14.4. Centralized lubrication systems including all conductors and bearings/lubrication points, shall be prefilled and cycled with the proper PacifiCorp approved lubricants as specified by PacifiCorp.

5.14.5. All Centralized Lubrication Systems shall be supplied with filtration devices capable of protecting the Distribution/Metering Devices and other system components from contamination.

5.14.6. All Centralized Grease Lubrication Systems shall have a replaceable element type (100 Mesh min.) Lubricant Pump Reservoir Fill Point Strainer. These Systems shall also incorporate a replaceable element type (325 Mesh min.) Lubricant Block Strainer located between the Lubricant Pump Outlet and the Master Feeder Block.

5.15. Filters

5.15.1. Lubrication filters shall be installed to allow for servicing without disturbing conductors or draining the reservoir.

5.15.2. The use of spin-on filters is allowed at the reservoir fill point and breather only.

5.15.3. All filter systems should have an electrical differential pressure-indicating device to indicate plugging/blockage of the filter element, but visual direct mechanical type indicators shall also be provided.

5.15.4. The filter(s) shall be appropriately sized and of sufficient Beta ratio to maintain a fluid contaminant level in accordance with the OEM specifications.

5.15.5. Replaceable cartridge type non-bypass, non-absorptive, full flow filters shall be installed on pressure side of the oil system pumps and at the reservoir fill point. The system shall be inoperable with the element removed. An absolute filter shall be used that meets all design requirements of the system such as fluid viscosity, pressure etc. The filter(s) shall be appropriately sized and of sufficient Beta ratio to maintain fluid contaminant levels in accordance with the OEM specifications.

5.15.6. The filter flow capacity shall be such that pressure drop across the filter housing and element with a clean element at full flow shall not exceed 0.13 MPa (5 psi).

5.16. Automatically Actuated Systems

5.16.1. Automatically actuated centralized lubrication systems shall be provided when re-lubrication will be required at a frequency less than once in every 200 operating hours.

5.17. Gravity Feed Systems

5.17.1. Gravity feed oil systems shall be avoided, and may only be utilized with written permission from PacifiCorp. If approved, they shall include an automatically controlled valve to permit oil flow only during operation of the components lubricated by the system.

5.17.2. Gravity Feed Systems. Gravity feed systems are discouraged and require written approval from PacifiCorp.

5.18. Recirculating Systems

5.18.1. Recirculating flow systems shall have full flow pressure line filtration to prevent the carrying of contaminants to the lubrication points. Contamination control levels for Recirculating flow systems shall be in compliance with the guidelines set forth in OEM instruction manual.

5.19. Automatic Conveyor Chain Lubricators.

The preferred method of Lubrication for Chain Conveyors should be Automatic Conveyor Chain Lubricator Systems unless otherwise specified by PacifiCorp. All Automatic Conveyor Chain Lubrication Systems shall meet, but shall not be limited to the following requirements:

5.19.1. Automatic Conveyor Chain Lubricators shall be designed so that if the conveyor chain backs up, the lubricator mechanism will not be damaged.

5.19.2. Automatic Conveyor Chain Lubricators shall have a clear, unobstructed view of the lubricant dispensing nozzles/couplers to facilitate inspection and adjustment.

5.19.3. An easily removable access cover of 305 mm (12 inches) in length shall be provided on conveyors that are required to have guarding installed.

5.19.4. Drip pans under automatic lubricators or reservoirs shall be provided and must have a drain plug at a low point.

5.19.5. Automatic Conveyor Lubricators with integral reservoirs shall be filled remotely by a centralized fill system, unless otherwise specified by PacifiCorp.

5.19.6. Remote transfer and filter Carts shall incorporate a filtration system capable of maintaining contamination control levels when transferring oil.

5.19.7. Automatic Lubricators should be utilized on all associated conveyor drive chains (when applicable).

5.20. Manually Actuated Systems.

5.20.1. Manually actuated lubrication systems shall be provided when re-lubrication will be required at a frequency greater than once in every 200 operating hours.

5.21. Indicators

5.21.1. A pressure indicator shall be provided at the pump to permit visual monitoring of the lube oil system pressure during system cycling.

5.21.2. Lubricant metering blocks operated by a portable pump shall have visible indication of operation. The use of this type of Pump shall require written approval from PacifiCorp.

5.21.3. Sight gages shall be provided to show the “High” and “Low” levels of oil in all systems, gearboxes, reservoirs, etc. and shall be readily visible to personnel at the fill point. Oil levels that vary from static to a running condition must show “High” and “Low” levels in both conditions. Bubble type sight gages shall not be permitted.

5.22. Stainless Steel Tubing

5.22.1. Stainless steel tubing that meets DIN 17458 or ASTM Standard A249/A26, shall be used when corrosive and or high oxidation conditions exist or may be caused by the type of coolant and machining materials that would damage steel tubing.

5.23. Conductors

5.23.1. Flexible Conductors.

5.23.1.1. Flexible conductors shall only be used when motion occurs between two or more components.

5.23.1.2. Flexible conductor runs shall be kept to a maximum length of 1 meter (3.28 feet) plus distance traveled by components being lubricated.

5.23.1.3. ISO 1436-2AT or SAE 100 - R2 type industrial grade hose shall be used.

5.23.1.4. Female swivel hose ends shall be used on all flexible-tubing ends.

5.23.1.5. All flexible conductors and associated fittings shall be of the same manufacturer.

5.23.2. Rigid conductors

5.23.2.1. Rigid conductors shall be securely mounted to machine structure.

5.23.2.2. Cast iron clamps shall not be used.

5.23.2.3. Tubing clips made of cadmium plated steel are acceptable.

5.23.2.4. Hydraulic tube clamps are acceptable.

5.23.2.5. The spacing of conductor supports shall comply with SAE J1751 5.1.8.2

5.23.3. Bulkhead Connectors.

5.23.3.1. Bulkhead or junction box type connections shall be used where conductors pass through machine structures and shall be terminated at both ends.

5.23.4. Conductors shall be located in such a manner as to prevent their use as a platform or step.

5.23.5. Covers shall be provided at corners and other areas where conductors are exposed to damage from external sources.

5.23.6. Conductors that are not readily traceable shall be identified with a permanent tag at both ends of the conductor with the same I.D. used on the lubrication drawing.

5.23.7. All lubrication conductors shall be capable of withstanding full system pressure. System pressures shall not exceed 10.44 MPa (1500 PSI) for oil and 13.89 MPa (2000 PSI) for grease. Accordingly, conductor sizing must be considered in system design. Ref. SAE J1751 5.1.3.3 /

5.23.8. Tubing used for conductors shall be welded steel annealed DOM hydraulic grade that meets ISO 3304-R-37-NBK or SAE Standard J-525, / J-527. Zinc Chromate Tubing shall be used at the request of PacifiCorp.

5.24. Magnet

5.24.1. Magnets shall not be used in machine lubrication systems unless specifically requested by PacifiCorp. When requested they shall be located in the system filter and not in the system reservoir.

5.25. Lubrication Reservoirs

5.25.1. All lubrication reservoirs shall be located in a central service area. Location shall allow for easy inspection and filling without machine shut off or creating a hazard to personnel.

5.25.2. Reservoir sight gages shall be provided to show high, safe operation and low liquid levels of lubricant and shall be visible to personnel while filling the reservoir. Sight gages shall be replaceable from the reservoir exterior without the need to drain the reservoir.

5.25.3. Reservoirs shall be filled through a filter(s), utilizing a quick action coupler located at working height. No other fill openings are allowed.

5.25.4. Reservoirs shall be contamination proof, with an adequately sized top mounted clean out which requires the use of hand tools to remove.

5.25.5. All reservoirs shall be provided with accessible drain plugs. The drains shall allow for complete draining of the reservoir. The drains shall be located at the lowest point of the reservoir and shall be at least 203.2mm, (8 inches) above floor level or the containment tray, whichever is the greater distance above floor level. The use of containment trays is mandatory. All Reservoirs shall have a “lockable valve” installed in the drain port.

5.25.6. All reservoirs shall be vented with replaceable Desiccant Filter breather for control of dirt and moisture ingress. All reservoir Desiccant filters shall be mounted above a combo breather fill port on the top of the reservoir.

5.25.7. Interior of reservoir shall be slag and scale free and protected against corrosion. Interior shall not be painted.

5.25.8. The top of the reservoir shall remain free of all fittings, brackets and filters with the exception of the combo breather/filter port and level switches.

5.25.9. Reservoirs of terminating lubrication systems shall contain sufficient lubricant as specified by the OEM for a minimum of 200 hours of system operation at maximum demand.

5.25.10. All (reservoir) capacity of 3.785 liters (1 Gallon) or larger, shall be supplied with lubricant sampling port(s). The sampling port(s) shall be an integral part of the reservoir and allow for the extraction of the Lubricant while the unit is in operation. The sampling port(s) shall incorporate a valved quick-connect style coupler attached to a probe (tube) which extends midway into the lubricant sump

5.26. Recirculation Lubrication Reservoirs

5.26.1. Reservoir capacity shall be sufficient to maintain an adequate lubricant supply to the lubrication system.

5.26.2. Reservoir capacity shall be designed such that the reservoir will contain all system lubricant draining back to the reservoir by gravity after the machine is shut down.

5.26.3. Sight gages shall indicate high and low levels for both the normal operating and off (lubricant drained to reservoir) conditions.

5.26.4. Recirculating system reservoirs shall be designed to promote rapid de-aeration of lubricant and the settling out of solid contaminants.

5.26.5. Recirculating oil systems shall only be allowed on internal lubrication systems where the oil is only recirculated through one component or machine.

5.27. Bearing Lubricant Distribution Grooves

5.27.1. All Journal Bearings, Rolling Element Bearings/Housings, Sliding/Rotating Bushings, Sliding Bearings and Sliding Ways, shall be provided with appropriate lubricant distribution grooves.

5.28. Sealed and Self-Lubricating Bearings

5.28.1. All lifetime lubrication bearings shall have rubber seals on both sides of the bearing.

5.28.2. The use of permanently lubricated and sealed "Lubed-for-life" Rolling Element Bearings, Self-Lubricating Bearings, Bushings, Ways and Slides should be guarantee from the equipment builder/supplier that any warranty of these elements for the design/service life of the equipment will not be compromised.

5.29. Pressure Relief.

5.29.1. Pressure relief fittings (vents) shall be incorporated into all housings of roller element bearings that are manually lubricated and should have relief fittings (vents) installed to prevent damage to seals.

5.29.2. Positive displacement pumps utilized on Series Progressive Systems shall be protected from excess pressure by the use of a relief valve, or a blowout disc rated at a maximum of 10.44 MPa (1500 PSI) for oil or 13.87 MPa (2000 PS) for grease and used in conjunction with an electrical sensing device.

5.30. Design for lubrication serviceability while equipment is in operation. All filters systems should be redundant with the capability of one or more filters being removable without loss any filtration. Grease points should be accessible with the equipment in service.

5.31. Use of non compatible lubricants in not acceptable. STP or similar products with additives not included in the base lubricant shall not be used for the lubrication and or assembly of bearings.

6.0 CENTRAL SERVICE AREAS

6.1. Industrial Equipment designs shall incorporate a central, readily accessible, lubricant service area. Large or complex industrial equipment may require the use of more than one central service area.

6.2. Central service areas shall contain but shall not be limited to all grease fitting manifolds, centralized system reservoirs, pumps, pressure gages and filters.

6.3. All central service areas shall be safely accessible while the machine, equipment or conveyor is in operation so as to allow for the safe servicing of lubrication components without removing guarding and impeding the operation of the equipment.

6.4. Difficult to reach bearings shall be provided with lubrication lines terminating at the central service area.

6.5. All lubricant level indicators shall be visible to personnel while filling all reservoirs.

7.0 EQUIPMENT

7.1. **Gearboxes**

7.1.1. Gear boxes shall be provided with a set of fill openings, drain openings and lubricant level indicators, located so that the set shall be properly positioned regardless of mounting position.

7.1.2. Visual indicators such as inset windows or sight glasses with reflectors and optical refraction indicators are preferred manufacture low and high level indication must be provided on the visual indicator. Petcocks are not acceptable.

7.1.3. Each drain opening shall be sized to permit gravity draining of the recommended lubricant.

7.1.4. Fill points, drain points and oil level indicator positions shall be clearly and permanently identified on gearboxes. Gearboxes incorporating only one set of fill-drain-indicator devices shall be clearly and permanently marked to show proper mounting position.

7.1.5. Gearboxes shall be located on the equipment so that the oil level indicators and oil fill openings shall be accessible for checking and servicing.

7.1.6. Gearboxes shall be located on the equipment so that the drain shall be accessible and convenient for servicing. A clear vertical drop of at least 203.2 mm (8 inch) minimum shall be provided below the drain opening.

7.1.7. All Gearboxes shall be equipped with a “Ball Valve” installed in the drain opening. The specific brand of “Ball Valve” shall be determined by the Receiving facility.

7.1.8. Oil level indicators shall be positioned so that the level can be readily observed, both while the fluid is being added and during equipment operation.

7.1.9. Location of fill and drain openings and oil level indicators shall be shown on machine and equipment drawings.

7.1.10. Fill, drain, or level indicator extensions shall not be utilized without prior written approval of PacifiCorp. Proposed extensions shall comply with the following:

7.1.10.1. Extensions shall be of 12.7 mm (½ inch) pipe or larger.

7.1.10.2. All extensions shall be rigidly supported. If any extensions incorporate elbows, then “tight pipe threads” shall not be considered adequate support.

7.1.11. Remotely filled gearboxes shall be vented. Vents shall be a Desiccant Filter breather for control of dirt and moisture ingress All gearbox Desiccant filters shall be mounted above a combo breather fill port on the top of the gear box.

7.1.12. Gearboxes with a Lubricant Sump (reservoir) capacity of 3.785 liters (1Gallon) or larger, shall be supplied with a Bottom

Sediment and Water Monitoring Device installed in the Gearbox drain port.

7.1.13. All gearboxes with a Lubricant Sump (reservoir) capacity of 3.785 liters (1Gallon) or larger, shall be supplied with a lubricant sampling port(s). The sampling port(s) shall be an integral part of the Gearbox and allow for the extraction of the Lubricant while the unit is in operation. The sampling port(s) shall incorporate a valved quick-connect style coupler attached to a probe (tube) which extends midway into the lubricant sump.

7.2. **PUMPS**

7.2.1. All Pumps with oil lubricated bearing housings shall be Equipped with a Constant Level Oiler.

7.2.2. All Pump Bearing Housings with a Lubricant Sump (reservoir) capacity of 3.785 liters (1 Gallon) or larger, shall be supplied with a Bottom Sediment and Water Monitoring Device installed in the Sump drain port.

7.2.3. All Pump Bearing Housings with a Lubricant Sump (reservoir) capacity of 3.785 liters (1 Gallon) or larger, shall be supplied with lubricant sampling port(s). The sampling port(s) shall be an integral part of the reservoir and allow for the extraction of the Lubricant while the unit is in operation. The sampling port(s) shall incorporate a valved quick-connect style coupler attached to a probe (tube) which extends midway into the lubricant sump.

7.2.4. All Fluid Process Pumps shall be equipped with a “Ball Valve” installed in the drain opening. The specific brand of “Ball Valve” shall be determined by the Receiving facility.

7.2.5. All Pumps shall have the Fill, Level and Drain ports clearly Labeled

7.3. **CONVEYORS**

7.3.1. Accessibility requirements for manual single point lubrication of conveyor components shall be any authorized maintenance personnel working surface as specified by PacifiCorp.

7.3.2. It shall be the responsibility of the conveyor supplier to insure that all conveyor components are fully pre-lubricated with PacifiCorp approved lubricant prior to operation of the conveyor.

7.3.3. It shall be the responsibility of the Conveyor supplier to insure that all conveyor components are fully pre-lubricated prior to the installation and operation of the conveyor “Transport” chain(s).

7.3.3.1. The Receiving facility shall reserve the right to have any conveyor component(s) dismantled for inspection for pre-lubrication.

7.3.3.2. All Conveyor “Transport” Chain components shall be fully pre-lubricated prior to installation and operation.

7.3.3.3. All conveyor Drive and/or Chain Lubrication Systems shall be completely operational prior to the Start-Up of any conveyor.

8.0 LUBE ROOM, HANDLING, STORAGE

8.1. A properly designed lube room must be functional, safe and expandable, and provide all necessary storage and handling requirements for the facility. Lube room designs should allow the maximum storage capacity without allowing for too much bulk oil and grease storage. Limiting the amount of bulk oil and grease storage will allow the oils that are stored to be used in a timely manner. Some key features to consider are a limited access door, which will allow for logging of who and when a lube technician enters and leaves the room; visible landing area for new lubricants; log all new lubricant deliveries; make filtration of stored lubricants easy; provide proper safety devices; designate enough floor space for fire proof storage cabinets to store top-up containers, grease guns, etc.; and include a desk and computer to track inventory, sampling, filtration, and receiving.

8.2. Proper storage and handling of lubricants is fundamental to success in machinery lubrication. The following key elements shall be included when designing and laying out a lubricant storage room:

8.2.1. Contamination, in its various forms, is the scourge of lubricated and hydraulic machines. It causes abrasion, surface fatigue, rust, corrosion and a host of other wear mechanisms that rob equipment of its life, compromises equipment reliability and drives up costs to operate and maintain the equipment. Contamination often enters the machine from new lubricants due to 1) poor delivered cleanliness, 2) failure to store lubricants in a manner that limits contaminant ingestion and 3) failure to deliver lubricants using containers and devices that limit or eliminate contaminant incursions. These sources must be managed through the storage and handling process to ensure effective contamination control.

8.2.2. Cross-contamination of lubricants can adversely influence the performance characteristics. Base oils, additive systems and grease thickeners all present compatibility risks. For example, contaminating turbine oil with engine oil additives compromises the turbine oil's demulsibility and air release properties. Or commingling lithium complex soap thickened grease with polyurea thickened grease typically leads to severe softening of the thickener. To avoid mixing of lubricants, the lubricant storeroom must be well-organized and tidy. All lube containers, hoses, funnels, transfer containers and other devices and hardware must be marked to identify the lubricant or lubricants with which they may be used.

8.2.3. To facilitate effective and efficient machinery lubrication, the lubricant storage facility must be easy to use. That means that it should be located in an accessible area near where lubrication work is completed, enable access for incoming and outgoing lubricants, and be equipped to allow lubrication technicians to complete their work with a minimum amount of waste, errors and frustration. Equipment such as drum handling equipment, lube storage racks, hose rollers, well-designed lubricant transfer pumps and other lubricant handling equipment can improve a lubricant storage room's ease of use.

8.2.4. Lubricants are chemical products, and as such, don't last forever. Accumulation of contaminants and time take their toll on lubricants. Base oils oxidize and/or hydrolyze over time. Additives hydrolyze, come out of solution or are scrubbed or washed out by particle and moisture contamination. Grease thickener will separate from the oil and additive components, which actually provide the lubrication. Managing lubricant inventory has four major elements:

8.2.4.1. Optimize the number of lubricants in service at the facility,

8.2.4.2. Optimize the volume of each lubricant kept on hand,

8.2.4.3. Set up a material handling system that facilitates effective and efficient usage on a well, first-out (FIFO) inventory system, and

8.2.4.4. Clearly mark containers to identify the product, the date it was received and the date it was placed into service.

8.2.5. Safety environmental protection is an important byproduct of a well-organized and well-managed lubricant storage room. The major safety concerns include accidents associated spilled lubricants, excessive skin contact with lubricants, discharge of static electricity, inhalation of chemical vapors and fire. Environmental protection relates the management of spills and the containment cleanup of those spills that can't be avoided. A well-designed lubricant storage room is well-ventilated, equipped for fire prevention (for example, away from ignition sources, well-marked with "No Smoking" and other signs warning against bringing ignition sources), equipped for fire extinguishing, grounded where applicable, designed to minimize leakage, equipped to contain and/or quickly clean up leaked lubricants, stocked with protective barrier creams and gloves, etc. Likewise, a lube storage room must contain material safety data sheets (MSDS) and those who work in and around the lube storage area must be clearly trained to understand their meaning. A safe, environmentally friendly lubricant storage room that is well-equipped to enable lube techs to effectively and efficiently perform their lubrication tasks is a cornerstone of achieving excellence in machinery lubrication and equipment reliability.

8.2.6. Location the lube room should be located in a clean area of the facility with easy access for delivery of bulk shipments of lubricant. The tool room should be sized to accommodate the need bulk storage of grease, and oil needed to maintain the facility.

8.2.7. The lube room should have room for explosion proof cabinets for the storage of top off containers and lubrication tools.

8.2.8. Lubricant containers should be handled according to manufacturer recommendations:

8.2.8.1. Drums should not be bounced off freight cars, trucks and racks

8.2.8.2. Metal drum slings and overhead hoists should be used when drums are tiered

8.2.8.3. Drums should be rolled not dragged

8.2.8.4. All containers and transfers take place under clean conditions

8.2.9. Fluid properties should be checked to insure the fundamental quality of the lubricating fluid. Many factors, including time itself, can alter oil's vital physical and chemical properties. There have been situations where irreparable damage and costly downtime have occurred as a result of using poor quality oil supplied as new oil (new oil does not necessarily mean clean oil).

8.2.10. New oil analysis testing (off-site lab) is required to check for the main properties of the lubricant and to establish a baseline for future analysis:

8.2.10.1. If oil doesn't meet the specifications, it should not be accepted, furthermore, it should never be put in a component.

8.2.10.2. Improper storage of lubricants will lead to contamination. Lubricants must be protected from weather, contamination, spills, and fire. Avoidance of temperature and environmental extremes will eliminate virtually all the potential problems. Lubrication disposal should be performed in accordance with site environmental procedures.

8.2.11. Lubricant containers should be stored according to manufacturer recommendations. Drums should be stored indoors, in a ventilated area, on racks, or blocks, off the floors, and on their side bungs at 3:00 and 9:00. Drums in use shall have descant breathers installed. Drums should not be stored outdoors, but if temporary outside storage is required they should be covered and move indoors as soon as possible.

8.2.12. Containers and hoses should be clearly marked to prevent cross contamination. Stored lubricant should be tested on site randomly to ensure quality.

8.2.13. Only the needed quantity of lubricant should be dispensed. Use the right lubricant for the specific machine and never return a lubricant to its container after it has been removed in order to prevent contamination of the stored oil. Lubricant containers should be resealed and labeled according to plant procedures after usage and work area should be inspected for cleanliness (good housekeeping).

8.2.14. Many problems can be avoided by good housekeeping practices. Exercise extreme care to prevent introduction of foreign material into clean systems. Recommendations include.

8.2.14.1. Use oldest lubricant first (first come first use basis)

8.2.14.2. If in doubt test lubricant before use

8.2.14.3. Use drum spigots for fast dispensing, quick cutoff, and to prevent dipping

8.2.14.4. Use color coded system designed to ensure right lubricant for each machine

8.2.14.5. Never mix different lubes in dispensing containers

8.2.14.6. Always keep dispensing equipment clean

8.2.14.7. Keep containers tightly closed when not in use

8.2.14.8. Avoid galvanized containers (these containers react with zinc)

8.2.15. It is extremely important that oils used in equipment are not mixed, as different types and grades are generally not compatible. Mixing could result in equipment damage or failure. For draining and flushing, be careful with cleanup and keep less than 5% of old material in the new (some systems don't allow a complete drain and flush). For best results, use only lubricants specified in the Lube Manual or an approved substitution determined by the vendor.

8.2.16. The lube room will need properly sized filtered ventilation.

8.2.17. The lube room will need properly sized automatic sprinkler system.

8.2.18. All lighting, heating, switches, pumps and receptacles must be explosion-proof.

8.2.19. The lube room must be constructed of fire proof material.

8.2.20. The lube room must have adequate number of fire proof cabinets for storage of tools and dispensing containers.

8.2.21. The lube room may have automatic pneumatic grease–dispensing for 120 lb. bulk grease storage containers to hand held grease guns.

8.2.22. The lube room must be supplied with bulk storage containers for storage of oil. The storage system must have a transfer pump to filter and transferred oil from the 55 gallon barrels (or other delivery container) to the bulk storage containers and then form the storage containers to the top-up container, it is best to filter the dispensing oil. This can be made very easy with the use of a hard plumbed filtration system and a rack mounted storage system fitted with dedicated dispensing nozzles. If using 55-gallon drums, they can be fitted with quick connect fittings, a hand pump, an inline filter manifold breather and sight glass to achieve the same goal.

8.2.23. Dispensing containers must have sight glass to see the level if each bulk container.

8.2.24. The lube room floor must be coated with a non-slip oil resistant epoxy coating.

8.2.25. All bulk containers, piping, top-up container and valves must be labeled and color coded for the correct lubricant (standard below).


HONING OIL

Color Code for Lube Products

*320 SYN	R&O or Hydorclear
*460 SYN	R&O or Hydorclear
680 SYN	R&O or Hydorclear

320	SYN	EP
460	SYN	EP
680	SYN	EP

Grease

*General Purpose #2 EP
*General Purpose HT
*Water Resistant
* Electric Motor
*Coupling
*Synthetic (Soot blowers)

Equipment Specific

* Gold Foil (Pulsa Lube)
*Silver Foil (A.T.F.)
*Brass Metal Tag, Mobil Syn. 630
*Diesel
*Fluid Silicon
* R&O 100 Syn

9.0 REFERENCES

9.1. "PacifiCorp Employees". A special thanks to the dedicated plant employees for their insight and input.

9.2. "National Aeronautics and Space Administration"; Reliability Centered Maintenance Guide for Facilities and Collateral Equipment. February 2000.

9.3. "American Petroleum Institute", API Technical Publication 684, 2003

9.4. EPRI, Predictive Maintenance Development and Implementation TR-108936. 1998

9.5. International Standard Organization, ISO1940-1, 2003

9.6. "NORIA Corporation", Machinery lubrication and Oil Analysis Level I training manual

9.7. GM, "GM Lube Standard for Industrial Equipment and Machine Tools"

10.0 Any questions regarding this standard can be directed to the PacifiCorp Generation Support Predictive Maintenance Group at:

PacifiCorp Generation Support
Attn: Predictive Maintenance GroupAlb
1407 W. North Temple Room 330
Salt Lake City, UT 84116

PACIFICORP
Engineering Handbook

8B.3.1—Data and Voice Network Infrastructure Wiring Guidelines

Asset Management Department

Date: 20 Apr 06

Contents

FIGURES	PAGE

8B.3.1—Data and Voice Network Infrastructure Wiring Guidelines

1 Scope

The purpose of this Engineering Handbook document is to provide a guide for the design, product selection and installation procedures of PacifiCorp's voice, data and videoconference cabling. This design is based on a multiple floor or other large facility. Smaller buildings may have a combined equipment room and telecommunications room, or may have the equipment mounted in a cabinet or other suitable enclosure in the office space.

1.1 Application

1. **General –** This Engineering Handbook document covers the installation of copper and fiber optic cables for voice, videoconference and data network use in PacifiCorp facilities. Most locations will use fiber optic cable to distribute the LAN from the main cross-connect (MC) room to distributed telecommunications closets (TC). In addition there will be multi-conductor house cable to distribute any analog or non-LAN voice service to those same local closets. The horizontal wiring from those closets to individual work stations will be the same for both voice and data to allow any cable to be used for either voice or data.
2. **New Horizontal Wiring –** Effective July 2004, new installations will have two Cat 5e cables installed to each work location to be used for videoconference, voice or data. See section 11.3.
3. **Existing Horizontal Wiring –** All existing areas of the company either have four Cat 5 or 5e cables for voice and data, or two Cat 3 cables for voice and two Cat 5 or 5e cables for data, installed to each work location. If remodeling is being done, and the existing cables can be reused, there is no need to do rewiring of a facility to bring it up to "standard." If minor rewiring is being done, then the existing site method should be followed. If a significant area of the facility is being remodeled (such as a building, floor, or suite), then the two Cat 5e cabling standard should be implemented.
4. **Testing and Documentation –** Each new or relocated Cat 5e cable that is installed must be tested, and documented in accordance with Sections 15 and 16..
5. **Deviation from Standard –** This Engineering Handbook document is meant to be a guideline to achieve a high performance, good quality, cost effective installation. If specific sites require adaptation then good engineering practice must be used to do what makes the most sense for that installation. Standard equipment items may be adapted for specific designs with prior written approval by appropriate PacifiCorp telecommunications engineers. If new products become available, they should be considered and the

possibility of revising the standard considered. All requests for deviation from the standard should be referred to IT Network Engineering for coordination with all affected business units.

1.2 Use

This Engineering Handbook document has been developed in a joint effort by PacifiCorp business units and wiring contractors. to establish a standard communication cabling plan to be implemented company wide. It is intended for use in any building wiring installation performed for PacifiCorp facilities by company employees or contractors.

2 References and Resource Documents

All structured cabling systems shall comply with the following standards:

IEEE C37.2 (ANSI) *Standard Electrical Power System Device Function Numbers*

ANSI, TIA, EIA 568B *Commercial Building Telecommunications Standards*

ANSI, TIA, EIA 569 *Commercial Building Standards for Telecommunications Pathways and Spaces*

ANSI, TIA, EIA 606 *Administration Standards for the Telecommunications Infrastructure of Commercial Buildings*

ANSI, TIA, EIA 607 *Commercial Building Grounding and Bonding Requirements for Telecommunications*

Additional resources include:

National Electric Code (NEC) and local building codes

PacifiCorp Engineering Handbook Section 8E, *Electronic Communications and SCADA Documentation*

BICSI Telecommunications Distribution Methods Manual, 10th Edition

BICSI LAN Design Manual

3 Manufacturer's Performance Warranty

A manufacturer's minimum 20-year application and performance warranty is required for each contractor installed cable plant. The preferred product manufacturer warranty is Siemon for Fiber and Commscope for Cat 5e. Other manufacturers of Cat 5e or fiberoptic cable may be substituted upon written approval (see section 1.1.5 of this document).

4 Authorized Designer and Installer

A designer trained in Cat 5e installation and layout requirements must develop the designs for any site. Preferably, the designer will possess local low voltage wiring license or certification.

A technician trained to install and test Cat 5e cables shall install all installations. Technicians must be trained by the manufacturer, or other approved training facility.

Designers and installers must follow the guidelines of this Engineering Handbook document at PacifiCorp facilities.

5 Entrance Facilities (EF)

5.1 Interface Between Service Provider and Premise Equipment

The EF includes the network components needed to provide a means to interface the outside Telco facilities to the premise equipment. This includes cables, connecting hardware, electrical protection devices, and grounding and bonding. The service provider is responsible for delivering all outside services to a point of demarcation, which is the interface point between the service provider's facility and the premise equipment. It is PacifiCorp's responsibility for extending the services from the point of demarcation to the structured cabling system and customer equipment.

5.2 Service Extended to Main Equipment Room

These services should be extended to the main equipment room and mounted on the left–hand side of the main backboard. Enough space should be allocated to provide for future growth in this area. The services shall be grounded and bonded to the Telecommunications Main Grounding Busbar (TMGB) and labeled accordingly. This information must be recorded and included in the system administration documentation.

6 Equipment Rooms (ER) and Main Cross-Connect (MC)

6.1 General Information

An ER is a special-purpose room, which provides space and maintains a suitable operating environment for telecommunications equipment. The ER provides a central point for distributing telecommunications services to entire floors, buildings, or campuses. All distribution cables, such as backbones, are served from this location. The telephone and data service providers use this area for distribution to other Telecommunications Rooms (TR) throughout the building.

6.2 Equipment Room Space

An ER must provide enough space for all planned equipment, access to the equipment for maintenance and administration and growth. The ER must meet lighting, air conditioning, floor loading and electrical requirements as per ANSI, TIA, EIA 569A.

6.3 Clean Location

An ER shall be located in a place that is free from dust, water infiltration, steam infiltration, humidity from nearby water or steam, heat, or any corrosive atmospheric or environmental conditions. Rooms with copy machines should be avoided.

6.4 Central Location

An ER should be centrally located within the building to keep backbone cable runs as short as possible.

6.5 Room and Backboard Layout

All copper cables shall be routed to, and terminated on, a Siemon S110M Modular Tower System with five pair connecting blocks or Modular Patch Panels, depending on the needs of the equipment being installed. Although this document refers to the 300 pair tower unit, the requirements of the backbone cables will determine the size of the tower system. Vertical cable managers shall be installed between each tower system. This cable manager will be sized the same as the tower system. A metal trough shall be installed on the bottom of each row for additional cable management. All towers and racks shall be grounded with #6 ground to the site single point ground system in accordance with PacifiCorp practices. See Figure 1, Figure 2, Figure 3 and Figure 4 for typical layouts. The rack mount layout is preferred in most instances.

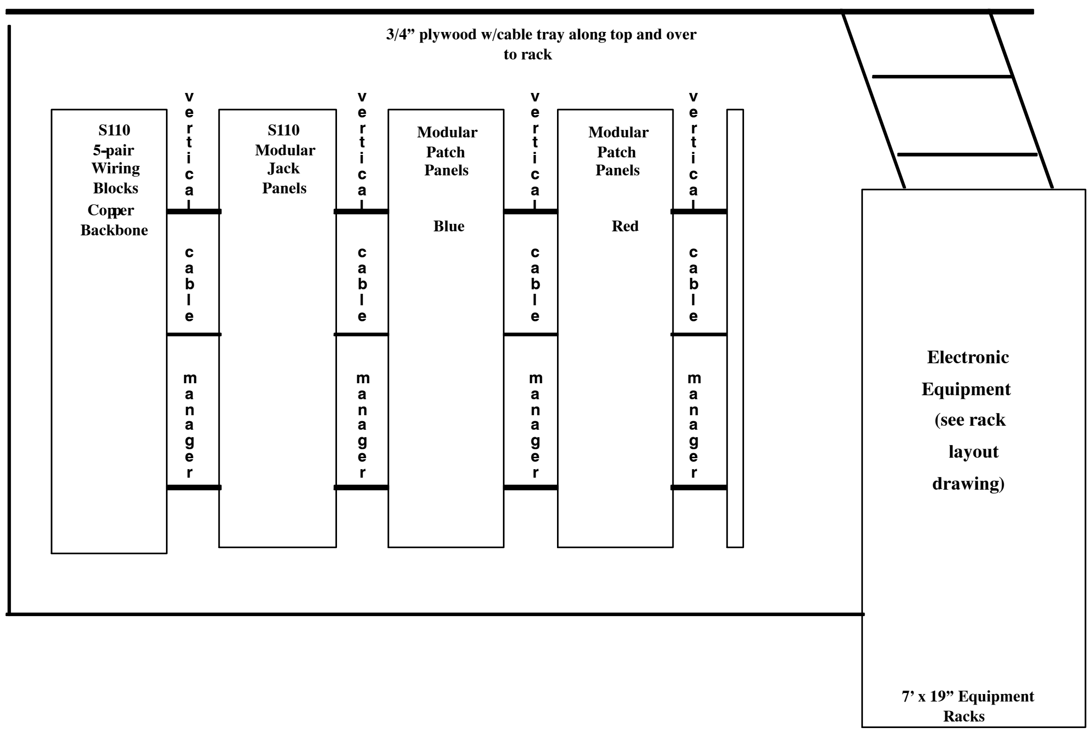

Figure 1 - Wall Mount Option

7 Telecommunications Rooms (TR)

7.1 General Information

A TR differs from an ER in that it is generally considered to be a floor-serving facility, as opposed to a building–serving facility. The TRs are an area where horizontal cables are cross-connected to the backbone system. The TR is also the area where data racks, concentrators, and patch cords are used to cross–connect to the workstation outlets. A TR may also contain active electronic equipment, such as data switches, that support other devices at the workstation location.

7.2 Clean Location

A TR shall be located in a place that is free from dust, water infiltration, steam infiltration, humidity from nearby water or steam, heat, or any corrosive atmospheric or environmental conditions. Rooms with copy machines should be avoided.

7.3 Backboard/Rack Layout

The copper backbone shall be routed to the left side of the backboard or row of racks where it will be terminated on a Siemon S110M Modular Tower System using five-pair connecting blocks. Siemon S110 Modular Jack Blocks shall be installed in the same or next row as the copper backbone. Two more rows of Siemon Category 5e Modular Patch Panels shall be installed to the right, with a vertical cable manager between each. These modular patch panels shall be used for horizontal cable terminations. (See Figure 1, Figure 2, Figure 3 and Figure 4 for typical layouts.)

In locations that require additional telecommunications cabling, four rows of modular patch panels can be installed with enough pairs for the required number of workstations and projected expansion. Although one of the cables is normally for voice and one for data (and two of the cables are normally used for voice and two for data in the four-cable system), the installation should be planned so that any of the cables can be used for either voice or data. This means that there must be a way for patch cords or cross connects to route to house cable or PBX blocks as well as an equipment rack with voice or data equipment mounted in it.

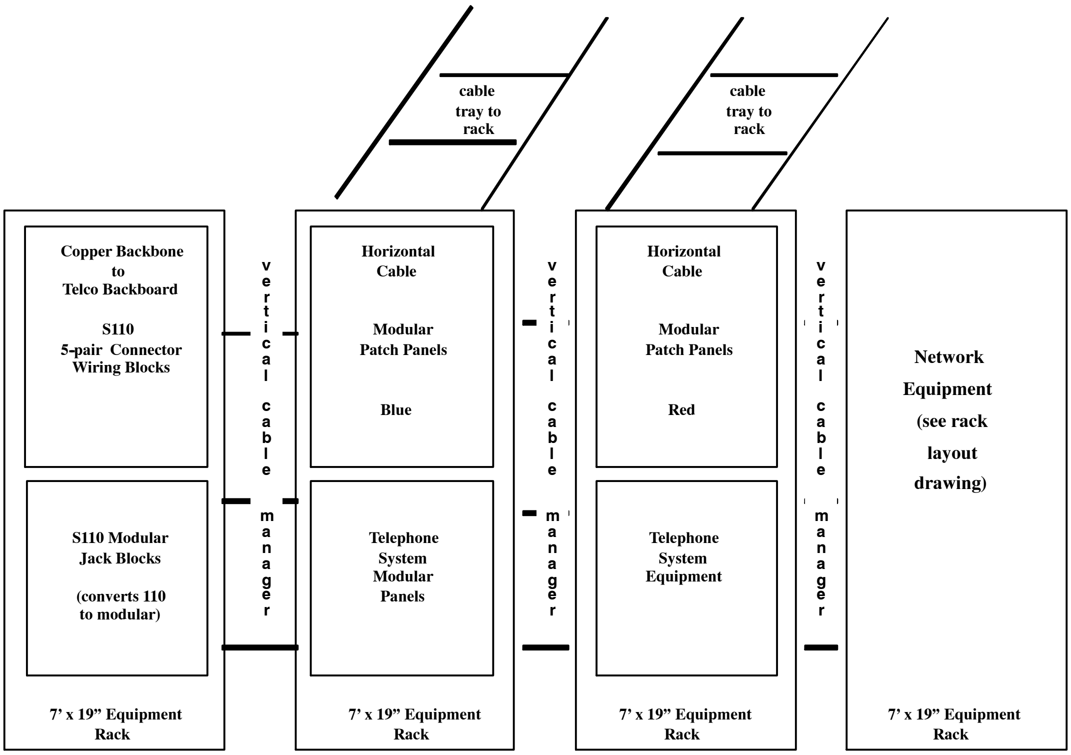

Figure 2 – Rack Mount Option

7.4 Labeling:

All termination hardware must be labeled with computer printed designation labels. The copper backbone cable shall be labeled using the same color designation strip as is used in the equipment room. The horizontal cables shall be labeled left to right using blue and red designation strips. These colors shall coordinate with colored icons on the workstation faceplate. Where four colors of designation labels are used, the cables shall be labeled using green, yellow, blue and red designation strips as established by existing installation. New installations will only use blue and red even if additional racks are needed.

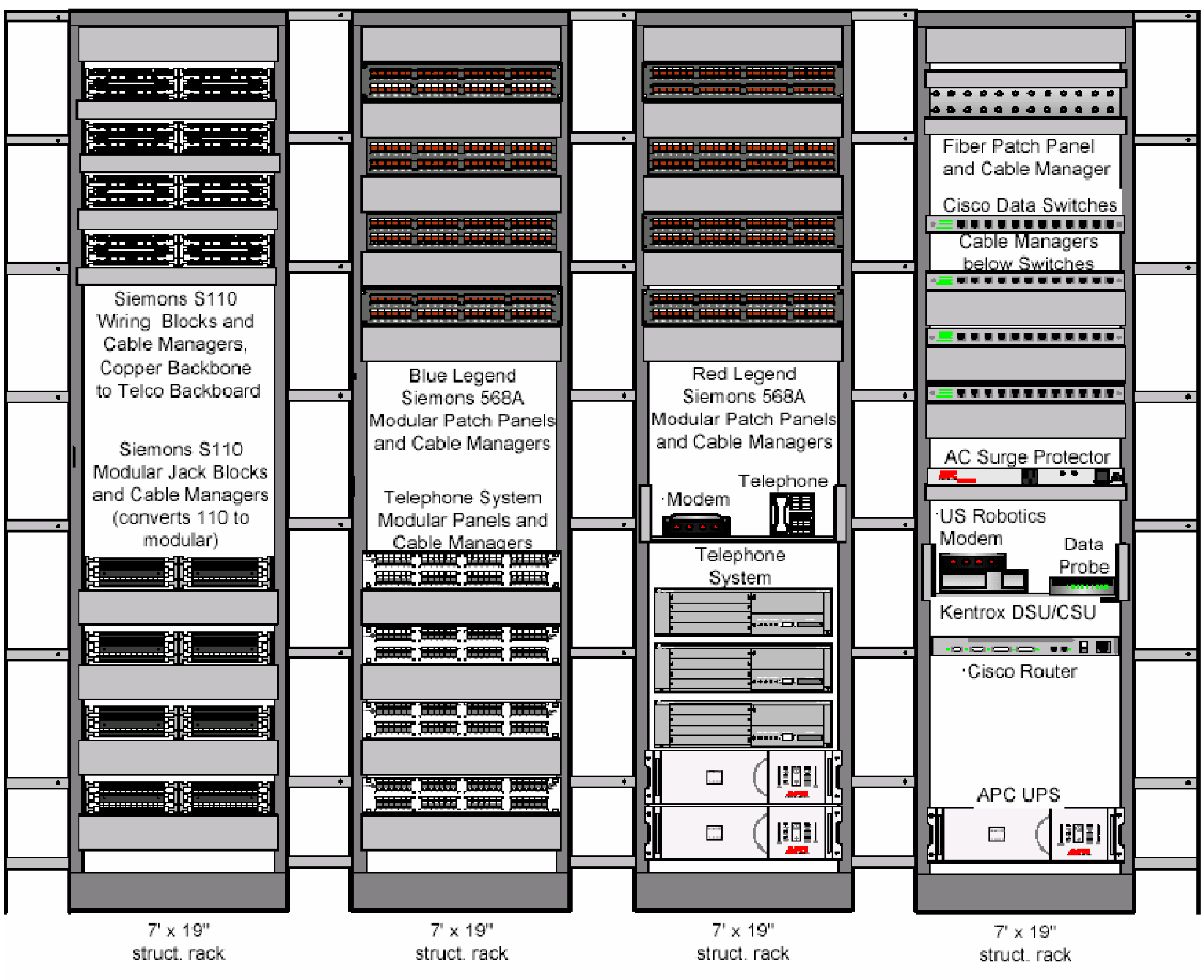

Figure 3 – Rack Equipment Layout I

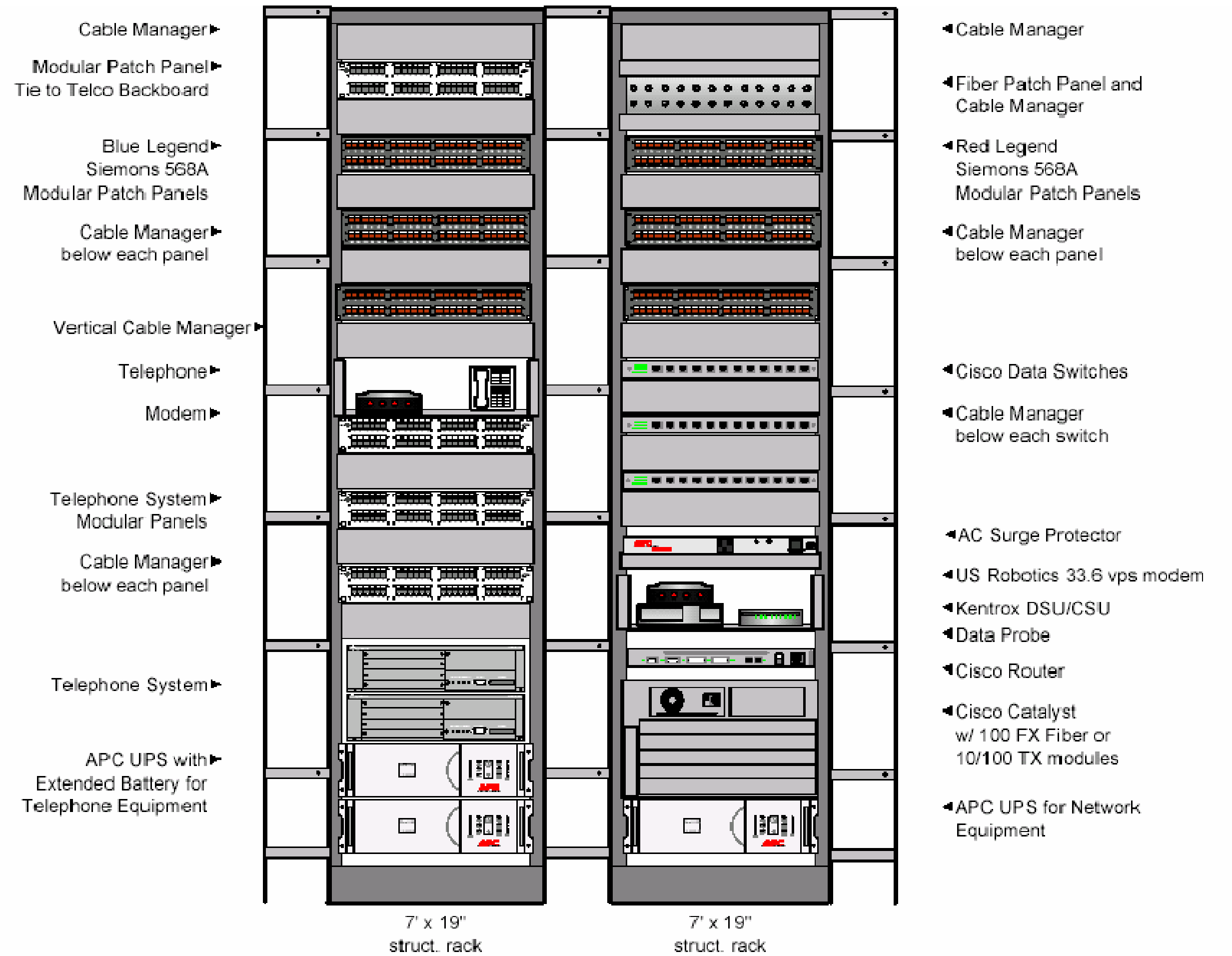

Figure 4 – Rack Equipment Layout II

8 Rack Layout and Hardware for MCs and TRs

8.1 Rack Layout

A Chatsworth 7′ x 19″ standard equipment rack shall be installed for data equipment. This rack shall be securely mounted to the floor using 1/2-inch concrete anchors. A Chatsworth 12-inch cable tray shall be extended from the top of the rack to the wall where it is securely attached. The rack must be grounded with a #6 ground wire. A power protection or surge suppression panel shall be mounted in the rack. A quad power outlet shall be mounted on the side of the rack. A UPS may be mounted at the bottom of the rack. An additional power outlet on a dedicated circuit shall be mounted near the bottom of the rack near the UPS for use by the UPS. A rack-mounted fiberoptic patch panel with 568SC style bulkheads shall be mounted near the top of the rack if required. (See Figure 1, Figure 2, Figure 3 and Figure 4 for typical layouts.)

8.2 Labeling

All termination hardware must be labeled with computer printed designation labels. Orange designation strips will denote the service provider blocks, purple for the PBX cables and white, brown, or gray for the backbone cable.

The same color designation strip must be used in the TR, as is used in the ER for backbone cables.

9 Telecommunications Backboards

9.1 Backboard Required

In the wiring rooms and main equipment rooms it is necessary to install and secure backboards to mount connecting hardware, cable trays, and other devices for a structured wiring system. Where space is not available for a backboard on the wall, the 110 cabling system may be mounted in standard 19-inch equipment racks.

9.2 Coated Plywood

It is required that a 3/4-inch A–C plywood backboard be used and coated with a fireproof paint.

9.3 Required Space and Placement

The amount of backboard space that is needed is determined by the number of devices and the amount of cables to be terminated. It is recommended that these backboards be offset from the wall at least four inches, so that cables may be routed in from behind for termination onto the connecting blocks. This procedure provides security and a visual appearance that is valuable to the customer.

10 Backbone Cables

10.1 General Information

Backbone cables are used to provide interconnections between TRs, ERs, and EFs. Copper cables should generally be used for voice backbone applications, and fiberoptic cables should be used for data backbone applications.

10.2 Space and Layout Requirements

When designing a cable backbone system, considerations for cable pathways, actual types of cable used (fiber or copper), cable support hardware, fire stopping and connecting hardware must be considered. Plans should include enough space and future growth in the system to accommodate future expansion.

10.3 Conduit between MC and TRs

A minimum of three each of 4-inch (4”) conduit pipes shall be installed between each TR and the ER, unless otherwise approved. One conduit will be used for voice applications and the other for data applications. This is necessary to protect the backbone cables as well as to provide a secure route for these cables.

10.4 Copper Backbone

10.4.1 Number of Pairs Required

A minimum of three copper pairs per workstation shall be installed to form the equipment room main cross-connect to the telecommunication room. As a rule of thumb, 25 percent of extra pairs should be allowed for future growth.

Example 1: Telecommunications room #1 has 100 workstations terminating in its room. Allowing three connections per workstation, a 300-pair cable will be specified.

Example 2: Telecommunications room #2 has 30 workstations terminating in its room. This will require a minimum of 90 copper pairs, so the next size up cable of 100 pairs will be specified.

This cable will be grounded in the equipment room using a #6 ground wire to the site single point ground system in accordance with PacifiCorp practices.

10.4.2 Copper Cable Testing

All copper cable pairs shall be tested for continuity and polarity.

10.4.3 Material

A solid conductor Cat 3 or better CMR cable must be installed as the copper backbone cable. Avaya and Commscope are the only approved cable manufacturers. Cable size will be determined by the particular job environment based on the requirements stated above and specified by the designer.

10.4.4 Labeling

All cables shall be labeled on each end showing the destination TR or ER and shown on site layout diagrams.

10.5 Fiber-optic Backbone

10.5.1 Installation Requirements

A minimum of 6 pair of 50 micron multi-mode fiberoptic (MMF) cable shall be installed from the ER main cross-connect to each TR. This fiber shall be installed inside a conduit or a one-inch innerduct. All fibers are to be terminated on each end using 568SC style connectors. These fibers shall be installed into a rack-mount fiber-optic patch panel. Fiberoptic cables to small remote locations (less than 24 workstations) shall have six pairs.

Starting in May of 2003, all new optical fiber installations shall be of the 50 micron type. It is recognized that there is an existing plant of 62.5 micron optical fiber. The existing plant shall remain in place, and be replaced in the future only in cases where new communications equipment dictates or failures occur.

Careful attention shall be paid to clearly labeling the new fiber installations on the fiber, and at the patch panel. This will become even more important to avoid the situation of mixed fiber types on a single path. Mixed fiber types can and will result in unacceptably high error rates. If for example, a fiber runs from the equipment port to the patch panel as 50 micron, but is extended from the patch panel using a 62.5 micron patch cord, data errors will be introduced into the optical path.

The manufacturer's recommended minimum bend radius shall be strictly observed to prevent damage to the fibers or attenuation to the optical signal.

Fiber connectors should be cleaned before installation. Fiber connectors should be kept covered until the moment of installation. Fiber connectors should be kept away from a high particulate environment to prevent contamination of the fiber end.

10.5.2 Fiberoptic Testing

The most important test is the end-to-end attenuation test, referred to as the link test. A link test must be performed on each fiberoptic strand. This is accomplished using an optical power meter. Each fiber must be tested at 850nm/1300nm wavelengths. The standard is 3.50dB/Km at 850nm and 0.75dB/Km at 1300nm.

It is generally accepted that loss rates less than allowable loss rates should be achieved. Maximum cable loss will be determined by TIA 568B standards. All test reports must be submitted upon completion.

Note: In instances where the fiber distance will exceed 1,800 feet (550 meters), single-mode fiber (SMF) will be used.

11 Horizontal Cables

11.1 Definition

The horizontal cabling system is the portion of the telecommunications cabling system that extends from the horizontal cross-connect in the telecommunications room to the workstation telecommunications outlet. This unit of cabling is referred to as a link. This system includes patch cords, cross-connect hardware and cable pathways and spaces. Cat 5e cables that terminate by punch-down on both ends will be of solid conductor type. Cat 5e cables that are terminated on both ends with a connector, such as those manufactured with a crimping tool, shall be of stranded conductor type. If cables are manufactured on site, extreme care shall be taken to match the crimp tool to the actual connector used, as mismatches will produce a poor quality connection.

11.2 Maximum Length

The horizontal cable length between the TR and the workstation area shall not exceed 90 meters (295 feet). The patch cord length at the workstation shall not exceed five meters (16 feet). The patch cord length within the TR shall not exceed five meters (16 feet). Each run shall be continuous with no splices.

11.3 Cables Per Workstation

A minimum of two Cat 5e blue cables will be installed to each workstation. These cables will be installed into a four-port faceplate or a two or four-port modular furniture adapter at the workstation. See Figure 5 below for layout of the faceplate. At sites that have existing cable that is Cat 5e, but is not certified, the cable will be tested and used if possible. Additional runs will be made as necessary. At sites with existing certified Cat 5e installations, the existing certified cable will be used, and documentation copied for network operations use.

If additional outlets are needed at a work location, additional runs of two cables will be installed to that location. These cables may be installed in a separate duplex outlet or combined in a single four-port faceplate and labeled appropriately. At new installations this will mean using blue and red for both pairs of cables in a single four-port faceplate with them having different cable numbers.

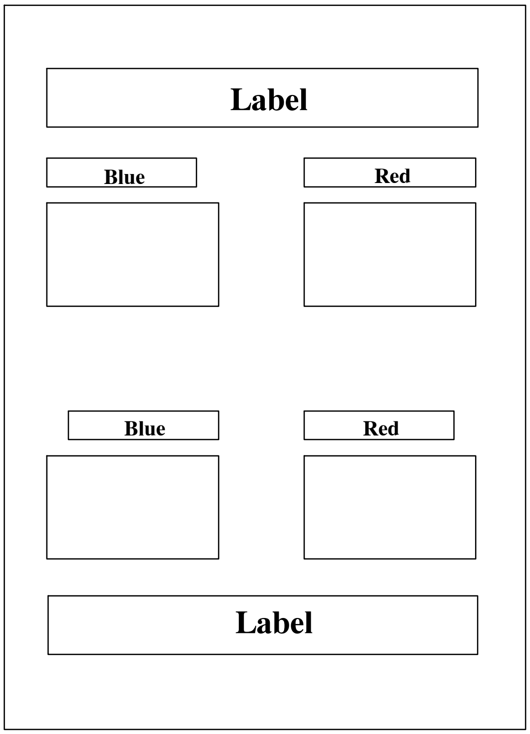

Figure 5 – Faceplate

11.4 PVC vs. Plenum Cable

The installation shall be determined by code (NEC) as to whether PVC or plenum cable is to be used. This determination shall be made prior to the ordering and installation of cable. Installation technicians must also make a final check of appropriate cable type prior to pulling cable.

11.5 Cable Support

Cables must be supported in ceilings every four feet using either J–hooks or ceiling hangers for supports. Supporting cables by using existing ceiling hangers is not acceptable. Power and heat sources must be avoided.

11.6 Bend Radius

Bends shall not be less than the minimum bending radius established by the cable manufacturer. This is often four times the cable diameter or greater.

11.7 Cable Pulling

Cable pulling tension must not exceed the maximum tension recommended by the cable manufacture. This is usually 25 pounds or less.

11.8 Hook and Lattice

When hook and lattice or Velcro fastening devices are used, they must be installed loosely to avoid crushing the outer jacket of the cable. No stapling is allowed.

11.9 Cable Termination—Workstation

Each solid conductor cable shall be terminated by punch down on a Cat 5e T568A wired insert at the workstation location, and installed into a four–port faceplate or a two or four–port modular furniture adapter.

11.10 Cable Termination—Telecommunications Room

All cables shall be terminated on Cat 5e modular patch panels in their designated locations in the TR.

11.11 Horizontal Cable Installation Instructions

11.11.1 Running Cable

All cable pathways and spaces must be in place before actual installation can occur. These pathways may be cable trays above a ceiling, under-floor systems, or open spaces above ceilings and in hallways. A customer provided floor plan should be available to provide the necessary destination point for placing the workstation cables.

Set up cable reels and boxes in the TRs and mark each cable according to the documentation provided. Feed the cables by hand into the tray or duct systems and pull out to workstations leaving slack at the ends with sufficient length to terminate to the communications outlet.

In the TR, once it is determined that the cable has reached the far end of its destination, cut the cables from the reels or boxes leaving sufficient length to reach the termination hardware. Try to be conservative in this respect to avoid wasting cable by overestimating this required length.

Repeat this procedure until all locations have been cabled according to the floor plans.

11.11.2 Terminating Cable

These cables should be dressed into the 110 blocks or patch-panels in a uniform manner with attention paid to appearance of cables; they should look smooth and not twisted or tangled.

Tie-wrap the cables to the support hardware in a loose but firm fashion to secure them in place.

Terminate the cable by the following procedure:

1. Strip about six inches of sheath, and expose the twisted pairs inside.
2. Do not untwist the cable pairs.
3. Insert the untwisted pair into the connector, leaving no more than 1/2-inch of exposed wiring.
4. Punch it down with the punch tool, according to the manufacturer’s wiring standard.
5. Repeat this process for every pair in the cable until all of your wires and cables have been terminated as per 568B

12 Workstation Outlet

12.1 General Considerations

When installing cables into the work areas there may be several different aspects to consider such as: Is this cable to be routed inside of furniture such as cubicles, placed into wall outlets or floor locations?

If installing into modular furniture, route the cable to the appropriate outlet.

12.2 Mounting Boxes

After installing the cable, it is necessary to install mounting hardware for the faceplates and connectors such as device boxes, monuments or mud rings.

Terminate the cable by the following procedure:

1. Strip about six inches of sheath, and expose the twisted pairs inside.
2. Do not untwist the cable pairs.
3. Insert the untwisted pair into the connector, leaving no more than 1/2–inch of exposed wiring.
4. Punch it down with the punch tool, according to the manufacturer's wiring standard.
5. Repeat this procedure for every cable located at that workstation.
6. Insert the connectors into the faceplate and fasten faceplate to mounting hardware. See Figure 4 for faceplate layout.

12.3 Color Code

Faceplate colors shall be determined on a job by job basis. The faceplate color must be the same as the electrical faceplate. Each Cat 5e insert within the faceplate will be the same color as the faceplate, with a distinct color icon. The color of the insert shall directly correspond to the color scheme at the backboard.

12.4 Labeling

All faceplates will be labeled with an adhesive backed machine label (example: Brothers P–touch). Each faceplate shall have a distinct three-digit number preceded by the room number. Example: workstation #5 routes out of room #2. The label will read 02-005.

13 Patch cords and Jumpers

13.1 Patch cords

Cat 5e modular-to-modular patch cords shall be supplied for data applications in the TRs and for the workstations. The TR patch cords shall be routed from the modular patch panels, across the cable tray, to the equipment rack. Although 5-meter patch cord lengths will be considered standard in the TR, and 5-meter at the workstation, proper lengths need to be determined prior to ordering. Both TR and workstation patch cord requirements will be determined as part of the project design. Keeping the patch cord lengths reasonably short in the TR will help reduce the bulk of extra cable in the vertical cable manager.

13.2 Cross-connects

To be determined on a job by job basis.

14 Approved Materials

The project engineer will specify the specific material required for the job. The following list of materials (section 14.1) is the starting point for a job using Siemon/Commscope equipment.

14.1 Materials for MCs and TRs

The materials listed below shall be used in construction of equipment for the ER racks, TRs and associated facilities as indicated in their respective sections of this document.

Part No.	Description
55053-503	Chatsworth 7′ x 19″ standard equipment rack
10250-112	Chatsworth 12″ cable runway
11421-112	Chatsworth 12″ wall angle support kit
10595-112	Chatsworth rack-to-runway mounting plate
08009-001	Chatsworth ground terminal block
11374-503	Chatsworth vertical cable manager
S110MA2-300FT	Siemon 300 pair modular tower system with five-pair connecting block
S110MB2-300FT	Siemon 300 pair modular tower system with four-pair connecting block
S188-300	Siemon vertical cable manager
S188-WD	Siemon metal trough
S188-GND	Siemon ground kit
FCP-DWR-Blank	Siemon rack-mount fiber panel with drawer
FCP-BZL-1SC	Siemon Bezel (black) with one duplex 568SC adapter (two ports)
S110DB2-200RWM	Siemon 200 pair 19″ panel with four–pair wiring blocks, cable managers and covers
S110DB5-24RJPT	Siemon 24 port jack panel, on a 19 inch panel, T568A wiring
S110MB5-300JPT	Siemon 36 port S110 Tower modular jack panel kit, T568A wiring
HD5-24	Siemon 24 port Cat 5e modular patch panel
HD5-48	Siemon 48 port Cat 5e modular patch panel
WM-143-5	Siemon rack mount cable manager 1 RMS
WM-145-5	Siemon rack mount cable manager 2 RMS
SBH-4	Siemon stand-off bracket for patch panel mounting 4 RMS

14.2 Approved Material for Fiberoptic Backbone

Materials from the following list shall be used as applicable in fiberoptic installations.

Part No.	Description
P012DS5H000	Commscope 12-fiber 50 micron plenum
P012DS5H000	Commscope 12-fiber 50 micron PVC
P006DS5H000	Commscope 6-fiber 50 micron plenum
R006DS5H000	Commscope 6-fiber 50 micron PVC
FC2-SC-MM-B80	Siemon 568SC connector

14.3 Approved Material for Horizontal Cabling and Workstation Outlets

The following materials shall be used in cabling terminations.

Part No.	Description
5504	Commscope Cat 5e plenum cable - blue
55N4R	Commscope Cat 5e PVC cable - blue
CT4-FP-(XX)	Siemon 2 coupler single gang faceplate
CT-C5-C5-(XX)	Siemon Cat 5e double coupler – universal T568A/B installed T568A.
CT-ICON-05	Siemon yellow icon - package of 25
CT-ICON-07	Siemon green icon - package of 25
MX-C5-(XX)	Siemon Cat 5e MAX tool-less module with universal T568A/B wiring – installed T568A.
MX-FP-S-04-(XX)	Single gang faceplate for four (4) MAX modules.
CT-MFP-(XX)	Siemon CT modular furniture adapter
MX-MFP-(XX)	Siemon MAX modular furniture adapter

In the part numbers above, replace (XX) with the following ordering codes to specify color as indicated below.

01=black

02=white

04=gray

20=ivory

80=light ivory

14.4 Approved Material for Patch Cords

The patch cord approved for this application is listed below. (Other patch cords may be required based on equipment room layouts.)

Part No.	Description
S110P4T4-07-B01	Siemon 7′ 110-to-modular patch cord with black string relief boot, T568A
MC5-8T-10-B01	Siemon 10′ Cat 5e, double-ended modular patch cord, T568A with black strain relief boots

15 Testing

All cables will be tested in accordance with the manufacturer's recommendations and requirements of ANSI, TIA, EIA 568B. All test records (one paper and one electronic copy) will be furnished to PacifiCorp as part of the completed documentation package.

16 Documentation

Documentation will be in accordance with the current PacifiCorp documentation guidelines (see PacifiCorp Engineering Handbook Section 8E.) A site layout drawing with the location of all assigned workstation numbers will be provided, as well as all cable certification documentation.

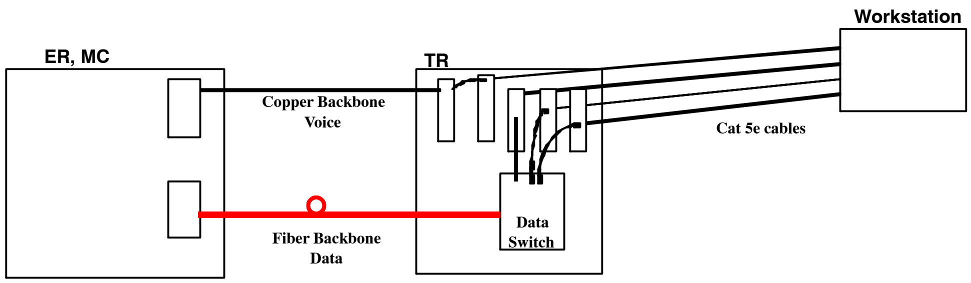

Figure 6 – Wiring Overview

17 Issuing Department

The Asset Management Documentation Department of PacifiCorp is responsible for issuing this document. Comments and suggestions are welcome. Additional copies may be obtained from:

Asset Management Documentation, Lloyd Center Tower
825 NE Multnomah St., Suite 1600, Portland, Oregon 97232
Telephone: (503) 813-5293 Fax: (503) 813-6804

Technical questions regarding the content of this document may be directed to Milt Patzkowski, Electronic Communications and SCADA Engineering Manager at (503) 813-6916. Publication and use of this document is authorized by the Manager of Standards Engineering when the block below has been signed.

Approved: ______________________
Milt Patzkowski, Manager
Electronic Communications and
Scada Engineering

Approved: ______________________
Gail Shaw, Manager
Standards Engineering

APPENDIX H

REPORT OF GEOTECHNICAL EXPLORATION

DOCUMENT 1 OF 5

REPORT OF GEOTECHNICAL EXPLORATION

PROPOSED CURRANT CREEK POWER PLANT

JUAB COUNTY NEAR MONA, UTAH

Prepared for:

PACIFICORP
ONE UTAH CENTER
201 SOUTH MAIN STREET
SALT LAKE CITY, UTAH 84140

Prepared by:

MACTEC ENGINEERING AND CONSULTING, INC.
5145 S. Arville Street, Suite A
Las Vegas, NV 89118

October 20, 2003
Project No. 4400-03-2006

MACTEC

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1.0 SCOPE

This report presents the results of the geotechnical investigation performed by MACTEC Engineering & Consulting, Inc., (MACTEC), for the proposed Currant Creek Power Project. The plant site is in Juab County, approximately 1.5 miles west of the town of Mona, Utah. This report has been prepared using the *Technical Requirements for Geotechnical Engineering Services, Currant Creek Power Project for PacifiCorp*, dated June 18, 2003, by Shaw Stone & Webster, Inc. (SSW). MACTEC's scope of work was outlined in the Technical Requirements (SOW) dated June 18, 2003.

A vicinity map showing the location of the project in the Mona area is provided on Figure 1. Figure 2 shows the general topography of the site and site area from a USGS Topographic Map. Figure 3 shows the general geology in the vicinity of the site. The approximate location of the borings and test pits, in relation to the currently proposed power plant layout, are presented in Figure 4. This report is a draft version, which will be finalized after review comments by the design consultants for the owner.

MACTEC's proposed services do not include detailed geologic or seismic studies of the site. Accordingly, the conclusions and recommendations will be only for static loading conditions. Also, the assessment of general site environmental conditions for the presence of contaminants in the soils and groundwater of the site is beyond the scope of our currently proposed services, and is being performed by ECT.

This study was performed in conformance with the requirements of the SOW. The purpose of this study was to determine the static physical characteristics of the soils at the site of the proposed project, and to provide recommendations for use in design. MACTEC was engaged to evaluate the upper soil and groundwater conditions at the site, including the corrosion potential of the soils, and to provide the following:

- Results of the subsurface explorations and laboratory tests, with a description of the soil and groundwater conditions encountered.

- Recommended site coefficient and seismic zonation based on the current Uniform Building Code.
- Soil testing and analyses of data to provide parameters that will aid in computation of foundations and control of earthwork features on the project
- Recommendations for bearing values, frictional and passive values for the resistance of lateral forces for proposed structures.
- Recommendations for earthwork, including site preparation, excavation, and the placement of any required compacted fill.
- Results of chemical corrosion tests.

Our services were substantially as outlined in our July 1, 2003 proposal, and revised on July 11, 2003. These services did not include detailed geologic studies of the site. Accordingly, our conclusions and recommendations are for static loading conditions only; however, this does not imply that there is a geologic or seismic hazard affecting the site. Also, the assessment of general site environmental conditions for contaminants in the soils and groundwater of the site was beyond the scope of our current services.

2.0 PROJECT DESCRIPTION

MACTEC discussed the project with Messrs. Rod Gartner, Bill Zakely, et al. with Shaw Stone & Webster (SSW). We also received site and preliminary grading plans from SSW, as well as other related plans provided electronically. For the purposes of this report, the facilities have been divided into five categories: 1) primary structures (most sensitive to total and differential settlements); 2) secondary structures; 3) minor structures; 4) switchyard structures; and, 5) evaporation ponds.

The proposed Currant Creek Power Project is a natural gas fired, electric generating plant located in Juab County, Utah. Depending on the alternative selected for construction, the plant could include combustion turbine generators (CTG), steam turbine generators (STG) and heat recovery steam turbine generators (HRSG) with a capacity of 500 to 1000 megawatts.

Other major facilities for the plant include:

1. Offices, warehouse, control room laboratory, toilet, and lunchroom
2. Two auxiliary transformers
3. Air cooled steam condenser
4. STG bypass system (sized for 100% unfired steam production)
5. Air cooled closed cooling water system
6. Natural gas fuel systems
7. Plant air systems
8. Fire protection system
9. 345 kV switchyard
10. Distributed control system (DCS)
11. Electrical equipment buildings (PDCs)
12. Continuous emissions monitoring system (CEMS)
13. Water and steam sampling panel systems
14. One LCI that will be cross-connected and capable of starting either of the two CTGs.
15. Generator breakers
16. Generator step-up transformers
17. Exhaust stacks
18. Evaporation Ponds

MACTEC was informed that most of the major equipment and facilities are planned to be supported by mat-type foundations. In general, it is desired that total settlement should be no greater than approximately 1 inch, and differential settlement no more than approximately ½-inch at the end of construction. In addition, it is required that differential settlement be no more than approximately 1/8 inch in 40 feet for the primary structures after construction and during operation.

The primary structures are those primary generating components that will impose the greatest loads, and are the most sensitive to differential settlements. SSW provided us with information for some of the structures which are summarized in the table on the next page:

Facility	Foundation Information		
	Dimensions	Load Combination	Pressure (ksf)
Combustion Turbine Generator (CTG)	40 ft. x 115 ft.	DL + LL	1.5
		DL + LL + Wind	2.3
Steam Turbine Generator (STG)	40 ft. x 150 ft.	DL + LL	2.3
		DL + LL + Wind	3.8
Heat Recovery Steam Generator (HRSG)	40 ft. x 105 ft.	DL + LL	2.2
		DL + LL + Wind	3.5
Air Cooled Condenser (ACC)	15ft. x 15 ft.	DL + LL	2.0
		DL + LL + Wind	4.0
Main Transformer	16 ft. x 28 ft.	DL + LL	2.5
		DL + LL + Wind	3.2

The secondary structures would be structures that are moderately to heavily loaded, and are not as sensitive to differential settlements as the primary structures. These may be subject to static and not transitory loads.

The minor structures would be lightly loaded, and not as sensitive to settlement.

The switchyard structures were further defined in a recent correspondence from SSW dated October 7, 2003. Typical loads per leg for switchgear, bus support, stands and other similar equipment supports for switchyard equipment are as follows:

- Shear -- 1.5 to 4.5 kips;
- Moment - 20 to 150 kip-feet
- Axial load - 1.5 to 10 kips

For the dead-end structures, the typical loads per leg are:

- Shear -- 25 kips;
- Moment - 350 to 500 kip-feet
- Axial load - 85 to 100 kips downward/100 to 150 kips uplift.

Larger transformers weigh approximately 380 kips, and have plan dimensions of approximately 11 by 18 feet, resulting in a maximum bearing pressure on the order of 2 ksf.

The evaporation ponds are located east of, and down gradient from the Powerblocks 1 and 2. These ponds will hold from about 2 to 4 feet of water, and will be lined with high density polyethylene (HDPE) materials.

3.0 EXPLORATION PROGRAM

3.1 FIELD EXPLORATION

The field exploration program was under the auspices of RB&G Engineering. The drilling program included 24 borings (designated as B-1 through B-24), six test pits (designated as TP-1 through TP-6), and one monitoring well (designated as B-25) at the approximate locations shown on Figure 4. Two borings were advanced to about 200 feet (one at B-3 [STG-2], and one at B-8 [CTG-1A]); eight borings were advanced to about 80 feet at selected major structure locations; eight borings were advanced to approximately 30 feet at locations of other structures; four borings were advanced about 25 feet in the evaporation pond area; and two borings, to about 10 feet each, were drilled along the roadway. The monitoring well (B-25) was drilled and developed by FEC, Inc. using a heavy-duty, well drill rig. The boreholes were backfilled with bentonite-grout slurry at the completion of the field investigation.

Six test pits were excavated with a rubber-tired backhoe, to depths ranging from 10 to 12 feet. They were excavated near borings B-3, B-6, B-8, B-23, B-24 and B-25 (see Figure 4). Block soil samples were collected from these test pits for hydrocollapse testing. The excavations were backfilled with the excavated materials, and wheel-rolled.

The locations of the borings were established in the field with the assistance of a field survey crew from RB&G Engineering, Inc. (RBG). The test pits were measured from the nearby surveyed boring locations.

The field explorations were observed and recorded by Wayne Miller with MACTEC, under the direction of Richard T. Gomm. Continuous logs of the soil conditions were recorded from August 11 through September 3, 2003, and samples were obtained during the field-drilling program. Summaries of the subsurface conditions encountered are presented on the boring logs, Figure Nos. A-1.1 through A-1.24, in the Appendix. A Soil Classification Chart and Key to Test Data is provided on Figure A-1.25. The Driller's Log for the monitoring well is presented in Appendix B. The logs of the test pits are presented in Figures A-2.1 through A-2.6. Field drilling and excavations, as well as investigation procedures are further described in the Appendix A. Logs provided for the previous investigation by others, are included in Appendix C for reference.

3.2 LABORATORY TESTING

The laboratory testing program was performed basically as outlined in the SOW, with modifications as necessary, based on the types of soils and samples collected in the field. A major concern at the site is the potential hydrocollapse of the upper soils, and the field exploration and laboratory testing put an emphasis on characterizing this potential, as well as the common physical and engineering properties of the site soils.

Samples obtained during the field exploration were taken to the laboratory where they were visually classified in accordance with ASTM D-2488, which is based on the Unified Soils Classification System. Representative samples were then selected for testing to determine physical and engineering properties. These tests included moisture content, dry density, consolidated undrained direct shear, unconsolidated undrained triaxial shear, Atterberg Limits, particle size, consolidation, moisture-density relations, specific gravity, and various chemical tests included in Appendix A.

The results of the laboratory tests are summarized on the boring logs presented in Appendix A. This information, together with field observations, was used to prepare the boring logs.

The soil samples presently stored in our laboratory will be discarded after 90 days unless this office receives a specific re uest to retain the samples for a longer period.

4.0 GEOLOGY

4.1 GENERAL GEOLOGIC CONDITIONS

The Currant Creek Power Plant site lies within the USGS's Nephi Quadrangle. The geologic data compiled on the Nephi quadrangle are but part of a much larger geologic pattern best displayed on the Price, Utah, 1° x 2° quadrangle. The Price quadrangle contains parts of three major physiographic provinces: the Colorado Plateaus, the Basin and Range, and the Middle Rocky Mountains. Most of the quadrangle, including the central and eastern parts, underlies the western margin of the Colorado Plateaus.

Within this part of the Colorado Plateaus are the southern edge of the Uinta Basin (expressed as the southward-facing, sinuous escarpments formed by the Book and Roan Cliffs), the northern part of the Canyon Lands section (expressed by the northeast-trending San Rafael Swell), and the northernmost of the High Plateaus of Utah (the Wasatch Plateau). The western part of the quadrangle includes the eastern edge of the Basin and Range province (the Great Basin). A small wedge of the Middle Rocky Mountains province—the southern Wasatch Range—dominates the northwest corner of the quadrangle.

All three previously described physiographic provinces are represented in the Nephi quadrangle, although the boundaries between them are somewhat indistinct; uncertainty exists as to where one province ends and another begins. The sector between the western edge of the Colorado Plateaus (the western flank of the Wasatch Plateau) and the eastern edge of the Basin and Range province (the Wasatch fault zone) is a transitional zone between the two provinces. Two facts support this concept of a transition zone: the strata that form the Wasatch Plateau continue westward and underlie the San Pitch Mountains (also known as the Gunnison Plateau) and the Cedar Hills. And, in both the San Pitch Mountains and the Cedar Hills, these same rocks, almost undisturbed on the Wasatch Plateau, are intensely deformed locally into structures that are common in the Basin and Range province. Therefore, the San Pitch Mountains and the Cedar Hills are included within the Colorado Plateaus.

The Middle Rocky Mountains province is represented by the wedge-like mass of the southern Wasatch Range that towers above the rest of the western half of the quadrangle. The area west of the Wasatch fault zone is within the Basin and Range province and includes a long, narrow, north-trending ridge formed by Long Ridge and the West Hills. Younger Cretaceous and Tertiary rocks overlie this eastern edge and appear in a dissected range of low hills, known as the Cedar Hills, which lie along the east flank of the range.

A sinuous, north-trending, narrow range marked by a shallow saddle midway along its length forms the west side of Juab Valley. State Highway 132 uses the saddle as it passes from Juab Valley through Dog Valley toward Leamington. The upland north of the saddle is known as Long Ridge, and the land south of the saddle is known as the West Hills. In the past, both segments have been arbitrarily grouped and called Long Ridge. Long Ridge, bounded on the west by both Goshen and Dog Valleys and on the east by Juab Valley, is about 32 km (20 mi) long and averages 3 km (2 mi) in width. Its crest rises gradually from about 1,750 m (5,740 ft) near its southern end to about 1,900 m (6,235 ft) near its northern end.

Almost all streams are intermittent; Currant Creek, which drains Mona Reservoir, is the only perennial stream. West of Mona Reservoir, Long Ridge is divisible into two different parts. The northern part, an irregular belt of tilted and rotated fault blocks, is cut by high-angle normal faults. The rocks are mostly of early and middle Paleozoic age with a few sparse Proterozoic and Archean rocks exposed here and there. The Paleozoic rocks are similar to units exposed along the flanks of the southern Wasatch Range. Coarse elastic sedimentary rocks of the North Horn Formation, very much like those that lap onto the dissected east flank of Mt. Nebo, unconformably overlie these Paleozoic units.

The southern part of Long Ridge consists chiefly of Oligocene volcanic rocks that unconformably overlie the Paleozoic rocks. These volcanic rocks extend to the west, where extensive deposits have been mapped by Morris (1977). The Paleozoic rocks crop out locally in this southern part of the range and reappear in the West Hills to the south; from these outcrops we infer that the sheet of broken Paleozoic rocks underlies all of Long Ridge. The West Hills are about 24 km (15 mi) long, about 5 km (3 mi) wide, and their crest maintains a relatively even altitude of about 1,850 m (6,070 ft).

Most streams are small and intermittent; only Chicken Creek, which flows westward and drains Chicken Creek Reservoir, is perennial. The Long Ridge-West Hills topographic high decreases in altitude southward and the volcanic cove thins as well; as a result, older rocks are conspicuously exposed in the West Hills. Upper Paleozoic rocks crop out particularly in the northern West Hills.

4.2 SITE GEOLOGY

Review of the published documents for the area indicates that there are no mapped compaction faults or fissure zones in the area of the project. Inspection of the ground surface at the site showed no readily discernable evidence suggestive of recent faulting. The subject area is mostly undeveloped desert with sage brush at the surface. There are some cobbles and boulders exposed at the surface at the extreme southern portion of the site south of Boring B-16.

The subject site is situated about 4 miles west of the Wasatch Fault Zone presented on the Geologic Map of the Nephi 30'x60' Quadrangle. The Geologic Map of Nephi 30' by 60' Quadrangle shows the site to contain coalesced alluvial-fan deposits that are unconsoilidated to semiconsolidated, thin- to thick-bedded, commonly cross-bedded sediments of fluvial origin. Deposits consist of silt, sand, granules, pebbles, cobbles, and sparse boulders. Formed by the overlapping and interfingering of adjacent alluvial fans; forms broad, low, sloping apron at foot of adjacent highlands. These soils are derived from the parent, upgradient extrusive igneous rocks, chiefly latitic and andesitic tuffs having interbedded volcanic lava flows and volcanic mudflow breccia.

5.0 SITE AND SUBSURFACE CONDITIONS

The site is undeveloped land that slopes gently to the east. The overall elevation change from east to west is approximately 104 feet (5090 ft. in SWC to 4986 ft. in the NEC). The site is covered with a heavy growth of sagebrush, and has been used for cattle grazing.

The soils encountered in the borings and test pits, consisted mainly of silt with sand, sandy silt, and silty sand, with occasional layers of silty gravel, well-graded sand with silt, poorly graded sand, and various mixtures of silt, sand and gravel, with silt being the predominant soil type in the uppermost layers. Thin sand or gravel lenses were found in most of the borings and test pits. Occasionally, cobbles or boulders were encountered. Along the western edge of the site, silty clay with sand was encountered in B-1 and B-2, and was not found in any of the other explorations.

The upper approximately 15 feet was typically very soft to still, or loose to medium dense. The upper 2 to 3 feet typically contained organics and roots. As noted on the boring logs, observation of sampled soils included whether or not the soils exhibited any porous characteristics. The region has been know to have soils susceptible to "hydrocollapse", or rapid settlement when wetted with an increased loading, such as new fill or a structure. Laboratory test results show that the upper 15 feet exhibited the greatest hydroconsolidation. Typically, the order of magnitude of the consolidation decreased with depth, with just 2 exceptions.

Based on the results of our subsurface exploration and our experience with similar soil conditions, variations in the continuity and depth of subsoil deposits should be anticipated. Due to the nature and depositional characteristics of the natural soils at the site, care should be exercised in interpolating subsurface soil conditions beyond the exploratory borings. Summaries of the subsurface conditions encountered at each boring and test pit location are described in detail on the logs in Appendix A.

Groundwater was encountered in the monitoring well (B-25) and in the two deep borings (B-3 and

B-8). The water in the monitoring well was measured on September 3,2003 at 121.79 feet by Mountain States Analytical. In Boring B-3, the water level was at 134.5 feet on August 22, 2003 just before the pipe was removed and the hole was backfilled. In Boring B-8, the water level was at 150 feet on August 18, 2003.

Many factors contribute to fluctuations of groundwater levels. Evaluation of these factors was beyond the scope of this study. The groundwater levels in this area can be expected to fluctuate seasonally and may rise in the future due to increased landscape irrigation from future development near the site.

6.0 RECOMMENDATIONS

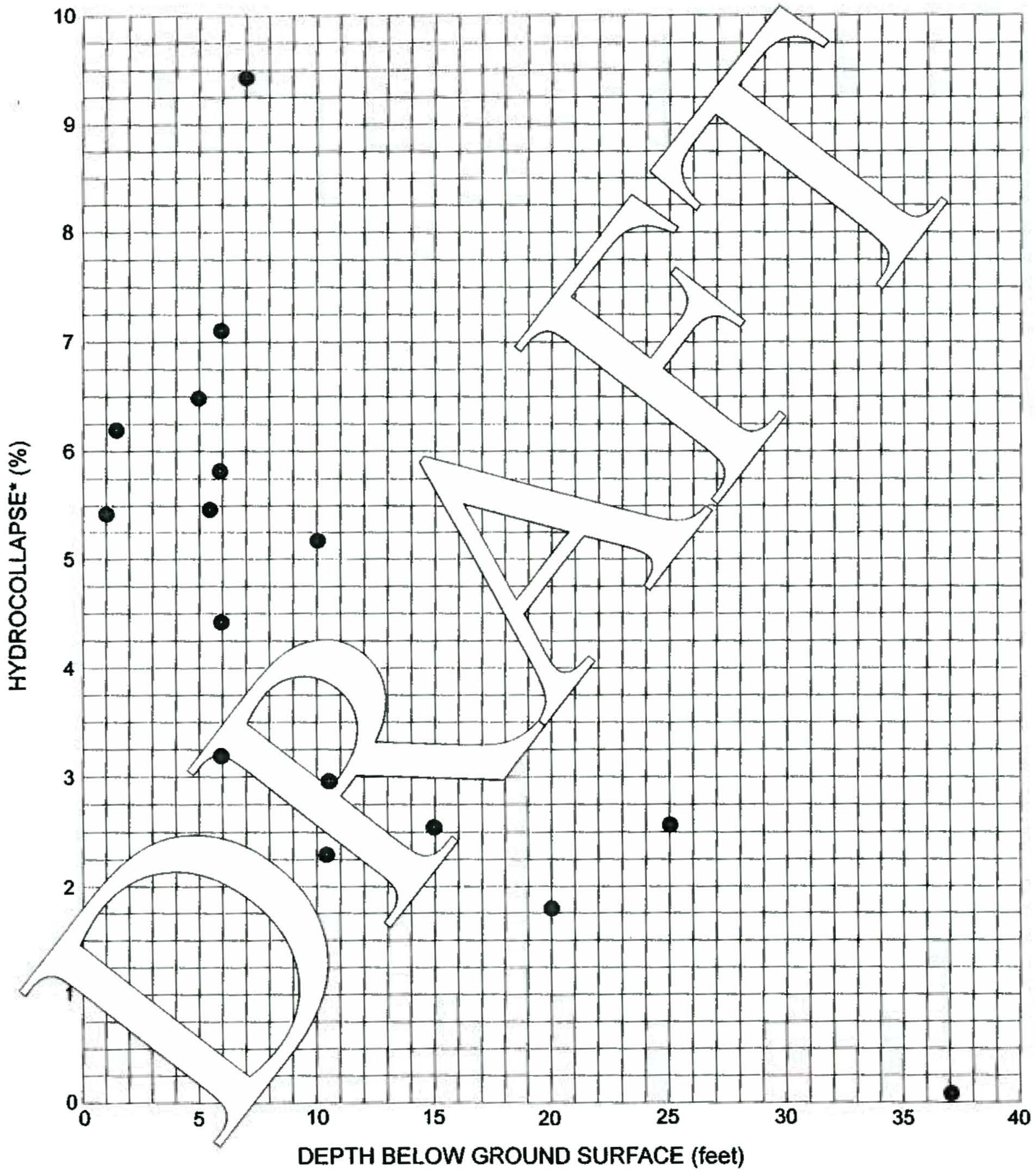
6.1 GENERAL

No geologic hazards which would restrict the planned development were identified on the site. The upper soils at the site were relatively dry and susceptible to rapid consolidation when wetted and subjected to heavy loads (hydrocollapse). The site soils are susceptible to hydrocollapsing when water is introduced. This means that these soils lose their strength and rapidly compress when introduced to free water. Based on the results of the field and laboratory investigations as well as our past experiences with similar subsurface soil conditions, it is our opinion that these soils are not suitable for support of the proposed structures in their present condition.

Sixteen borings and 4 test pits were advanced, logged and sampled within the proposed Units 1 and 2 power generating areas. Five borings and 2 test pits were advanced in the proposed evaporation pond area. Geotechnical laboratory testing was performed on select soil samples at various depths. Special attention was given to evaluation of the depth of potential "hydrocollapse" soils at the site, because of pre-investigation concerns. The hydrocollapse laboratory data indicated moderate (5% to 9%) collapse under a 2 ksf load in the upper 10 feet of sandy silt and silty sand. The percent collapse decreased to the approximately 2%, low collapse range in samples taken at depths of 10 to 20 feet. This is summarized in Drawing 1.

In MACTEC's opinion, hydrocollapse of this magnitude (i.e. 2% or less) is most likely due to sampling disturbance in these low moisture content granular soils. Review of the Standard Penetration Test (SPT) blow-count data versus depth in site borings demonstrated some low blow counts in the upper 15 feet (less than 10 blows per foot). Blow counts increased below 15 feet.

Based on the above field and laboratory data, it is MACTEC's judgment that the upper 15 feet of native soil at the site is relatively loose or soft, and is subject to moderate hydrocollapse potential. It should therefore not be allowed to support power plant structures.



* Hydrocollapse is measured for samples inundated and loaded at either 2000 psf or the overburden pressure, whichever is greater

CONSOLIDATION VS. DEPTH CHART

MACTEC

CURRANT CREEK POWER PLANT PROJECT
JUAB COUNTY NEAR MONA, UTAH

DRAWING
1

DRAWN	PROJECT NUMBER	APPROVED	DATE	REVISED DATE
RTG	4302032006		10/18/03	

MACTEC has evaluated foundation options for four groups of structures: 1) Primary Generating Structures sensitive to settlement; 2) Secondary Structures; 3) Minor Structures; and, 4) Switchyard structures. The following sections address these groups.

6.2 PRIMARY GENERATING STRUCTURES

These structures would include Combustion Turbine Generator (CTG), Steam Turbine Generator (STG), Heat Recovery Steam Generator (HRSG), and Main Transformer. MACTEC recommends two foundation support options for these structures (i.e., select fill and drilled cast-in-place concrete piles).

6.2.1 Select Fill Placement

Overexcavate the existing subgrade soils under these structures to a depth of 15 feet below the original grade. Replace the excavated soil with 'select fill' compacted to a minimum of 97% relative compaction based on ASTM D1557. The select fill should be similar to a road base material commonly used by DOT's. This will allow for careful field density testing using the ASTM D1557 compaction method. The resulting fill will have a high relative density with a resulting high modulus.

MACTEC will wait until SSW has evaluated potential local sources before finalizing a recommended specification. The fill should extend out horizontally 3 feet from the edge of the mat. From there, it should be present within an envelope below the mat defined by a 1:1 (horizontal to vertical) line extended from the edge of the mat bottom to an elevation that was originally 15 feet below the original grade. All mats should have a minimum of 5 feet of select fill beneath them. The HRSG and STG should have a minimum of 10 feet of select fill beneath them.

MACTEC has evaluated anticipated settlements of these critical structures on mats supported by the select fill. The effect of proposed cut and fill grading beneath the mats was considered. MACTEC estimates a maximum settlement on the order of 1 inch. This elastic settlement will take place during construction of the slab and loading with equipment. It is estimated an additional approximately ¼ inch of settlement will occur after initial loading. Differential settlement can be estimated at one-half of these total settlements.

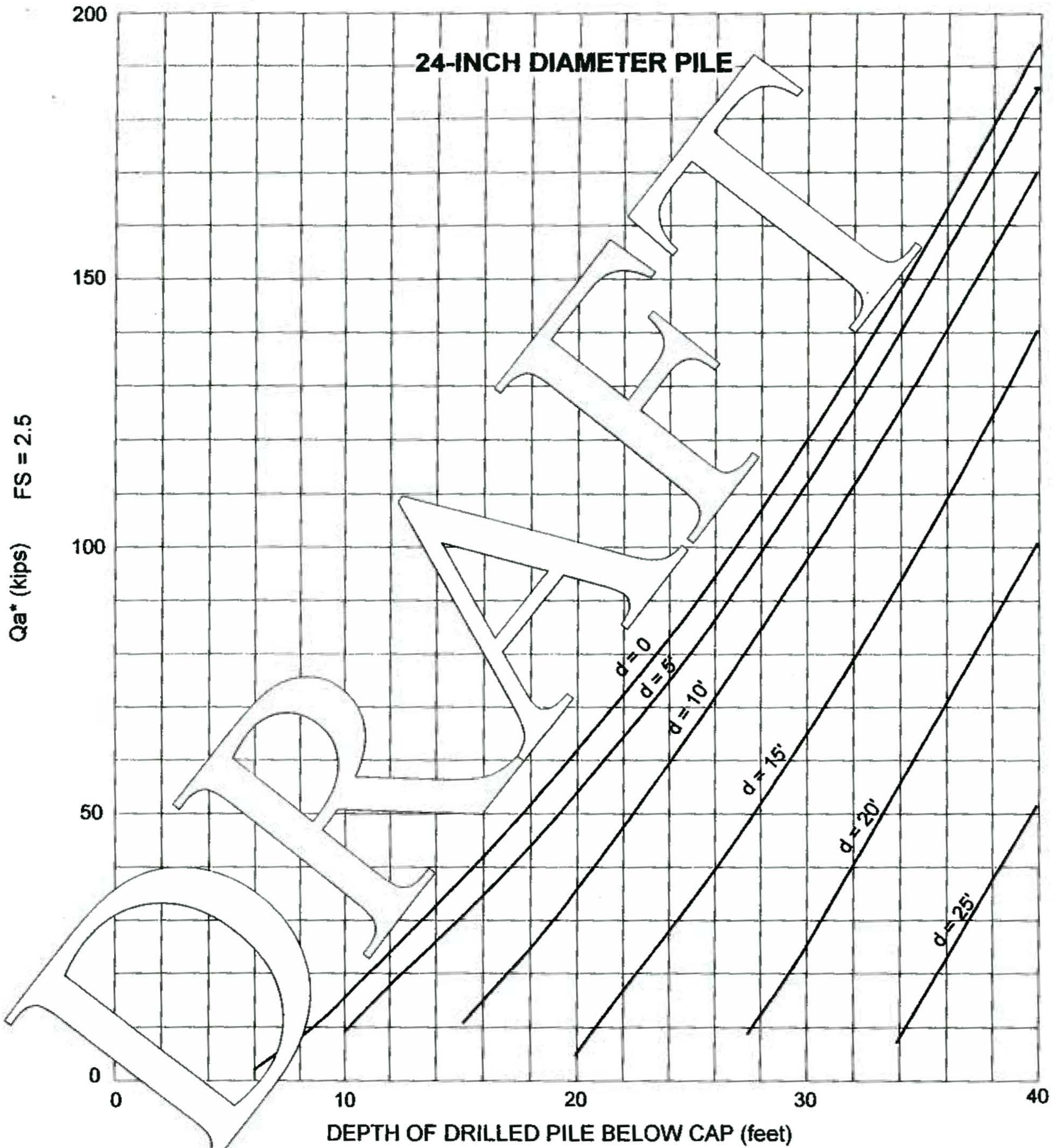
6.2.2 *Drilled Cast-In-Place Piles*

A second option for the Primary Generating Structures is to support the mats on drilled, cast-in-place concrete piles. Drilled cast-in-place concrete piles would more predictably control settlement of the Primary Generating Structures. MACTEC previously provided pile depth versus allowable capacity curves for 30-inch and 24-inch diameter piles to SSW. They are repeated in this report as Drawings 2 and 3. The curves consider the effect of downdrag due to potential collapse of the existing upper 15 feet of soils. The thickness of this collapsible layer will vary because of site grading. Therefore, curves are provided for downdrag thicknesses of 0, 5, 10, 15, 20 and 25 feet. The 20 and 25 foot curves are to be used where new fill is placed on the 15 feet of hydrocollapsible soil. Settlement of structures supported on piles would be less than ½ inch, and would not be expected to have significant post-construction settlement.

Lateral Resistance: Drilled shaft foundations are typically rigid and act as a pole which rotates around a fixed point at depth. SSW has indicated they will perform lateral design using the LPILE computer program. MACTEC's recommended soil properties for lateral capacities are based on the program LPILE 3.0 for Windows, written by Ensoft, Inc. The following values are provided for use in that program as follows:

LPILE PROGRAM DESIGN PARAMETERS

Depth Below Surface (ft.)	Allowable Coefficient of Friction (psf)	Angle of Internal Friction (degrees)	Unit Weight (pcf)	ε_{50} Value	Soil Modulus - k (pci)
0 to 15	0.30	33	100	0.010	100
15 to 30	0.30	38	110	0.005	150
30 to 60	0.30	40	120	0.005	200



* Can add 7 ksf end bearing below 15 ft. below original grade assuming possible maximum settlement of 1/2-inch for pile

Downdrag Depth = d, depth between top of pile and 15 ft. below original grade

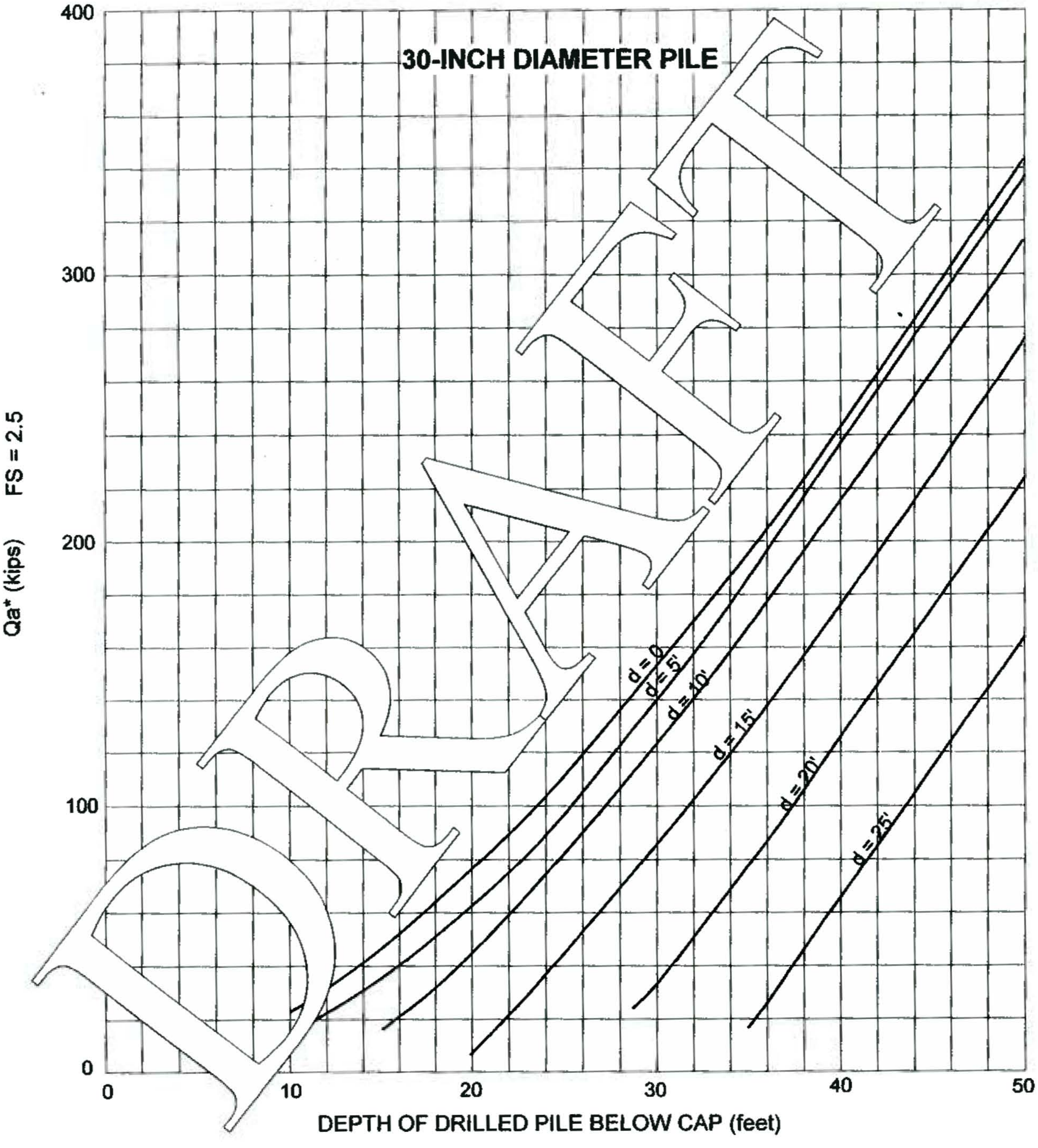
ALLOWABLE SINGLE PILE CAPACITY CHART

MACTEC

CURRANT CREEK POWER PLANT PROJECT
JUAB COUNTY NEAR MONA, UTAH

DRAWING
2

DRAWN	PROJECT NUMBER	APPROVED	DATE	REVISED DATE
RTG	4302032006		10/18/03	



* Can add 7 ksf end bearing below 15 ft. below original grade assuming possible maximum settlement of 1/2-inch for pile

Downdrag Depth = d, depth between top of pile and 15 ft. below original grade

ALLOWABLE SINGLE PILE CAPACITY CHART

MACTEC

CURRANT CREEK POWER PLANT PROJECT
JUAB COUNTY NEAR MONA, UTAH

DRAWING
3

DRAWN	PROJECT NUMBER	APPROVED	DATE	REVISED DATE
RTG	4302032006		10/18/03	

Shaft Spacing and Group Effects: The above-recommended values for compressive, uplift, and lateral capacity refer to single shafts unaffected by group interactions. To reduce or eliminate group effects for axial loading, we recommend that the shaft spacing never be less than *three* diameters (center to center). If shafts are spaced at least three diameters apart, group effects can be neglected for compressive and uplift loads. For in-line lateral loads applied on a shaft group, however, group effects reduce the lateral load capacity at a pile spacing less than eight diameters. The following capacity reduction factors from AASHTO Section 4.6.5.6.1.4 should be applied to in-line laterally loaded piles with a center-to-center spacing between three and eight diameters.

Pile Spacing	Reduction Factor
3 diameters	0.25
4 diameters	0.40
6 diameters	0.70
8 diameters	1.00

Construction Considerations: Construction activities for drilled shafts could encounter caving sidewalls, cemented layers, and other physical difficulties. We offer the following comments and recommendations regarding these issues.

Borehole Stability: The foundation drilling contractor should be prepared to case all or part of the excavation to prevent caving of the sidewalls. If alternative methods of stabilizing the sidewalls are proposed, these should be reviewed and accepted by the owner, or their representative, prior to installation.

Borehole Preparation: The foundation drilling contractor should be prepared to clean out the bottom of the borehole if loose soil is observed or suspected. We recommend that the drilling contractor have a cleanout bucket on site to remove loose soils and/or mud from the bottom of the borehole. Personnel entry into the borehole is not recommended.

Wet Excavation: Our exploration did not encounter groundwater within the depth anticipated for drilled piles; however, should groundwater be present during drilling, coagulant admixtures used during drilling of saturated or wet soils should consist of materials that will not deposit deleterious coatings on reinforcing steel. Specifically, we recommend synthetic-based coagulants.

Concreting: Concrete should be placed by tremie or other acceptable methods. For concrete placement under water, we recommend that the foundation concrete be tremied from the bottom of the hole to displace accumulated water and reduce the risk of adversely impacting the concrete mix.

6.2.3 Lateral Loads on Footings

Lateral loads may be resisted by soil friction on the footings and by the passive resistance of the soils. For 'select fill', 'structural fill', and on-site soils, as presented in this report, the following table provides the allowable coefficient of friction between the footings and the supporting soils, as well as the allowable passive resistance of properly compacted fill soils against footings. A one-third increase in the passive value may be combined with the frictional resistance without reduction in determining the total lateral resistance. If the design makes use of passive earth pressures, it is important that a representative of this office be present during the placement of any backfill against footings to observe and/or test the backfill.

ALLOWABLE LATERAL FOOTING PRESSURES

Material Type	Allowable Coefficient of Friction (psf)	Angle of Internal Friction (degrees)	Passive Resistance FS = 2.0 (pcf)
Select Fill	0.6	42	350
Structural Fill	0.5	38	150
On-Site Soil	0.4	40	200

6.3 SECONDARY STRUCTURES

These structures may include structures such as the Air Cooled Condenser (ACC), and Raw Water and Demineralized Water Storage Tanks. MACTEC recommends overexcavating existing subgrade soils under these structures to a depth of 15 feet below the original grade. All mats should have a minimum of 5 feet of structural fill beneath them. Replace the excavated soil with 'structural fill' compacted to a minimum of 95% relative compaction based on ASTM D1557. Structural fill should be granular, non-expansive, and well graded soil. It should have no greater than 30% retained on the ¾ inch sieve in order to allow field density testing. It should have no greater than 35% passing the No. 200 sieve. As with the select fill, MACTEC will wait until SSW has evaluated local sources before finalizing a recommended specification. Maximum settlement of the ACC footings supported in this manner is approximately 1 inch, with approximately ½ inch differential settlement. The water storage tanks may settle approximately 1 ½ to 2 inches during the initial filling. It is recommended that the tanks be filled with water before making the permanent connections to the tanks in order to preload the foundations so that the initial settlement can occur. The final piping connections should be made after that, and be made as flexible as practical, so that they may accommodate any additional settlement that may occur.

Lateral loads may be resisted by soil friction on the footings and by the passive resistance of the soils. For 'select fill', 'structural fill', and on-site soils, as presented in this report, the following table provides the allowable coefficient of friction between the footings and the supporting soils, as well as the allowable passive resistance of properly compacted fill soils against footings. A one-third increase in the passive value may be combined with the frictional resistance without reduction in determining the total lateral resistance. If the design makes use of passive earth pressures, it is important that a representative of this office be present during the placement of any backfill against footings to observe and/or test the backfill.

ALLOWABLE LATERAL FOOTING PRESSURES

Material Type	Allowable Coefficient of Friction (psf)	Angle of Internal Friction (degrees)	Passive Resistance FS = 2.0 (pcf)
Select Fill	0.6	42	350
Structural Fill	0.5	38	150
On-Site Soil	0.4	40	200

6.4 MINOR STRUCTURES

These Minor Structures would include structures such as the Administration Office, Warehouse, and other lightly loaded structures.

MACTEC recommends overexcavating one and one-half footing widths below minor structure footings, and replacing the excavated soil with 'structural fill' compacted to 95% relative compaction based on ASTM D1557. Settlement of lightly loaded minor structures is estimated to be less than 1 inch. Special design precautions should be employed to minimize the possibility of saturation of the collapsible soils, if, after site grading, the structure is located within the upper 15 feet of the original grade, e.g. positive drainage away from structures, encapsulating utilities in cement slurry, etc.

Lateral loads may be resisted by soil friction on the footings and by the passive resistance of the soils. For 'select fill', 'structural fill', and on-site soils, as presented in this report, the following table provides the allowable coefficient of friction between the footings and the supporting soils, as well as the allowable passive resistance of properly compacted fill soils against footings. A one-third increase in the passive value may be combined with the frictional resistance without reduction in determining the total lateral resistance. If the design makes use of passive earth pressures, it is important that a representative of this office be present during the placement of any backfill against footings to observe and/or test the backfill.

ALLOWABLE LATERAL FOOTING PRESSURES

Material Type	Allowable Coefficient of Friction (psf)	Angle of Internal Friction (degrees)	Passive Resistance FS = 2.0 (pcf)
Select Fill	0.6	42	350
Structural Fill	0.5	38	150
On-Site Soil	0.4	40	200

6.5 SWITCHYARD STRUCTURES

The switchgear legs and dead-end structures will require overexcavations to one and one-half the minimum footing width, and the overexcavated areas filled with structural fill compacted to 95% relative compaction per ASTMD1557. The total settlement is estimated to be less than 1 inch. The transformers will need to be overexcavated to one times the minimum footing width, and replaced with structural fill placed as described in this report. The estimated total settlement should be on the order of 1 inch. There may be potentially collapsible soils left under these structures, depending on the grading. Precautions need to be taken in these instances to evaluate the amount of hydrocollapsible soils beneath these structures, and to determine if additional measures will need to be taken.

Lateral loads may be resisted by soil friction on the footings and by the passive resistance of the soils. For 'select fill', 'structural fill', and on-site soils, as presented in this report, the following table provides the allowable coefficient of friction between the footings and the supporting soils, as well as the allowable passive resistance of properly compacted fill soils against footings. A one-third increase in the passive value may be combined with the frictional resistance without reduction in determining the total lateral resistance. If the design makes use of passive earth pressures, it is important that a representative of this office be present during the placement of any backfill against footings to observe and/or test the backfill.

ALLOWABLE LATERAL FOOTING PRESSURES

Material Type	Allowable Coefficient of Friction (psf)	Angle of Internal Friction (degrees)	Passive Resistance FS = 2.0 (pcf)
Select Fill	0.6	42	350
Structural Fill	0.5	38	150
On-Site Soil	0.4	40	200

6.6 EVAPORATION PONDS

The evaporation ponds are to be located in the east part of the site. They will be down gradient from the Powerblocks 1 and 2. We understand that these ponds will be lined with HDPE. Therefore, saturation of the hydrocollapsible soils beneath these ponds is not anticipated. Since the site soils are also erodible, it is recommended that erosion protection measures be accomplished on the embankment slopes, including sloping the top part of the embankment back towards the ponds. Periodic inspection and maintenance should be planned. During earthwork for the ponds, it is recommended that the fill soils be moisture conditioned in the borrow before being placed as fill in order to get a blending of the soils with the mixing water.

6.7 RETAINING WALL EARTH PRESSURES

Lateral earth pressures for use in design are given below using the on-site soils.

Lateral Earth Pressure	Design Value (psf/ ft h)
Active Earth Pressure, s_a	30
Passive Earth Pressure, s_p	260
Restrained Wall Pressure, s_r	40

6.8 EARTHWORK

6.8.1 Clearing

Strip and remove existing vegetation, debris, undocumented fill, all upper soft, loose or disturbed natural soils, and other deleterious materials from proposed embankment and right-of-way areas. Excavations should extend to at least five feet, or equal to the depth of excavation below foundations, whichever is deeper, beyond structures in plan view, where practicable. Undocumented fill is defined as any existing fill that was not properly placed, observed, tested, and documented. All exposed surfaces should be free of mounds and depressions that could prevent uniform compaction.

If unexpected fills or underground construction are encountered during site clearing, such features should be removed and the excavation thoroughly cleaned and backfilled. All excavations should be observed by the geotechnical engineer prior to backfill placement.

6.8.2 Excavation

It is anticipated that excavation of the on-site soil at the project site can be accomplished with conventional earthmoving equipment. Contractors performing utility excavations and other excavations will have to determine the stability of the soils and the equipment/techniques to perform the required excavations.

Trenching and shoring operations should be conducted in accordance with the *Occupational Safety and Health Standards for the Construction Industry* (29 CFR Part 1926) Section No. 1926.650 through .652 of the *State of Utah Occupational Safety and Health Standards for the Construction Industry* as currently amended. Safety of construction personnel is the responsibility of the Contractor.

6.8.3 *Subgrade Stabilization*

It is possible that during excavation of subgrade areas, very moist soils may be encountered which may pump and be unstable under construction traffic, particularly immediately after a heavy downpour. Use of tracked and comparatively lightweight, wheeled earth moving equipment should help reduce pumping subgrade conditions. Stabilization of the excavation bottom may be required prior to placement of structural fill. An approved geotextile or coarse gravel and cobbles may be required for the initial stabilization. Verification of the stabilized subgrade should be made by the Geotechnical Engineer.

6.8.4 *Fill Material*

Fill consisting of excavated on-site soils, or imported soils approved by the Geotechnical Engineer, shall be placed in controlled layers compatible with the type of compaction equipment used and on approved subsoils.

Where excavated soil is replaced with 'select fill' the fill should be compacted to a minimum of 97% relative compaction based on ASTM D1557. The select fill should be similar to a road base material commonly used by DOT's. This will allow for careful field density testing using the ASTM D1557 compaction method.

Where excavated soil is replaced with 'structural fill' the fill should be compacted to a minimum of 95% relative compaction based on ASTM D1557. Structural fill should be granular, non-expansive, and well graded soil. It should have no greater than 30% retained on the ¾ inch sieve in order to allow field density testing. It should have no greater than 35% passing the No. 200 sieve.

6.8.5 *Fill Placement and Compaction*

After performing the required excavations, the exposed soils should be carefully observed to verify removal of all unsuitable deposits. Exposed soils should then be scarified to a depth of approximately 8 inches, moisture-conditioned, as necessary, and compacted as recommended.

Fill materials should be placed on a horizontal plane unless otherwise accepted by the geotechnical engineer.

Where the slope ratio of the original ground is steeper than five horizontal to one vertical, the slope should be benched to create near-level areas for the placement of fill. The maximum allowable height of the bench is three feet. Bench excavation should be continued to the top of the existing slope in structural fill areas, or the daylight (cut/fill) contact.

All required fill should be placed in loose lifts not over eight inches in thickness.

Materials should be compacted to the following:

MATERIAL	PERCENT DENSITY (ASTM D1557/AASHTO T180)	MOISTURE CONTENT
Select Fill	97 minimum	Near optimum
Structural Fill	95 minimum	Near optimum

6.9 DRILLED SHAFT INSTALLATION CONSIDERATIONS

It is recommended that the following items concerning the installation of drilled shafts be incorporated into the job specifications.

1. Holes shall be drilled or bored in such a manner as to provide a full-sized shaft, diameter and length specified on the drawings or in the specifications.

2. Prior to placing concrete, the diameter and depth of each borehole along with the cleanliness of the bottom should be verified by a representative of the owner.

3. If groundwater is encountered, the method proposed by the Contractor to place concrete under water shall be approved by the Geotechnical Engineer.

4. Concrete shall have an ultimate compressive strength of not less than that provided for in the specifications and shall be workable and plastic so that it may be placed without segregation.

5. Concrete shall be cast-in-place against undisturbed earth in the holes in such a manner to provide for the exclusion of foreign matter in the concrete. Concrete shall not be dropped vertically into the excavation more than 5 feet unless an approved tremie (elephant trunk) or other similar approved method is used to prevent the concrete from striking the sides of the excavation.

6. Shafts should not be allowed to stand open for long periods of time. Shafts should be filled with concrete the same day as drilling, and open shafts should not be left open overnight.

7. Closely spaced piles should be drilled and filled alternately, with the concrete allowed to set at least 8 hours before drilling an adjacent hole.

8. Continuous observation of the drilling and pouring of the piles should be performed by the Geotechnical Engineer.

6.10 TRENCH EXCAVATION AND STABILITY

Based on the materials encountered during drilling, it is our opinion that conventional excavating equipment should be adequate for excavating the surficial materials for utility trenches. Based on the subsurface soils encountered during our field investigation, temporary trench excavations in the upper 15 feet are not expected to stand vertically for depths greater than 4 feet. It appears that trench excavations will generally consist of silty sands or sandy silts with varying amounts of gravel. These upper soils will need to be sloped back or shored etc. If workers are required to enter the trench, they should be protected from falling or rolling particles by a trench box or as required by the Occupational Safety and Health Standards for the Construction Industry (OSHA).

Surface drainage should be directed away from the top edge of the trench excavation. Surcharge loads such as construction equipment or stockpiled materials should not be placed within three feet of the top of the excavation. Traffic should be routed as far away from the excavation as practicable during construction.

Temporary trench excavations may be shored for sidewall support in place of sloping the sides. Shoring should be designed to accommodate adjacent traffic and surcharge loads and in accordance with OSHA requirements. Shoring should be designed by a registered engineer experienced in shoring design.

Safety during construction is the Contractor's responsibility. Contractors should meet the *Occupational Safety and Health Standards for the Construction Industry* (OSHA) 29 CFR, Part 1926, *State of Utah, Division of Occupational Safety and Health, Subpart P - Excavations, Trenching, and Shoring*, Sections 1926:650 through 1926:653 for safety requirements during construction operations, as currently amended.

6.11 PIPE BEDDING AND PIPE ZONE BACKFILL

The soils in the upper 15 feet are susceptible to hydroconsolidation, rapid settlement, upon the introduction of water, such as a leak, or landscaping water. Therefore, the preparation of the bedding for utilities is critical. Lines should be relatively flexible, with flexible joints. The trench bottom should be smooth, dry, and free of soft or hard spots, large rocks, and any foreign material. Medium dense to very dense granular soils, and/or properly placed backfill should provide suitable support for the proposed utilities. If the exposed native soils are loose sands, or soils disturbed by the trenching operations, the exposed soils should be densified prior to placing bedding material. Another option to consider is the placement of cement slurry for the bedding and in the pipe zone, where a site structure might be impacted by leaking pipes.

An import granular bedding material should be used to level out the irregular trench bottom and to allow an easily-shaped bedding surface. In the upper 15 feet of existing soil, the thickness of bedding material should be a minimum of 12 inches. The minimum permissible sidewall clearance between installed pipe and each trench wall is 12 inches. The pipe zone backfill should extend from the pipe bedding up to at least 12 inches above the top of the pipe.

The pipe bedding and pipe zone backfill should consist of road base material. The pipe bedding and pipe zone materials should be densified to a minimum of 95 percent of the maximum dry density as determined by ASTM D1557. Pipe bedding and pipe zone materials not meeting the gradation requirements outlined by ASTM D1557 should be compacted to a minimum of 70 percent of relative density as determined by ASTM D4253 and ASTM D4254. The materials should be densified by mechanical means. Flooding and jetting should not be used. If manufacturer's recommendations for bedding or pipe zone backfill exceed these standards, the manufacturer's recommendations should be followed.

6-12 TRENCH BACKFILL

The on-site trench backfill should consist of granular soil with material less than 3 inches in maximum size, with no more than 30% retained on the ¾-inch sieve, and no more than 35% passing the No. 200 sieve. The trench backfill material should be non-gypsiferous, have low corrosion potential. Trench backfill should be placed and densified in lifts by mechanical methods. The minimum compaction should be at least 90 percent of the maximum dry density as determined by ASTM D1557. All trench backfill materials should be observed and/or tested by a representative of the Owner for conformance with the project specifications.

The off-site trench backfill material and procedures shall conform to the *Juab County Utility & Road Digging Permit Agreement*, which is available on their website.

6.13 PAVEMENT DESIGN PARAMETERS

Two R-Value tests were performed at the site. They were collected from Borings B-1 and B-2. The R-Value at B-1 was 24, and the result of the testing at B-2 was 34.

6.14 MOISTURE PROTECTION AND SURFACE DRAINAGE

Precautions should be taken during and after construction to minimize moisture increases to foundation soils because of the potential for hydrocollapse. Positive drainage should be established away from the exterior of all structures.

The recommended minimum slope down and away from structures is 3 percent in areas of exposed subgrade, and 1½ percent in pavement areas. The recommended slopes should extend laterally a distance of about 10 feet away from any structures.

Landscape trees and plants requiring regular watering should be planted at least 10 feet away from footings. Plants should be sealed and all watering should be kept to a minimum.

Special care should be taken during installation of subfloor sewer and water lines to reduce the possibility of future leakage and subsoil saturation.

6.15 CORROSION AND SULFATE PROTECTION

The on-site soils should be considered corrosive to buried metal pipes and possess sufficient concentrations of sulfates to be considered corrosive to concrete. Consideration should be given to corrosion protection for buried metal pipes or use of nonmetallic pipe where permitted by local building codes. Test results are presented in Appendix A.

6.16 PROJECT REVIEW AND CONSTRUCTION OBSERVATION

This report has been prepared to aid in the evaluation of the project, and to assist in the design of this project. This office should be provided the opportunity to review the final grading plans, design drawings, and specifications in order to determine whether the assumptions and recommendations presented in this report are valid and have been implemented. Review of the final design drawings and specifications should be noted in writing and become a supplement to this report.

Variations in soil conditions may be encountered during construction of this project. In order to permit correlation between the field conditions encountered in this investigation and the actual conditions encountered during construction, and to confirm recommendations presented herein, sufficient review should be performed during construction of this project. Observation and testing should be performed during construction to confirm that the recommended overexcavations are performed, that suitable materials are used for structural fill, that the proper base course and asphaltic materials are used, and that the structural fill, base course and asphaltic concrete are properly placed and compacted.

APPENDIX H

REPORT OF GEOTECHNICAL EXPLORATION

DOCUMENT 2 OF 5

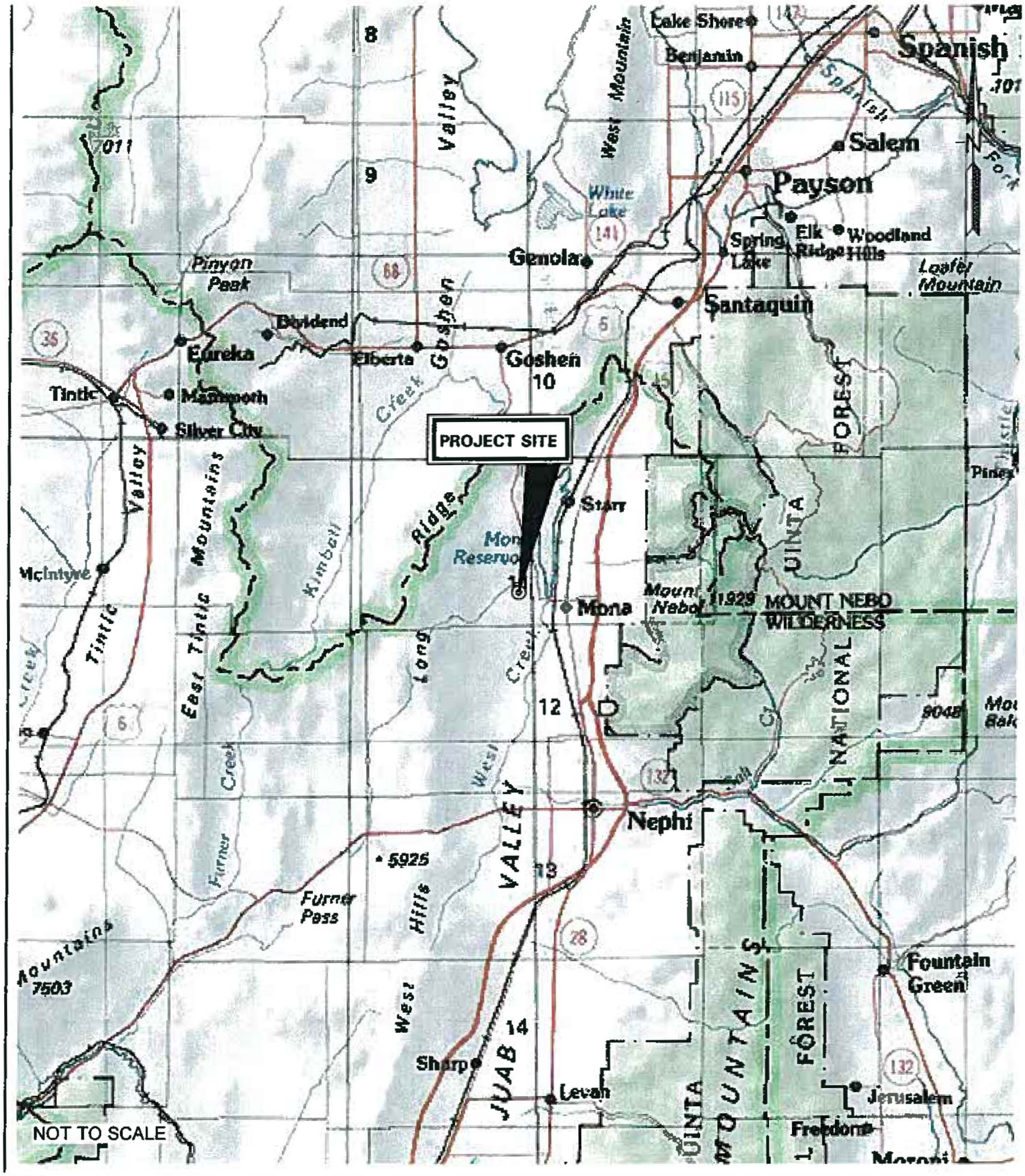
7.0 GENERAL LIMITATIONS AND BASIS FOR RECOMMENDATIONS

Our professional services have been performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical consultants practicing in this or similar localities. No other warranty, expressed or implied, is made to the professional advice included in this report. This report has been prepared for PacifiCorp and their consultant, Shaw Stone & Webster, to be used solely in the design of the proposed project. The report has not been prepared for use by other partied, and may not contain sufficient information for purpose of other partied or other uses. Any contractor reviewing this report must draw his own conclusions regarding site conditions and specific construction techniques to be used on this project.

The recommendations provided in this report are based upon our understanding of the described project information and on our interpretation of the data collected during our subsurface explorations. We have made our recommendations based upon experience with similar subsurface conditions under similar loading conditions. The recommendations apply to the specific project discussed in this report; therefore, any change in the structure configuration, loads, location, or the site grades should be provided to us so that we can review our conclusions and recommendations and make any necessary modifications.

The recommendations provided in this report are also based upon the assumption that the necessary geotechnical observations and testing during construction will be performed by representative of our firm. The field observation services are considered a continuation of the geotechnical investigation and essential to verify that the actual soil conditions are as expected. This also provides for the procedure whereby the client can be advised of unexpected or changed conditions that would require modifications of our original recommendations.

In addition, the presence of our representative at the site provides the client with an independent professional opinion regarding the geotechnically related construction procedures. If another firm were retained for the geotechnical observation services, our professional responsibility and liability would be limited to the extent that we would not be the geotechnical engineer of record.



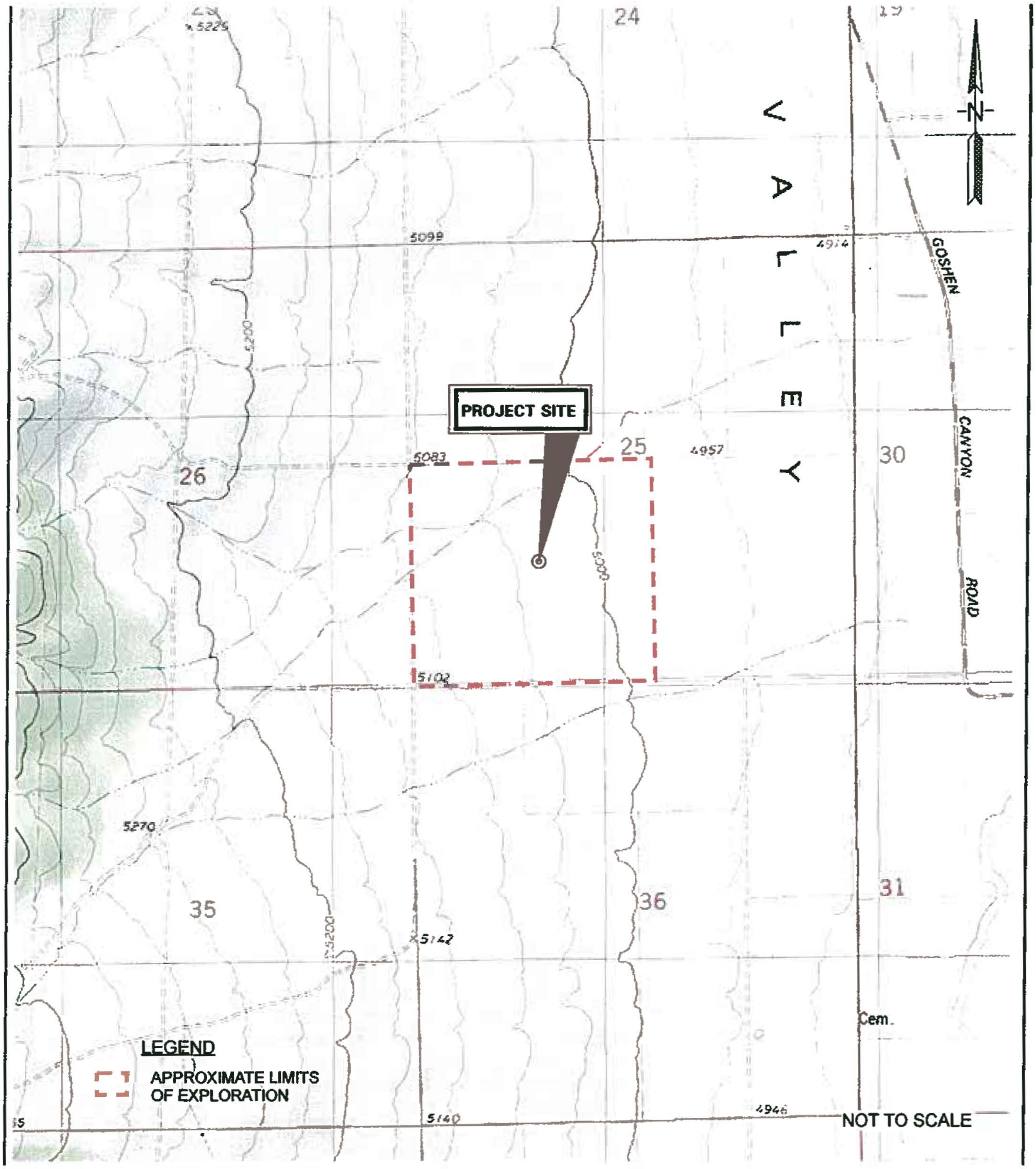
VICINITY MAP

MACTEC

CURRANT CREEK POWER PLANT PROJECT
JUAB COUNTY NEAR MONA, UTAH

FIGURE
1

DRAWN	PROJECT NUMBER	APPROVED	DATE	REVISED DATE
RTG	4302032006		10/5/03	



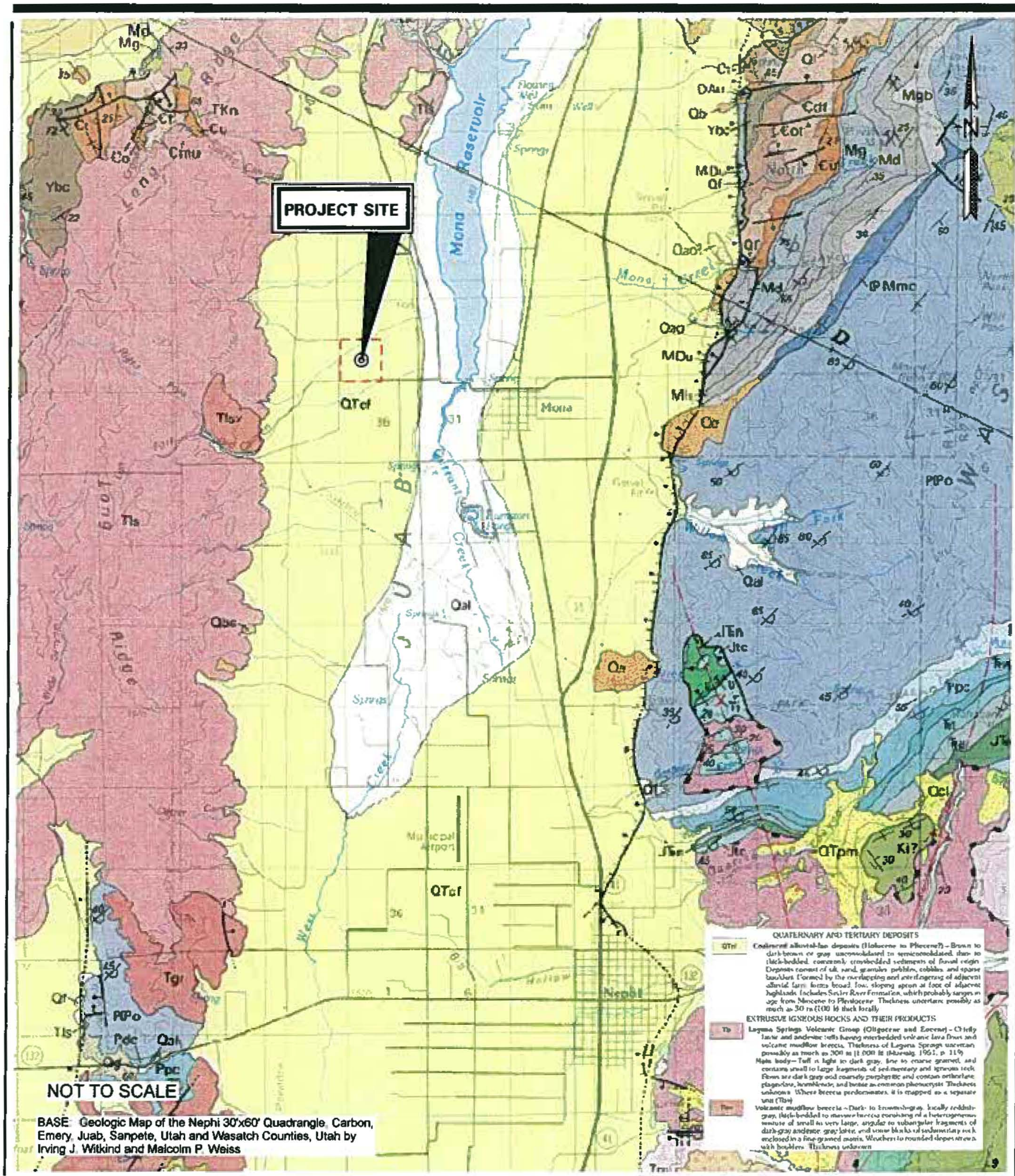
PORTION OF USGS TOPOGRAPHIC MAP

MACTEC

CURRANT CREEK POWER PLANT PROJECT
JUAB COUNTY NEAR MONA, UTAH

FIGURE
2

DRAWN	PROJECT NUMBER	APPROVED	DATE	REVISED DATE
RTG	4302032002		2/15/03	7/15/03



PORTION OF GEOLOGIC MAP

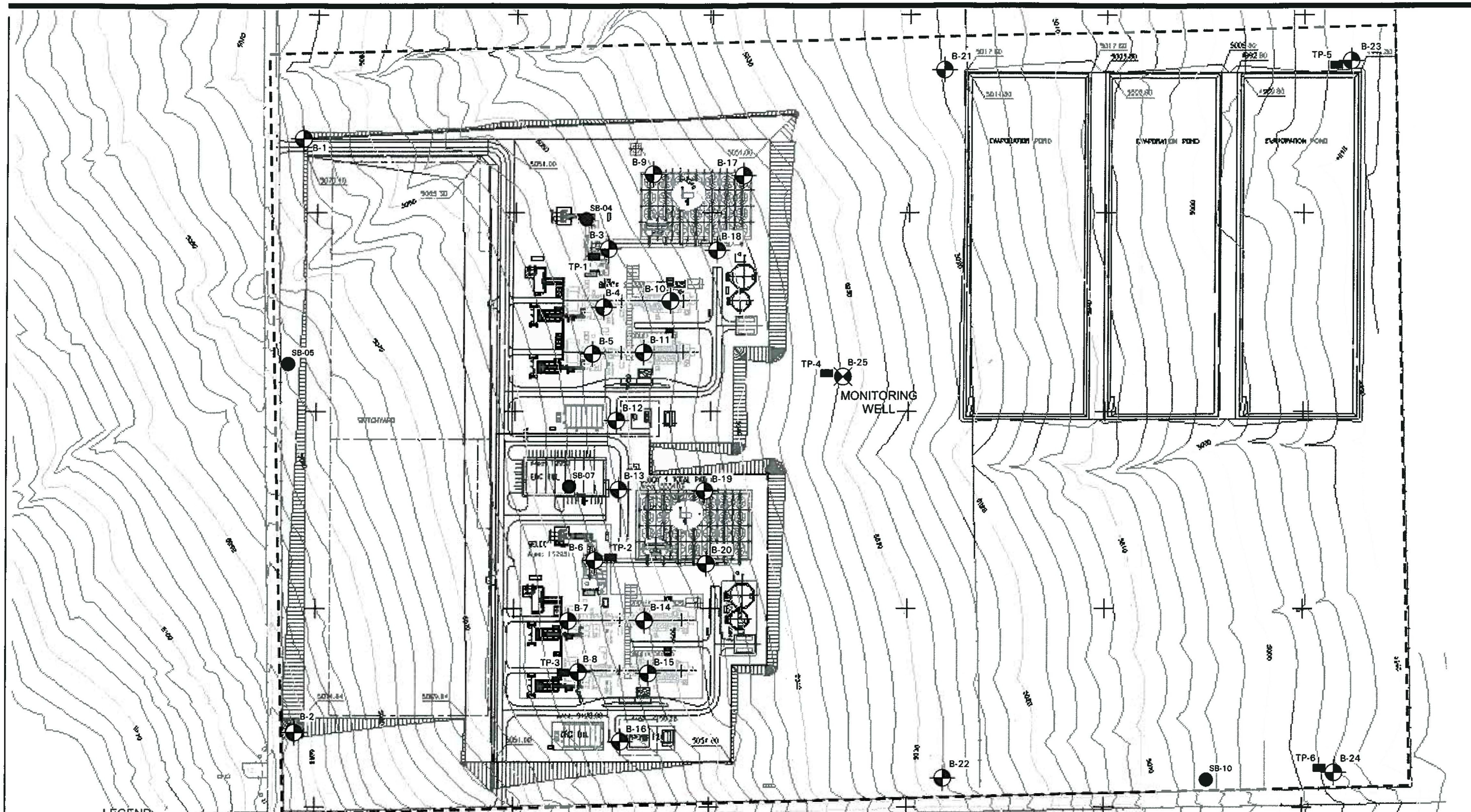
FIGURE

MACTEC

CURRANT CREEK POWER PLANT PROJECT
JUAB COUNTY NEAR MONA, UTAH

3

DRAWN	PROJECT NUMBER	APPROVED	DATE	REVISED DATE
RTG	4302032006		10/10/03	



LEGEND

B-24 Approximate Location of MACTEC Boring

TP-6 Approximate Location of MACTEC Exploratory Test Pit

SB-10 Approximate Location of Boring for Previous Study by Others

Limits of Study Area

APPROXIMATE SCALE (in feet)

0 100 200 300 400 500

BASE: Currant Creek Power Plant, UnitN o.1 , Preliminary Site Rough Grading, PacifiCorp, Mona, Utah, Drawing No.5 9321-SK-003,p repared by Shaw Stone & Webster, Inc., undated

BORING & TEST PIT LOCATION PLAN

MACTEC

CURRANT CREEK POWER PLANT PROJECT
JUAB COUNTY NEAR MONA, UTAH

FIGURE 4

DRAWN	PROJECT NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		1017/03	

APPENDIX A

SUMMARY OF
FIELD EXPLORATION
AND
LABORATORY TESTING

Date	8/25/03
Equipment	CME-55
Drilling Method	Hollow stem auger
Sampler	SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5066.0
	7107755.618 1529456.146

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
LL = 23%; PI = 6% MA: 0.8% Gravel; 26.7% Sand; 72.5% Silt and Clay R-Value = 24 pH = 9.25+ Red-Ox = +624 mv; Sulfate = 0.05% ASTM D698C: Max. Dry Density = 110.8 pcf; Opt. M.C. = 15.0% ASTM D1557C: Max. Dry Density = 117.0 pcf; Opt. M.C. = 13.5%				5065	0		**SILTY CLAY WITH SAND**, (CL-ML), light brown to tan, slightly damp, loose, low PI, no visible cementation or pores, with rootlets to about 2 feet.
	2|2|3			5060	5		**SANDY SILT** , (ML), light brown, slightly damp, loose
	6|8|6			5055	10		**SILTY SAND**, (SM), light brown, slightly damp, medium dense

TOTAL DEPTH = 11-1/2 FEET
No groundwater encountered
Hole backfilled with bentonite-grout slurry

MACTEC

Log of Boring B-1
See Location Map
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.1

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/25/03
Equipment	CME-55
Drilling Method	Hollow stem auger
Sampler	SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5092.0
	7106114.09 1529443.616

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
LL = 29%; PI = 12% MA: 5.4% Gravel; 18.9% Sand; 75.7% Silt and Clay R-Value = 34 pH = 8.88; Red-Ox = +622 mv; Sulfate = 0.05% ASTM D698C: Max. Dry Density = 116.0 pcf; Opt. M.C. = 13.0% ASTM D1557C: Max. Dry Density = 124.0 pcf; Opt. M.C. = 10.5%				5090	0		**SILTY CLAY WITH SAND**, (CL-ML), light brown to tan, slightly damp, loose, low PI, no visible cementation or pores, with rootlets to about 2 feet.
	14|40|40			5085	5		**SANDY SILT** , (ML), light brown, slightly damp, hard
	50/5"				10		**SILTY SAND**, (SM), light brown, slightly damp, very dense

TOTAL DEPTH = 10-1/2 FEET
No groundwater encountered
Hole backfilled with bentonite-grout slurry

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

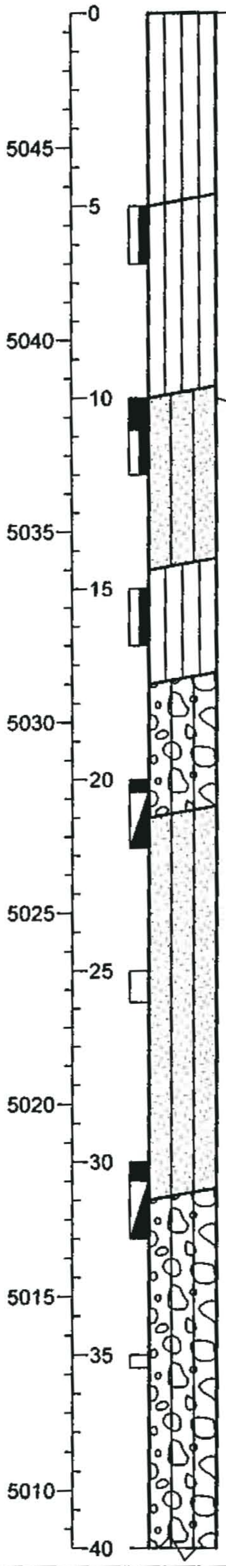
Log of Boring B- 2
Near SW Corner of Property
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.2

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date 8/14/03
Equipment CME-55
Drilling Method HSA/Rotary Wash
Sampler Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight 140 lbs. Drop 30"
Logged by Wayne L Miller Datum WGS-84
Surface Elevation 5048.5
7107554.632 1530188.123

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Depth (ft.)	Description
pH = 8.77, Red-Ox = +618 mv; Sulfate = 0.04				0	**SILT WITH SAND**, (ML), light brown to tan, slightly damp, very soft in upper 2 feet, then stiff
	6|7|10			5	**SANDY SILT**, (ML), light brown, slightly damp, very stiff, no visible cementation stringers or pores [NOTE: the term "cementation" on the logs refers to crystals formed by water evaporation] - with slight increase in sand content with depth
Hydrocollapse = 5.2% at 2000 psf	4|4|6	6.5	80.8	10	**SILTY SAND**, (SM), light brown to tan, slightly damp, loose, fine sand, no visible cementation stringers or pores
Hydrocollapse = 2.6% at 2000 psf	3|6|17	7.5	95.2	15	**SANDY SILT**, (ML), light brown, slightly damp, stiff, no visible pore spaces, with fine sand, with trace of light cementation stringers, very thin, short discontinuous stringers
					SILTY GRAVEL, (GM), light brown, slightly damp, very dense, no sample recovery, possibly with some cobbles based on audible noise of drill bit
- no recovery in Shelby Tube, end crimped during attempt to push tube	32|34|24			20	**SILTY SAND**, (SM), light brown to tan, slightly damp, very dense, with occasional gravel lenses (subrounded - 1/4- to 2 inch, black crystalline clasts)
- no sample recovery, rock in sampler shoe with black approx. 2-1/2 inch diameter crystalline	48|50/4"			25	
- no recovery in Shelby Tube, end crimped during attempt to push tube - audible chattering of augers from 31 to 33 ft., 35 to 37 ft., and 38 to 39 ft.; driller added 5 gallons of water at 32 ft. and 35 ft.	16|41|30			30	**SILTY GRAVEL WITH SAND**, (GM), brown, moist, very dense, gravel up to 1-inch, subrounded to subangular, crystalline
- no sampler recovery	50/4"			35	
Hydrocollapse = 0.1% at 3700 psf - drill rate from 35 to 40 feet: 10.8 minutes per foot				40	



HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Boring B- 3
Near STG-2
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.3

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/14/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5048.5
	7107554.632 1530188.123

Remarks	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Description
- no sample recovery, rock in sampler shoe					40	- rock in Shelby Tube, black subrounded to subangular, crystalline
	15|29|21					**SILTY SAND WITH GRAVEL**, (SM), brown, slightly damp, very dense, coarse sand to fine gravel with rock fragments, subrounded to subangular with cement crust, mostly brown medium sand with est. 10% black grains, no noticeable cementation in matrix
- drill rate from 40 to 45 feet: 2.6 minutes per foot				5005		
- driller added 5 gallons of water to free augers and move drill cuttings to surface	27|35|41				45	
- drill rate from 45 to 50 feet: 3 minutes per foot				5000		
Hydrocollapse = 1.5% at 5000 psf	9|13|18	10.2	89.6		50	- near SP with gravels est. at 1/4- to 2 inches, black crystalline, subrounded to subangular - grading to dense from 51 to 55 feet, no cementation, no visible pores
				4995		
- at 55 feet driller switched from hollow stem auger to rotary wash. Driller installed 3-1/2 inch OD/3-inch ID casing, and using NWJ 2-1/2-inch drill rods	35|35|28				55	- grading to blackish brown color, with trace gravel to 2" in max. size, moist, very dense - decreasing in fines with depth
				4990		
	7|11|14				60	**SANDY SILT**, (ML), brown, moist, very stiff, with no observable cementation, with less than 1/4-inch thick lenses of coarse sand in sample from 61-62 feet
				4985		
Hydrocollapse = 1.2% at 6700 psf	25|26|30	16.4	101.7		65	**SILTY SAND**, (SM), light brown, moist, dense, no noticeable cementation or pores
				4980		
	6|12|16				70	**SILT WITH SAND**, (ML), brown, moist, very stiff, with some visible white, discontinuous stringers of cementation, no noticeable pore spaces
				4975		
	12|15|16				75	- with visible thin, discontinuous in-fill cementation stringers, no visible pore spaces (stringers possibly calcite or gypsum)
- drill rate from 75 to 80 feet: 1.2 minutes per foot - water added to mud pit at 1 to 2 gallons per minute				4970	80	

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Boring B- 3
Near STG-2
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.3

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date 8/14/03
Equipment CME-55
Drilling Method HSA/Rotary Wash
Sampler Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight 140 lbs. Drop 30"
Logged by Wayne L Miller Datum WGS-84
Surface Elevation 5048.5
7107554.632 1530188.123

Remarks	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Description
					80	
	7|11|18					- wet exterior of samples probably from driller's rotary wash water, no visible white stringers or pores
- drill rate from 80 to 85 feet: 2 minutes per foot				4965		- slight increase in fine sand content with depth
					85	- no visible cementation or pores
	14|22|35					
- drill rate from 85 to 90 feet: 1 minute per foot				4960		
Hydrocollapse = 0.8% at 9000 psf		17.3	98.8		90	- top of Shelby tube wet from drill water
	11|14|17					- no visible cementation or pores
- water added to mud pit at 1 to 2 gallons per minute, drill rate from 90 to 95 feet: 1.6 minutes per foot				4955		
					95	- no visible cementation or pores, near SM
	12|12|20					
- water added to mud pit at 1 to 2 gallons per minute, drill rate from 95 to 100 feet: 1 minute per foot				4950		
					100	
	9|23|50					- grading to hard, with no visible cementation or pores
- 1/2 pint of polymer added to rotary wash tank				4945		**SILTY SAND**, (SM), light brown, moist, very dense, no noticeable cementation or pores, fine to coarse grains
- drill rate from 100 to 110 feet: 4 minutes per foot					105	
- driller noted that tricone bit encountered gravel at 107 feet				4940		**SILTY GRAVEL WITH SAND**, (GM), brown, moist, very dense, gravel up to 1-inch, subrounded to subangular, crystalline
- no advancement of Shelby tube at 110 feet	50/3"				110	**WELL-GRADED SAND WITH SILT**, (SP-SM), bluish brown, wet (from wash water?), very dense, up to 1/4-inch in max. size, subangular, no cementation or pores
				4935		**SILTY SAND**, (SM), light brown, moist, very dense, no noticeable cementation or pores, fine to coarse grains
- drill rate from 110 to 120 feet: 1.4 minutes per foot					115	
				4930		
					120	

MACTEC

Log of Boring B-3
Near STG-2
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.3

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date 8/14/03
Equipment CME-55
Drilling Method HSA/Rotary Wash
Sampler Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight 140 lbs. Drop 30"
Logged by Wayne L Miller Datum WGS-84
Surface Elevation 5048.5
7107554.632 1530188.123

Remarks	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Description
	17|36|44				120	**SILTY SAND WITH GRAVEL**, (SM), bluish brown, wet (from wash water?), very dense, 1/4-inch to 1-inch max. size, subangular, no cementation or pores
- 1/2 pint of polymer added to rotary wash tank - drill rate from 120 to 130 feet: 3.2 minutes per foot				4925	125	
				4920		
	10|17|21				130	**SILT WITH SAND**, (ML), brown, moist, very stiff, with some visible white, discontinuous stringers of cementation, no noticeable pore spaces
				4915	135	- water level measured at 134 ft. on 8/20/2003 - water level measured at 134.5 ft. on 8/21/2003
				4910		
- No sample recovery from Shelby tube at 140 feet	42|25|20				140	**SILTY SAND**, (SM), light brown, moist, very dense, no noticeable cementation or pores, fine to coarse grains **SANDY SILT**, (ML), brown, moist, very stiff, with some visible white, discontinuous stringers of cementation, no noticeable pore spaces
- drill rate from 140 to 150 feet: 2 minutes per foot				4905	145	**SILTY GRAVEL WITH SAND**, (GM), brown, moist, very dense, gravel up to 1-inch, subrounded to subangular, crystalline **SILT WITH SAND**, (ML), brown, very moist, very stiff, with some visible white, discontinuous stringers of cementation, no noticeable pore spaces
				4900		
	21|24|24				150	
				4895		
- drill rate from 150 to 160 feet: 1.2 minutes per foot - 1/2 pint of polymer added to rotary wash tank					155	
				4890	160	

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Boring B- 3
Near STG-2
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.3

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/14/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5048.5
	7107554.632 1530188.123

Remarks	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
					160		
	8|12|35						**SILTY SAND**, (SM), light brown, moist, very dense, no noticeable cementation or pores, fine to coarse grains
							SILTY GRAVEL WITH SAND, (GM), brown, moist, very dense, gravel up to 1-inch, subrounded to subangular, crystalline
				4885			
- drill rate from 160 to 170 feet: 1.8 minutes per foot - water added to mud pit at 1 to 2 gallons per minute					165		
				4880			**SILT WITH SAND**, (ML), brown, moist, very stiff, with some visible white, discontinuous stringers of cementation, no noticeable pore spaces, with trace fine gravel 1/4- to 1/2-inch, subrounded to subangular
- No sample recovery from Shelby tube at 170 feet					170		
	14|24|25						
				4875			
- drill rate from 170 to 180 feet: 2 minutes per foot					175		
				4870			
					180		
	2|9|23						
				4865			
- drill rate from 180 to 190 feet: 1.3 minutes per foot - water added to mud pit at 1 to 2 gallons per minute - 8 oz. of polymer added to rotary wash tank					185		
				4860			
					190		
	9|14|19						
				4855			
- drill rate from 190 to 200 feet: 0.8 minutes per foot					195		
							SILTY GRAVEL WITH SAND, (GM), brown, moist, very dense, gravel up to 1-inch, subrounded to subangular, crystalline
				4850			
					200		

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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Log of Boring B- 3
Near STG-2
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.3

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/14/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5048.5
	7107554.632 1530188.123

	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	
- approximately 200 ft. of 1-inch diameter PVC casing with 20 ft. of slot was placed in the borehole upon completion of drilling and sampling on 8-19-2003	4|32|50/2"				200		SANDY SILT, (ML), brown, moist, very stiff, with some visible white, discontinuous stringers of cementation, no noticeable pore spaces
				4845			TOTAL DEPTH = 202 FEET Began drilling on 8/14/03, and completed drilling on 8/19/03 Temporary piezometer installed upon completion of drilling, to measure the groundwater level, then removed and filled with bentonite-grout slurry

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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Log of Boring B- 3
Near STG-2
Currant Creek Power Plant
Mona, Juab County, UT

PLATE **A-1.3**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	9/2/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5051.2
	7107396.838 1530144.868

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Description
					0	**SILT WITH SAND**, (ML), brown, slightly damp, very soft in upper 2 feet, then stiff, with trace pores, with organics and roots
	6|6|6			5050		
						SILTY GRAVEL WITH SAND, (GM), brown, slightly damp, loose, gravel up to 1-inch, subrounded to subangular, crystalline
- no sample recovery in Shelby tube					5	**SILTY SAND**, (SM), light brown, slightly damp, medium dense, no visible cementation stringers or pores [NOTE: the term "cementation" on the logs refers to crystals formed by water evaporation], with trace organics
	5|6|5			5045		- with gravel in sampler shoe to 1-1/2 inches
					10	**SANDY SILT**, (ML), brown, slightly damp, stiff, with fine sand and trace gravel, with very thin, discontinuous, cementation stringers, no visible pores
	3|5|10			5040		
- no sample recovery in Shelby tube					15	**SILTY SAND**, (SM), light brown to tan, slightly damp, medium dense, with occasional gravel lenses (subrounded - 1/4- to 2 inch, black crystalline clasts)
	8|10|15			5035		
						SILTY GRAVEL WITH SAND, (GM), brown, moist, dense, gravel up to 1-inch, subrounded to subangular, crystalline
- no sample recovery	50/4"				20	**SANDY SILT**, (ML), brown, slightly damp, stiff, with fine sand and trace gravel, with very thin, discontinuous, cementation stringers, no visible pores
				5030		
- no sample recovery in Shelby tube					25	**SILTY SAND WITH GRAVEL**, (SM), brown, slightly damp, very dense, coarse sand to fine gravel with rock fragments, subrounded to subangular, no noticeable cementation in matrix
	12|26|27			5025		**COARSE SAND WITH SILT**, (SP-SM), brown, dense, with some gravel and rock fragments, no cementation, black, crystalline
					30	**SILTY GRAVEL**, (GM), brown/black, slightly damp, medium dense, with gravel 1/4- to 3/4-inch, and traces up to 2 inches
	17|16|12			5020		
- no sample recovery in Shelby tube					35	**POORLY GRADED SAND WITH SILT**, (SP-SM), brown/black, slightly damp, to moist, dense, crystalline, subrounded to subangular
	12|17|18			5015		
					40	

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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Log of Boring B- 4
Near CTG-2B
Currant Creek Power Plant
Mona, Juab County, UT

PLATE

A-1.4

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	9/2/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs.
Drop	30"
Logged by	Wayne L Miller
Datum	WGS-84
Surface Elevation	5051.2
	7107396.838 1530144.868

Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)
17|15|11		
11|10|10	14.2	
22|34|50/4"	4.7	124.0
12|16|19	15.0	
9|14|50/4"	7.8	107.8
17|16|21	11.9	
17|16|22	6.7	112.0
14|17|24	19.2	

Elevation (ft): 5010, 5005, 5000, 4995, 4990, 4985, 4980, 4975

Depth (ft.): 40, 45, 50, 55, 60, 65, 70, 75, 80

Sample

- convert to rotary wash with 3-inch casing to 43 feet

- added 1/2 pint of polymer to drill wash water

- no sample recovery in Shelby tube

- added approx. 1 to 2 lbs. of bentonite gel powder to wash tank water

SANDY SILT, (ML), brown, moist, very stiff, with no observable pores, with trace very thin, white, discontinuous stringers

SILTY SAND, (SM), light brown, moist, medium dense, no noticeable cementation or pores, with varying amounts of silt

SILT WITH SAND, (ML), brown, moist, very stiff, with no noticeable stringers of cementation, no noticeable pore spaces

POORLY GRADED SAND, (SP), black/brown, moist, very dense, fine to coarse sand, some gravel

SANDY SILT, (ML), brown, moist, very stiff, with no observable pores or discontinuous stringers

WELL-GRADED SAND WITH SILT, (SP-SM), black/brown, moist, very dense, with gravel

SILT WITH SAND, (ML), brown, moist, very stiff, with no visible discontinuous stringers of cementation, no noticeable pore spaces

- with trace very thin white discontinuous stringers from 72 ft.

- increasing sand content with depth

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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Log of Boring B- 4
Near CTG-2B
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.4

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	9/2/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5051.2
	7107396.838 1530144.868

Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
37|21|19			4970	80		**SILTY GRAVEL WITH SAND**, (GM), brown, moist, very dense, gravel up to 2-inch, subrounded to subangular, crystalline
						TOTAL DEPTH = 81-1/2 FEET Started drilling on 9/2/03, and finished on 9/3/03 Borehole filled with bentonite-grout slurry

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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Log of Boring B- 4
Near CTG-2B
Currant Creek Power Plant
Mona, Juab County, UT

PLATE **A-1.4**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

APPENDIX H

REPORT OF GEOTECHNICAL EXPLORATION

DOCUMENT 3 OF 5

Date	8/28/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5053.3
	7107264.664 1530143.861

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Material Description
	4|4|5	5.5	77.0		0	SILT WITH SAND, (ML), brown, slightly damp, very soft in upper 2 feet, then medium stiff, with no observed pores or cementation
				5050		
- no sample recovery from Shelby tube - rock crimped end of tube	9|8|7	2.0			5	SILTY GRAVEL WITH SAND, (GM), brown, slightly damp, loose, gravel up to 1-inch, subrounded to subangular, crystalline
						SAND WITH SILT, (SM), light brown, slightly damp, medium dense to dense, no visible cementation stringers or pores [NOTE: the term "cementation" on the logs refers to crystals formed by water evaporation], with trace organics
				5045		
- no sample recovery	10|16|27				10	
				5040		
	10|20|38	5.4			15	- medium to coarse sand particles, with moderately cemented finer particles
				5035		
	35|37|21	3.5	97.0		20	- with rock fragments, broken cobbles and large gravel in sampler from 20 to 21 feet, predominantly silty fine sand with no cementation to 25 feet
				5030		
	5|10|20	3.2			25	- with trace cementation and trace visible pores at 25-1/2 feet
						SILTY GRAVEL WITH SAND, (GM), brown, moist, dense, gravel up to 1-inch, subrounded to subangular, crystalline
				5025		
	36|50/5"	3.4			30	
				5020		
- no sample recovery from Shelby tube - rock crimped end of tube	21|28|20	13.3			35	SANDY SILT, (ML), brown, slightly damp, stiff, with fine sand and trace gravel, with very thin, discontinuous, cementation stringers, no visible pores
				5015		
					40	

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT GDT 10/20/03

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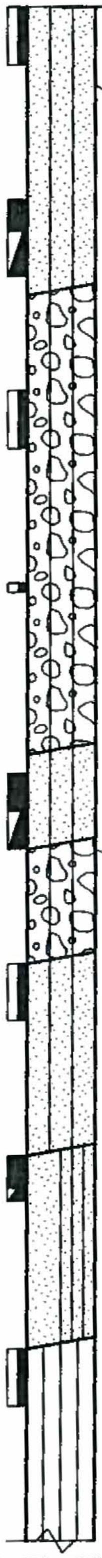
Log of Boring B- 5
Near CTG-2A
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.5

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/28/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5053.3
	7107264.664 1530143.861

Remarks	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Description
- convert to rotary wash with casing driven to 43 feet	14|21|30	4.7	100.9		40	**SILTY SAND WITH GRAVEL**, (SM), brown, slightly damp, very dense, coarse sand to fine gravel with rock fragments, subrounded to subangular, no noticeable cementation in matrix - decreasing silt content with depth, occasionally alternating 3- to 4-inch thick layers of silt and sand
				5010		
	9|13|16	20.6			45	
				5005		**SILTY GRAVEL**, (GM), brown/black, slightly damp, dense to very dense, with gravel 1/4- to 3/4-inch, and traces up to 2 inches
	18|26|43	9.3			50	
				5000		
	50/5"	11.6			55	
- added approx. 1/2 pint of polymer and 2 lbs. of bentonite powder						
				4995		
	12|25|45	17.5			60	**SILTY SAND WITH GRAVEL**, (SM), brown, slightly damp, very dense, coarse sand to fine gravel with rock fragments, subrounded to subangular, no noticeable cementation in matrix
- added 2 to 3 lbs. of bentonite powder, and 1 to 2 gpm of water added to wash tank during advancement of drill hole				4990		**SILTY GRAVEL**, (GM), brown/black, slightly damp, dense to very dense, with gravel 1/4- to 3/4-inch, and traces up to 2 inches
	13|14|26	12.1			65	**SILTY SAND WITH GRAVEL**, (SM), brown, slightly damp, very dense, coarse sand to fine gravel with rock fragments, subrounded to subangular, no noticeable cementation in matrix
- 1 to 2 lbs. of bentonite powder added to tank				4985		
- no sample recovery from Shelby tube - rock crimped end of tube	33|50/2"	14.6			70	**WELL-GRADED SAND WITH SILT**, (SP-SM), black/brown, moist, very dense, with gravel
- approx. 1/2 pint of polymer added to wash tank between 70 and 75 feet				4980		
	13|13|15	20.4			75	**SANDY SILT**, (ML), brown, moist, very stiff, with no observable pores or discontinuous stringers
				4975		
					80	



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Log of Boring B- 5

Near CTG-2A
Currant Creek Power Plant
Mona, Juab County, UT

PLATE

A-1.5

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/28/03			
Equipment	CME-55			
Drilling Method	HSA/Rotary Wash			
Sampler	Mod. CA Sampler; Shelby Tube; SPT			
Hammer Weight	140 lbs.	Drop	30"	
Logged by	Wayne L Miller	Datum	WGS-84	
Surface Elevation	5053.3			
	7107264.664		1530143.861	

Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample
				80	
15|23|33	18.4				
			4970		

TOTAL DEPTH = 82 FEET
No groundwater observed during drilling
Hole backfilled with bentonite-grout slurry

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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Log of Boring B- 5
Near CTG-2A
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.5

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/21/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5055.9
	7106699.708 1530181.913

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
				5055	0		**SILT WITH SAND**, (ML), brown, slightly damp, very soft in upper 2 feet, then stiff, with trace pores, with organics and roots, no visible cementation or pores
	5|10|11			5050	5		- no visible cementation or pores
	4|8|9			5045	10		- no visible cementation or pores
	3|4|3			5040	15		**SANDY SILT**, (ML), brown, slightly damp, medium stiff, with fine sand and trace gravel, with very thin, discontinuous, cementation stringers, no visible pores
	12|20|18			5035	20		**SILTY SAND**, (SM), light brown to tan, slightly damp, medium dense, with occasional gravel lenses (subrounded - 1/4- to 2 inch, black crystalline clasts)
	9|16|28			5030	25		**POORLY GRADED SAND WITH SILT**, (SP-SM), brown/black, slightly damp, to moist, dense, crystalline, subrounded to subangular **POORLY GRADED SAND**, (SP), black/brown, moist, very dense, fine to coarse sand, some gravel
	32|48|31			5025	30		
	18|50/5"			5020	35		
					40		

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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Log of Boring B- 6
Near STG-1
Currant Creek Power Plant
Mona, Juab County, UT

PLATE **A-1.6**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/21/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5055.9
	7106699.708 1530181.913

Remarks	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Description
	40|50/5"			5015	40	
	27|38|33			5010	45	
- at 49 ft., augers and bit jammed in borehole -- added 15 gallons of water to free augers - converted over to rotary wash on 9/3/03 at 50 ft.	27|34|31			5005	50	
						SILTY GRAVEL WITH SAND, (GM), brown, moist, very dense, gravel up to 2-inch, subrounded to subangular, crystalline
	14|16|30			5000	55	**SANDY SILT**, (ML), brown, moist, very stiff, with no observable pores or discontinuous stringers
- no sample recovery, Shelby tube crimped at end encountering large gravel or cobble	28|31|50			4995	60	**SILTY GRAVEL WITH SAND**, (GM), brown, moist, very dense, gravel up to 2-inch, subrounded to subangular, crystalline
	48|50/2"			4990	65	
- no sample recovery, Shelby tube crimped at end encountering large gravel or cobble	14|16|16			4985	70	**SILTY SAND**, (SM), black/brown, moist, very dense, with gravel
	15|30|30			4980	75	**SILT WITH SAND**, (ML), brown, moist, very stiff, with no visible discontinuous stringers of cementation, no noticeable pore spaces
					80	

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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Log of Boring B- 6

Near STG-1
Currant Creek Power Plant
Mona, Juab County, UT

PLATE **A-1.6**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

							Date	8/21/03
							Equipment	CME-55
							Drilling Method	HSA/Rotary Wash
							Sampler	Mod. CA Sampler; Shelby Tube; SPT
							Hammer Weight	140 lbs. Drop 30"
							Logged by	Wayne L Miller Datum WGS-84
							Surface Elevation	5055.9
	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample		7106699.708 1530181.913
					80			
	13|13|13			4975				

TOTAL DEPTH = 82 FEET
No groundwater observed during drilling
Hole backfilled with bentonite-grout slurry

Date 8/22/03
Equipment CME-55
Drilling Method HSA/Rotary Wash
Sampler Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight 140 lbs. Drop 30"
Logged by Wayne L Miller Datum WGS-84
Surface Elevation 5059.4
7106557.704 1530138.543

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Description
					0	**SILT WITH SAND**, (ML), brown, slightly damp, very soft in upper 2 feet, then stiff, with trace pores, with organics and roots, no visible cementation or pores
	6|10|18			5055	5	- with trace visible thin, white stringers, trace pore spaces or rootlets
						SILTY GRAVEL WITH SAND, (GM), brown/black, slightly damp, very dense, gravel up to 2-inch, no visible cementation, subrounded to subangular, crystalline
- no sample recovery, Shelby tube crimped at end encountering large gravel or cobble	21|22|33			5050	10	- encountered cobbles or boulders from about 10 to 15 ft.
- refusal of hollow-stem auger at 15 ft., driller sampled, then installed 3-inch casing to 20 ft. and converted to rotary wash	38|50/4"	4.7		5045	15	
- no sample recovery, rock in sampler shoe						- with cobbles and boulders?
	16|13|15	14.4		5040	20	**SANDY SILT**, (ML), brown, slightly damp, very stiff, with fine sand and trace gravel, with very thin, discontinuous, cementation stringers, no visible pores
MA: 0% Gravel; 52.9% Sand; 47.1% Silt and Clay	7|8|10	13.6 17.1		5035	25	**SILTY SAND**, (SM), brown, moist, medium dense, no cementation
	24|41|31	7.6		5030	30	**SILTY GRAVEL WITH SAND**, (GM), brown/black, slightly damp, very dense, gravel up to 2-inch, no visible cementation, subrounded to subangular, crystalline
- no sample recovery, Shelby tube crimped at end encountering large gravel or cobble	11|7|7	13.8		5025	35	**POORLY GRADED SAND**, (SP), black/brown, moist, dense, fine to coarse sand, some gravel
				5020	40	

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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Log of Boring B- 7
Near CTG-1B
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.7

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/22/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs.
Drop	30"
Logged by	Wayne L Miller
Datum	WGS-84
Surface Elevation	5059.4
	7106557.704
	1530138.543

Remarks	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Description
	21|25|26	16.8	98.3		40	**SILT WITH SAND**, (ML), brown, moist, very stiff, with no visible discontinuous stringers of cementation, no noticeable pore spaces
- no sample recovery, Shelby tube crimped at end encountering large gravel or cobble	10|12|12	12.2		5015	45	**SILTY SAND**, (SM), black/brown, moist, very dense, with gravel
	12|16|24	16.1 16.9	101.4	5010	50	**SILT WITH SAND**, (ML), brown, moist, very stiff, with no visible discontinuous stringers of cementation, no noticeable pore spaces
- no sample recovery, Shelby tube crimped at end encountering large gravel or cobble	18|13|17	10.1		5005	55	**SILTY GRAVEL WITH SAND**, (GM), brown, moist, very dense, gravel up to 2-inch, subrounded to subangular, crystalline
						SANDY SILT, (ML), brown, moist, very stiff, with no observable pores or discontinuous stringers
						SILTY GRAVEL WITH SAND, (GM), brown, moist, very dense, gravel up to 2-inch, subrounded to subangular, crystalline
	33|36|50/5"	10.6		5000	60	**POORLY GRADED SAND**, (SP), black/brown, moist, dense, fine to coarse sand, some gravel
	12|16|15	18.6		4995	65	**SILTY SAND**, (SM), black/brown, moist, very dense, with gravel
	14|19|26			4990	70	
	28|30|30	20.0		4985	75	**SILT WITH SAND**, (ML), brown, moist, very stiff, with no visible discontinuous stringers of cementation, no noticeable pore spaces
				4980	80	

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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Log of Boring B- 7
Near CTG-1B
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.7

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Date 8/22/03 Equipment CME-55 Drilling Method HSA/Rotary Wash Sampler Mod. CA Sampler; Shelby Tube; SPT Hammer Weight 140 lbs. Drop 30" Logged by Wayne L Miller Datum WGS-84 Surface Elevation 5059.4 7106557.704 1530138.543
					80		
	17|20|22	11.2 17.2	93.2 92.7				**TOTAL DEPTH = 81-1/2 FEET** No groundwater observed during drilling Hole backfilled with bentonite-grout slurry
				4975			

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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Log of Boring B- 7
Near CTG-1B
Currant Creek Power Plant
Mona, Juab County, UT

PLATE **A-1.7**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/11/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5059.4
	7106425.783 1530137.434

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
					0		**SILT WITH SAND**, (ML), light brown to tan, slightly damp, very soft in upper 2 feet, then stiff
	13|13|15			5055	5		**SANDY SILT**, (ML), light brown, slightly damp, very stiff, with some gravel, no visible pores - decreasing gravel content with depth
							SILTY SAND, (SM), light brown, slightly damp, very dense, medium to coarse sand with some gravel
MA: 14.2% Gravel; 53.2% Sand; 22.9% Silt; 9.7% Clay WSSS = 0.03% per AWWA 4500 E	18|48|50/4"	6.1 9.1		5050	10		
DSCU: Cohesion = 550 psf; Phi = 33 Degrees (Peak)	16|24|20						
MA: 1.9% Gravel; 40.0% Sand; 37.0% Silt; 21.1% Clay	3|7|13	5.1		5045	15		**SANDY SILT**, (ML), light brown, slightly damp, stiff, no visible pores, with fine sand - with very light cementation stringers, no visible pores
MA: 8.2% Gravel; 40.5% Sand; 51.3% Silt and Clay SOL = 0.11% per AWWA 2540 C	33|35|27	4.9		5040	20		**SILT WITH SAND**, (ML), light brown to tan, slightly damp, very soft in upper 2 feet, then stiff - with 1/2- to 3/4-inch rock in sampler shoe, mostly fine to coarse sand - 5 gallons of water added by driller to advance the hole
Hydrocollapse = 2.6% when inundated at 2100 psf Void Ratio = 0.77; Degree of Saturation = 48.2%	9|16|24	6.5		5035	25		- with trace visible pores, trace very thin and discontinuous cementation stringers, very slight increase in sand content
MA: 5.8% Gravel; 45.0% Sand; 49.2% Silt and Clay	5|7|7	7.0		5030	30		**SILTY SAND**, (SM), light brown, slightly damp, medium dense
	13|21|31			5025	35		**SILT WITH SAND**, (ML), light brown to tan, slightly damp, very soft in upper 2 feet, then stiff - with 2-1/2 inch rock in sampler shoe (black, crystalline, subrounded) - after sampling, driller added 5 gallons of water to hole -- still using hollow-stem augers
MA: 1.3% Gravel; 47.5% Sand; 51.2% Silt and Clay		20.1					
				5020	40		

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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Log of Boring B- 8
Near CTG-1A
Currant Creek Power Plant
Mona, Juab County, UT

PLATE **A-1.8**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date 8/11/03
Equipment CME-55
Drilling Method HSA/Rotary Wash
Sampler Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight 140 lbs. Drop 30"
Logged by Wayne L Miller Datum WGS-84
Surface Elevation 5059.4
7106425.783 1530137.434

Remarks	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
					40		SANDY SILT, (ML), light brown, slightly damp, stiff
MA: 12.0% Gravel; 53.0% Sand; 35.0% Silt and Clay	24|50/4"	4.5					SILTY SAND, (SM), light brown, slightly damp, very dense
				5015	45		
Hydrocollapse = 5.8% when inundated at 2100 psf - 5 gallons of water added around augers to advance borehole	15|16|29	6.8					
				5010	50		SILTY SAND WITH GRAVEL, (SM), brown, slightly damp, dense
MA: 15.2% Gravel; 52.2% Sand; 19.2% Silt; 13.4% Clay	10|17|18	8.2					SANDY SILT, (ML), brown, moist, very stiff to hard, with no visible cementation, and no visible pores
				5005	55		SILTY SAND, (SM), light brown, slightly damp, very dense, no visible cementations or pores
- driller switched to rotary wash to advance the borehole	15|25|28	4.9					
				5000	60		
MA: 4.3% Gravel; 59.6% Sand; 27.6% Silt; 8.5% Clay	20|31|21	17.1					
				4995	65		
	10|13|17	21.1					
				4990	70		SANDY SILT, (ML), brown, moist, very stiff to hard, with no visible cementation, and no visible pores
MA: 0% Gravel; 33.5% Sand; 56.0% Silt; 10.5% Clay	8|12|14	24.3					
				4985	75		
	8|10|12	25.1					
				4980	80		

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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Log of Boring B- 8
Near CTG-1A
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.8

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/11/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5059.4
	7106425.783 1530137.434

	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
MA: 0.8% Gravel; 23.2% Sand; 76.0% Silt and Clay	9|13|21	25.9			80		SILT WITH SAND, (ML), light brown to tan, slightly damp, very stiff to hard, with trace visible cementation, no visible pores
	11|23|38	15.4		4975	85		
				4970	90		
	11|17|18	28.1		4965	95		- with no visible pores
	23|36|44	12.4		4960	100		
	16|28|32	20.2		4955	105		
MA: 0.3% Gravel; 28.0% Sand; 71.7% Silt and Clay	17|26|27	21.0		4950	110		- no noticeable change in material type
				4945	115		
				4940	120		

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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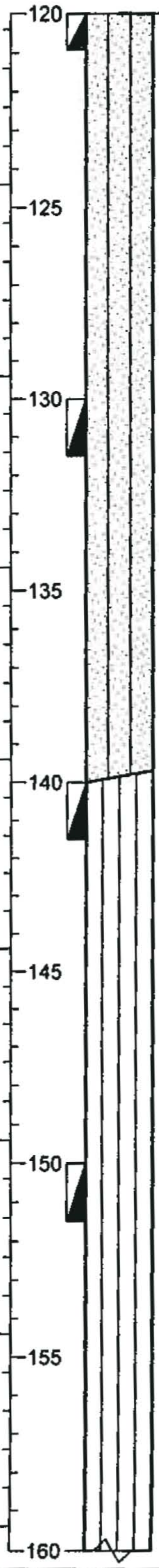
Log of Boring B- 8
Near CTG-1A
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.8

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/11/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5059.4
	7106425.783 1530137.434

Remarks	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
MA: 18.3% Gravel; 63.5% Sand; 18.2% Silt and Clay	30|50/5"	11.6			120		**SILTY SAND WITH GRAVEL**, (SM), brown/black, moist, very dense, with fine gravel, with trace cementation encrustation on some of gravel surfaces
				4935	125		
MA: 28.9% Gravel; 44.5% Sand; 26.7% Silt and Clay	36|42|35	12.9		4930	130		
				4925	135		
MA: 1.7% Gravel; 30.6% Sand; 67.6% Silt and Clay	7|18|26	21.3		4920	140		**SANDY SILT**, (ML), brown, moist, very stiff to hard, with no visible cementation, and no visible pores
				4915	145		
- water level measured at approx. 148 feet on 8/14/2003							
- water level measured at approx. 150 feet on 8/18/2003 MA: 8.0% Gravel; 36.3% Sand; 55.7% Silt and Clay	10|22|29	24.0		4910	150		
				4905	155		
				4900	160		



HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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Log of Boring B- 8
Near CTG-1A
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.8

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/11/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5059.4
	7106425.783 1530137.434

Remarks	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
MA: 0.8% Gravel; 19.2% Sand; 80.0% Silt and Clay	8|17|34	20.0			160		
- drill rate: 1 minute per foot from 160 to 170 ft. - water added to wash tub at about 1 gallon per minute during drilling				4895	165		SILTY SAND WITH GRAVEL, (SM), brown/black, moist, very dense, with fine gravel, no visible cementation or pores
MA: 26.0% Gravel; 40.1% Sand; 33.9% Silt and Clay	23|24|30	15.4		4890	170		
- drill rate: 1 minute per foot from 170 to 180 ft. - water added to wash tub at about 1 gallon per minute during drilling				4885	175		
MA: 17.4% Gravel; 57.4% Sand; 25.2% Silt and Clay	31|35|47	12.1		4880	180		
- drill rate: 1.3 minutes per foot from 180 to 190 ft. - water added to wash tub at about 4 gallons per minute during drilling, and about 1 lb. of bentonite powder added				4875	185		
MA: 7.0% Gravel; 62.2% Sand; 30.8% Silt and Clay	14|30|50/2"	15.6		4870	190		
- drill rate: 1.1 minutes per foot from 180 to 190 ft. - no water added to wash tub during drilling of this portion of borehole				4865	195		
				4860	200		

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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Log of Boring B- 8
Near CTG-1A
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.8

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/11/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5059.4
	7106425.783 1530137.434

Description	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample
MA: 19.3% Gravel; 53.9% Sand; 26.8% Silt and Clay	27|39|47	12.0			200	
- approximately 200 ft. of 1-inch diameter PVC casing with 20 ft. of slot was placed in the borehole upon completion of drilling and sampling on 8-19-2003				4855		

TOTAL DEPTH = 201-1/2 FEET
Began drilling on 8/11/03, and completed drilling on 8/13/03
Temporary piezometer installed upon completion of drilling, to measure the groundwater level, then removed and filled with bentonite-grout slurry

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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Log of Boring B- 8
Near CTG-1A
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.8

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date 8/29/03
Equipment CME-55
Drilling Method Hollow stem auger
Sampler Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight 140 lbs. Drop 30"
Logged by Wayne L Miller Datum WGS-84
Surface Elevation 5042.9
7107749.349 1530263.811

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
					0		SILTY GRAVEL WITH SAND, (GM), light brown, slightly damp, loose
							SILT WITH SAND, (ML), brown, slightly damp, very soft in upper 2 feet, then stiff, with trace pores, with organics and roots, no visible cementation or pores
				5040			SILTY GRAVEL WITH SAND, (GM), brown/black, slightly damp, loose
					5		SILT WITH SAND, (ML), brown, slightly damp, medium stiff, with trace very small pores, trace cementation
	3|3|5						
				5035			SILTY GRAVEL WITH SAND, (GM), brown/black, slightly damp, loose
					10		SILT WITH SAND, (ML), brown, moist, very stiff, with trace discontinuous stringers of cementation, and trace noticeable pore spaces
	14|16|13						
				5030			
- no sample recovery					15		POORLY GRADED SAND, (SP), black/brown, moist, dense, fine to coarse sand, some gravel
	26|36|25						
				5025			
					20		SILTY SAND, (SM), brown, moist, very dense, no cementation, with minor gravel
	15|35|50						
				5020			
- no sample recovery					25		
	11|15|34						
- with rock fragment in sampler shoe				5015			
					30		POORLY GRADED SAND, (SP), black/brown, moist, dense, fine to coarse sand, some gravel
	12|16|24						

TOTAL DEPTH = 31-1/2 FEET
No groundwater observed during drilling
Hole backfilled with bentonite-grout slurry

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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Log of Boring B- 9
Near ACC-2
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.9

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/27/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs.
Drop	30"
Logged by	Wayne L Miller
Datum	WGS-84
Surface Elevation	5046.0
	7107395.608 1530329.832

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Description
				5045	0	**SILT WITH SAND**, (ML), brown, slightly damp, very soft in upper 2 feet, then stiff, with trace pores, with organics and roots, no visible cementation or pores
- no sample recovery from Shelby tube, nor from SPT sampler	13|14|13			5040	5	**SILTY GRAVEL WITH SAND**, (GM), brown, moist, medium dense, no visible cementation
	5|12|16	2.9		5035	10	**POORLY GRADED SAND**, (SP), black/brown, slightly damp, medium dense, fine to coarse sand, some gravel
- no sample recovery from Shelby tube	49|50/4"	2.1		5030	15	
	9|10|12	5.4	90.2	5025	20	**SILTY SAND**, (SM), light brown to tan, slightly damp, dense, with occasional gravel lenses (subrounded - 1/4- to 2 inch, black crystalline clasts)
MA: 12.2% Gravel; 49.5% Sand; 38.3% Silt and Clay	14|13|25	5.2		5020	25	
- no sample recovery	50/5"			5015	30	
MA: 30.7% Gravel; 58.5% Sand; 20.8% Silt and Clay	27|48|50	9.9		5010	35	**SILTY SAND WITH GRAVEL**, (SM), brown/black, slightly damp, to moist, very dense, , no cementation or pores, crystalline, subrounded to subangular
					40	

Sample

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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Log of Boring B-10
Near HRSG-2B
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.10

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/27/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5046.0
	7107395.608 1530329.832

Remarks	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Description
	33|50/5"	6.8	90.2	5005	40	
- no sample recovery from Shelby tube	39|50/4"	15.2		5000	45	**SANDY SILT**, (ML), brown, moist, very stiff, with no observable pores or discontinuous stringers
	8|12|12			4995	50	**SILTY SAND**, (SM), black/brown, moist, very dense, with gravel
- no sample recovery from Shelby tube	34|36|15	10.2		4990	55	**SILTY GRAVEL WITH SAND**, (GM), brown, moist, very dense, gravel up to 2-inch, subrounded to subangular, crystalline
	13|15|15			4985	60	**SILT WITH SAND**, (ML), brown, moist, very stiff, with no visible discontinuous stringers of cementation, no noticeable pore spaces
	11|20|33	8.4		4980	65	**SILTY GRAVEL WITH SAND**, (GM), brown, moist, very dense, gravel up to 2-inch, subrounded to subangular, crystalline
	14|15|18	11.9		4975	70	**SILT WITH SAND**, (ML), brown, moist, very stiff, with no visible discontinuous stringers of cementation, no noticeable pore spaces
- no sample recovery from Shelby tube	9|36|48	10.1		4970	75	**SILTY GRAVEL WITH SAND**, (GM), brown, moist, very dense, gravel up to 2-inch, subrounded to subangular, crystalline
					80	

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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Log of Boring B-10
Near HRSG-2B
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.10

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

						Date 8/27/03
						Equipment CME-55
						Drilling Method HSA/Rotary Wash
						Sampler Mod. CA Sampler; Shelby Tube; SPT
						Hammer Weight 140 lbs. Drop 30"
						Logged by Wayne L Miller Datum WGS-84
Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Surface Elevation 5046.0
						7107395.608 1530329.832
23|31|50/5"			4965	80		**SILTY SAND**, (SM), black/brown, moist, very dense, with gravel
						TOTAL DEPTH = 81-1/2 FEET No groundwater observed during drilling Hole backfilled with bentonite-grout slurry

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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Log of Boring B-10
Near HRSG-2B
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.10

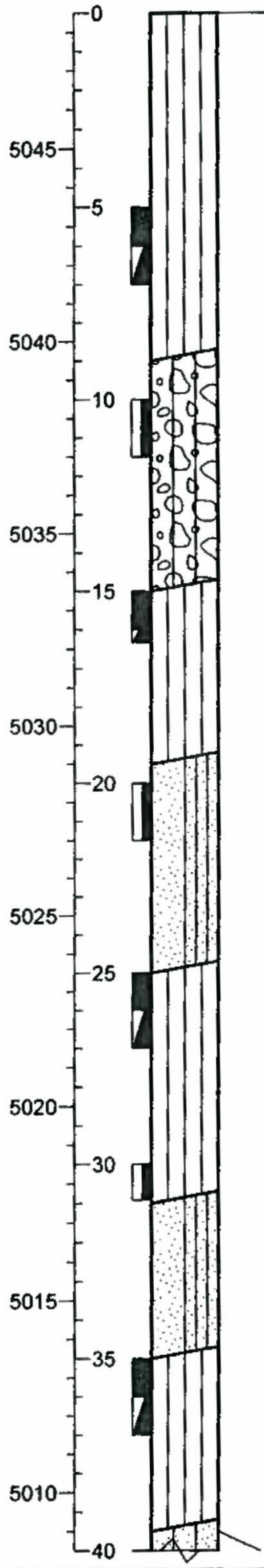
DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

APPENDIX H

REPORT OF GEOTECHNICAL EXPLORATION

DOCUMENT 4 OF 5

Date	8/26/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5048.5
	7107263.511 1530328.538



Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Depth (ft.)	Description
				0	**SILT WITH SAND**, (ML), brown, slightly damp, very soft in upper 2 feet, then stiff,with organics and roots, no visible cementation or pores
	5|6|6	4.1		5	
					- with some rootlets
	9|14|21	2.0		10	**SILTY GRAVEL WITH SAND**, (GM), brown, moist, medium dense, no visible cementation or pores
- no sample recovery from Shelby tube	11|16|16	6.7		15	**SILT WITH SAND**, (ML), brown, slightly damp, very stiff, no visible cementation or pores
- no sample recovery	10|13|15	2.0		20	**POORLY GRADED SAND WITH SILT**, (SP-SM), black/brown, slightly damp, medium dense, fine to coarse sand, some gravel
	3|5|12	4.4		25	**SILT WITH SAND**, (ML), brown, moist, very stiff, with trace discontinuous stringers of cementation, trace pore spaces
	27|50/5"	2.9		30	**POORLY GRADED SAND WITH SILT**, (SP-SM), black/brown, slightly damp, dense, fine to coarse sand, some gravel
	3|4|5	7.1		35	**SANDY SILT**, (ML), brown, moist, stiff, with no observable pores or discontinuous stringers
				40	

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Boring B-11
Near HRSG-2A
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.11

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date 8/26/03
Equipment CME-55
Drilling Method HSA/Rotary Wash
Sampler Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight 140 lbs. Drop 30"
Logged by Wayne L Miller Datum WGS-84
Surface Elevation 5048.5
7107263.511 1530328.538

	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	
	24|50/4"				40		**SILTY SAND**, (SM), black/brown, moist, very dense, with gravel
- switched from HSA to rotary wash, set 3-inch diameter casing to 42 ft.				5005			
DSCU: Cohesion = 0 psf; Phi = 39 Degrees (Peak)	32|50/5"	10.4			45		**SILTY GRAVEL WITH SAND**, (GM), brown, moist, very dense, gravel up to 2-inch, subrounded to subangular, crystalline
				5000			
	40|50/4"				50		**POORLY GRADED SAND**, (SP), black/brown, slightly damp, medium dense, fine to coarse sand, some gravel
- advance casing to 53 ft., water added to wash tank at 1 to 2 gpm from 50 to 55 ft.				4995			
	33|50/4"				55		
- casing driven to 58 ft.				4990			
	32|32|24				60		
- water added at a rate of 1 to 2 gpm from 60 to 65 ft. - casing driven to 63 ft.				4985			
	21|15|23				65		**SILTY SAND**, (SM), black/brown, moist, very dense, with gravel
				4980			
	15|28|26				70		
				4975			
- no sample recovery	50/5"				75		**SILTY GRAVEL WITH SAND**, (GM), brown, moist, very dense, gravel up to 2-inch, subrounded to subangular, crystalline
- added 1/2 pint of polymer to wash water				4970			
					80		

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

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Log of Boring B-11
Near HRSG-2A
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.11

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/26/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5048.5
	7107263.511 1530328.538

Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
27|11|8				80		**SILTY SAND**, (SM), black/brown, moist, very dense, with gravel
						SILT WITH SAND, (ML), brown, moist, very stiff, with no visible discontinuous stringers of cementation, no noticeable pore spaces
			4965			**TOTAL DEPTH = 81-1/2 FEET**
						No groundwater observed during drilling
						Hole completed on 8/27/03
						Hole backfilled with bentonite-grout slurry

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Log of Boring B-11
Near HRSG-2A
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.11

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date 8/29/03
Equipment CME-55
Drilling Method Hollow stem auger
Sampler Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight 140 lbs. Drop 30"
Logged by Wayne L Miller Datum WGS-84
Surface Elevation 5051.1
7107079.14 1530284.83

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)
	4|4|5			5050	0
MA: 0% Gravel; 35% Sand; 65% Silt and Clay	5|20|22	7.8		5045	5
	2|3|5			5040	10
MA: 0.5% Gravel; 50.6% Sand; 48.8% Silt and Clay	7|11|22	7.6		5035	15
	10|15|19			5030	20
- no sample recovery from Shelby tube	11|23|23			5025	25
	17|12|30			5020	30

SANDY SILT, (ML), brown, slightly damp, very soft in upper 2 feet, then stiff,with organics and roots, no visible cementation or pores

- rock in SPT sampler shoe, black, crystalline

- at 6 ft., 8 ft., and 9 ft., with thin gravel lenses

SILTY SAND, (SM), black/brown, moist, very dense, with gravel

- with few thin white discontinuous stringers

- with trace cementation but no pores

SILTY GRAVEL WITH SAND, (GM), brown, moist, very dense, gravel up to 2-inch, subrounded to subangular, crystalline

POORLY GRADED SAND, (SP), black/brown, slightly damp, dense, fine to coarse sand, some gravel 1/4 to 1/2 inch

SILT WITH SAND, (ML), brown, moist, very stiff, with no visible discontinuous stringers of cementation, no noticeable pore spaces

TOTAL DEPTH = 31-1/2 FEET
No groundwater observed during drilling
Hole backfilled with bentonite-grout slurry

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Boring B-12

Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.12

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	9/3/03
Equipment	CME-55
Drilling Method	Hollow stem auger
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs.
Drop	30"
Logged by	Wayne L Miller
Datum	WGS-84
Surface Elevation	5052.2
	7106910.31
	1530257.292

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)
					0
	5|6|5	4.7	85.8		
				5050	
					5
	10|8|8	1.7			
				5045	
- no sampler recovery					10
	9|10|14	3.4			
				5040	
					15
	50/3"	6.0			
				5035	
- no sampler recovery	50/5"				20
				5030	
- no sampler recovery					25
	6|10|12	14.4			
				5025	
					30
	7|10|17	6.9	94.3		

Sample

SANDY SILT, (ML), brown, slightly damp, very soft in upper 2 feet, then stiff,with organics and roots, no visible cementation or pores

SILTY GRAVEL WITH SAND, (GM), brown, moist, very dense, gravel up to 2-inch, subrounded to subangular, crystalline

SILT WITH SAND, (ML), brown, moist, very stiff, with trace discontinuous stringers of cementation, trace pore spaces

SILTY GRAVEL WITH SAND, (GM), brown, moist, very dense, subrounded to subangular, crystalline

SILTY SAND, (SM), black/brown, slightly damp, medium dense, fine to coarse sand, some gravel

TOTAL DEPTH = 31-1/2 FEET
No groundwater observed during drilling
Hole backfilled with bentonite-grout slurry

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Boring B-13
Near ACC-1
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.13

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/25/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5052.4
	7106556.009 1530323.078

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Description
					0	**SILT WITH SAND**, (ML), brown, slightly damp, very soft in upper 2 feet, then stiff, with trace pores, with organics and roots, no visible cementation or pores
Hydrocollapse = 6.2% at 2000 psf	5|4|6	8.4	83.7	5050		
- no Shelby tube sample recovery	11|50/4"	2.6		5045	5	**SILTY GRAVEL WITH SAND**, (GM), brown/black, slightly damp, very dense, gravel up to 2-inch, no visible cementation, subrounded to subangular, crystalline
Hydrocollapse = 2.9% at 3000 psf	29|30|17	6.1	101.3	5040	10	
- no Shelby tube sample recovery	8|6|6	7.7		5035	15	**SILTY SAND**, (SM), brown, moist, medium dense, no cementation
Hydrocollapse = 1.8% at 3000 psf	5|8|10	9.0	94.3	5030	20	- with no cementation or pores
	18|22|14	6.7 3.6		5025	25	- with trace gravel 1/2 to 1-inch
- no sample recovery, rock stuck in sampler shoe	22|27|27			5020	30	
- no Shelby tube sample recovery	39|45|48	4.9		5015	35	**SILTY GRAVEL WITH SAND**, (GM), brown/black, slightly damp, very dense, gravel up to 2-inch, no visible cementation, subrounded to subangular, crystalline
					40	

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Boring B-14
HRSG-1B
Currant Creek Power Plant
Mona, Juab County, UT

PLATE **A-1.14**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/25/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5052.4
	7106556.009 1530323.078

Remarks	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Description
Hydrocollapse = 3.6% at 5000 psf; - no sample recovery, rock stuck in sampler shoe; - switch from HSA to rotary wash, installed casing to 42 ft.	50/4"	13.2	78.2		40	- with large gravel or boulder
				5010		
	14|30|25	9.5		5005	45	- with gravel 1/4 to 1-inch
	14|32|50			5000	50	**SILTY SAND**, (SM), black/brown, moist, very dense, with fine gravel
	15|32|40			4995	55	**SILTY GRAVEL WITH SAND**, (GM), brown, moist, very dense, gravel 1/4 to 1 inch, subrounded to subangular, crystalline
	5|9|13	21.3		4990	60	**SANDY SILT**, (ML), brown, moist, very stiff, with no observable pores, with very thin discontinuous stringers
	6|7|10			4985	65	- grading very stiff to hard
	11|20|30	14.1		4980	70	- with no visible cementation or pores
	13|18|22	12.6	106.1	4975	75	- with trace visible cementation
					80	

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Boring B-14
HRSG-1B
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.14

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/25/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5052.4
	7106556.009 1530323.078

Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
				80		**POORLY GRADED SAND,** (SP), black/brown, moist, dense, fine to coarse sand, some gravel
17|17|20	19.2					
			4970			**TOTAL DEPTH = 82 FEET** No groundwater observed during drilling Hole backfilled with bentonite-grout slurry

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Boring B-14
HRSG-1B
Current Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.14

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/23/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5053.0
	7106424.304 1530322.387

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Description
Hydrocollapse = 5.4% at 2000 psf	4|5|7			5053.0	0	**SILT WITH SAND**, (ML), brown, slightly damp, very soft in upper 2 feet, then stiff, with trace pores, with organics and roots, no visible cementation
	8|50/3"	7.8			5	- with no observable cementation or pores - with gravel lens at 6 ft.
Hydrocollapse = 2.3% at 2000 psf	28|30|23	5.7	105.4		10	**SILTY SAND**, (SM), brown, moist, very dense, no cementation, with fine gravel (1/4 to 1/2-inch, black, crystalline, subrounded)
MA: 10.9% Gravel; 54.1% Sand; 35.0% Silt and Clay Void Ratio = 1.16; Degree of Saturation = 34.2%	9|7|7	8.9 14.7	81.4 77.9		15	- grades to medium dense
	5|9|13				20	
- no sample recovery	4|6|6				25	**SANDY SILT**, (ML), brown, moist, very stiff, with no observable pores or discontinuous stringers
	31|38|50/5"				30	**SILTY SAND**, (SM), black/brown, moist, very dense, with gravel
- no sample recovery	4|6|6				35	- grades to medium dense
					40	

Elevation scale: 5050, 5045, 5040, 5035, 5030, 5025, 5020, 5015

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Boring B-15
HRSG-1A
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.15

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/23/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5053.0
	7106424.304 1530322.387

Remarks	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Description
					40	
	13|33|50/5"					
				5010		
					45	
	11|19|26					**SANDY SILT**, (ML), brown, moist, very stiff, with no observable pores, with discontinuous stringers
				5005		
					50	**SILTY SAND**, (SM), black/brown, moist, dense, with gravel
	13|21|25					
				5000		
Void Ratio = 0.69; Degree of Saturation = 73.5%	10|24|39	18.7	99.9		55	**SANDY SILT**, (ML), brown, moist, very stiff, with no observable pores, with few discontinuous stringers
				4995		
					60	
	10|12|12					- with no noticeable cementation or pores
				4990		
					65	
	10|13|16					
				4985		- with some gravel
					70	**SILTY SAND**, (SM), black/brown, moist, very dense, with gravel
	45|50/5"					
				4980		
- no sample recovery					75	
	26|14|11					- grades to medium dense
				4975		
					80	

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Boring B-15
HRSG-1A
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.15

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/23/03
Equipment	CME-55
Drilling Method	HSA/Rotary Wash
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5053.0
	7106424.304 1530322.387

Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
				80		SANDY SILT, (ML), brown, moist, very stiff, with no observable pores or discontinuous stringers
18|25|26						TOTAL DEPTH = 81-1/2 FEET
			4970			No groundwater observed during drilling Hole backfilled with bentonite-grout slurry

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Boring B-15
HRSG-1A
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.15

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	9/3/03
Equipment	CME-55
Drilling Method	Hollow stem auger
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5056.9
	7106239.548 1530278.497

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Description
					0	**SANDY SILT**, (ML), brown, slightly damp, very soft in upper 2 feet, then stiff,with organics and roots, no visible cementation or pores
				5055		- with occasional gravels
	14|17|14	5.5	91.9		5	
				5050		
- no sample recovery					10	**SILTY SAND**, (SM), black/brown, slightly damp, dense, fine to coarse sand, some gravel
	18|20|14	7.5		5045		
	7|12|16	14.4	92.4		15	
				5040		- with occasional gravel from 18 to 19 ft.
- no sample recovery					20	
	14|11|11	5.7		5035		- with occasional gravel from 23 to 24 ft.
	38|50/5"	3.5			25	
				5030		- with gravel 1/4 to 3/4 inch
	18|20|22	5.3			30	**SILTY GRAVEL WITH SAND**, (GM), brown, moist, very dense, gravel up to 2-inch, subrounded to subangular, crystalline
				5025		**TOTAL DEPTH = 32 FEET** No groundwater observed during drilling Hole backfilled with bentonite-grout slurry

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Boring B-16

Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.16

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date 8/27/03
Equipment CME 55
Drilling Method Hollow stem auger with 8" OD, 4-1/4 inch I
Sampler Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight 140 lbs. Drop 30"
Logged by Wayne L Miller Datum WGS-84
Surface Elevation 5036.3
7107748.15 1530474.854

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Description
					0	**SANDY SILT**, (ML), brown, slightly damp, very soft in upper 2 feet, then stiff,with organics and roots, no visible cementation or pores
				5035		
MA: 1.0% Gravel; 28.9% Sand; 70.1% Silt and Clay	4|7|7				5	
				5030		- with trace organics in sample
MA: 40.9% Gravel; 47.3% Sand; 11.8% Silt and Clay	27|50				10	**WELL-GRADED SAND WITH SILT AND GRAVEL**, (SW-SM), black/brown, slightly damp, dense, fine to coarse sand, some gravel 1/4 to 1/2- inch
				5025		
	31|18|6				15	- with occasional subrounded to subangular gravel
				5020		
	7|22|17				20	- with no cementation
				5015		
	4|6|6				25	**SILT WITH SAND**, (ML), brown, moist, stiff, with gravel
				5010		
	9|20|21				30	- grades very stiff to hard
				5005		

TOTAL DEPTH = 31-1/2 FEET
No groundwater observed during drilling
Hole backfilled with bentonite-grout slurry

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

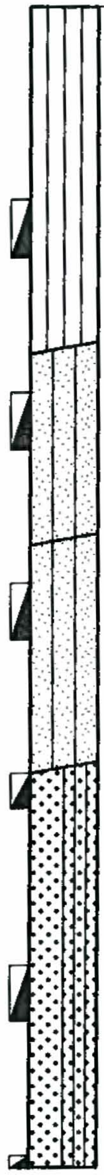
Log of Boring B-17
ACC-2
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.17

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/27/03
Equipment	CME 55
Drilling Method	Hollow stem auger with 8" OD, 4-1/4 inch
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5040.9
	7107510.421 1530472.799

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
					0		**SANDY SILT**, (ML), brown, slightly damp, very soft in upper 2 feet, then stiff,with organics and roots, no visible cementation or pores
				5040			
	6|9|13			5035	5		- with trace organics (rootlets)
MA: 0.1% Gravel; 52.0% Sand; 48.0% Silt and Clay	2|4|4			5030	10		**SILTY SAND**, (SM), black/brown, slightly damp, medium dense, fine to coarse sand, some gravel
MA: 33.3% Gravel; 37.2% Sand; 29.5% Silt and Clay	13|21|40			5025	15		**SILTY SAND WITH GRAVEL**, (SM), brown, moist, very dense, gravel up to 2-inch, subrounded to subangular, crystalline
	45|50/5"			5020	20		**WELL-GRADED SAND WITH SILT AND GRAVEL**, (SW-SM), black/brown, slightly damp, very dense, fine to coarse sand, some gravel
	24|24|21			5015	25		
	50/4"				30		**TOTAL DEPTH = 30-1/4 FEET** No groundwater observed during drilling Hole backfilled with bentonite-grout slurry



HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Boring B-18
ACC-1
Currant Creek Power Plant
Mona, Juab County, UT

PLATE **A-1.18**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	9/3/03
Equipment	CME 55
Drilling Method	Hollow stem auger with 8" OD, 4-1/4 inch
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5044.2
	7106908.965 1530468.394

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
	5|6|11	6.5			0		SANDY SILT, (ML), brown, slightly damp, very soft in upper 2 feet, then stiff,with organics and roots, no visible cementation or pores
				5040	5		
	4|5|6	5.2					
				5035	10		SILTY SAND WITH GRAVEL, (SM), black/brown, slightly damp, dense, fine to coarse sand, some gravel
	3|19|25	3.0					
				5030	15		
	20|19|20	1.6					SILTY GRAVEL WITH SAND, (GM), brown/black, slightly damp, very dense, no visible cementation, subrounded to subangular, crystalline
				5025	20		
	9|35|41						
				5020	25		SILTY SAND WITH GRAVEL, (SM), black/brown, slightly damp, dense, fine to coarse sand, some gravel
	7|7|6						SILT WITH SAND, (ML), brown, moist, very dense, gravel up to 2-inch, subrounded to subangular, crystalline
				5015	30		
	50/3"						TOTAL DEPTH = 30-1/4 FEET No groundwater observed during drilling Hole backfilled with bentonite-grout slurry

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Boring B-19
ACC-1 NEC
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.19

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Field	Value
Date	9/3/03
Equipment	CME 55
Drilling Method	Hollow stem auger with 8" OD, 4-1/4 inch I
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5046.0
	7106671.111 1530466.591

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
					0		**SANDY SILT**, (ML), brown, slightly damp, very soft in upper 2 feet, then stiff,with organics and roots, no visible cementation or pores
	3|5|5	8.3	72.1	5045			
							- with gravel lens from 4 to 5 ft.
					5		
	3|2|4	5.8		5040			
							- with trace small pores
					10		
	9|22|32	7.5	90.2	5035			- with light cementation
- no sample recovery					15		
	13|14|12	7.3		5030			
					20		**SILTY GRAVEL WITH SAND**, (GM), brown/black, slightly damp, very dense, gravel up to 2-inch, no visible cementation, subrounded to subangular, crystalline
	13|20|15	7.8	93.1	5025			
- no sample recovery					25		
	8|15|14	5.1		5020			
					30		**SILTY SAND WITH GRAVEL**, (SM), black/brown, slightly damp, dense, fine to coarse sand, some gravel
	22|22|14	7.4	89.6	5015			**SILT WITH SAND**, (ML), brown, moist, very dense, gravel up to 2-inch, subrounded to subangular, crystalline

TOTAL DEPTH = 31-1/2 FEET
No groundwater observed during drilling
Hole backfilled with bentonite-grout slurry

MACTEC

Log of Boring B-20
ACC-1 SEC
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.20

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date 8/20/03
Equipment CME 55
Drilling Method Hollow stem auger with 8" OD, 4-1/4 inch
Sampler Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight 140 lbs. Drop 30"
Logged by Wayne L Miller Datum WGS-84
Surface Elevation 5017.9
7107980.272 1531120.48

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
	4|4|5				0		SANDY SILT, (ML), brown, slightly damp, very soft in upper 2 feet, then stiff,with organics and roots, no visible cementation, trace pores
				5015			
Field Vertical Permeability = 2.57E-05 cm/sec Field Horizontal Permeability = 1.79E-03 cm/sec	3|6|10				5		
				5010			- with slight increase in fine sand
Field Vertical Permeability = 0 cm/sec Field Horizontal Permeability = 2.58E-03 cm/sec	8|13|14				10		
				5005			- with trace pores
Field Vertical Permeability = 0 cm/sec Field Horizontal Permeability = 1.16E-04 cm/sec	5|17|22				15		SILTY SAND WITH GRAVEL, (SM), black/brown, slightly damp, dense, fine to coarse sand, some gravel
				5000			
Field Vertical Permeability = 8.53E-04 cm/sec Field Horizontal Permeability = 8.97E-04 cm/sec	5|7|10				20		- with no visible cementation or pores
				4995			
Field Vertical Permeability = 1.19E-05 cm/sec Field Horizontal Permeability = 1.77E-03 cm/sec	9|8|10				25		SILT WITH SAND, (ML), brown, moist, very dense, gravel up to 2-inch, subrounded to subangular, crystalline

TOTAL DEPTH = 26-1/2 FEET
No groundwater observed during drilling
Hole backfilled with bentonite-grout slurry

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Boring B-21
NWC of Evaporation Ponds
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.21

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/21/03
Equipment	CME 55
Drilling Method	Hollow stem auger with 8" OD, 4-1/4 inch I
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	5028.6
	7105996.029 1531105.583

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
	3|6|14				0		SANDY SILT, (ML), brown, slightly damp, very soft in upper 2 feet, then stiff,with organics and roots, no visible cementation or pores
				5025			
Field Vertical Permeability = 1.54E-04 cm/sec Field Horizontal Permeability = 9.57E-04 cm/sec	6|7|8				5		SILTY SAND WITH GRAVEL, (SM), black/brown, slightly damp, dense, fine to coarse sand, some gravel
				5020			
Field Vertical Permeability = 1.18E-03 cm/sec Field Horizontal Permeability = 2.58E-03 cm/sec	9|15|22				10		SILT WITH SAND, (ML), brown, moist, very dense, gravel up to 2-inch, subrounded to subangular, crystalline
				5015			
Field Vertical Permeability = 5.02E-04 cm/sec Field Horizontal Permeability = 4.63E-03 cm/sec	15|26|25				15		SILTY GRAVEL WITH SAND, (GM), brown/black, slightly damp, very dense, gravel up to 2-inch, no visible cementation, subrounded to subangular, crystalline
							SILTY SAND WITH GRAVEL, (SM), black/brown, slightly damp, dense, fine to coarse sand, some gravel
				5010			
Field Vertical Permeability = 2.06E-04 cm/sec Field Horizontal Permeability = 2.91E-03 cm/sec	9|9|11				20		SILT WITH SAND, (ML), brown, moist, very dense, gravel up to 2-inch, subrounded to subangular, crystalline
				5005			
Field Vertical Permeability = 1.19E-05 cm/sec Field Horizontal Permeability = 2.26E-03 cm/sec	8|10|8				25		

TOTAL DEPTH = 26-1/2 FEET
No groundwater observed during drilling
Hole backfilled with bentonite-grout slurry

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Boring B-22
SWC of Evaporation Ponds
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.22

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date 8/20/03
Equipment CME 55
Drilling Method Hollow stem auger with 8" OD, 4-1/4 inch
Sampler Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight 140 lbs. Drop 30"
Logged by Wayne L Miller Datum WGS-84
Surface Elevation 4990.3
7105988.001 1530871.102

Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)
	5|6|10			4990	0
Field Vertical Permeability = 1.29E-05 cm/sec Field Horizontal Permeability = 3.15E-03 cm/sec	3|8|9			4985	5
Field Vertical Permeability = 3.93E-04 cm/sec Field Horizontal Permeability = 1.85E-03 cm/sec	13|14|16			4980	10
Field Vertical Permeability = 3.86E-05 cm/sec Field Horizontal Permeability = 3.41E-03 cm/sec	17|39|50/4"			4975	15
Field Vertical Permeability = 3.67E-06 cm/sec Field Horizontal Permeability = 7.06E-03 cm/sec	7|15|26			4970	20
Field Vertical Permeability = 1.66E-04 cm/sec Field Horizontal Permeability = 3.74E-03 cm/sec	16|24|36			4965	25

Sample

SANDY SILT, (ML), brown, slightly damp, very soft in upper 2 feet, then stiff,with organics and roots, no visible cementation or pores

SILTY SAND WITH GRAVEL, (SM), black/brown, slightly damp, dense, fine to coarse sand, some gravel

SILTY GRAVEL WITH SAND, (GM), brown/black, slightly damp, very dense, gravel up to 2-inch, no visible cementation, subrounded to subangular, crystalline

SILTY SAND WITH GRAVEL, (SM), black/brown, slightly damp, dense, fine to coarse sand, some gravel

TOTAL DEPTH = 26-1/2 FEET
No groundwater observed during drilling
Hole backfilled with bentonite-grout slurry

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

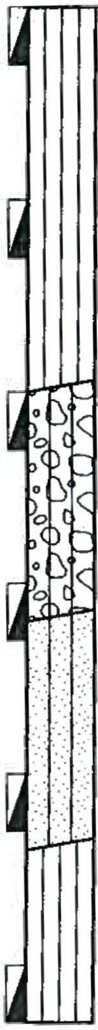
MACTEC

Log of Boring B-23
NEC of Evaporation Ponds
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.23

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date	8/20/03
Equipment	CME 55
Drilling Method	Hollow stem auger with 8" OD, 4-1/4 inch I
Sampler	Mod. CA Sampler; Shelby Tube; SPT
Hammer Weight	140 lbs. Drop 30"
Logged by	Wayne L Miller Datum WGS-84
Surface Elevation	4995.0
	7107972.675 1532183.527



Other Tests/Drilling Notes	Blows/6 Inches	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
	2|2|3			4995	0		**SANDY SILT**, (ML), brown, slightly damp, very soft in upper 2 feet, then stiff,with organics and roots, no visible cementation or pores
Field Vertical Permeability = 6.43E-05 cm/sec Field Horizontal Permeability = 3.09E-03 cm/sec	10|10|10			4990	5		
Field Vertical Permeability = 7.30E-03 cm/sec Field Horizontal Permeability = 2.69E-02 cm/sec	10|8|5			4985	10		**SILTY GRAVEL WITH SAND**, (GM), brown/black, slightly damp, very dense, gravel up to 2-inch, no visible cementation, subrounded to subangular, crystalline
Field Vertical Permeability = 6.17E-04 cm/sec Field Horizontal Permeability = 2.22E-02 cm/sec	12|6|5			4980	15		**SILTY SAND WITH GRAVEL**, (SM), black/brown, slightly damp, dense, fine to coarse sand, some gravel
Field Vertical Permeability = 2.20E-05 cm/sec Field Horizontal Permeability = 1.06E-02 cm/sec	14|12|13			4975	20		**SANDY SILT**, (ML), brown, slightly damp, very soft in upper 2 feet, then stiff,with organics and roots, no visible cementation or pores
Field Vertical Permeability = 1.78E-05 cm/sec Field Horizontal Permeability = 3.09E-03 cm/sec	15|19|21			4970	25		

TOTAL DEPTH = 26-1/2 FEET
No groundwater observed during drilling
Hole backfilled with bentonite-grout slurry

HARDING_LV_ELEV CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Boring B-24
SEC of Evaporation Ponds
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-1.24

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RTG	4400032006		10/03	

Date 9/4/03
Equipment Case 580 Backhoe

Logged by Wayne L Miller Datum WGS-84
Surface Elevation 5050

Other Tests/Drilling Notes	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample
			5050	0	
			5045	5	
Hydrocollapse = 5.8% at 2300 psf	8.0	82.1			
			5040	10	

SILT WITH SAND(ML), light brown, slightly damp, soft, with minor gravel, with organics and rootlets in upper 2 feet

SILTY GRAVEL WITH SAND(GM), brown, slightly damp, loose, with fine to coarse sand

SILT WITH SAND(ML), light brown, slightly damp, soft to medium stiff, with minor gravel

SILTY GRAVEL WITH SAND(GM), brown, slightly damp, loose to medium dense, with fine to coarse sand

SILT WITH SAND(ML), light brown, slightly damp, stiff, with minor gravel

TOTAL DEPTH = 12 FEET
No groundwater observed during excavation
Hole backfilled with excavated materials

TEST PIT LOG CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Test Pit TP-1
40'S & 18'W of B-3
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-2.1

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
	4400032006		10/03	

Date 9/4/03
Equipment Case 580 Backhoe

Logged by Wayne L Miller Datum WGS-84
Surface Elevation 5055

Other Tests/Drilling Notes	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	
			5055	0		**SILT WITH SAND**(ML), light brown, slightly damp, soft, with minor gravel, with organics and rootlets in upper 2 feet
						SILTY GRAVEL WITH SAND(GM), brown, slightly damp, loose, with fine to coarse sand
						SILT WITH SAND(ML), light brown, slightly damp, soft, with minor gravel
			5050	5		
Hydrocollapse = 4.4% at 2300 psf	8.2	88.7				
						SILTY GRAVEL WITH SAND(GM), brown, slightly damp, medium dense, with fine to coarse sand
						SILT WITH SAND(ML), light brown, slightly damp, medium stiff, with minor gravel
						SILTY GRAVEL WITH SAND(GM), brown, slightly damp, medium dense, with fine to coarse sand
			5045	10		**TOTAL DEPTH = 10 FEET** No groundwater observed during excavation Hole backfilled with excavated materials

TEST PIT LOG CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Test Pit TP-2
6'N & 40'E of B-6
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-2.2

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
	4400032006		10/03	

Date 9/4/03
Equipment Case 580 Backhoe
Logged by Wayne L Miller Datum WGS-84
Surface Elevation 5060

Other Tests/Drilling Notes	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
			5060	0		**SILT WITH SAND**(ML), light brown, slightly damp, soft, with minor gravel, with organics and rootlets in upper 2 feet
						SILTY GRAVEL WITH SAND(GM), brown, slightly damp, loose, with fine to coarse sand
			5055	5		**SILTY SAND**(SM), brown, slightly damp, medium dense, with minor gravel
						SILT WITH SAND(ML), light brown, slightly damp, stiff, with minor gravel
Hydrocollapse = 5.4% at 2300 psf	11.2	80.3				
Hydrocollapse = 1.1% at 2300 psf	11.1	82.6				
						SILTY GRAVEL WITH SAND(GM), brown, slightly damp, medium dense, with fine to coarse sand
			5050	10		**TOTAL DEPTH = 10 FEET** No groundwater observed during excavation Hole backfilled with excavated materials

TEST PIT LOG CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Test Pit TP-3
7'S & 10'W of B-8
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-2.3

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
	4400032006		10/03	

Date 9/4/03
Equipment Case 580 Backhoe

Logged by Wayne L Miller Datum WGS-84
Surface Elevation 5032

Other Tests/Drilling Notes	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
				0		**SILT WITH SAND**(ML), light brown, slightly damp, soft, with minor gravel, with organics and rootlets in upper 2 feet
			5030			
				5		
Hydrocollapse = 9.4% at 2300 psf			5025			
	8.9	82.9			X	
				10		
						SILTY GRAVEL WITH SAND(GM), brown, slightly damp, loose to medium dense, with fine to coarse sand
			5020			**TOTAL DEPTH = 12 FEET** No groundwater observed during excavation Hole backfilled with excavated materials

TEST PIT LOG CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Test Pit TP-4
12'N & 40'W of B-25
Currant Creek Power Plant
Mona, Juab County, UT

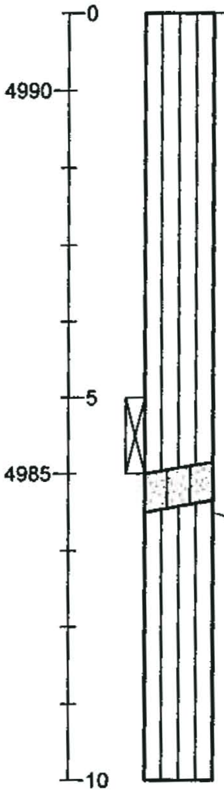
PLATE
A-2.4

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
	4400032006		10/03	

Date 9/5/03
Equipment Case 580 Backhoe

Logged by Wayne L Miller Datum WGS-84
Surface Elevation 4991

Other Tests/Drilling Notes	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
				0		SILT WITH SAND(ML), light brown, slightly damp, soft, with minor gravel, with organics and rootlets in upper 2 feet
			4990			
Hydrocollapse = 6.5% at 2300 psf				5		
	7.5	88.2				
			4985			SILTY SAND(SM), brown, slightly damp, medium dense, with fine to coarse sand
						SILT WITH SAND(ML), light brown, slightly damp, soft to medium stiff, with minor gravel, with organics and rootlets in upper 2 feet
				10		TOTAL DEPTH = 10 FEET No groundwater observed during excavation Hole backfilled with excavated materials



TEST PIT LOG CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Test Pit TP-5
12'S & 20'W of B-23
Currant Creek Power Plant
Mona, Juab County, UT

PLATE
A-2.5

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
	4400032006		10/03	

Date 9/5/03
Equipment Case 580 Backhoe
Logged by Wayne L Miller Datum WGS-84
Surface Elevation 4996

Other Tests/Drilling Notes	Moisture Content (%)	Dry Density (pcf)	Elevation (ft)	Depth (ft.)	Sample	Description
				0		**SILT WITH SAND**(ML), light brown, slightly damp, soft, with minor gravel, with organics and rootlets in upper 2 feet
			4995			
						SILTY GRAVEL WITH SAND(GM), brown, slightly damp, loose, with fine to coarse sand
						SILT WITH SAND(ML), light brown, slightly damp, soft, with minor gravel
				5		**POORLY GRADED SAND**(SP), brown, slightly damp, medium dense, with fine to coarse sand
						SILT WITH SAND(ML), light brown, slightly damp, medium stiff, with minor gravel
Hydrocollapse = 7.1% at 2300 psf			4990			
Hydrocollapse = 3.2% at 2300 psf	7.7	89.0			X	
	9.2	85.1				
						POORLY GRADED SAND(SP), brown, slightly damp, medium dense, with fine to coarse sand
						SILT WITH SAND(ML), light brown, slightly damp, medium stiff
				10		**SILTY GRAVEL WITH SAND**(GM), brown, slightly damp, medium dense, with fine to coarse sand
						TOTAL DEPTH = 10 FEET
						No groundwater observed during excavation
						Hole backfilled with excavated materials

TEST PIT LOG CURRANT CREEK POWER PLANT 7.GPJ NV_DOT.GDT 10/20/03

MACTEC

Log of Test Pit TP-6
12'N & 12'W of B-24
Currant Creek Power Plant
Mona, Juab County, UT

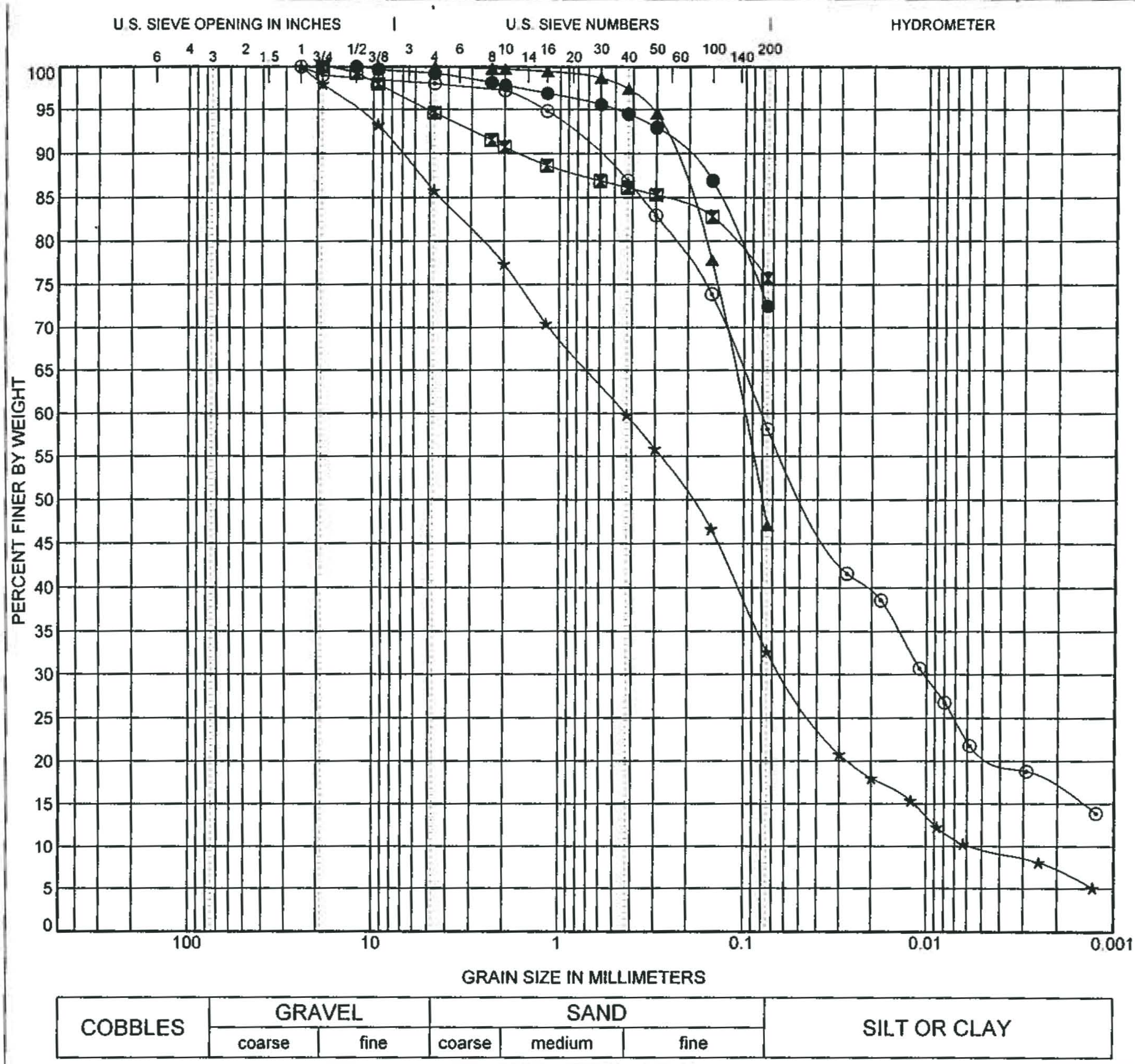
PLATE
A-2.6

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
	4400032006		10/03	

APPENDIX H

REPORT OF GEOTECHNICAL EXPLORATION

DOCUMENT 5 OF 5



	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-1	0.0	SILTY CLAY with SAND(CL-ML)	23	17	6		
⊠	B-2	0.0	LEAN CLAY with SAND(CL)	29	17	12		
▲	B-7	25.0	SILTY SAND(SM)	NP	NP	NP		
★	B-8	10.0	SILTY SAND(SM)	NP	NP	NP	1.56	77.70
⊙	B-8	15.0	SANDY SILT(ML)	NP	NP	NP		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1	0.0	19				0.8	26.7	72.5	
⊠	B-2	0.0	19				5.4	18.9	75.7	
▲	B-7	25.0	9.5	0.1			0.0	52.9	47.1	
★	B-8	10.0	25	0.432	0.061	0.006	14.2	53.2	22.9	9.7
⊙	B-8	15.0	25	0.081	0.01		1.9	39.9	37.0	21.1

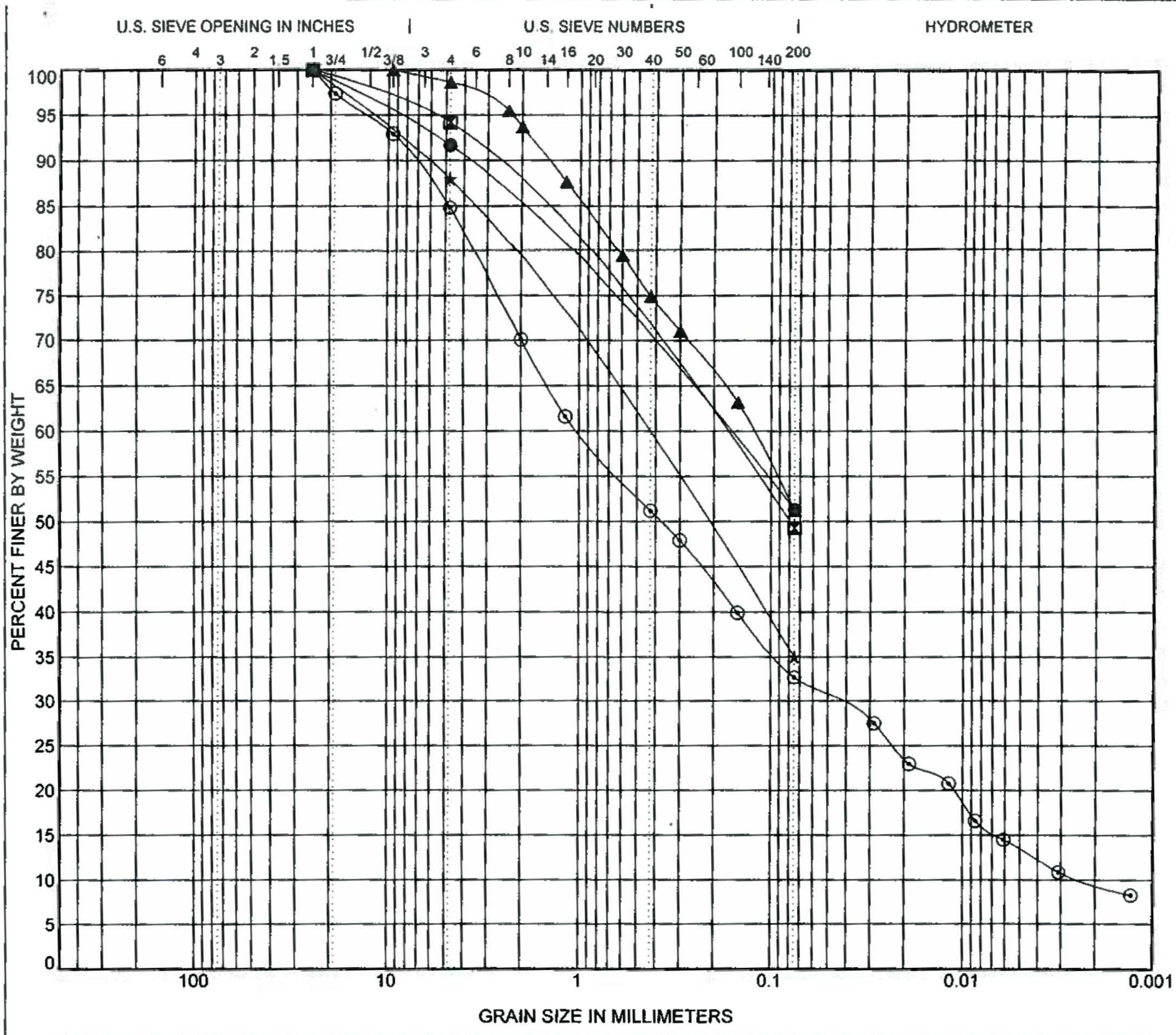
Grain Size Distribution

FIGURE

MACTEC

Currant Creek Power Plant
Mona, Juab County, UT

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
	4400032006		10/03	



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● B-8	20.0	SANDY SILT(ML)	NP	NP	NP		
⊠ B-8	30.0	SILTY SAND(SM)	NP	NP	NP		
▲ B-8	37.0	SANDY SILT(ML)	NP	NP	NP		
★ B-8	41.0	SILTY SAND(SM)	NP	NP	NP		
⊙ B-8	50.0	SILTY SAND with GRAVEL(SM)	NP	NP	NP	0.90	438.88

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-8	20.0	25	0.183			8.2	40.4	51.3	
⊠ B-8	30.0	25	0.202			5.8	45.0	49.3	
▲ B-8	37.0	9.5	0.125			1.3	47.5	51.2	
★ B-8	41.0	25	0.53			12.0	53.0	35.0	
⊙ B-8	50.0	25	1.007	0.046	0.002	15.2	52.2	19.2	13.4

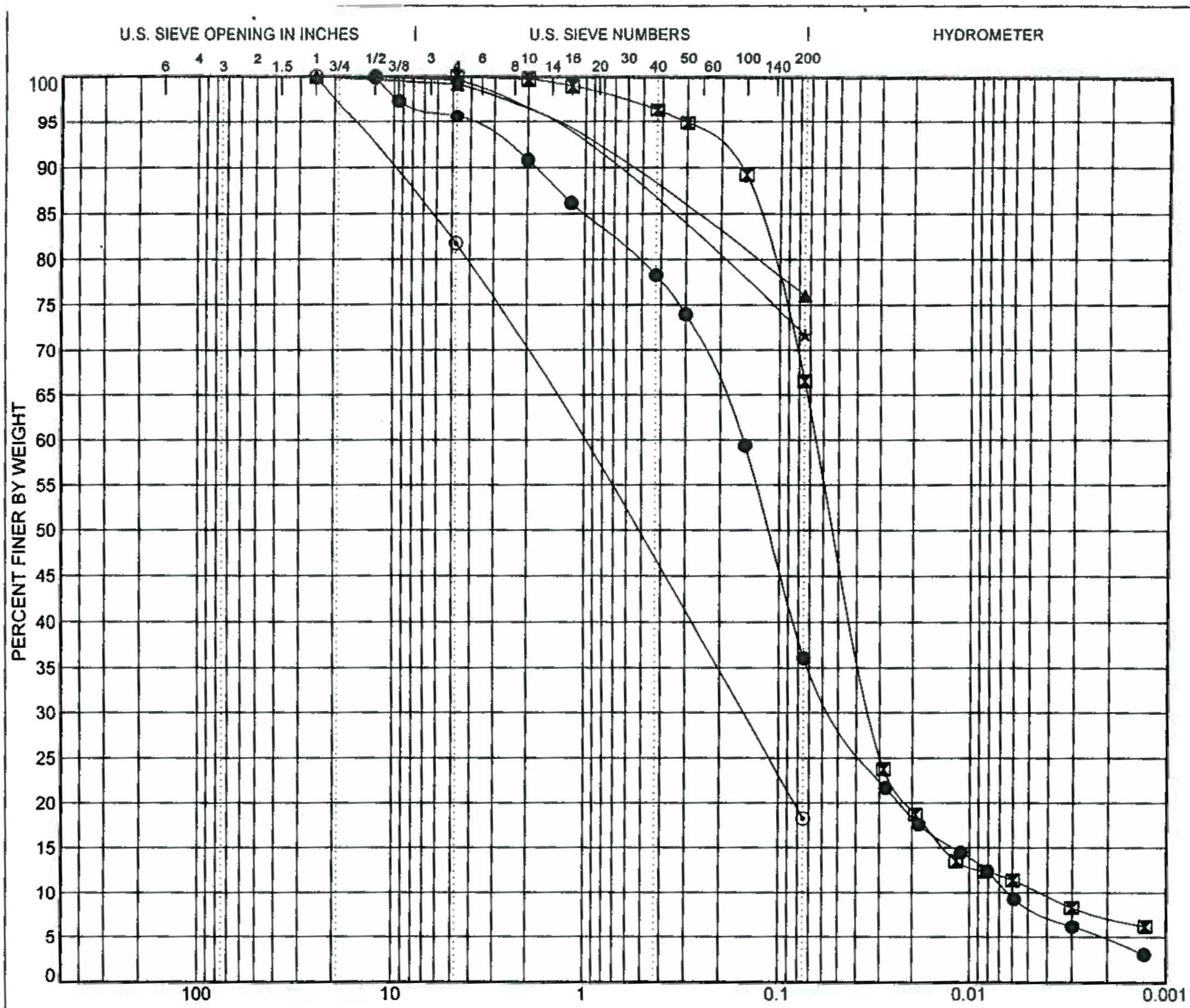
Grain Size Distribution

FIGURE

MACTEC

Currant Creek Power Plant
Mona, Juab County, UT

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
	4400032006		10/03	



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B- 8	60.0	SILTY SAND(SM)	NP	NP	NP	2.49	24.34
⊠	B- 8	70.0	SANDY SILT(ML)	NP	NP	NP	3.81	14.72
▲	B- 8	80.0	SILT with SAND(ML)	NP	NP	NP		
★	B- 8	110.0	SILT with SAND(ML)	NP	NP	NP		
⊙	B- 8	120.0	SILTY SAND with GRAVEL(SM)	NP	NP	NP		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B- 8	60.0	12.5	0.154	0.049	0.006	4.3	59.6	27.6	8.5
⊠	B- 8	70.0	4.75	0.065	0.033	0.004	0.0	33.5	56.0	10.6
▲	B- 8	80.0	25				0.8	23.3	76.0	
★	B- 8	110.0	25				0.3	28.0	71.7	
⊙	B- 8	120.0	25	1.147	0.162		18.3	63.5	18.3	

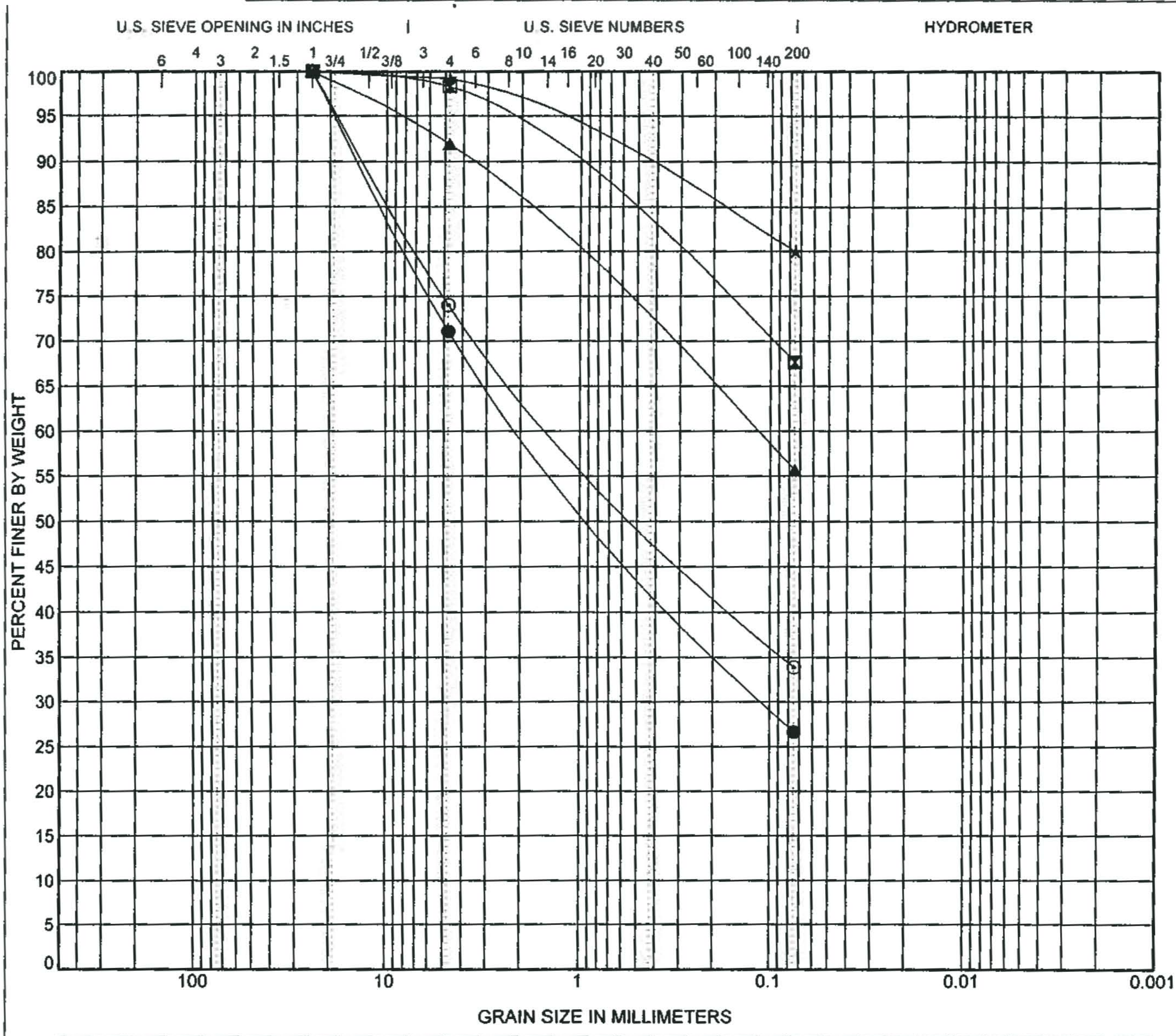
Grain Size Distribution

FIGURE

MACTEC

Currant Creek Power Plant
Mona, Juab County, UT

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
	4400032006		10/03	



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● B- 8	130.0	SILTY SAND with GRAVEL(SM)	NP	NP	NP		
⊠ B- 8	140.0	SANDY SILT(ML)	NP	NP	NP		
▲ B- 8	150.0	SANDY SILT(ML)	NP	NP	NP		
★ B- 8	160.0	SILT with SAND(ML)	NP	NP	NP		
⊙ B- 8	170.0	SILTY SAND with GRAVEL(SM)	NP	NP	NP		

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B- 8	130.0	25	1.684	0.102		28.9	44.5	26.7	
⊠ B- 8	140.0	25				1.7	30.6	67.6	
▲ B- 8	150.0	25	0.123			8.0	36.3	55.7	
★ B- 8	160.0	25				0.8	19.2	80.0	
⊙ B- 8	170.0	25	1.115			26.0	40.1	33.9	

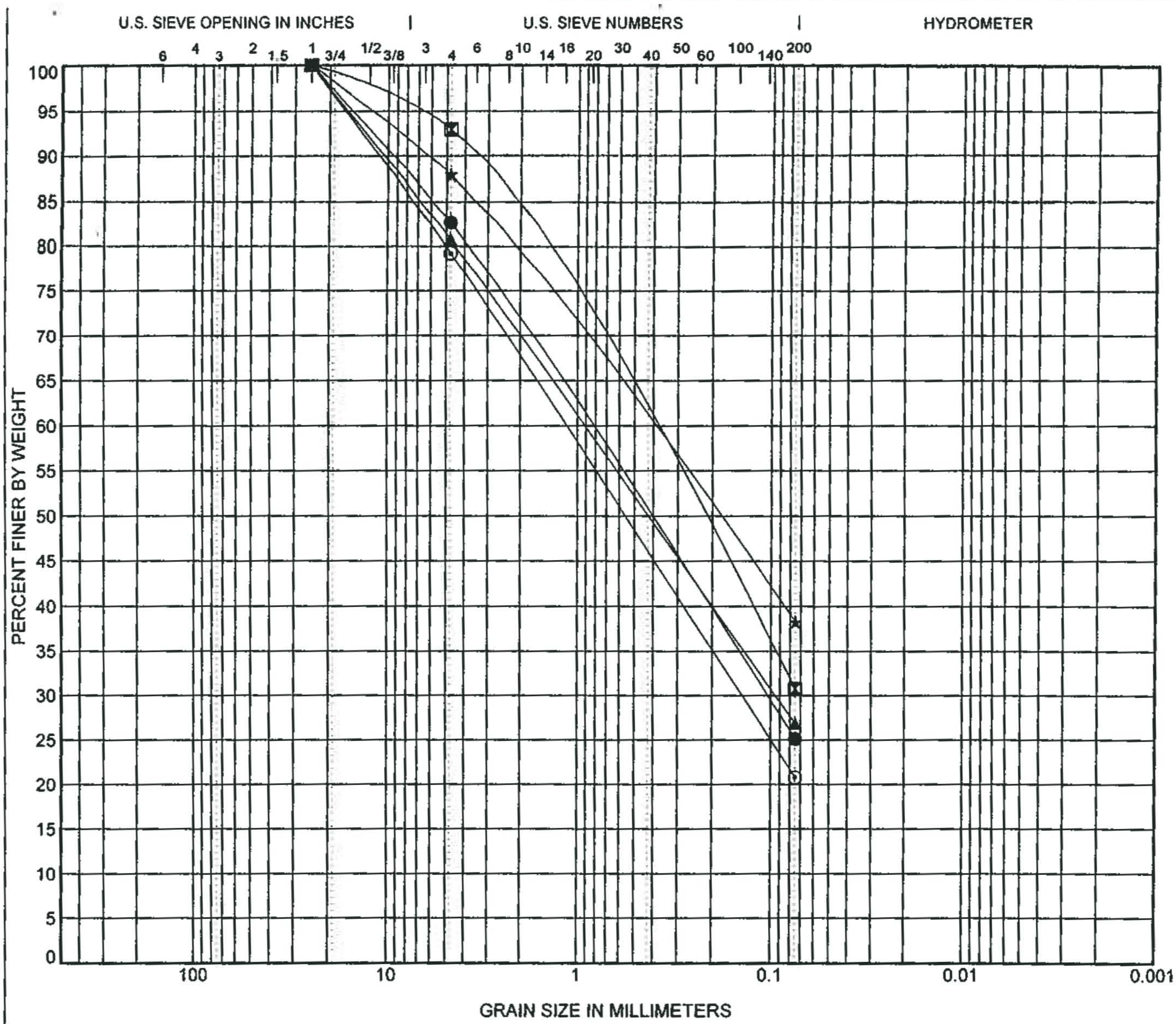
Grain Size Distribution

FIGURE

MACTEC

Currant Creek Power Plant
Mona, Juab County, UT

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
	4400032006		10/03	



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	B- 8	180.0	SILTY SAND with GRAVEL(SM)	NP	NP	NP		
⊠	B- 8	190.0	SILTY SAND(SM)	NP	NP	NP		
▲	B- 8	200.0	SILTY SAND with GRAVEL(SM)	NP	NP	NP		
★	B-10	25.0	SILTY SAND(SM)	NP	NP	NP		
⊙	B-10	35.0	SILTY SAND with GRAVEL(SM)	NP	NP	NP		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B- 8	180.0	25	0.931	0.107		17.4	57.4	25.1	
⊠	B- 8	190.0	25	0.526			7.0	62.2	30.8	
▲	B- 8	200.0	25	0.965	0.096		19.3	53.9	26.8	
★	B-10	25.0	25	0.462			12.2	49.5	38.3	
⊙	B-10	35.0	25	1.209	0.144		20.7	58.5	20.8	

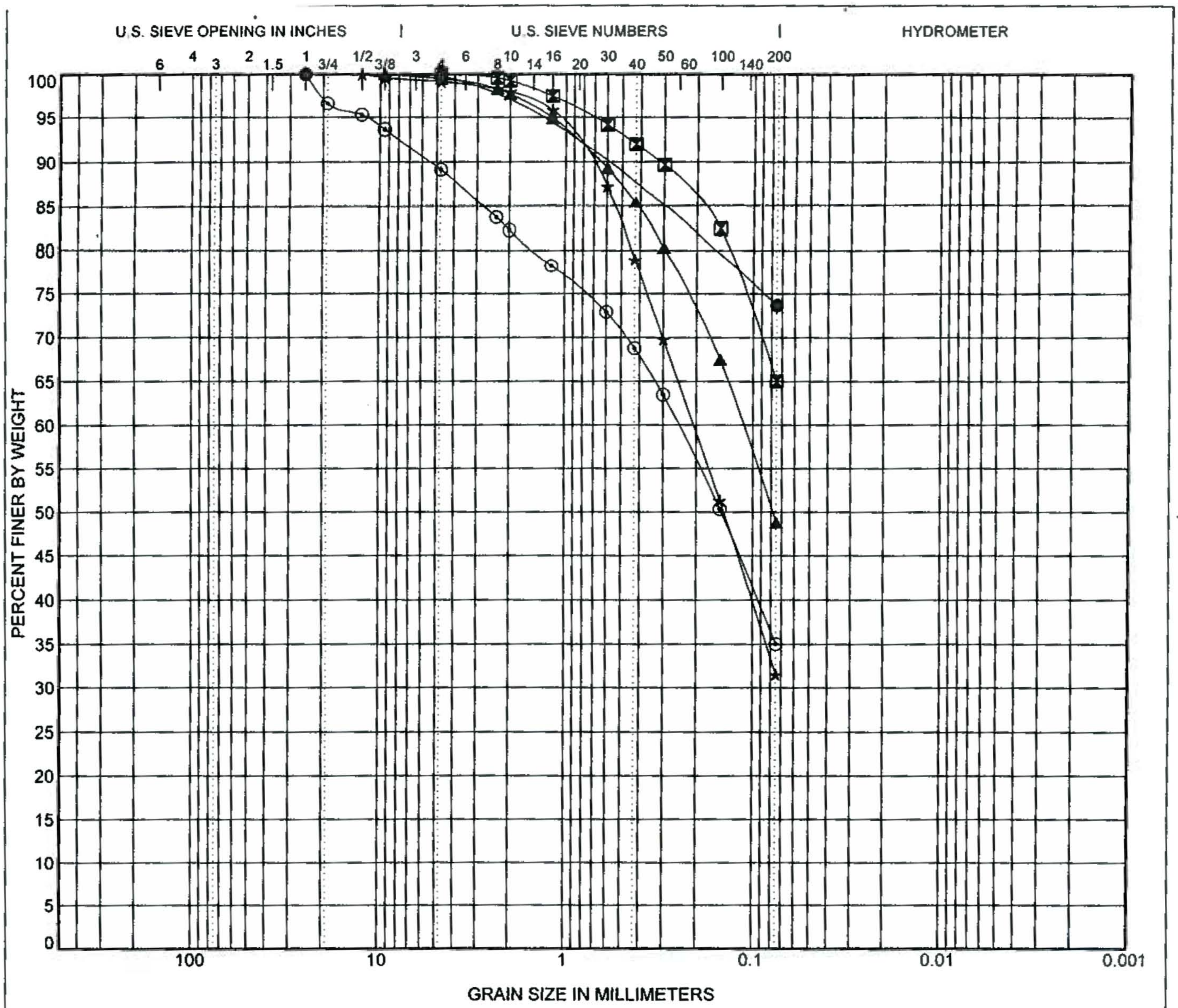
Grain Size Distribution

FIGURE

MACTEC

Currant Creek Power Plant
Mona, Juab County, UT

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
	4400032006		10/03	



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-11	5.0	SILT with SAND(ML)	NP	NP	NP		
⊠	B-12	5.0	SANDY SILT(ML)	NP	NP	NP		
▲	B-12	15.0	SILTY SAND(SM)	NP	NP	NP		
★	B-14	25.0	SILTY SAND(SM)	NP	NP	NP		
⊙	B-15	5.0	SILTY SAND(SM)	NP	NP	NP		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-11	5.0	25				0.2	26.1	73.7	
⊠	B-12	5.0	4.75				0.0	35.0	65.0	
▲	B-12	15.0	9.5	0.114			0.5	50.6	48.8	
★	B-14	25.0	12.5	0.208			0.8	67.6	31.5	
⊙	B-15	5.0	25	0.249			10.9	54.1	35.0	

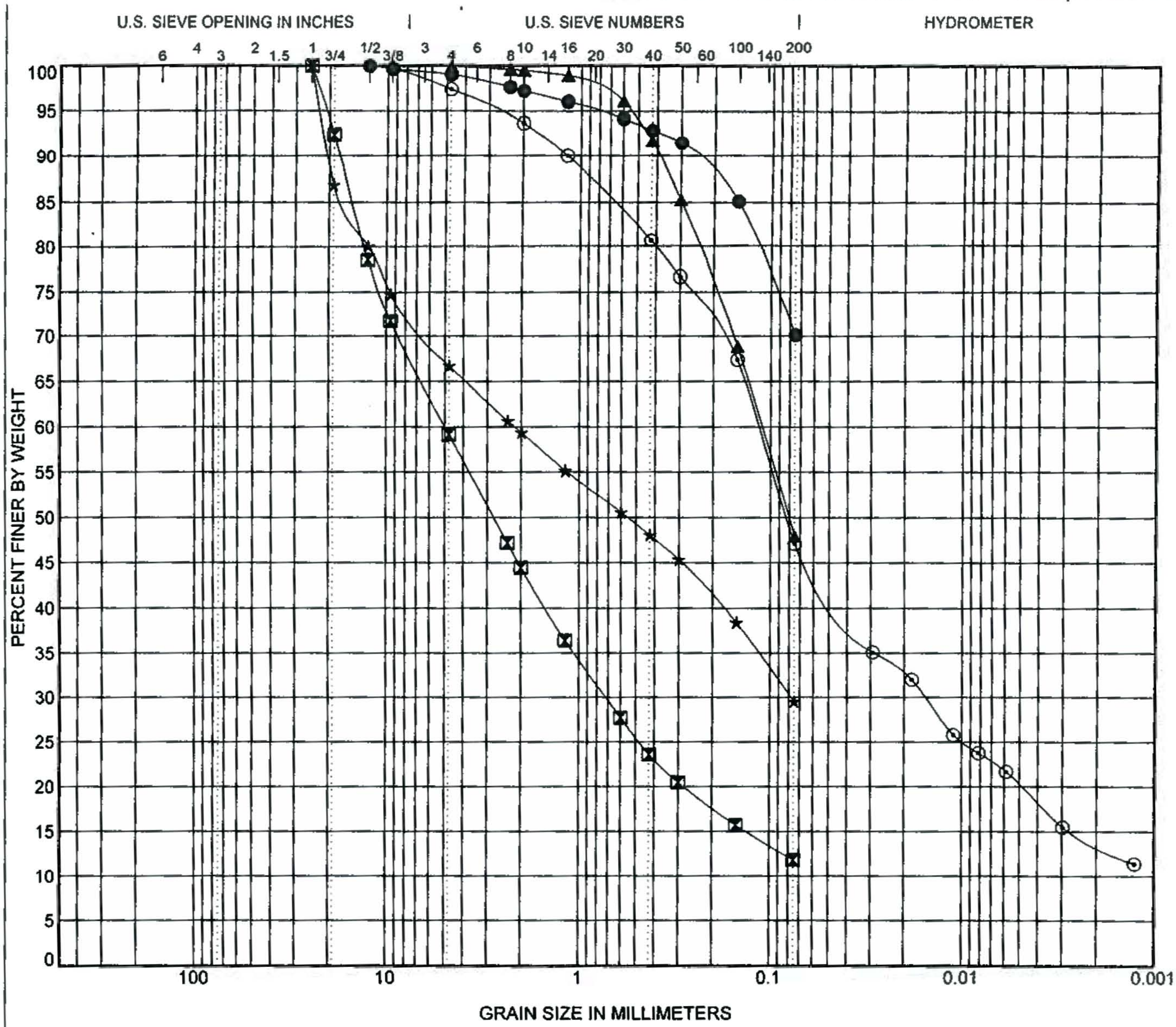
Grain Size Distribution

FIGURE

MACTEC

Currant Creek Power Plant
Mona, Juab County, UT

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
	4400032006		10/03	



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-17	5.0	SILT with SAND(ML)	NP	NP	NP		
⊠	B-17	10.0	WELL-GRADED SAND with SILT and GRAVEL(SW-SM)	NP	NP	NP	1.90	91.61
▲	B-18	10.0	SILTY SAND(SM)	NP	NP	NP		
★	B-18	15.0	SILTY SAND with GRAVEL(SM)	NP	NP	NP		
⊙	B-23	132.0	SILTY SAND(SM)	NP	NP	NP		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-17	5.0	12.5				1.0	28.9	70.1	
⊠	B-17	10.0	25	4.98	0.717		40.9	47.3	11.8	
▲	B-18	10.0	9.5	0.112			0.1	52.0	48.0	
★	B-18	15.0	25	2.163	0.078		33.3	37.2	29.5	
⊙	B-23	132.0	12.5	0.117	0.016		2.6	50.3	26.9	20.2

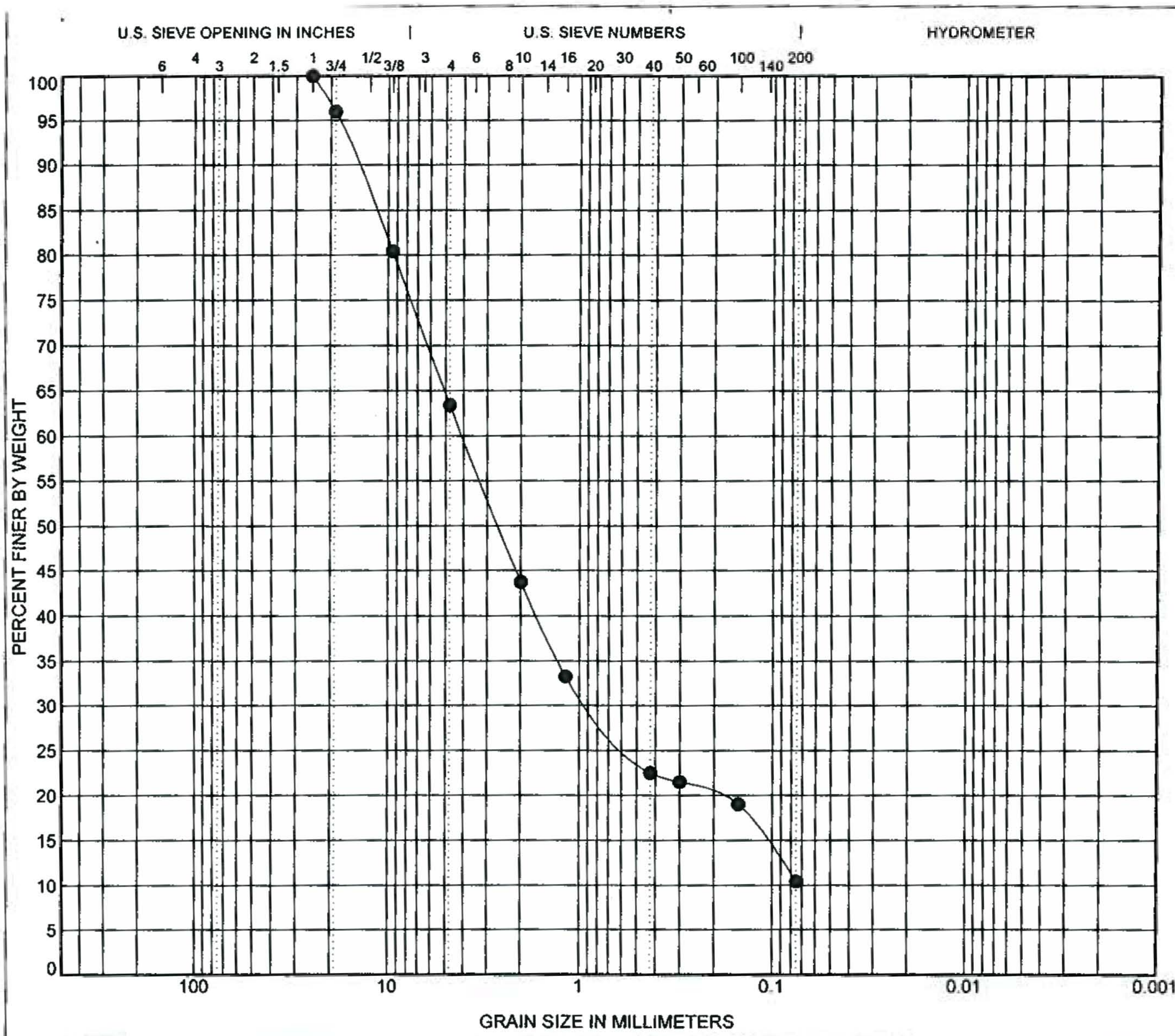
Grain Size Distribution

FIGURE

MACTEC

Monitoring Well
Currant Creek Power Plant
Mona, Juab County, UT

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
	4400032006		10/03	



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● B-23	142.0	WELL-GRADED SAND with SILT and GRAVEL(SW-SM)	NP	NP	NP	2.52	56.49

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-23	142.0	25	4.084	0.863		36.6	53.0	10.5	

Grain Size Distribution

FIGURE

MACTEC

Monitoring Well
Currant Creek Power Plant
Mona, Juab County, UT

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
	4400032006		10/03	

Atlas Consultants, Inc.

6000 S. Eastern Avenue, Suite 10J • Las Vegas, Nevada 89119
(702) 383-1199 • Fax (702) 383-4983

member of
AMERICAN SOCIETY FOR
TESTING MATERIALS

ACT LAB NO: 11781(b) **DATE:** August 21, 2003

PROJECT NO: 32006 **P.O.:**

ANALYZED BY: Robert L. Summers **LAB ID:** 5053

CURRENT CREEK POWER PLANT

REPORT OF DETERMINATION

AWWA 2540 C

SOIL SIEVE SIZE = -10

Sample No.	Location	Depth (feet)	Solubility (Percent)
	DH-8	20.0	0.11

LABORATORY MANAGER

Atlas Consultants, Inc.

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(702) 383-1199 • Fax (702) 383-4983

member of
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TESTING MATERIALS

ACT LAB NO:	11781(c)	**DATE:**	August 21, 2003
MARKED:	32006	**P.O.:**	
ANALYZED BY:	Robert L. Summers	**LAB ID:**	5053

CURRENT CREEK POWER PLANT

REPORT OF DETERMINATION

AWWA 4500 E

SOIL SIEVE SIZE = -10 MESH

Sample No.	Location	Depth (Feet)	Water Soluble Sulfate (SO_4) in soil Percent By Weight
	DH-8	10.0-11.5	0.03

Robert L. Summers

LABORATORY MANAGER

Notes: The results for each constituent denote the percentage of that analyte, at a 1:5 (soil:water) extraction ratio, which is present in the soil.

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TESTING MATERIALS

LABORATORY NO: 11832(c) **DATE:** September 22, 2003

SAMPLE: Soil **P.O.:**

MARKED: 4400032006 **CURRENT CREEK POWER PLANT**

LABORATORY NO: 5059

SUBMITTED BY: MACTEC, Inc.

REPORT OF DETERMINATION

AWWA 4500 H, ASTM D 1498, AWWA 4500 E

LOCATION	DEPTH (Feet)	Ph VALUE	RED-OX (MV)	SULFATE (%)
DH-1	0-5	9.25	+624	0.05
DH-2	0-5	8.88	+622	0.05
DH-3	0-5	8.77	+618	0.04

Respectfully submitted,

Robert L. Summers
Robert L. Summers
Analytical Chemist

APPENDIX B

WELL DRILLER'S REPORT
BORING B-25

WELL DRILLER'S REPORT

State of Utah
Division of Water Rights
For additional space, use "Additional Well Data Form" and attach

Well Identification MONITOR WELL: 03-53-001-M-01

Owner *Note any changes*

PACIFICORP
201 SOUTH MAIN 22ND FLOOR
SALT LAKE CITY, UT 84111

Contact Person/Engineer: R.B. & G. Engineering
Provo, UT – Brad Price

Well Location *Note any changes*

SOUTH 1439 feet EAST 1415 feet from the W4 Corner of
SECTION 25, TOWNSHIP 11S, RANGE 1W, SLB&M.

Location Description: (address, proximity to buildings, landmarks, ground elevation, local well #) Near Mona, Utah

Drillers Activity Start Date: 8/2/03 Completion Date: 8/26/03

Check all that apply: ☑ New ☐ Repair ☐ Deepen ☐ Clean ☐ Replace ☐ Public Nature of Use:

If a replacement well, provide the location of the new well. _____ feet north/south and _____ feet east/west of the existing well.

DEPTH (feet) FROM	TO	BOREHOLE DIAMETER (in)	DRILLING METHOD	DRILLING FLUID
0	185	8	Air Rotary	NONE

Well Log

DEPTH (feet) FROM	TO	WATER	PERMEABLE high	PERMEABLE low	UNCONSOLIDATED CLAY	SILT	SAND	GRAVEL	COBBLES	BOULDER	OTHER	CONSOLIDATED ROCK TYPE	COLOR	DESCRIPTIONS AND REMARKS (e.g., relative %, grain size, sorting, angularity, bedding, grain composition, density, plasticity, shape, cementation, consistancy, water bearing, odor, fracturing, minerology, texture, degree of weathering, hardness, water quality, etc.)
0	5					X						Dust	Brown	
5	12					X		X				Dust	Brown	
12	22					X		X					Grey	Rock Chips
22	32					X		X					Brown/Grey	Rock Chips
32	42					X		X					Grey/Brown	Very fine silt
42	52					X		X						Brown soil with some gravel
52	62							X					Grey	mostly gravel, sandy
62	72					X		X						Brown silt, gravel
72	82					X		X						Brown silt, very little gravel
82	92					X		X						Brown silt, gravel, rock chip

Static Water Level

Date 8/26/03 Water Level 119 feet Flowing? ☐ Yes ☒ No See Att.

Method of Water Level Measurement Indicator If Flowing, Capped Pressure Ø PSI

Point to Which Water Level Measurement was Referenced Ground level Ground Elevation (If known) _____

Height of Water Level reference point above ground surface Ø feet Temperature _____ ☐ °C ☐ °F

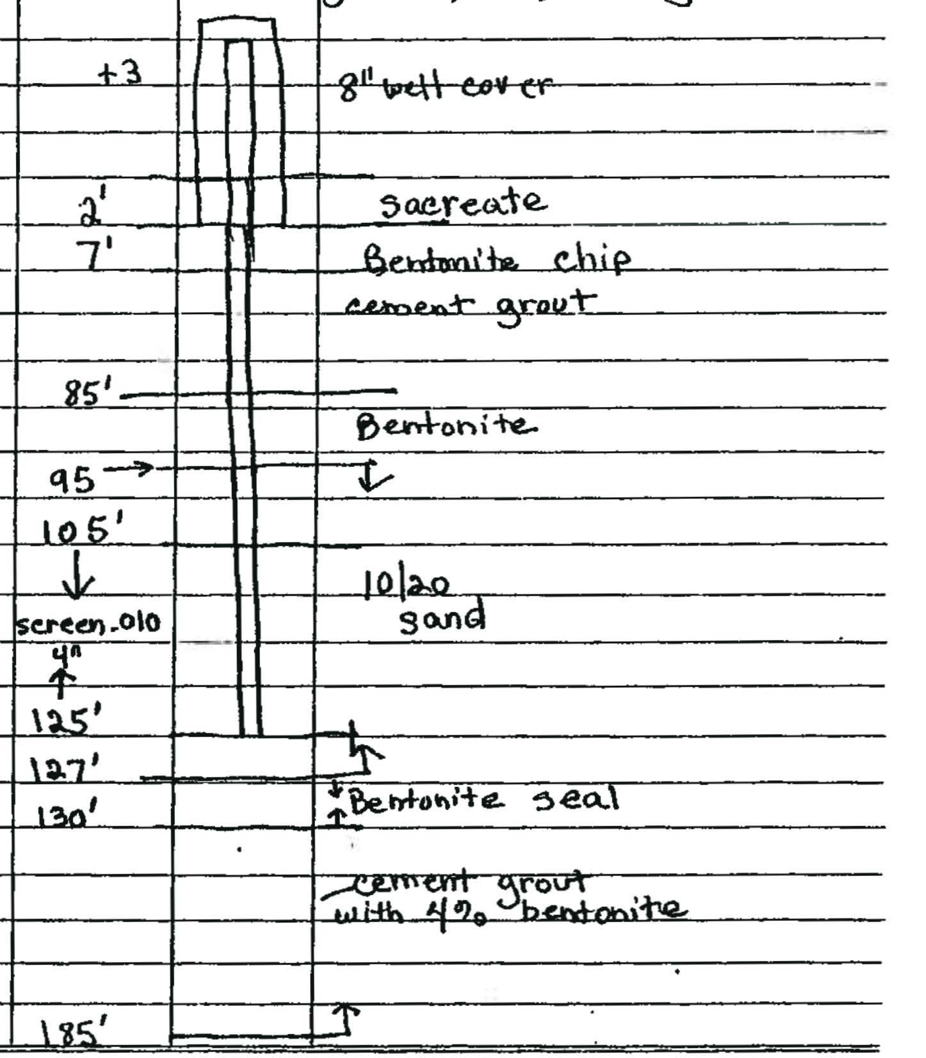
ADDITIONAL WELL DATA FORM

Water Right # 03-53-001-m-01

OWNER NAME Pacific Corp.

Well Log

DEPTH (feet) FROM	TO	WATER	PERMEABLE high	PERMEABLE low	UNCONSOLIDATED CLAY	SILT	SAND	GRAVEL	COBBLES	BOULDER	OTHER	CONSOLIDATED ROCK TYPE	COLOR	DESCRIPTIONS AND REMARKS (e.g. relative %, grain size, sorting, angularity, bedding, grain composistion, density, plasticity, shape, cementation, consistancy, water bearing, odor, fracturing, minerology, texture, degree of weathering, hardness, water quality, etc.)
92	102					X		X					Brown	Silt-gravel
102	112					X	X	X						Brown silt, black sand, gravel
112	122					X		X						Brown silt, silt is moist, gravel
122	132	X				X		X						Cuttings very muddy, gravel, brown si
132	142	X				X								Brown silt, muddy
142	152	X				X								Brown silt, muddy
152	162	X				X		X						muddy, gravel, black rock chips
162	172	X				X		X						gravel, silt, muddy
172	182	X				X		X						gravel, silt, muddy



Construction Information

DEPTH (feet)		CASING			DEPTH (feet)		☒ SCREEN ☐ PERFORATIONS ☐ OPEN BOTTOM		
FROM	TO	CASING TYPE AND MATERIAL/GRADE	WALL THICK (in)	NOMINAL DIAM. (in)	FROM	TO	SCREEN SLOT SIZE OR PERF SIZE (in)	SCREEN DIAM. OR PERF LENGTH (in)	SCREEN TYPE OR NUMBER PERF (per round/interval)
+3	105	P.V.C	Sch 40	4"	105	125	.010	4"	Sch 40 PVC

Well Head Configuration: Above Ground locking Cover Access Port Provided? ☒ Yes ☐ No

Casing Joint Type: Flush Thread Perforator Used: N/A. Slot by factory

Was a Surface Seal installed? ☒ Yes ☐ No Depth of Surface Seal: 85 feet Drive Shoe? ☐ Yes ☒ No

Surface Seal Material Placement Method: Tremmie

Provide Seal Material description below:

DEPTH (feet)		SURFACE SEAL / INTERVAL SEAL / FILTER PACK / PACKER INFORMATION		
FROM	TO	SEAL MATERIAL, FILTER PACK and PACKER TYPE and DESCRIPTION	Quantity of Material Used (if applicable)	GROUT DENSITY (lbs./gal., # bag mix, gal./sack etc.)
0	2	Sackrete \ Concrete	300 lbs	6 sks @ 50 lbs
2	7	Bentonite chips	400 lbs	8 bags x 50 lbs
7	85	Cement Grout with 4% bentonite	13 sks with 4% bentonite	1:1 mix - 7.9 gal water per (3 parts)
85	95	Bentonite Pellets	150 lbs	
95	127	10/20 Sand	2000 lbs	(40 sks x 50 lbs)
127	182	Cement Grout with 4% bentonite	14 sacks Cement w/ 4% benton	- 1:1 mix 9½ gallons per sk

Well Development and Well Yield Test Information

Date	Method	Yield	Units Check One: GPM	CFS	DRAWDOWN (ft)	TIME PUMPED (hrs & min)
not	completed					

Pump (Permanent)

Pump Description: None Installed Horsepower:________ Pump Intake Depth:________ feet

Approximate maximum pumping rate:____________ Well disinfected upon completion? ☐ Yes ☐ No

Comments

Description of construction activity, additional materials used, problems encountered, extraordinary circumstances, abandonment procedures. *Use additional well data form for more space.*

Well Driller Statement

This well was drilled and constructed under my supervision, according to applicable rules and regulations, and this report is complete and correct to the best of my knowledge and belief.

Name F.E.C. Inc License No. 756
(Person, Firm, or Corporation – Print or Type)

Signature Dean Walton Date 8/29/03
(Licensed Well Driller)

DRILLER'S LOG

JOB ____________________ HOLE NO. ____________________

DRILLERS ____________________ Water MACHINE NO. ____________________

DATE	SHIFT	DRILLER	RODS IN HOLE	STICK UP	DEPTH	LENGTH OF RUN	CORE	ROCK	BIT NO.	MATERIALS USED: MUD	CEMENT	OTHER
		0-5	Dust									
		5-12	dust, Gravel									
1	X	12-22'	gravel, Rock Chips, Soil - Grey color									
2		22-32'	gravel, Rock Chips, Brown & Grey soil									
3		32'-42'	gravel, Grey soil to Brown soil very fine									
4		42'-52'	Fine Brown Dirt w/ some Gravel									
5		52'-62'	mostly gravel, Sandy soil - Grey color									
6		62'-72'	Brown Silty Soil - Gravel									
7		72'-82'	Brown Silty Soil - very little Gravel									
8		82-92'	Brown Silty Soil - Gravel, Rock Chips									
9 core		92-102	Brown Silt - Gravel									(~~[illegible]~~)
10		102-112	Brown Silt - Black Sand - Gravel									112-122
11	no reading	112-122 ~~110-120~~	Brown silt - Gravel - Hole caved 8' when added this rod									mostly silt, Gravel
12	W	122-132 ~~120-130~~	cutting very muddy water Brown sandy material - Black sandy material - Some Gravel									
	W	132-142 ~~130-140~~	~~no cuttings~~ Brown silty goop + Cuttings very muddy									
		142-152 ~~140-150~~	Brown silty muck									
W	water	152-162'	muddy - gravel 153 to 162' Black Rock Chips									
	W	162'-172'	gravel, Silty wet cuttings, - Black Rock Chips,									
		172'-182'	gravel, Silty, very wet cuttings, Black Rock Chips,									

APPENDIX C

BORING LOGS
FROM
PREVIOUS INVESTIGATION
PROVIDED BY
SHAW STONE AND WEBSTER

STONE & WEBSTER ENGINEERING CORP.	LOG OF BORING CCPP-SB-01 (Page 1 of 1)
PACIFICORP. CURRANT CREEK POWER PROJECT Mona, Utah Project # 59321	Drilling Contractor : Bedke Drilling; Drill Rig Type : CME 75; Coordinates : UTM; North : 4408819; East : 422997; Surface Elevation : 5118 ft-amsl; Date Started : 5/23/03; Date Ended : 5/23/03; Total Depth (ft-bgs) : 31.5; Water Level (ft-bgs) : not encountered

Depth in FT	USCS	GRAPHIC	DESCRIPTION	Blow Count	% Recovery	REMARKS
0	ML		Silt, sandy w/ cobbles and rocks. Brownish grey, dry			
			Recovery from auger returns only. Cobble a: ~2.0 feet			Cobbles @ 2ft
5	ML		Silt, w/ trace fine sand. Dense, dry, brown	13 34 23	60	
	SM/GM		Sand, silty w/gravel and rock fragments. Fine to medium, poorly sorted, angular, v. dense, dry, grey			
			No recovery			
10	SM/GM		Sand, same as above	6 22 20	75	Cobbles generally continuous from 2 feet; extreme auger chatter
			No recovery			
15	SM/GM		Sand, same as above	8 12 13	15	Still in cobbles
			No recovery			
20	SM/GM		Sand, same as above	5 8 8	40	Out of cobble zone at approximately 20 ft-bgs
	ML		Silt, w/trace fine sand and some rock fragments. Med. dense, dry, brownish grey			
			No recovery			
25			Sample not collected at 25 ft-bgs			
30	SM		Sand, silty w/gravel and rock fragments. Fine to medium, poorly sorted, angular, dense, dry, brownish grey	12 15 23	60	
35						

Notes: 4.25 ID x 6.5 OD HSA w/center bit.
2"x18" split spoon w/ sand trap
140# x 30" drop hammer
Spoon samples collected at 5 foot intervals

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STONE & WEBSTER ENGINEERING CORP.	LOG OF BORING CCPP-SB-04 (Page 1 of 2)

PACIFICORP.
CURRANT CREEK POWER PROJECT
Mona, Utah
Project # 59321

Drilling Contractor	Bedke Drilling	Surface Elevation	: 5059 ft-amsl
Drill Rig Type	: CME 75	Date Started	: 5/21/03
Coordinates	: UTM	Date Ended	: 5/22/03
North	: 4408488	Total Depth (ft-bgs)	: 56.5
East	: 423508	Water Level (ft-bgs)	: not encountered

Depth in FT	USCS	GRAPHIC	DESCRIPTION	Blow Count	% Recovery	REMARKS
0	ML		Surface soil. Silt, sandy with rocks, dry, brownish grey. Recovery from auger returns only.			
			No recovery			
	SM		Sand, silty. V. fine, poorly sorted, angular, dense, dry, grey w/some small rock fragments.	8 16 21	50	
5			No recovery			
	SM		Sand, silty. Same as above but medium dense	5 [illegible] 8	40	
			No recovery			
10	SM		Sand, same as above but loose	5 4 5	60	
			No recovery			
15	SM		Sand, same as above.	8 23 49	90	Many large rock fragments (not gravel) at 15.5 ft-bgs
			No recovery			Difficult drilling from 16-20 ft-bgs
20	SM/GM		Sand, silty w/gravel or rock fragments. Fine to medium, poorly sorted, angular, v. dense, dry, greyish brown	34 55 50 for 5 inches	60	
			No recovery			
25	SM/GM		Sand, silty w/gravel. Same as above	11 12 22	90	
	SM		Sand, silty. V. fine, poorly sorted, angular, dense, slightly moist, brownish grey			
	SM/GM		Returning to Sand, silty w/gravel as at 25 ft-bgs			
			No recovery			
30						

Notes: 4.25 ID x 6.5 OD HSA w/center bit.
2"x18" split spoon w/ sand trap
140# x 30" drop hammer
Spoon samples collected at 5 foot intervals

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STONE & WEBSTER
ENGINEERING CORP.

LOG OF BORING CCPP-SB-04

PACIFICORP.
CURRANT CREEK POWER PROJECT
Mona, Utah
Project # 59321

Drilling Contractor	: Bedke Drilling	Surface Elevation	: 5059 ft-amsl
Drill Rig Type	: CME 75	Date Started	: 5/21/03
Coordinates	: UTM	Date Ended	: 5/22/03
North	: 4408488	Total Depth (ft-bgs)	: 56.5
East	: 423508	Water Level (ft-bgs)	: not encountered

Depth in FT	USCS	GRAPHIC	DESCRIPTION	Blow Count	% Recovery	REMARKS
30	SM/GM		Sand, silty w/gravel or rock fragments. Fine to medium, poorly sorted, angular, v. dense, dry, greyish brown	33 33 27	50	
			No recovery			
35	SM/GM		Sand, silty w/gravel as above for approximately 6 inches	11	100	
	ML		Silt, sandy. Medium dense, slightly moist, brownish grey. No gravel	7 9		
			No recovery			
40	SM		Sand, silty w/gravel or rock fragments. Medium, poorly sorted, angular, v. dense, dry, grey	28 47 44	70	
			No recovery			
45	ML		Silt, w/minor fine sand. Medium dense, slightly moist, brown. Some rock fragments	26 13 15	80	Some rock fragments at approximately 46 ft-bgs
			No recovery			
50	ML		Silt, same as above but no rock fragments	7 6 12	60	
			No recovery			
55	ML		Silt, same as above	9 8	100	Dropped 25 foot of drill rod w/spoon down hole. Fell approximately 30 ft and penentrated 1 foot Total depth @ 56.5 ft-bgs
60						

Notes: 4.25 ID x 6.5 OD HSA w/center bit.
2"x18" split spoon w/ sand trap
140# x 30" drop hammer
Spoon samples collected at 5 foot intervals

STONE & WEBSTER ENGINEERING CORP.	LOG OF BORING CCPP-SB-05 (Page 1 of 2)

PACIFICORP. CURRANT CREEK POWER PROJECT Mona, Utah Project # 59321				
	Drilling Contractor	: Bedke Drilling	Surface Elevation	: 5092 ft-amsl
	Drill Rig Type	: CME 75	Date Started	: 5/22/03
	Coordinates	: UTM	Date Ended	: 5/23/03
	North	: 4408385	Total Depth (ft-bgs)	: 23
	East	: 423302	Water Level (ft-bgs)	: not encountered

Depth in FT	USCS	GRAPHIC	DESCRIPTION	Blow Count	% Recovery	REMARKS
0	ML		Surface soil. Silt, sandy with rocks, dry, brownish grey. Recovery from auger returns only.			
			No recovery			
5	ML		Silt. Dense, dry, grey. No sand or rock fragments	17 18 18	40	
			No recovery			
10	ML		Silt. Same as above but medium dense with occasional rock fragments and traces of sand	7 7 9	40	
			No recovery			
15						

Notes: 4.25 ID x 6.5 OD HSA w/center bit.
2"x18" split spoon w/ sand trap
140# x 30" drop hammer
Spoon samples collected at 5 foot intervals

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STONE & WEBSTER ENGINEERING CORP.	LOG OF BORING CCPP-SB-05 (Page 2 of 2)

PACIFICORP. CURRANT CREEK POWER PROJECT Mona, Utah Project # 59321				
	Drilling Contractor	: Bedke Drilling	Surface Elevation	: 5092 ft-amsl
	Drill Rig Type	: CME 75	Date Started	: 5/22/03
	Coordinates	: UTM	Date Ended	: 5/23/03
	North	: 4408385	Total Depth (ft-bgs)	: 23
	East	: 423302	Water Level (ft-bgs)	: not encountered

Depth in FT	USCS	GRAPHIC	DESCRIPTION	Blow Count	% Recovery	REMARKS
15	ML		Silt, same as above for approximately 2 inches (probably slough). Poor recovery due to rock fragment plugging spoon.	27 39 42	25	
			No recovery			Drilling through rock or cobbles (auger chatter)
20	ML		Silt, gravelly w/traces of fine sand.	15		Still in rock or cobbles
			Heavy rock or cobbles (not gravel) at approximately 20.3 ft-bgs. Probably pounding through cobbles.	27 23	60	
			No recovery			
	SM/GM		Auger refusal @ 23 ft-bgs in cobbles.			Moved rig approximately 10 feet east and attempted to resume drilling. Auger refusal in cobbles at approximately 17 ft-bgs
25						
30						

Notes: 4.25 ID x 6.5 OD HSA w/center bit
2"x18" split spoon w/ sand trap
140# x 30" drop hammer
Spoon samples collected at 5 foot intervals

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STONE & WEBSTER ENGINEERING CORP.	LOG OF BORING CCPP-SB-07
	(Page 1 of 2)

PACIFICORP. CURRANT CREEK POWER PROJECT Mona, Utah Project # 59321	Drilling Contractor Drill Rig Type Coordinates North East	: Bedke Drilling : CME 75 : UTM : 4408283 : 423499	Surface Elevation : 5063 ft-amsl Date Started : 5/20/03 Date Ended : 5/20/03 Total Depth (ft-bgs) : 51.5 Water Level (ft-bgs) : not encountered

Depth In FT	USCS	GRAPHIC	DESCRIPTION	Blow Count	% Rec-overy	REMARKS
0	ML		Surface soil. Silt, sandy with rocks and cobbles, dry, brownish grey. Recovery from auger returns only.			
			No recovery			
	ML		Silt w/trace fine sand. Loose, dry, greyish brown	4 [illegible] 5	30	
			No recovery			
5	ML		Silt. Same as above but dense. Color to grey with occasional rock fragments	17 [illegible] 15	30	
			No recovery			
10	ML		Silt, same as above.	[illegible]	10	Occasional cobble or rock causing poor recovery
			No recovery			
15	ML		Silt, same as above	20 13 20	40	
			No recovery			
20	ML		Silt, same as above but medium dense	na	na	Slough in spoon?
			Auger refusal @ 23 ft-bgs in cobbles.			Ocassional cobble or rock fragments during drilling or in spoon
25	SM		Sand, silty. V.fine, poorly sorted, angular, loose, dry, greyish brown	3 3 4	70	
			No recovery			
30						

Notes: 4.25 ID x 6.5 OD HSA w/center bit.
2"x18" split spoon w/ sand trap
140# x 30" drop hammer
Spoon samples collected at 5 foot intervals

STONE & WEBSTER ENGINEERING CORP.	LOG OF BORING CCPP-SB-07 (Page 2 of 2)

PACIFICORP. CURRANT CREEK POWER PROJECT Mona, Utah Project # 59321				
	Drilling Contractor: Bedke Drilling		Surface Elevation: 5063 ft-amsl	
	Drill Rig Type: CME 75		Date Started: 5/20/03	
	Coordinates: UTM		Date Ended: 5/20/03	
	North: 4408283		Total Depth (ft-bgs): 51.5	
	East: 423499		Water Level (ft-bgs): not encountered	

Depth in FT	USCS	GRAPHIC	DESCRIPTION	Blow Count	% Recovery	REMARKS
30	SM		Sand, same as above but medium dense. More rock fragments	[illegible]	30	
			No recovery			Auger refusal at 33 ft-bgs in grey/black crystalline rock. Drove spoon to knock rock out of the way.
35	SM		Sand, same as above but slightly moist	45 16 14	70	
			No recovery			
40	SM		Sand, same as above grading to:	12 [illegible] 17	50	gravel may be rock fragments from hammering but appear more rounded
	SM/GM		Sand, same as above with increased gravel			
			No recovery			
45	SM		Sand, silty. V fine, poorly sorted, angular, medium dense, slightly moist, brownish grey	13 14 15	60	
			No recovery			
50	SM		Sand, same as above	6 5 8	80	Ceased drilling at 50 ft-bgs and spooned from 50.0 to 51.5 ft-bgs
55						
60						

Notes: 4.25 ID x 6.5 OD HSA w/center bit
2"x18" split spoon w/ sand trap
140# x 30" drop hammer
Spoon samples collected at 5 foot intervals

STONE & WEBSTER ENGINEERING CORP.	LOG OF BORING CCPP-SB-10
	(Page 1 of 2)

PACIFICORP.
CURRANT CREEK POWER PROJECT
Mona, Utah
Project # 59321

Drilling Contractor	: Bedke Drilling	Surface Elevation	: 5012 ft-amsl
Drill Rig Type	: CME 75	Date Started	: 5/23/03
Coordinates	: UTM	Date Ended	: 5/23/03
North	: 4408055	Total Depth (ft-bgs)	: 61.5
East	: 424033	Water Level (ft-bgs)	: not encountered

Depth in FT	USCS	GRAPHIC	DESCRIPTION	Blow Count	% Recovery	REMARKS
0	ML		Surface soil. Silt w/some sand and cobbles, dry, grey. Recovery from auger returns only.			Logged from auger returns
	ML		Silt w/trace fine sand, no rocks or cobbles			Logged from auger returns
			No recovery			
			No recovery			
5	ML		Pulverized rock frags and rock flour. Little soil	[illegible]	40	Tried unsuccesfully to push Shelby Tube. Recovered approximately 8 inches. Drove spoon from 5.5 to 7.0 ft-bgs
			No recovery			
10	ML		Silt w/some sand, medium dense, dry, brown (probably slough)	[illegible]	5	Still in rocks and cobbles as described at 6.0 ft-bgs. Extreme auger chatter.
			No recovery			
15	ML		Silt, gravelly w/some sand, medium dense, dry, brownish grey	[illegible]	50	
			No recovery			
20	ML		Silt, sandy, mixed with rock fragments, v. dense, dry, brown	[illegible]	70	Still in large cobbles. Very slow drilling
			No recovery			Out of cobble layer @ approximately 23 ft-bgs
25			No recovery, rock in shoe of split spoon	22	0	
30	ML		Silt, w/some sand, medium dense, slightly moist, brownish grey	6 7 7	75	
			No recovery			Collected Shelby Tube from 32 -34 ft-bgs
35						

Notes: 4.25 ID x 6.5 OD HSA w/center bit.
2"x18" split spoon w/ sand trap
140# x 30" drop hammer
Spoon samples collected at 5 foot intervals

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STONE & WEBSTER ENGINEERING CORP.	LOG OF BORING CCPP-SB-10

PACIFICORP.
CURRANT CREEK POWER PROJECT
Mona, Utah
Project # 59321

Drilling Contractor	: Bedke Drilling	Surface Elevation	: 5012 ft-amsl
Drill Rig Type	: CME 75	Date Started	: 5/23/03
Coordinates	: UTM	Date Ended	: 5/23/03
North	: 4408055	Total Depth (ft-bgs)	: 61.5
East	: 424033	Water Level (ft-bgs)	: not encountered

Depth in FT	USCS	GRAPHIC	DESCRIPTION	Blow Count	% Rec-overy	REMARKS
35	ML		Silt, same as above for approximately 4 inches turning to:	14 26 38	75	
	SM/GM		Sand, silty w/gravel or rock fragments. Fine to medium, poorly sorted, angular, v. dense, dry, greyish white			Auger binding in hole at approximately 37 ft-bgs. Added 5 gallons of water
			No recovery			
40	ML		Silt, w/some fine sand, medium dense, slightly moist, brownish grey (moist from added water)	8 11 17	80	Added additional 5 gallons water
			No recovery			
45	ML		Silt, same as above	8 16 27	50	
			No recovery. Burned from 45 ft-bgs to 60 ft-bgs in attempt to tag tuff that underlies the unconsolidated alluvial deposits. No spoon samples collected from 45 to 60 ft-bgs. Auger returns suggest: Silt, same as above from 45 to 60 ft-bgs			
50						
55						
60	SM/GM		Sand, silty w/gravel. Fine to medium, poorly sorted, angular, v. dense, dry, varigated color (black to red clasts in greyish white soil matrix)	15 41 50	85	
			Reached total depth of 61.5 ft-bgs			
65						
70						

Notes: 4.25 ID x 6.5 OD HSA w/center bit
2"x18" split spoon w/ sand trap
140# x 30" drop hammer
Spoon samples collected at 5 foot intervals

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APPENDIX I

WATER ANALYSIS

APPENDIX I

RAW WATER ANALYSIS

	Units	Min	Max	Average
Barium	mg/L	0.051	0.057	0.053
Calcium	mg/L	53	54	53.5
Magnesium	mg/L	22	24	22.5
Silicon	mg/L			
Sodium	mg/L	5.9	7.4	6.7
Strontium	mg/L			
Conductivity	microS/CM	450	480	461.7
Turbidity	NTU	0.61	1.9	1.2
Chlorides	mg/L	7.44	8.36	7.9
Total-alkalinity	mg/L	180	190	185.0
Sulfate	mg/L	43.8	47.5	46.1
TOC	mg/L			
pH		7.68	8	7.8
TSS	mg/L	ND	8	ND
Nitrates	mg/L	0.382	0.532	0.5
TDS	mg/L	260	276	263.7
Ammonia	mg/L	ND	0.035	ND
Phosphate	mg/L			ND

ND = Not Detectable

Note: Water quality analysis taken from existing Currant Creek wells from periodic samples over the period from February 2006 through July 15, 2011.

APPENDIX J

FUEL ANALYSIS

Composition of Natural Gas by Gas Chromatography, ASTM D 1945
Questar Service @ Currant Creek Power Plant

	Mol %
Nitrogen	0.269
Carbon Dioxide	1.488
Carbon Monoxide	
Methane	92.767
Ethane	3.785
Propane	1.158
Iso-butane	0.182
N-butane	0.206
Iso-Pentane	0.056
N-Pentane	0.041
t-2-Butene	
Ethylene	
Propylene	
Hexanes Plus	0.048
Total	**100.000**

Caloric Value and Specific Gravity of Gases, ASTM D 3588

Specific Gravity at 60°F	0.609

Calculated BTU/cu. Ft. @14.696 psia and 60°F

Gross (Dry basis)	1,057.0

APPENDIX K

DATA TO BE SUBMITTED WITH CONTRACTOR’S BID

Site Conditions For Guarantee Ratings

Site location:		
Site elevation:		feet above mean sea level
Temperature:	95	deg F
Relative Humidity	20	%

Guarantee Rating Information

Combustion Turbine-Generator manufacturer:		
Combustion Turbine-Generator type/model number:		
Steam Turbine-Generator manufacturer:		
Steam Turbine-Generator type/model number:		
Steam turbine-generator nameplate capacity at given power factor:	@	MVa @ p.f.
Combustion turbine-generator nameplate capacity at given power factor:	@	MVa @ p.f.
Guaranteed net dependable capacity, full load with duct firing @ site conditions:		MW
Guaranteed net dependable capacity, full load without duct firing @ site conditions:		MW
Guaranteed net heat rate, full load with duct firing, HHV @ site conditions:		Btu/KWh
Guaranteed net heat rate, full load without duct firing, HHV @ site conditions:		Btu/KWh
Guaranteed net minimum capacity for emissions compliance @ site conditions:		MW

Start Information

Maximum number of starts per day: ________________ starts/day

Maximum number of starts per month: ________________ starts/month

Maximum number of starts per year: ________________ starts/year

Time to bring the facility on line (minutes):	Both combustion turbines synchronized	Minimum Load (for emissions compliance, both CT's)	Full Load (for steam turbine)
Cold Start (define time offline):			
Warm Start (define time offline):			
Hot Start (define time offline):			

Do the above times assume a purge credit? ("Yes" or "No")____________

Fuel required to bring facility on line (MMBTU):	Both combustion turbines synchronized	Minimum load (for emissions compliance)	Full Load (for steam turbine)
Cold Start			
Warm Start			
Hot Start			

Method of combustion turbine starting: ________________ electric motor or static start

-if motor start, size of electric starting motor: ________________ HP

-if static start, number of Load Commutated Inverter's (Static Frequency Converters): ________________ per combustion turbine OR

-if static start, can static start device be connected to alternate turbine for redundant starting capability: ________________ "Yes" or "No"

Ramp Rates

Minimum time on line (from start initiation to stop initiation): ________________ hours

Minimum time off line (from stop initiation to start initiation): ________________ hours

Time from minimum load to full load: ________________ minutes

Time from full load to minimum load: ________________ minutes

Normal Ramp Rate within operating range: ________________ MW/minute

Emergency Ramp Rate: ________________ MW/minute

Ramp rate for increasing production: ________________ MW per minute

Ramp rate for decreasing production: ________________ MW per minute

Facility equipped with duct burners: ________________ "Yes" or "No"

Time from 2x1 full load to 2x1 full load with maximum duct firing: ________________ minutes

Minimum duct firing load: ________________ MW

Minimum duct firing heat input: ________________ MMBtu

Capable of Automatic Generation Control (AGC): ________________ "Yes" or "No"

Operating Range for (AGC): ________________ (__MW to __MW)

Substantial Operations

Expected number of starts per combustion turbine to reach Substantial Completion: ________________ starts

Expected total energy production prior to Substantial Completion: ________________ MW-hrs

Expected total fuel consumed prior to Substantial Completion: ________________ MMBtu

Scenarios

To the extent that performance varies based on these characteristics of the facility and/or ambient conditions, the Bidder shall clearly identify the relationship in tabular form, including the relationship between temperature, relative humidity, capacity, and heat rate over the local ambient range inclusive of 0°F to 100°F.

2x1 Operation at Full Load

Ambient Temp.	Relative Humidity	Inlet Evap or Chiller	Duct Burner	Net Heat Rate (HHV)	Gross Output	Net Output	Net Min. Load
°F	Percent	On/Off	On/Off	Btu/kWhr	MW	MW	MW
0	100	Off	Off				
0	100	Off	On				
20	82	Off	Off				
20	82	Off	On				
40	64	Off	Off				
40	64	Off	On				
51	46	Off	Off				
51	46	Off	On				
60	39	On	Off				
60	39	On	On				
80	25	On	Off				
80	25	On	On				
95	20	On	Off				
95	20	On	On				
100	13	On	Off				
100	13	On	On				

1x1 Operation

Ambient Temp.	Relative Humidity	Inlet Evap or Chiller	Duct Burner	Net Heat Rate (HHV)	Gross Output	Net Output	Net Min. Load
°F	Percent	On/Off	On/Off	Btu/kWhr	MW	MW	MW
0	100	Off	Off				
0	100	Off	On				
20	82	Off	Off				
20	82	Off	On				
40	64	Off	Off				
40	64	Off	On				
51	46	Off	Off				
51	46	Off	On				
60	39	On	Off				
60	39	On	On				
80	25	On	Off				
80	25	On	On				
95	20	On	Off				
95	20	On	On				
100	13	On	Off				
100	13	On	On				

2x1 Operation at Partial Load

Ambient Temp.	Relative Humidity	Inlet Evap or Chiller	Load	Net Heat Rate (HHV)	Gross Output	Net Output	Net Min. Load
°F	Percent	On/Off	%	Btu/kWhr	MW	MW	MW
51	46	Off	Min				
51	46	Off	60				
51	46	Off	70				
51	46	Off	80				
51	46	Off	90				
95	20	Off	Min				
95	20	Off	60				
95	20	Off	70				
95	20	Off	80				
95	20	Off	90				

Steam Condensing

Technology type: ____________ air-cooled, wet-cooled

Manufacturer: ____________

Materials of construction: ____________

Wet-cooled

-if wet cooled, number of cells: ____________

Cooling water flow rate: ____________ gallons/minute

Motor rating per cell ____________ HP

Design cooling water inlet temperature: ____________ deg F

Design cooling water outlet temperature: ____________ deg F

Design wet bulb temperature: ____________ deg F

Air-cooled

-if air-cooled, number of cells ____________

Min condenser absolute backpressure
-at full load: ____________ psig

-at minimum load: ____________ psig

Water Consumption

Maximum water consumption: ____________ gallons/minute

Expected water consumption: ____________ acre-feet per year

Temp-weighted avg raw make-up water consumption: ____________ gallons/minute

Heat Recovery Steam Generator (HRSG)

HRSG manufacturer: ____________________

Steam flow conditions @ 51 deg F through both HRSGs

	Combined Cycle, without duct firing	Combined Cycle, with duct firing	Units
High Pressure Steam Flow			lbs/hr
High Pressure Steam Temperature			deg F
High Pressure Steam Pressure			psig
Intermediate Pressure Steam Flow			lbs/hr
Intermediate Pressure Steam Temperature			deg F
Intermediate Pressure Steam Pressure			psig
Low Pressure Steam Flow			lbs/hr
Low Pressure Steam Temperature			deg F
Low Pressure Steam Pressure			psig
Condensate Flow			lbs/hr
Condenser Pressure			in Hg
Condensate Temperature			deg F

Emissions

NOx emissions rate at gas turbine exhaust with15% O2: __________ ppmvd

CO emissions rate at gas turbine exhaust: __________ ppmvd

Auxiliary Boiler

Auxiliary boiler heat input, HHV: __________ MMBtu/hr

Auxiliary boiler design steam flow: __________ lbs/hr

Auxiliary boiler steam pressure: __________ psig

Auxiliary boiler steam temperature: __________ deg F

Boiler Feed Pumps

Boiler feed pump manufacturer: ____________________

Boiler feed pump model number: ____________________

Number of boiler feed pumps per HRSG: __________

APPENDIX L

FACILITY INTERCONNECTION REQUIREMENTS

APPENDIX L

Facility Interconnection Requirements

Large Generation Interconnection Agreement (LGIA)

Facility Connection Requirements for Transmission Systems (36kV and Above)

STANDARD LARGE GENERATOR

INTERCONNECTION AGREEMENT (LGIA)
between
PACIFICORP, ON BEHALF OF ITS TRANSMISSION FUNCTION
and
PACIFICORP, ON BEHALF OF ITS PACIFICORP ENERGY BUSINESS DIVISION
for
LAKE SIDE 2 POWER PLANT

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STANDARD LARGE GENERATOR INTERCONNECTION AGREEMENT

THIS STANDARD LARGE GENERATOR INTERCONNECTION AGREEMENT ("Agreement") is made and entered into this 20th day of December, 2010 by and between PacifiCorp, a corporation organized and existing under the laws of the State of Oregon, on behalf of its PacifiCorp Energy business division ("Interconnection Customer") with a Large Generating Facility), and PacifiCorp a corporation organized and existing under the laws of the State of Oregon, on behalf of its Transmission Function ("Transmission Provider and/or Transmission Owner"). Interconnection Customer and Transmission Provider each may be referred to as a "Party" or collectively as the "Parties."

Recitals

WHEREAS, Transmission Provider operates the Transmission System; and

WHEREAS, Interconnection Customer intends to own, lease and/or control and operate the Generating Facility identified as a Large Generating Facility in Appendix C to this Agreement; and,

WHEREAS, Interconnection Customer and Transmission Provider have agreed to enter into this Agreement for the purpose of interconnecting the Large Generating Facility with the Transmission System;

NOW, THEREFORE, in consideration of and subject to the mutual covenants contained herein, it is agreed:

When used in this Standard Large Generator Interconnection Agreement, terms with initial capitalization that are not defined in Article 1 shall have the meanings specified in the Article in which they are used or the Open Access Transmission Tariff (Tariff).

Article 1. Definitions

Adverse System Impact shall mean the negative effects due to technical or operational limits on conductors or equipment being exceeded that may compromise the safety and reliability of the electric system.

Affected System shall mean an electric system other than the Transmission Provider's Transmission System that may be affected by the proposed interconnection.

Affected System Operator shall mean the entity that operates an Affected System.

Affiliate shall mean, with respect to a corporation, partnership or other entity, each such other corporation, partnership or other entity that directly or indirectly, through one or more intermediaries, controls, is controlled by, or is under common control with, such corporation, partnership or other entity.

Ancillary Services shall mean those services that are necessary to support the transmission of capacity and energy from resources to loads while maintaining reliable operation of the Transmission Provider's Transmission System in accordance with Good Utility Practice.

Applicable Laws and Regulations shall mean all duly promulgated applicable federal, state and local laws, regulations, rules, ordinances, codes, decrees, judgments, directives, or judicial or administrative orders, permits and other duly authorized actions of any Governmental Authority.

Applicable Reliability Council shall mean the reliability council applicable to the Transmission System to which the Generating Facility is directly interconnected.

Applicable Reliability Standards shall mean the requirements and guidelines of NERC, the Applicable Reliability Council, and the Control Area of the Transmission System to which the Generating Facility is directly interconnected.

Base Case shall mean the base case power flow, short circuit, and stability data bases used for the Interconnection Studies by the Transmission Provider or Interconnection Customer.

Breach shall mean the failure of a Party to perform or observe any material term or condition of the Standard Large Generator Interconnection Agreement.

Breaching Party shall mean a Party that is in Breach of the Standard Large Generator Interconnection Agreement.

Business Day shall mean Monday through Friday, excluding Federal Holidays.

Calendar Day shall mean any day including Saturday, Sunday or a Federal Holiday.

Clustering shall mean the process whereby a group of Interconnection Requests is studied together, instead of serially, for the purpose of conducting the Interconnection System Impact Study.

Commercial Operation shall mean the status of a Generating Facility that has commenced generating electricity for sale, excluding electricity generated during Trial Operation.

Commercial Operation Date of a unit shall mean the date on which the Generating Facility commences Commercial Operation as agreed to by the Parties pursuant to Appendix E to the Standard Large Generator Interconnection Agreement.

Confidential Information shall mean any confidential, proprietary or trade secret information of a plan, specification, pattern, procedure, design, device, list, concept, policy or compilation relating to the present or planned business of a Party, which is designated as confidential by the Party supplying the information, whether conveyed orally, electronically, in writing, through inspection, or otherwise.

Control Area shall mean an electrical system or systems bounded by interconnection metering and telemetry, capable of controlling generation to maintain its interchange schedule with other Control Areas and contributing to frequency regulation of the interconnection. A Control Area must be certified by the Applicable Reliability Council.

Default shall mean the failure of a Breaching Party to cure its Breach in accordance with Article 17 of the Standard Large Generator Interconnection Agreement.

Dispute Resolution shall mean the procedure for resolution of a dispute between the Parties in which they will first attempt to resolve the dispute on an informal basis.

Distribution System shall mean the Transmission Provider's facilities and equipment used to transmit electricity to ultimate usage points such as homes and industries directly from nearby generators or from interchanges with higher voltage transmission networks which transport bulk power over longer distances. The voltage levels at which distribution systems operate differ among areas.

Distribution Upgrades shall mean the additions, modifications, and upgrades to the Transmission Provider's Distribution System at or beyond the Point of Interconnection to facilitate interconnection of the Generating Facility and render the transmission service necessary to effect Interconnection Customer's wholesale sale of electricity in interstate commerce. Distribution Upgrades do not include Interconnection Facilities.

Effective Date shall mean the date on which the Standard Large Generator Interconnection Agreement becomes effective upon execution by the Parties subject to acceptance by FERC, or if filed unexecuted, upon the date specified by FERC.

Emergency Condition shall mean a condition or situation: (1) that in the judgment of the Party making the claim is imminently likely to endanger life or property; or (2) that, in the case of a Transmission Provider, is imminently likely (as determined in a non-discriminatory manner) to cause a material adverse effect on the security of, or damage to Transmission Provider's Transmission System, Transmission Provider's Interconnection Facilities or the electric systems of others to which the Transmission Provider's Transmission System is directly connected; or (3) that, in the case of Interconnection Customer, is imminently likely (as determined in a non-discriminatory manner) to cause a material adverse effect on the security of, or damage to, the Generating Facility or

Interconnection Customer's Interconnection Facilities. System restoration and black start shall be considered Emergency Conditions; provided, that Interconnection Customer is not obligated by the Standard Large Generator Interconnection Agreement to possess black start capability.

Energy Resource Interconnection Service shall mean an Interconnection Service that allows the Interconnection Customer to connect its Generating Facility to the Transmission Provider's Transmission System to be eligible to deliver the Generating Facility's electric output using the existing firm or nonfirm capacity of the Transmission Provider's Transmission System on an as available basis. Energy Resource Interconnection Service in and of itself does not convey transmission service.

Engineering & Procurement (E&P) Agreement shall mean an agreement that authorizes the Transmission Provider to begin engineering and procurement of long lead-time items necessary for the establishment of the interconnection in order to advance the implementation of the Interconnection Request.

Environmental Law shall mean Applicable Laws or Regulations relating to pollution or protection of the environment or natural resources.

Federal Power Act shall mean the Federal Power Act, as amended, 16 U.S.C. §§ 791a et seq.

FERC shall mean the Federal Energy Regulatory Commission (Commission) or its successor.

Force Majeure shall mean any act of God, labor disturbance, act of the public enemy, war, insurrection, riot, fire, storm or flood, explosion, breakage or accident to machinery or equipment, any order, regulation or restriction imposed by governmental, military or lawfully established civilian authorities, or any other cause beyond a Party's control. A Force Majeure event does not include acts of negligence or intentional wrongdoing by the Party claiming Force Majeure.

Generating Facility shall mean Interconnection Customer's device for the production of electricity identified in the Interconnection Request, but shall not include the Interconnection Customer's Interconnection Facilities.

Generating Facility Capacity shall mean the net capacity of the Generating Facility and the aggregate net capacity of the Generating Facility where it includes multiple energy production devices.

Good Utility Practice shall mean any of the practices, methods and acts engaged in or approved by a significant portion of the electric industry during the relevant time period, or any of the practices, methods and acts which, in the exercise of reasonable judgment in light of the facts known at the time the decision was made, could have been expected to accomplish the desired result at a reasonable cost consistent with good business practices, reliability, safety and expedition. Good Utility Practice is not intended to be limited to the optimum practice, method, or act to the exclusion of all others, but rather to be acceptable practices, methods, or acts generally accepted in the region.

Governmental Authority shall mean any federal, state, local or other governmental regulatory or administrative agency, court, commission, department, board, or other governmental subdivision, legislature, rulemaking board, tribunal, or other governmental authority having jurisdiction over the Parties, their respective facilities, or the respective services they provide, and exercising or entitled to exercise any administrative, executive, police, or taxing authority or power; provided, however, that such term does not include Interconnection Customer, Transmission Provider, or any Affiliate thereof.

Hazardous Substances shall mean any chemicals, materials or substances defined as or included in the definition of "hazardous substances," "hazardous wastes," "hazardous materials," "hazardous constituents," "restricted hazardous materials," "extremely hazardous substances," "toxic substances," "radioactive substances," "contaminants," "pollutants," "toxic pollutants" or words of similar meaning and regulatory effect under any applicable Environmental Law, or any other chemical, material or substance, exposure to which is prohibited, limited or regulated by any applicable Environmental Law.

Initial Synchronization Date shall mean the date upon which the Generating Facility is initially synchronized and upon which Trial Operation begins.

In-Service Date shall mean the date upon which the Interconnection Customer reasonably expects it will be ready to begin use of the Transmission Provider's Interconnection Facilities to obtain back feed power.

Interconnection Customer shall mean any entity, including the Transmission Provider, Transmission Owner or any of the Affiliates or subsidiaries of either, that proposes to interconnect its Generating Facility with the Transmission Provider's Transmission System.

Interconnection Customer's Interconnection Facilities shall mean all facilities and equipment, as identified in Appendix A of the Standard Large Generator Interconnection Agreement, that are located between the Generating Facility and the Point of Change of Ownership, including any modification, addition, or upgrades to such facilities and equipment necessary to physically and electrically interconnect the Generating Facility to the Transmission Provider's Transmission System. Interconnection Customer's Interconnection Facilities are sole use facilities.

Interconnection Facilities shall mean the Transmission Provider's Interconnection Facilities and the Interconnection Customer's Interconnection Facilities. Collectively, Interconnection Facilities include all facilities and equipment between the Generating Facility and the Point of Interconnection, including any modification, additions or upgrades that are necessary to physically and electrically interconnect the Generating Facility to the Transmission Provider's Transmission System. Interconnection Facilities are sole use facilities and shall not include Distribution Upgrades, Stand Alone Network Upgrades or Network Upgrades.

Interconnection Facilities Study shall mean a study conducted by the Transmission Provider or a third party consultant for the Interconnection Customer to determine a list of facilities (including Transmission Provider's Interconnection Facilities and Network Upgrades as identified in the Interconnection System Impact Study), the cost of those facilities, and the time required to interconnect the Generating Facility with the Transmission

Provider's Transmission System. The scope of the study is defined in Section 43 of the Standard Large Generator Interconnection Procedures.

Interconnection Facilities Study Agreement shall mean the form of agreement contained in Appendix 4 of the Standard Large Generator Interconnection Procedures for conducting the Interconnection Facilities Study.

Interconnection Feasibility Study shall mean a preliminary evaluation of the system impact and cost of interconnecting the Generating Facility to the Transmission Provider's Transmission System, the scope of which is described in Section 41 of the Standard Large Generator Interconnection Procedures.

Interconnection Feasibility Study Agreement shall mean the form of agreement contained in Appendix 2 of the Standard Large Generator Interconnection Procedures for conducting the Interconnection Feasibility Study.

Interconnection Request shall mean an Interconnection Customer's request, in the form of Appendix 1 to the Standard Large Generator Interconnection Procedures, in accordance with the Tariff, to interconnect a new Generating Facility, or to increase the capacity of, or make a Material Modification to the operating characteristics of, an existing Generating Facility that is interconnected with the Transmission Provider's Transmission System.

Interconnection Service shall mean the service provided by the Transmission Provider associated with interconnecting the Interconnection Customer's Generating Facility to the Transmission Provider's Transmission System and enabling it to receive electric energy and capacity from the Generating Facility at the Point of Interconnection, pursuant to the terms of the Standard Large Generator Interconnection Agreement and, if applicable, the Transmission Provider's Tariff.

Interconnection Study shall mean any of the following studies: the Interconnection Feasibility Study, the Interconnection System Impact Study, and the Interconnection Facilities Study described in the Standard Large Generator Interconnection Procedures.

Interconnection System Impact Study shall mean an engineering study that evaluates the impact of the proposed interconnection on the safety and reliability of Transmission Provider's Transmission System and, if applicable, an Affected System. The study shall identify and detail the system impacts that would result if the Generating Facility were interconnected without project modifications or system modifications, focusing on the Adverse System Impacts identified in the Interconnection Feasibility Study, or to study potential impacts, including but not limited to those identified in the Scoping Meeting as described in the Standard Large Generator Interconnection Procedures.

Interconnection System Impact Study Agreement shall mean the form of agreement contained in Appendix 3 of the Standard Large Generator Interconnection Procedures for conducting the Interconnection System Impact Study.

IRS shall mean the Internal Revenue Service.

Joint Operating Committee shall be a group made up of representatives from Interconnection Customers and the Transmission Provider to coordinate operating and technical considerations of Interconnection Service.

Large Generating Facility shall mean a Generating Facility having a Generating Facility Capacity of more than 20 MW.

Loss shall mean any and all losses relating to injury to or death of any person or damage to property, demand, suits, recoveries, costs and expenses, court costs, attorney fees, and all other obligations by or to third parties, arising out of or resulting from the other Party's performance, or non-performance of its obligations under the Standard Large Generator Interconnection Agreement on behalf of the indemnifying Party, except in cases of gross negligence or intentional wrongdoing by the indemnifying Party.

Material Modification shall mean those modifications that have a material impact on the cost or timing of any Interconnection Request with a later queue priority date.

Metering Equipment shall mean all metering equipment installed or to be installed at the Generating Facility pursuant to the Standard Large Generator Interconnection Agreement at the metering points, including but not limited to instrument transformers, MWh-meters, data acquisition equipment, transducers, remote terminal unit, communications equipment, phone lines, and fiber optics.

NERC shall mean the North American Electric Reliability Council or its successor organization.

Network Resource shall mean any designated generating resource owned, purchased, or leased by a Network Customer under the Network Integration Transmission Service Tariff. Network Resources do not include any resource, or any portion thereof, that is committed for sale to third parties or otherwise cannot be called upon to meet the Network Customer's Network Load on a non-interruptible basis.

Network Resource Interconnection Service shall mean an Interconnection Service that allows the Interconnection Customer to integrate its Large Generating Facility with the Transmission Provider's Transmission System (1) in a manner comparable to that in which the Transmission Provider integrates its generating facilities to serve native load customers; or (2) in an RTO or ISO with market based congestion management, in the same manner as Network Resources. Network Resource Interconnection Service in and of itself does not convey transmission service.

Network Upgrades shall mean the additions, modifications, and upgrades to the Transmission Provider's Transmission System required at or beyond the point at which the Interconnection Facilities connect to the Transmission Provider's Transmission System to accommodate the interconnection of the Large Generating Facility to the Transmission Provider's Transmission System.

Notice of Dispute shall mean a written notice of a dispute or claim that arises out of or in connection with the Standard Large Generator Interconnection Agreement or its performance.

Optional Interconnection Study shall mean a sensitivity analysis based on assumptions specified by the Interconnection Customer in the Optional Interconnection Study Agreement.

Optional Interconnection Study Agreement shall mean the form of agreement contained in Appendix 5 of the Standard Large Generator Interconnection Procedures for conducting the Optional Interconnection Study.

Party or Parties shall mean Transmission Provider, Transmission Owner, Interconnection Customer or any combination of the above.

Point of Change of Ownership shall mean the point, as set forth in Appendix A to the Standard Large Generator Interconnection Agreement, where the Interconnection Customer's Interconnection Facilities connect to the Transmission Provider's Interconnection Facilities.

Point of Interconnection shall mean the point, as set forth in Appendix A to the Standard Large Generator Interconnection Agreement, where the Interconnection Facilities connect to the Transmission Provider's Transmission System.

Queue Position shall mean the order of a valid Interconnection Request, relative to all other pending valid Interconnection Requests, that is established based upon the date and time of receipt of the valid Interconnection Request by the Transmission Provider.

Reasonable Efforts shall mean, with respect to an action required to be attempted or taken by a Party under the Standard Large Generator Interconnection Agreement, efforts that are timely and consistent with Good Utility Practice and are otherwise substantially equivalent to those a Party would use to protect its own interests.

Scoping Meeting shall mean the meeting between representatives of the Interconnection Customer and Transmission Provider conducted for the purpose of discussing alternative interconnection options, to exchange information including any transmission data and earlier study evaluations that would be reasonably expected to impact such interconnection options, to analyze such information, and to determine the potential feasible Points of Interconnection.

Site Control shall mean documentation reasonably demonstrating: (1) ownership of, a leasehold interest in, or a right to develop a site for the purpose of constructing the Generating Facility; (2) an option to purchase or acquire a leasehold site for such purpose; or (3) an exclusivity or other business relationship between Interconnection Customer and the entity having the right to sell, lease or grant Interconnection Customer the right to possess or occupy a site for such purpose.

Small Generating Facility shall mean a Generating Facility that has a Generating Facility Capacity of no more than 20 MW.

Stand Alone Network Upgrades shall mean Network Upgrades that an Interconnection Customer may construct without affecting day-to-day operations of the Transmission System during their construction. Both the Transmission Provider and the Interconnection Customer must agree as to what constitutes Stand Alone Network Upgrades and identify them in Appendix A to the Standard Large Generator Interconnection Agreement.

Standard Large Generator Interconnection Agreement (LGIA) shall mean the form of interconnection agreement applicable to an Interconnection Request pertaining to a Large Generating Facility that is included in the Transmission Provider's Tariff.

Standard Large Generator Interconnection Procedures (LGIP) shall mean the interconnection procedures applicable to an Interconnection Request pertaining to a Large Generating Facility that are included in the Transmission Provider's Tariff.

System Protection Facilities shall mean the equipment, including necessary protection signal communications equipment, required to protect (1) the Transmission Provider's Transmission System from faults or other electrical disturbances occurring at the Generating Facility and (2) the Generating Facility from faults or other electrical system disturbances occurring on the Transmission Provider's Transmission System or on other delivery systems or other generating systems to which the Transmission Provider's Transmission System is directly connected.

Tariff shall mean the Transmission Provider's Tariff through which open access transmission service and Interconnection Service are offered, as filed with FERC, and as amended or supplemented from time to time, or any successor tariff.

Transmission Owner shall mean an entity that owns, leases or otherwise possesses an interest in the portion of the Transmission System at the Point of Interconnection and may be a Party to the Standard Large Generator Interconnection Agreement to the extent necessary.

Transmission Provider shall mean the public utility (or its designated agent) that owns, controls, or operates transmission or distribution facilities used for the transmission of electricity in interstate commerce and provides transmission service under the Tariff. The term Transmission Provider should be read to include the Transmission Owner when the Transmission Owner is separate from the Transmission Provider.

Transmission Provider's Interconnection Facilities shall mean all facilities and equipment owned, controlled or operated by the Transmission Provider from the Point of Change of Ownership to the Point of Interconnection as identified in Appendix A to the Standard Large Generator Interconnection Agreement, including any modifications, additions or upgrades to such facilities and equipment. Transmission Provider's Interconnection Facilities are sole use facilities and shall not include Distribution Upgrades, Stand Alone Network Upgrades or Network Upgrades.

Transmission System shall mean the facilities owned, controlled or operated by the Transmission Provider or Transmission Owner that are used to provide transmission service under the Tariff.

Trial Operation shall mean the period during which Interconnection Customer is engaged in on-site test operations and commissioning of the Generating Facility prior to Commercial Operation.

Article 2. Effective Date, Term, and Termination

2.1 Effective Date. This LGIA shall become effective upon execution by the Parties subject to acceptance by FERC (if applicable), or if filed unexecuted, upon the date specified by FERC. Transmission Provider shall promptly file this LGIA with FERC upon execution in accordance with Article 3.1, if required.

2.2 Term of Agreement. Subject to the provisions of Article 2.3, this LGIA shall remain in effect for a period of ten (10) years from the Effective Date or such other longer period as Interconnection Customer may request (Term to be specified in individual agreements) and shall be automatically renewed for each successive one-year period thereafter.

2.3 Termination Procedures.

2.3.1 Written Notice. This LGIA may be terminated by Interconnection Customer after giving Transmission Provider ninety (90) Calendar Days advance written notice, or by Transmission Provider notifying FERC after the Generating Facility permanently ceases Commercial Operation.

2.3.2 Default. Either Party may terminate this LGIA in accordance with Article 17.

2.3.3 Notwithstanding Articles 2.3.1 and 2.3.2, no termination shall become effective until the Parties have complied with all Applicable Laws and Regulations applicable to such termination, including the filing with FERC of a notice of termination of this LGIA, which notice has been accepted for filing by FERC.

2.4 Termination Costs. If a Party elects to terminate this Agreement pursuant to Article 2.3 above, each Party shall pay all costs incurred (including any cancellation costs relating to orders or contracts for Interconnection Facilities and equipment) or charges assessed by the other Party, as of the date of the other Party's receipt of such notice of termination, that are the responsibility of the Terminating Party under this LGIA. In the event of termination by a Party, the Parties shall use commercially Reasonable Efforts to mitigate the costs, damages and charges arising as a consequence of termination. Upon termination of this LGIA, unless otherwise ordered or approved by FERC:

2.4.1 With respect to any portion of Transmission Provider's Interconnection Facilities that have not yet been constructed or installed, Transmission Provider shall to the extent possible and with Interconnection Customer's authorization cancel any pending orders of, or return, any materials or equipment for, or contracts for construction of, such facilities; provided that in the event Interconnection Customer elects not to authorize such cancellation, Interconnection Customer shall assume all payment obligations with respect to such materials, equipment, and contracts, and Transmission Provider shall deliver such material and equipment, and, if necessary, assign such contracts, to Interconnection Customer as soon as practicable, at Interconnection Customer's expense. To the extent that Interconnection Customer has already paid Transmission Provider for any or all such costs of materials or equipment not taken by Interconnection Customer, Transmission Provider shall promptly refund such amounts to Interconnection Customer, less any costs, including penalties incurred by Transmission Provider to cancel any pending orders of or return such materials, equipment, or contracts.

If an Interconnection Customer terminates this LGIA, it shall be responsible for all costs incurred in association with that Interconnection Customer's interconnection, including any cancellation costs relating to orders or contracts for Interconnection Facilities and equipment, and other expenses including any Network Upgrades for which Transmission Provider has incurred expenses and has not been reimbursed by Interconnection Customer.

2.4.2 Transmission Provider may, at its option, retain any portion of such materials, equipment, or facilities that Interconnection Customer chooses not to accept delivery of, in which case Transmission Provider shall be responsible for all costs associated with procuring such materials, equipment, or facilities.

2.4.3 With respect to any portion of the Interconnection Facilities, and any other facilities already installed or constructed pursuant to the terms of this LGIA, Interconnection Customer shall be responsible for all costs associated with the removal, relocation or other disposition or retirement of such materials, equipment, or facilities.

2.5 **Disconnection.** Upon termination of this LGIA, the Parties will take all appropriate steps to disconnect the Large Generating Facility from the Transmission System. All costs required to effectuate such disconnection shall be borne by the terminating Party, unless such termination resulted from the non-terminating Party's Default of this LGIA or such non-terminating Party otherwise is responsible for these costs under this LGIA.

2.6 **Survival.** This LGIA shall continue in effect after termination to the extent necessary to provide for final billings and payments and for costs incurred hereunder, including billings and payments pursuant to this LGIA; to permit the determination and enforcement of liability and indemnification obligations arising from acts or events that occurred while this LGIA was in effect; and to permit each Party to have access to the lands of the other Party pursuant to this LGIA or other applicable agreements, to disconnect, remove or salvage its own facilities and equipment.

Article 3. Regulatory Filings

3.1 **Filing.** Transmission Provider shall file this LGIA (and any amendment hereto) with the appropriate

Governmental Authority, if required. Interconnection Customer may request that any information so provided be subject to the confidentiality provisions of Article 22. If Interconnection Customer has executed this LGIA, or any amendment thereto, Interconnection Customer shall reasonably cooperate with Transmission Provider with respect to such filing and to provide any information reasonably requested by Transmission Provider needed to comply with applicable regulatory requirements.

Article 4. Scope of Service

4.1 Interconnection Product Options. Interconnection Customer has selected the following (checked) type of Interconnection Service:

☑ **4.1.1 Energy Resource Interconnection Service.**

4.1.1.1 The Product. Energy Resource Interconnection Service allows Interconnection Customer to connect the Large Generating Facility to the Transmission System and be eligible to deliver the Large Generating Facility's output using the existing firm or non-firm capacity of the Transmission System on an "as available" basis. To the extent Interconnection Customer wants to receive Energy Resource Interconnection Service, Transmission Provider shall construct facilities identified in Attachment A.

4.1.1.2 Transmission Delivery Service Implications. Under Energy Resource Interconnection Service, Interconnection Customer will be eligible to inject power from the Large Generating Facility into and deliver power across the interconnecting Transmission

Provider's Transmission System on an "as available" basis up to the amount of MWs identified in the applicable stability and steady state studies to the extent the upgrades initially required to qualify for Energy Resource Interconnection Service have been constructed. Where eligible to do so (e.g., PJM, ISO-NE, NYISO), Interconnection Customer may place a bid to sell into the market up to the maximum identified Large Generating Facility output, subject to any conditions specified in the interconnection service approval, and the Large Generating Facility will be dispatched to the extent Interconnection Customer's bid clears. In all other instances, no transmission delivery service from the Large Generating Facility is assured, but Interconnection Customer may obtain Point-to-Point Transmission Service, Network Integration Transmission Service, or be used for secondary network transmission service, pursuant to Transmission Provider's Tariff, up to the maximum output identified in the stability and steady state studies. In those instances, in order for Interconnection Customer to obtain the right to deliver or inject energy beyond the Large Generating Facility Point of Interconnection or to improve its ability to do so, transmission delivery service must be obtained pursuant to the provisions of Transmission Provider's Tariff. The Interconnection Customer's ability to inject its Large Generating Facility output beyond the Point of Interconnection, therefore, will depend on the existing capacity of Transmission Provider's Transmission System at such time as a transmission service request is made that would accommodate such delivery. The provision of firm Point-to-Point Transmission Service or Network Integration Transmission Service may require the construction of additional Network Upgrades.

☐ 4.1.2 **Network Resource Interconnection Service.**

4.1.2.1 **The Product.** Transmission Provider must conduct the necessary studies and construct the Network Upgrades needed to integrate the Large Generating Facility (1) in a manner comparable to that in which Transmission Provider integrates its generating facilities to serve native load customers; or (2) in an ISO or RTO with market based congestion management, in the same manner as all Network Resources. To the extent Interconnection Customer wants to receive Network Resource Interconnection Service, Transmission Provider shall construct the facilities identified in Attachment A to this LGIA.

4.1.2.2 **Transmission Delivery Service Implications.** Network Resource Interconnection Service allows Interconnection Customer's Large Generating Facility to be designated by any Network Customer under the Tariff on Transmission Provider's

Transmission System as a Network Resource, up to the Large Generating Facility's full output, on the same basis as existing Network Resources interconnected to Transmission Provider's Transmission System, and to be studied as a Network Resource on the assumption that such a designation will occur. Although Network Resource Interconnection Service does not convey a reservation of transmission service, any Network Customer under the Tariff can utilize its network service under the Tariff to obtain delivery of energy from the interconnected Interconnection Customer's Large Generating Facility in the same manner as it accesses Network Resources. A Large Generating Facility receiving Network Resource Interconnection Service may also be used to provide Ancillary Services after technical studies and/or periodic analyses are performed with respect to the Large Generating Facility's ability to provide any applicable Ancillary Services, provided that such studies and analyses have been or would be required in connection with the provision of such Ancillary Services by any existing Network Resource. However, if an Interconnection Customer's Large Generating Facility has not been designated as a Network Resource by any load, it cannot be required to provide Ancillary Services except to the extent such requirements extend to all generating facilities that are similarly situated. The provision of Network Integration

Transmission Service or firm Point-to-Point Transmission Service may require additional studies and the construction of additional upgrades. Because such studies and upgrades would be associated with a request for delivery service under the Tariff, cost responsibility for the studies and upgrades would be in accordance with FERC's policy for pricing transmission delivery services.

Network Resource Interconnection Service does not necessarily provide Interconnection Customer with the capability to physically deliver the output of its Large Generating Facility to any particular load on Transmission Provider's Transmission System without incurring congestion costs. In the event of transmission constraints on Transmission Provider's Transmission System, Interconnection Customer's Large Generating Facility shall be subject to the applicable congestion management procedures in Transmission Provider's Transmission System in the same manner as Network Resources.

There is no requirement either at the time of study or interconnection, or at any point in the future, that Interconnection Customer's Large Generating Facility be designated as a Network Resource by a Network Service Customer under the Tariff or that Interconnection Customer identify a specific buyer (or sink). To the extent a Network Customer does designate the Large Generating Facility as a Network Resource, it must do so pursuant to Transmission Provider's Tariff.

Once an Interconnection Customer satisfies the requirements for obtaining Network Resource Interconnection Service, any future transmission service request for delivery from the Large Generating Facility within Transmission Provider's Transmission System of any amount of capacity and/or energy, up to the amount initially studied, will not require that any additional studies be performed or that any further upgrades associated with such Large Generating Facility be undertaken, regardless of whether or not such Large Generating Facility is ever designated by a Network Customer as a Network Resource and regardless of changes in ownership of the Large Generating Facility. However, the reduction or elimination of congestion or redispatch costs may require additional studies and the construction of additional upgrades.

To the extent Interconnection Customer enters into an arrangement for long term transmission service for deliveries from the Large Generating Facility outside Transmission Provider's Transmission System, such request may require additional studies and upgrades in order for Transmission Provider to grant such request.

4.2 Provision of Service. Transmission Provider shall provide Interconnection Service for the Large Generating Facility at the Point of Interconnection.

4.3 Performance Standards. Each Party shall perform all of its obligations under this LGIA in accordance with Applicable Laws and Regulations, Applicable Reliability Standards, and Good Utility Practice, and to the extent a Party is required or prevented or limited in taking any action by such regulations and standards, such Party shall not be deemed to be in Breach of this LGIA for its compliance therewith. If such Party is a Transmission Provider or Transmission Owner, then that Party shall amend the LGIA and submit the amendment to FERC for approval.

4.4 No Transmission Delivery Service. The execution of this LGIA does not constitute a request for, nor the provision of, any transmission delivery service under Transmission Provider's Tariff, and does not convey any right to deliver electricity to any specific customer or Point of Delivery.

4.5 Interconnection Customer Provided Services. The services provided by Interconnection Customer under this LGIA are set forth in Article 9.6 and Article 13.5.1.

Interconnection Customer shall be paid for such services in accordance with Article 11.6.

Article 5. Interconnection Facilities Engineering, Procurement, and Construction

5.1 Options. Unless otherwise mutually agreed to between the Parties, Interconnection Customer shall select the In-Service Date, Initial Synchronization Date, and Commercial Operation Date; and either Standard Option or Alternate Option set forth below for completion of Transmission Provider's Interconnection Facilities and Network Upgrades as set forth in Appendix A, Interconnection Facilities and Network Upgrades, and such dates and selected option shall be set forth in Appendix B, Milestones.

5.1.1 **Standard Option.** Transmission Provider shall design, procure, and construct Transmission Provider's Interconnection Facilities and Network Upgrades, using Reasonable Efforts to complete Transmission Provider's Interconnection Facilities and Network Upgrades by the dates set forth in Appendix B, Milestones. Transmission Provider shall not be required to undertake any action which is inconsistent with its standard safety practices, its material and equipment specifications, its design criteria and construction procedures, its labor agreements, and Applicable Laws and Regulations. In the event Transmission Provider reasonably expects that it will not be able to complete Transmission Provider's Interconnection Facilities and Network Upgrades by the specified dates, Transmission Provider shall promptly provide written notice to Interconnection Customer and shall undertake Reasonable Efforts to meet the earliest dates thereafter.

5.1.2 **Alternate Option.** If the dates designated by Interconnection Customer are acceptable to Transmission Provider, Transmission Provider shall so notify Interconnection Customer within thirty (30) Calendar Days, and shall assume responsibility for the design, procurement and construction of Transmission Provider's Interconnection Facilities by the designated dates.

If Transmission Provider subsequently fails to complete Transmission Provider's Interconnection Facilities by the In-Service Date, to the extent necessary to provide back feed power; or fails to complete Network Upgrades by the Initial Synchronization Date to the extent necessary to allow for Trial Operation at full power output, unless other arrangements are made by the Parties for such Trial Operation; or fails to complete the Network Upgrades by the Commercial Operation Date, as such dates are reflected in Appendix B, Milestones; Transmission Provider shall pay Interconnection Customer liquidated damages in accordance with Article 5.3, Liquidated Damages, provided, however, the dates designated by Interconnection Customer shall be extended day for day for each day that the applicable RTO or ISO refuses to grant clearances to install equipment.

5.1.3 **Option to Build.** If the dates designated by Interconnection Customer are not acceptable to Transmission Provider, Transmission Provider shall so notify Interconnection Customer within thirty (30) Calendar Days, and unless the Parties agree otherwise, Interconnection Customer shall have the option to assume responsibility for the design, procurement and construction of Transmission Provider's Interconnection Facilities and Stand Alone Network Upgrades on the dates specified in Article 5.1.2. Transmission Provider and Interconnection Customer must agree as to what constitutes Stand Alone Network Upgrades and identify such Stand Alone Network Upgrades in Appendix A. Except for Stand Alone Network Upgrades, Interconnection Customer shall have no right to construct Network Upgrades under this option.

5.1.4 **Negotiated Option.** If Interconnection Customer elects not to exercise its option under Article 5.1.3, Option to Build, Interconnection Customer shall so notify Transmission Provider within thirty (30) Calendar Days, and the Parties shall in good faith attempt to negotiate terms and conditions (including revision of the specified dates and liquidated damages, the provision of incentives or the procurement and construction of a portion of Transmission Provider's Interconnection

Facilities and Stand Alone Network Upgrades by Interconnection Customer) pursuant to which Transmission Provider is responsible for the design, procurement and construction of Transmission Provider's Interconnection Facilities and Network Upgrades. If the Parties are unable to reach agreement on such terms and conditions, Transmission Provider shall assume responsibility for the design, procurement and construction of Transmission Provider's Interconnection Facilities and Network Upgrades pursuant to 5.1.1, Standard Option.

5.2 General Conditions Applicable to Option to Build. If Interconnection Customer assumes responsibility for the design, procurement and construction of Transmission Provider's Interconnection Facilities and Stand Alone Network Upgrades,

(1) Interconnection Customer shall engineer, procure equipment, and construct Transmission Provider's Interconnection Facilities and Stand Alone Network Upgrades (or portions thereof) using Good Utility Practice and using standards and specifications provided in advance by Transmission Provider;

(2) Interconnection Customer's engineering, procurement and construction of Transmission Provider's Interconnection Facilities and Stand Alone Network Upgrades shall comply with all requirements of law to which Transmission Provider would be subject in the engineering, procurement or construction of Transmission Provider's Interconnection Facilities and Stand Alone Network Upgrades;

(3) Transmission Provider shall review and approve the engineering design, equipment acceptance tests, and the construction of Transmission Provider's Interconnection

Facilities and Stand Alone Network Upgrades;

(4) prior to commencement of construction, Interconnection Customer shall provide to Transmission Provider a schedule for construction of Transmission Provider's Interconnection Facilities and Stand Alone Network Upgrades, and shall promptly respond to requests for information from Transmission Provider;

(5) at any time during construction, Transmission Provider shall have the right to gain unrestricted access to Transmission Provider's Interconnection Facilities and Stand Alone Network Upgrades and to conduct inspections of the same;

(6) at any time during construction, should any phase of the engineering, equipment procurement, or construction of Transmission Provider's Interconnection Facilities and Stand Alone Network Upgrades not meet the standards and specifications provided by Transmission Provider, Interconnection Customer shall be obligated to remedy deficiencies in that portion of Transmission Provider's Interconnection Facilities and Stand Alone Network Upgrades;

(7) Interconnection Customer shall indemnify Transmission Provider for claims arising from Interconnection Customer's construction of Transmission Provider's Interconnection Facilities and Stand Alone Network Upgrades under the terms and procedures applicable to Article 18.1 Indemnity;

(8) Interconnection Customer shall transfer control of Transmission Provider's Interconnection Facilities and Stand Alone Network Upgrades to Transmission Provider;

(9) Unless Parties otherwise agree, Interconnection Customer shall transfer ownership of Transmission Provider's Interconnection Facilities and Stand-Alone Network Upgrades to Transmission Provider;

(10) Transmission Provider shall approve and accept for operation and maintenance Transmission Provider's Interconnection Facilities and Stand Alone Network Upgrades to the extent engineered, procured, and constructed in accordance with this Article 5.2; and

(11) Interconnection Customer shall deliver to Transmission Provider "as-built" drawings, information, and any other documents that are reasonably required by Transmission Provider to assure that the Interconnection Facilities and Stand-Alone Network Upgrades are built to the standards and specifications required by Transmission Provider.

5.3 Liquidated Damages. The actual damages to Interconnection Customer, in the event Transmission Provider's Interconnection Facilities or Network Upgrades are not completed by the dates designated by Interconnection Customer and accepted by Transmission Provider pursuant to subparagraphs 5.1.2 or 5.1.4, above, may include Interconnection Customer's fixed operation and maintenance costs and lost opportunity costs. Such actual damages are uncertain and impossible to determine at this time. Because of such uncertainty, any liquidated damages paid by Transmission Provider to Interconnection Customer in the event that Transmission Provider does not complete any portion of Transmission Provider's Interconnection Facilities or Network Upgrades by the applicable dates, shall be an amount equal to ½ of 1 percent per day of the actual cost of Transmission Provider's Interconnection Facilities and Network Upgrades, in the aggregate, for which Transmission Provider has assumed responsibility to design, procure and construct.

However, in no event shall the total liquidated damages exceed 20 percent of the actual cost of Transmission Provider's Interconnection Facilities and Network Upgrades for which Transmission Provider has assumed responsibility to design, procure, and construct. The foregoing payments will be made by Transmission Provider to Interconnection Customer as just compensation for the damages caused to Interconnection Customer, which actual damages are uncertain and impossible to determine at this time, and as reasonable liquidated damages, but not as a penalty or a method to secure performance of this LGIA. Liquidated damages, when the Parties agree to them, are the exclusive remedy for the Transmission Provider's failure to meet its schedule.

No liquidated damages shall be paid to Interconnection Customer if: (1) Interconnection Customer is not ready to commence use of Transmission Provider's Interconnection Facilities or Network Upgrades to take the delivery of power for the Large Generating Facility's Trial Operation or to export power from the Large Generating Facility on the specified dates, unless Interconnection Customer would have been able to commence use of Transmission Provider's Interconnection Facilities or Network Upgrades to take the delivery of power for Large Generating Facility's Trial Operation or to export power from the Large Generating Facility, but for Transmission Provider's delay; (2) Transmission Provider's failure to meet the specified dates is the result of the action or inaction of Interconnection Customer or any other Interconnection Customer who has entered into an LGIA with Transmission Provider or any cause beyond Transmission Provider's reasonable control or reasonable ability to cure; (3) the interconnection Customer has assumed responsibility for the design, procurement and construction of Transmission Provider's Interconnection Facilities and Stand Alone Network Upgrades; or (4) the Parties have otherwise agreed.

5.4 Power System Stabilizers. The Interconnection Customer shall procure, install, maintain and operate Power System Stabilizers in accordance with the guidelines and procedures established by the Applicable Reliability Council. Transmission

Provider reserves the right to reasonably establish minimum acceptable settings for any installed Power System Stabilizers, subject to the design and operating limitations of the Large Generating Facility. If the Large Generating Facility's Power System Stabilizers are removed from service or not capable of automatic operation, Interconnection Customer shall immediately notify Transmission Provider's system operator, or its designated representative. The requirements of this paragraph shall not apply to wind generators.

5.5 Equipment Procurement. If responsibility for construction of Transmission Provider's Interconnection Facilities or Network Upgrades is to be borne by Transmission Provider, then Transmission Provider shall commence design of Transmission Provider's Interconnection Facilities or Network Upgrades and procure necessary equipment as soon as practicable after all of the following conditions are satisfied, unless the Parties otherwise agree in writing:

5.5.1 Transmission Provider has completed the Facilities Study pursuant to the Facilities Study Agreement;

5.5.2 Transmission Provider has received written authorization to proceed with design and procurement from Interconnection Customer by the date specified in Appendix B, Milestones; and

5.5.3 Interconnection Customer has provided security to Transmission Provider in accordance with Article 11.5 by the dates specified in Appendix B, Milestones.

5.6 Construction Commencement. Transmission Provider shall commence construction of Transmission Provider's Interconnection Facilities and Network Upgrades for which it is responsible as soon as practicable after the following additional conditions are satisfied:

5.6.1 Approval of the appropriate Governmental Authority has been obtained for any facilities requiring regulatory approval;

5.6.2 Necessary real property rights and rights-of-way have been obtained, to the extent required for the construction of a discrete aspect of Transmission Provider's Interconnection Facilities and Network Upgrades;

5.6.3 Transmission Provider has received written authorization to proceed with construction from Interconnection Customer by the date specified in Appendix B, Milestones; and

5.6.4 Interconnection Customer has provided security to Transmission Provider in accordance with Article 11.5 by the dates specified in Appendix B, Milestones.

5.7 **Work Progress.** The Parties will keep each other advised periodically as to the progress of their respective design, procurement and construction efforts. Either Party may, at any time, request a progress report from the other Party. If, at any time, Interconnection Customer determines that the completion of Transmission Provider's Interconnection Facilities will not be required until after the specified In-Service Date, Interconnection Customer will provide written notice to Transmission Provider of such later date upon which the completion of Transmission Provider's Interconnection Facilities will be required.

5.8 **Information Exchange.** As soon as reasonably practicable after the Effective Date, the Parties shall exchange information regarding the design and compatibility of the Parties' Interconnection Facilities and compatibility of the Interconnection Facilities with Transmission Provider's Transmission System, and shall work diligently and in good faith to make any necessary design changes.

5.9 **Limited Operation.** If any of Transmission Provider's Interconnection Facilities or Network Upgrades are not reasonably expected to be completed prior to the

Commercial Operation Date of the Large Generating Facility, Transmission Provider shall, upon the request and at the expense of Interconnection Customer, perform operating studies on a timely basis to determine the extent to which the Large Generating Facility and Interconnection Customer's Interconnection Facilities may operate prior to the completion of Transmission Provider's Interconnection Facilities or Network Upgrades consistent with Applicable Laws and Regulations, Applicable Reliability Standards, Good Utility Practice, and this LGIA. Transmission Provider shall permit Interconnection Customer to operate the Large Generating Facility and Interconnection Customer's Interconnection Facilities in accordance with the results of such studies.

5.10 Interconnection Customer's Interconnection Facilities ('ICIF'). Interconnection Customer shall, at its expense, design, procure, construct, own and install the ICIF, as set forth in Appendix A, Interconnection Facilities, Network Upgrades and Distribution Upgrades.

5.10.1 Interconnection Customer's Interconnection Facility Specifications. Interconnection Customer shall submit initial specifications for the ICIF, including System Protection Facilities, to Transmission Provider at least one hundred eighty (180) Calendar Days prior to the Initial Synchronization Date; and final specifications for review and comment at least ninety (90) Calendar Days prior to the Initial Synchronization Date. Transmission Provider shall review such specifications to ensure that the ICIF are compatible with the technical specifications, operational control, and safety requirements of Transmission Provider and comment on such specifications within thirty (30) Calendar Days of Interconnection Customer's submission. All specifications provided hereunder shall be deemed confidential.

5.10.2 **Transmission Provider's Review.** Transmission Provider's review of Interconnection Customer's final specifications shall not be construed as confirming, endorsing, or providing a warranty as to the design, fitness, safety, durability or reliability of the Large Generating Facility, or the ICIF. Interconnection Customer shall make such changes to the ICIF as may reasonably be required by Transmission Provider, in accordance with Good Utility Practice, to ensure that the ICIF are compatible with the technical specifications, operational control, and safety requirements of Transmission Provider.

5.10.3 **ICIF Construction.** The ICIF shall be designed and constructed in accordance with Good Utility Practice. Within one hundred twenty (120) Calendar Days after the Commercial Operation Date, unless the Parties agree on another mutually acceptable deadline, Interconnection Customer shall deliver to Transmission Provider "as-built" drawings, information and documents for the ICIF, such as: a one-line diagram, a site plan showing the Large Generating Facility and the ICIF, plan and elevation drawings showing the layout of the ICIF, a relay functional diagram, relaying AC and DC schematic wiring diagrams and relay settings for all facilities associated with Interconnection Customer's step-up transformers, the facilities connecting the Large Generating Facility to the step-up transformers and the ICIF, and the impedances (determined by factory tests) for the associated step-up transformers and the Large Generating Facility. The Interconnection Customer shall provide Transmission Provider specifications for the excitation system, automatic voltage regulator, Large Generating Facility control and protection settings, transformer tap settings, and communications, if applicable.

5.11 Transmission Provider's Interconnection Facilities Construction. Transmission Provider's Interconnection Facilities shall be designed and constructed in accordance with Good Utility Practice. Upon request, within one hundred twenty (120) Calendar Days after the Commercial Operation Date, unless the Parties agree on another mutually acceptable deadline, Transmission Provider shall deliver to Interconnection Customer the following "as-built" drawings, information and documents for Transmission Provider's Interconnection Facilities [include appropriate drawings and relay diagrams].

Transmission Provider will obtain control of Transmission Provider's Interconnection Facilities and Stand Alone Network Upgrades upon completion of such facilities.

5.12 Access Rights. Upon reasonable notice and supervision by a Party, and subject to any required or necessary regulatory approvals, a Party ("Granting Party") shall furnish at no cost to the other Party ("Access Party") any rights of use, licenses, rights of way and easements with respect to lands owned or controlled by the Granting Party, its agents (if allowed under the applicable agency agreement), or any Affiliate, that are necessary to enable the Access Party to obtain ingress and egress to construct, operate, maintain, repair, test (or witness testing), inspect, replace or remove facilities and equipment to: (i) interconnect the Large Generating Facility with the Transmission System; (ii) operate and maintain the Large Generating Facility, the Interconnection Facilities and the Transmission System; and (iii) disconnect or remove the Access Party's facilities and equipment upon termination of this LGIA. In exercising such licenses, rights of way and easements, the Access Party shall not unreasonably disrupt or interfere with normal operation of the Granting Party's business and shall adhere to the safety rules and procedures established in advance, as may be changed from time to time, by the Granting Party and provided to the Access Party.

5.13 Lands of Other Property Owners. If any part of Transmission Provider or Transmission Owner's Interconnection Facilities and/or Network Upgrades is to be installed on property owned by persons other than Interconnection Customer or Transmission Provider or Transmission Owner, Transmission Provider or Transmission Owner shall at Interconnection Customer's expense use efforts, similar in nature and extent to those that it typically undertakes on its own behalf or on behalf of its Affiliates, including use of its eminent domain authority, and to the extent consistent with state law, to procure from such persons any rights of use, licenses, rights of way and easements that are necessary to construct, operate, maintain, test, inspect, replace or remove Transmission Provider or Transmission Owner's Interconnection Facilities and/or Network Upgrades upon such property.

5.14 Permits. Transmission Provider or Transmission Owner and Interconnection Customer shall cooperate with each other in good faith in obtaining all permits, licenses and authorizations that are necessary to accomplish the interconnection in compliance with Applicable Laws and Regulations. With respect to this paragraph, Transmission Provider or Transmission Owner shall provide permitting assistance to Interconnection Customer comparable to that provided to Transmission Provider's own, or an Affiliate's generation.

5.15 Early Construction of Base Case Facilities. Interconnection Customer may request Transmission Provider to construct, and Transmission Provider shall construct, using Reasonable Efforts to accommodate Interconnection Customer's In-Service Date, all or any portion of any Network Upgrades required for Interconnection Customer to be interconnected to the Transmission System which are included in the Base Case of the Facilities Study for Interconnection Customer, and which also are required to be constructed for another Interconnection Customer, but where such construction is not scheduled to be completed in time to achieve Interconnection Customer's In-Service Date.

5.16 Suspension. Interconnection Customer reserves the right, upon written notice to Transmission Provider, to suspend at any time all work by Transmission Provider associated with the construction and installation of Transmission Provider's Interconnection Facilities and/or Network Upgrades required under this LGIA with the condition that Transmission System shall be left in a safe and reliable condition in accordance with Good Utility Practice and Transmission Provider's safety and reliability criteria. In such event, Interconnection Customer shall be responsible for all reasonable and necessary costs which Transmission Provider (i) has incurred pursuant to this LGIA prior to the suspension and (ii) incurs in suspending such work, including any costs incurred to perform such work as may be necessary to ensure the safety of persons and property and the integrity of the Transmission System during such suspension and, if applicable, any costs incurred in connection with the cancellation or suspension of material, equipment and labor contracts which Transmission Provider cannot reasonably avoid; provided, however, that prior to canceling or suspending any such material, equipment or labor contract, Transmission Provider shall obtain Interconnection Customer's authorization to do so.

Transmission Provider shall invoice Interconnection Customer for such costs pursuant to Article 12 and shall use due diligence to minimize its costs. In the event Interconnection Customer suspends work by Transmission Provider required under this LGIA pursuant to this Article 5.16, and has not requested Transmission Provider to recommence the work required under this LGIA on or before the expiration of three (3) years following commencement of such suspension, this LGIA shall be deemed terminated. The three-year period shall begin on the date the suspension is requested, or the date of the written notice to Transmission Provider, if no effective date is specified.

5.17 Taxes.

5.17.1 Interconnection Customer Payments Not Taxable. The Parties intend that all payments or property transfers made by

Interconnection Customer to Transmission Provider for the installation of Transmission Provider's Interconnection Facilities and the Network Upgrades shall be non-taxable, either as contributions to capital, or as an advance, in accordance with the Internal Revenue Code and any applicable state income tax laws and shall not be taxable as contributions in aid of construction or otherwise under the Internal Revenue Code and any applicable state income tax laws.

5.17.2 **Representations and Covenants.** In accordance with IRS Notice 2001-82 and IRS Notice 88-129, Interconnection Customer represents and covenants that (i) ownership of the electricity generated at the Large Generating Facility will pass to another party prior to the transmission of the electricity on the Transmission System, (ii) for income tax purposes, the amount of any payments and the cost of any property transferred to Transmission Provider for Transmission Provider's Interconnection Facilities will be capitalized by Interconnection Customer as an intangible asset and recovered using the straight-line method over a useful life of twenty (20) years, and (iii) any portion of Transmission Provider's Interconnection Facilities that is a "dual-use intertie," within the meaning of IRS Notice 88-129, is reasonably expected to carry only a de minimis amount of electricity in the direction of the Large Generating Facility. For this purpose, "de minimis amount" means no more than 5 percent of the total power flows in both directions, calculated in accordance with the "5 percent test" set forth in IRS Notice 88-129. This is not intended to be an exclusive list of the relevant conditions that must be met to conform to IRS requirements for non-taxable treatment.

At Transmission Provider's request, Interconnection Customer shall provide Transmission Provider with a report from an independent engineer confirming its representation in clause (iii), above. Transmission Provider represents and covenants that the cost of Transmission Provider's Interconnection Facilities paid for by Interconnection Customer will have no net effect on the base upon which rates are determined.

5.17.3 **Indemnification for the Cost Consequences of Current Tax Liability Imposed Upon the Transmission Provider.** Notwithstanding Article 5.17.1, Interconnection Customer shall protect, indemnify and hold harmless Transmission Provider from the cost consequences of any current tax liability imposed against Transmission Provider as the result of payments or property transfers made by Interconnection Customer to Transmission Provider under this LGIA for Interconnection Facilities, as well as any interest and penalties, other than interest and penalties attributable to any delay caused by Transmission Provider.

Transmission Provider shall not include a gross-up for the cost consequences of any current tax liability in the amounts it charges Interconnection Customer under this LGIA unless (i) Transmission Provider has determined, in good faith, that the payments or property transfers made by Interconnection Customer to Transmission Provider should be reported as income subject to taxation or (ii) any Governmental Authority directs Transmission Provider to report payments or property as income subject to taxation; provided, however, that Transmission Provider may require Interconnection Customer to provide security for Interconnection Facilities, in a form reasonably acceptable to Transmission Provider (such as a parental guarantee or a letter of credit), in an amount equal to the cost consequences of any current tax liability under this Article 5.17. Interconnection Customer shall reimburse Transmission Provider for such costs on a fully grossed-up basis, in accordance with Article 5.17.4, within thirty (30) Calendar Days of receiving written notification from Transmission Provider of the amount due, including detail about how the amount was calculated.

The indemnification obligation shall terminate at the earlier of (1) the expiration of the ten year testing period and the applicable statute of limitation, as it may be extended by Transmission Provider upon request of the IRS, to keep these years open for audit or adjustment, or (2) the occurrence of a subsequent taxable event and the payment of any related indemnification obligations as contemplated by this Article 5.17.

5.17.4 **Tax Gross-Up Amount.** Interconnection Customer's liability for the cost consequences of any current tax liability under this Article 5.17 shall be calculated on a fully grossed-up basis. Except as may otherwise be agreed to by the parties, this means that Interconnection Customer will pay Transmission Provider, in addition to the amount paid for the Interconnection Facilities and Network Upgrades, an amount equal to (1) the current taxes imposed on Transmission Provider ("Current Taxes") on the excess of (a) the gross income realized by Transmission Provider as a result of payments or property transfers made by Interconnection Customer to Transmission Provider under this LGIA (without regard to any payments under this Article 5.17) (the "Gross Income Amount") over (b) the present value of future tax deductions for depreciation that will be available as a result of such payments or property transfers (the "Present Value Depreciation Amount"), plus (2) an additional amount sufficient to permit Transmission Provider to receive and retain, after the payment of all Current Taxes, an amount equal to the net amount described in clause (1).

For this purpose, (i) Current Taxes shall be computed based on Transmission Provider's composite federal and state tax rates at the time the payments or property transfers are received and Transmission Provider will be treated as being subject to tax at the highest marginal rates in effect at that time (the "Current Tax Rate"), and (ii) the Present Value Depreciation Amount shall be computed by discounting Transmission Provider's anticipated tax depreciation deductions as a result of such payments or property transfers by Transmission Provider's current weighted average cost of capital. Thus, the formula for calculating Interconnection Customer's liability to Transmission Owner pursuant to this Article 5.17.4 can be expressed as follows: (Current Tax Rate x (Gross Income Amount - Present Value of Tax Depreciation))/(1-Current Tax Rate). Interconnection Customer's estimated tax liability in the event taxes are imposed shall be stated in Appendix A, Interconnection Facilities, Network Upgrades and Distribution Upgrades.

5.17.5 **Private Letter Ruling or Change or Clarification of Law.** At Interconnection Customer's request and expense, Transmission Provider shall file with the IRS a request for a private letter ruling as to whether any property transferred or sums paid, or to be paid, by Interconnection Customer to Transmission Provider under this LGIA are subject to federal income taxation. Interconnection Customer will prepare the initial draft of the request for a private letter ruling, and will certify under penalties of perjury that all facts represented in such request are true and accurate to the best of Interconnection Customer's knowledge. Transmission Provider and Interconnection Customer shall cooperate in good faith with respect to the submission of such request.

Transmission Provider shall keep Interconnection Customer fully informed of the status of such request for a private letter ruling and shall execute either a privacy act waiver or a limited power of attorney, in a form acceptable to the IRS, that authorizes Interconnection Customer to participate in all discussions with the IRS regarding such request for a private letter ruling. Transmission Provider shall allow Interconnection Customer to attend all meetings with IRS officials about the request and shall permit Interconnection Customer to prepare the initial drafts of any follow-up letters in connection with the request.

5.17.6 **Subsequent Taxable Events.** If, within 10 years from the date on which the relevant Transmission Provider's Interconnection Facilities are placed in service, (i) Interconnection Customer Breaches the covenants contained in Article 5.17.2, (ii) a "disqualification event" occurs within the meaning of IRS Notice 88-129, or (iii) this LGIA terminates and Transmission Provider retains ownership of the Interconnection Facilities and Network Upgrades, Interconnection Customer shall pay a tax gross-up for the cost consequences of any current tax liability imposed on Transmission Provider, calculated using the methodology described in Article 5.17.4 and in accordance with IRS Notice 90-60.

5.17.7 **Contests.** In the event any Governmental Authority determines that Transmission Provider's receipt of payments or property constitutes income that is subject to taxation, Transmission Provider shall notify Interconnection Customer, in writing, within thirty (30) Calendar Days of receiving notification of such determination by a Governmental Authority. Upon the timely written request by Interconnection Customer and at Interconnection Customer's sole expense, Transmission Provider may appeal, protest, seek abatement of, or otherwise oppose such determination. Upon Interconnection Customer's written request and sole expense, Transmission Provider may file a claim for refund with respect to any taxes paid under this Article 5.17, whether or not it has received such a determination. Transmission Provider reserves the right to make all decisions with regard to the prosecution of such appeal, protest, abatement or other contest, including the selection of counsel and compromise or settlement of the claim, but Transmission Provider shall keep Interconnection Customer informed, shall consider in good faith suggestions from Interconnection Customer about the conduct of the contest, and shall reasonably permit Interconnection Customer or an Interconnection Customer representative to attend contest proceedings.

Interconnection Customer shall pay to Transmission Provider on a periodic basis, as invoiced by Transmission Provider, Transmission Provider's documented reasonable costs of prosecuting such appeal, protest, abatement or other contest. At any time during the contest, Transmission Provider may agree to a settlement either with Interconnection Customer's consent or after obtaining written advice from nationally-recognized tax counsel, selected by Transmission

Provider, but reasonably acceptable to Interconnection Customer, that the proposed settlement represents a reasonable settlement given the hazards of litigation. Interconnection Customer's obligation shall be based on the amount of the settlement agreed to by Interconnection Customer, or if a higher amount, so much of the settlement that is supported by the written advice from nationally-recognized tax counsel selected under the terms of the preceding sentence. The settlement amount shall be calculated on a fully grossed-up basis to cover any related cost consequences of the current tax liability. Any settlement without Interconnection Customer's consent or such written advice will relieve Interconnection Customer from any obligation to indemnify Transmission Provider for the tax at issue in the contest.

5.17.8 **Refund.** In the event that (a) a private letter ruling is issued to Transmission Provider which holds that any amount paid or the value of any property transferred by Interconnection Customer to Transmission Provider under the terms of this LGIA is not subject to federal income taxation, (b) any legislative change or administrative announcement, notice, ruling or other determination makes it reasonably clear to Transmission Provider in good faith that any amount paid or the value of any property transferred by Interconnection Customer to Transmission Provider under the terms of this LGIA is not taxable to Transmission Provider, (c) any abatement, appeal, protest, or other contest results in a determination that any payments or transfers made by Interconnection Customer to Transmission Provider are not subject to federal income tax, or (d) if Transmission Provider receives a refund from any taxing authority for any overpayment of tax attributable to any payment or property transfer made by Interconnection Customer to Transmission Provider pursuant to this LGIA, Transmission Provider shall promptly refund to Interconnection Customer the following:

(i) any payment made by Interconnection Customer under this Article 5.17 for taxes that is attributable to the amount determined to be non-taxable, together with interest thereon,

(ii) interest on any amounts paid by Interconnection Customer to Transmission Provider for such taxes which Transmission Provider did not submit to the taxing authority, calculated in accordance with the methodology set forth in FERC's regulations at 18 CFR §35.19a(a)(2)(iii) from the date payment was made by Interconnection Customer to the date Transmission Provider refunds such payment to Interconnection Customer, and

(iii) with respect to any such taxes paid by Transmission Provider, any refund or credit Transmission Provider receives or to which it may be entitled from any Governmental Authority, interest (or that portion thereof attributable to the payment described in clause (i), above) owed to Transmission Provider for such overpayment of taxes (including any reduction in interest otherwise payable by Transmission Provider to any Governmental Authority resulting from an offset or credit); provided, however, that Transmission Provider will remit such amount promptly to Interconnection Customer only after and to the extent that Transmission Provider has received a tax refund, credit or offset from any Governmental Authority for any applicable overpayment of income tax related to Transmission Provider's Interconnection Facilities.

The intent of this provision is to leave the Parties, to the extent practicable, in the event that no taxes are due with respect to any payment for Interconnection Facilities and Network Upgrades hereunder, in the same position they would have been in had no such tax payments been made.

5.17.9 **Taxes Other Than Income Taxes.** Upon the timely request by Interconnection Customer, and at Interconnection Customer's sole expense, Transmission Provider may appeal, protest, seek abatement of, or otherwise contest any tax (other than federal or state income tax) asserted or assessed against Transmission Provider for which Interconnection Customer may be required to reimburse Transmission Provider under the terms of this LGIA. Interconnection Customer shall pay to Transmission Provider on a periodic basis, as invoiced by Transmission Provider, Transmission Provider's documented reasonable costs of prosecuting such appeal, protest, abatement, or other contest. Interconnection Customer and Transmission Provider shall cooperate in good faith with respect to any such contest. Unless the payment of such taxes is a prerequisite to an appeal or abatement or cannot be deferred, no amount shall be payable by Interconnection Customer to Transmission Provider for such taxes until they are assessed by a final, non-appealable order by any court or agency of competent jurisdiction. In the event that a tax payment is withheld and ultimately due and payable after appeal, Interconnection Customer will be responsible for all taxes, interest and penalties, other than penalties attributable to any delay caused by Transmission Provider.

5.17.10 Transmission Owners Who Are Not Transmission Providers. If Transmission Provider is not the same entity as the Transmission Owner, then (i) all references in this Article 5.17 to Transmission Provider shall be deemed also to refer to and to include the Transmission Owner, as appropriate, and (ii) this LGIA shall not become effective until such Transmission Owner shall have agreed in writing to assume all of the duties and obligations of Transmission Provider under this Article 5.17 of this LGIA.

5.18 Tax Status. Each Party shall cooperate with the other to maintain the other Party's tax status. Nothing in this LGIA is intended to adversely affect any Transmission Provider's tax exempt status with respect to the issuance of bonds including, but not limited to, Local Furnishing Bonds.

5.19 Modification.

5.19.1 General. Either Party may undertake modifications to its facilities. If a Party plans to undertake a modification that reasonably may be expected to affect the other Party's facilities, that Party shall provide to the other Party sufficient information regarding such modification so that the other Party may evaluate the potential impact of such modification prior to commencement of the work. Such information shall be deemed to be confidential hereunder and shall include information concerning the timing of such modifications and whether such modifications are expected to interrupt the flow of electricity from the Large Generating Facility. The Party desiring to perform such work shall provide the relevant drawings, plans, and specifications to the other Party at least ninety (90) Calendar Days in advance of the commencement of the work or such shorter period upon which the Parties may agree, which agreement shall not unreasonably be withheld, conditioned or delayed.

In the case of Large Generating Facility modifications that do not require Interconnection Customer to submit an Interconnection Request, Transmission Provider shall provide, within thirty (30) Calendar Days (or such other time as the Parties may agree), an estimate of any additional modifications to the Transmission System, Transmission Provider's Interconnection Facilities or Network Upgrades necessitated by such Interconnection Customer modification and a good faith estimate of the costs thereof.

5.19.2 **Standards.** Any additions, modifications, or replacements made to a Party's facilities shall be designed, constructed and operated in accordance with this LGIA and Good Utility Practice.

5.19.3 **Modification Costs.** Interconnection Customer shall not be directly assigned for the costs of any additions, modifications, or replacements that Transmission Provider makes to Transmission Provider's Interconnection Facilities or the Transmission System to facilitate the interconnection of a third party to Transmission Provider's Interconnection Facilities or the Transmission System, or to provide transmission service to a third party under Transmission Provider's Tariff. Interconnection Customer shall be responsible for the costs of any additions, modifications, or replacements to Interconnection Customer's Interconnection Facilities that may be necessary to maintain or upgrade such Interconnection Customer's Interconnection Facilities consistent with Applicable Laws and Regulations, Applicable Reliability Standards or Good Utility Practice.

Article 6. Testing and Inspection

6.1 **Pre-Commercial Operation Date Testing and Modifications**. Prior to the Commercial Operation Date, Transmission Provider shall test Transmission Provider's Interconnection Facilities and Network Upgrades and Interconnection Customer shall test the Large Generating Facility and Interconnection Customer's Interconnection Facilities to ensure their safe and reliable operation. Similar testing may be required after initial operation. Each Party shall make any modifications to its facilities that are found to be necessary as a result of such testing. Interconnection Customer shall bear the cost of all such testing and modifications. Interconnection Customer shall generate test energy at the Large Generating Facility only if it has arranged for the delivery of such test energy.

6.2 **Post-Commercial Operation Date Testing and Modifications**. Each Party shall at its own expense perform routine inspection and testing of its facilities and equipment in accordance with Good Utility Practice as may be necessary to ensure the continued interconnection of the Large Generating Facility with the Transmission System in a safe and reliable manner. Each Party shall have the right, upon advance written notice, to require reasonable additional testing of the other Party's facilities, at the requesting Party's expense, as may be in accordance with Good Utility Practice.

6.3 **Right to Observe Testing**. Each Party shall notify the other Party in advance of its performance of tests of its Interconnection Facilities. The other

Party has the right, at its own expense, to observe such testing.

6.4 Right to Inspect. Each Party shall have the right, but shall have no obligation to: (i) observe the other Party's tests and/or inspection of any of its System Protection Facilities and other protective equipment, including Power System Stabilizers; (ii) review the settings of the other Party's System Protection Facilities and other protective equipment; and (iii) review the other Party's maintenance records relative to the Interconnection Facilities, the System Protection Facilities and other protective equipment. A Party may exercise these rights from time to time as it deems necessary upon reasonable notice to the other Party. The exercise or non-exercise by a Party of any such rights shall not be construed as an endorsement or confirmation of any element or condition of the Interconnection Facilities or the System Protection Facilities or other protective equipment or the operation thereof, or as a warranty as to the fitness, safety, desirability, or reliability of same. Any information that a Party obtains through the exercise of any of its rights under this Article 6.4 shall be deemed to be Confidential Information and treated pursuant to Article 22 of this LGIA.

Article 7. Metering

7.1 General. Each Party shall comply with the Applicable Reliability Council requirements. Unless otherwise agreed by the Parties, Transmission Provider shall install Metering Equipment at the Point of Interconnection prior to any operation of the Large Generating Facility and shall own, operate, test and maintain such Metering Equipment. Power flows to and from the Large Generating Facility shall be measured at or, at Transmission Provider's option, compensated to, the Point of Interconnection. Transmission Provider shall provide metering quantities, in analog and/or digital form, to Interconnection Customer upon request. Interconnection Customer shall bear all reasonable documented costs associated with the purchase, installation, operation, testing and maintenance of the Metering Equipment.

7.2 **Check Meters.** Interconnection Customer, at its option and expense, may install and operate, on its premises and on its side of the Point of Interconnection, one or more check meters to check Transmission Provider's meters. Such check meters shall be for check purposes only and shall not be used for the measurement of power flows for purposes of this LGIA, except as provided in Article 7.4 below. The check meters shall be subject at all reasonable times to inspection and examination by Transmission Provider or its designee. The installation, operation and maintenance thereof shall be performed entirely by Interconnection Customer in accordance with Good Utility Practice.

7.3 **Standards.** Transmission Provider shall install, calibrate, and test revenue quality Metering Equipment in accordance with applicable ANSI standards.

7.4 **Testing of Metering Equipment.** Transmission Provider shall inspect and test all Transmission Provider-owned Metering Equipment upon installation and at least once every two (2) years thereafter. If requested to do so by Interconnection Customer, Transmission Provider shall, at Interconnection Customer's expense, inspect or test Metering Equipment more frequently than every two (2) years. Transmission Provider shall give reasonable notice of the time when any inspection or test shall take place, and Interconnection Customer may have representatives present at the test or inspection. If at any time Metering Equipment is found to be inaccurate or defective, it shall be adjusted, repaired or replaced at Interconnection Customer's expense, in order to provide accurate metering, unless the inaccuracy or defect is due to Transmission Provider's failure to maintain, then Transmission Provider shall pay. If Metering Equipment fails to register, or if the measurement made by Metering Equipment during a test varies by more than two percent from the measurement made by the standard meter used in the test, Transmission Provider shall adjust the measurements by correcting all measurements for the period during which Metering Equipment was in error by using Interconnection

Customer's check meters, if installed. If no such check meters are installed or if the period cannot be reasonably ascertained, the adjustment shall be for the period immediately preceding the test of the Metering Equipment equal to one-half the time from the date of the last previous test of the Metering Equipment.

7.5 **Metering Data.** At Interconnection Customer's expense, the metered data shall be telemetered to one or more locations designated by Transmission Provider and one or more locations designated by Interconnection Customer. Such telemetered data shall be used, under normal operating conditions, as the official measurement of the amount of energy delivered from the Large Generating Facility to the Point of Interconnection.

Article 8. Communications

8.1 **Interconnection Customer Obligations.** Interconnection Customer shall maintain satisfactory operating communications with Transmission Provider's Transmission System dispatcher or representative designated by Transmission Provider. Interconnection Customer shall provide standard voice line, dedicated voice line and facsimile communications at its Large Generating Facility control room or central dispatch facility through use of either the public telephone system, or a voice communications system that does not rely on the public telephone system. Interconnection Customer shall also provide the dedicated data circuit(s) necessary to provide Interconnection Customer data to Transmission Provider as set forth in Appendix D, Security Arrangements Details. The data circuit(s) shall extend from the Large Generating Facility to the location(s) specified by Transmission Provider. Any required maintenance of such communications equipment shall be performed by Interconnection Customer. Operational communications shall be activated and maintained under, but not be limited to, the following events: system paralleling or separation, scheduled and unscheduled shutdowns, equipment clearances, and hourly and daily load data.

8.2 **Remote Terminal Unit.** Prior to the Initial Synchronization Date of the Large Generating Facility, a Remote Terminal Unit, or equivalent data collection and transfer equipment acceptable to the Parties, shall be installed by Interconnection Customer, or by Transmission Provider at Interconnection Customer's expense, to gather accumulated and instantaneous data to be telemetered to the location(s) designated by Transmission Provider through use of a dedicated point-to-point data circuit(s) as indicated in Article 8.1. The communication protocol for the data circuit(s) shall be specified by Transmission Provider. Instantaneous bi-directional analog real power and reactive power flow information must be telemetered directly to the location(s) specified by Transmission Provider.

Each Party will promptly advise the other Party if it detects or otherwise learns of any metering, telemetry or communications equipment errors or malfunctions that require the attention and/or correction by the other Party. The Party owning such equipment shall correct such error or malfunction as soon as reasonably feasible.

8.3 **No Annexation.** Any and all equipment placed on the premises of a Party shall be and remain the property of the Party providing such equipment regardless of the mode and manner of annexation or attachment to real property, unless otherwise mutually agreed by the Parties.

Article 9. Operations

9.1 **General.** Each Party shall comply with the Applicable Reliability Council requirements. Each Party shall provide to the other Party all information that may reasonably be required by the other Party to comply with Applicable Laws and Regulations and Applicable Reliability Standards.

9.2 **Control Area Notification.** At least three months before Initial Synchronization Date, Interconnection Customer shall notify Transmission Provider in writing of the Control Area in which the Large Generating Facility will be located. If

Interconnection Customer elects to locate the Large Generating Facility in a Control Area other than the Control Area in which the Large Generating Facility is physically located, and if permitted to do so by the relevant transmission tariffs, all necessary arrangements, including but not limited to those set forth in Article 7 and Article 8 of this LGIA, and remote Control Area generator interchange agreements, if applicable, and the appropriate measures under such agreements, shall be executed and implemented prior to the placement of the Large Generating Facility in the other Control Area.

9.3 **Transmission Provider Obligations.** Transmission Provider shall cause the Transmission System and Transmission Provider's Interconnection Facilities to be operated, maintained and controlled in a safe and reliable manner and in accordance with this LGIA. Transmission Provider may provide operating instructions to Interconnection Customer consistent with this LGIA and Transmission Provider's operating protocols and procedures as they may change from time to time. Transmission Provider will consider changes to its operating protocols and procedures proposed by Interconnection Customer.

9.4 **Interconnection Customer Obligations.** Interconnection Customer shall at its own expense operate, maintain and control the Large Generating Facility and Interconnection Customer's Interconnection Facilities in a safe and reliable manner and in accordance with this LGIA. Interconnection Customer shall operate the Large Generating Facility and Interconnection Customer's Interconnection Facilities in accordance with all applicable requirements of the Control Area of which it is part, as such requirements are set forth in Appendix C, Interconnection Details, of this LGIA. Appendix C, Interconnection Details, will be modified to reflect changes to the requirements as they may change from time to time. Either Party may request that the other Party provide copies of the requirements set forth in Appendix C, Interconnection Details, of this LGIA.

9.5 **Start-Up and Synchronization.** Consistent with the Parties' mutually acceptable procedures, Interconnection Customer is responsible for the proper synchronization of the Large Generating Facility to Transmission Provider's Transmission System.

9.6 Reactive Power.

9.6.1 Power Factor Design Criteria. Interconnection Customer shall design the Large Generating Facility to maintain a composite power delivery at continuous rated power output at the Point of Interconnection at a power factor within the range of 0.95 leading to 0.95 lagging, unless Transmission Provider has established different requirements that apply to all generators in the Control Area on a comparable basis. The requirements of this paragraph shall not apply to wind generators.

9.6.2 Voltage Schedules. Once Interconnection Customer has synchronized the Large Generating Facility with the Transmission System, Transmission Provider shall require Interconnection Customer to operate the Large Generating Facility to produce or absorb reactive power within the design limitations of the Large Generating Facility set forth in Article 9.6.1 (Power Factor Design Criteria). Transmission Provider's voltage schedules shall treat all sources of reactive power in the Control Area in an equitable and not unduly discriminatory manner. Transmission Provider shall exercise Reasonable Efforts to provide Interconnection Customer with such schedules at least one (1) day in advance, and may make changes to such schedules as necessary to maintain the reliability of the Transmission System. Interconnection Customer shall operate the Large Generating Facility to maintain the specified output voltage or power factor at the Point of Interconnection within the design limitations of the Large Generating

Facility set forth in Article 9.6.1 (Power Factor Design Criteria). If Interconnection Customer is unable to maintain the specified voltage or power factor, it shall promptly notify the System Operator.

9.6.2.1 Governors and Regulators. Whenever the Large Generating Facility is operated in parallel with the Transmission System and the speed governors (if installed on the generating unit pursuant to Good Utility Practice) and voltage regulators are capable of operation, Interconnection Customer shall operate the Large Generating Facility with its speed governors and voltage regulators in automatic operation. If the Large Generating Facility's speed governors and voltage regulators are not capable of such automatic operation, Interconnection Customer shall immediately notify Transmission Provider's system operator, or its designated representative, and ensure that such Large Generating Facility's reactive power production or absorption (measured in MVARs) are within the design capability of the Large Generating Facility's generating unit(s) and steady state stability limits. Interconnection Customer shall not cause its Large Generating Facility to disconnect automatically or instantaneously from the Transmission System or trip any generating unit comprising the Large Generating Facility for an under or over frequency condition unless the abnormal frequency condition persists for a time period beyond the limits set forth in ANSI/IEEE Standard C37.106, or such other standard as applied to other generators in the Control Area on a comparable basis.

9.6.3 **Payment for Reactive Power.** Transmission Provider is required to pay Interconnection Customer for reactive power that Interconnection Customer provides or absorbs from the Large Generating Facility when Transmission Provider requests Interconnection Customer to operate its Large Generating Facility outside the range specified in Article 9.6.1, provided that if Transmission Provider pays its own or affiliated generators for reactive power service within the specified range, it must also pay Interconnection Customer. Payments shall be pursuant to Article 11.6 or such other agreement to which the Parties have otherwise agreed.

9.7 Outages and Interruptions.

9.7.1 Outages.

9.7.1.1 **Outage Authority and Coordination.** Each Party may in accordance with Good Utility Practice in coordination with the other Party remove from service any of its respective Interconnection Facilities or Network Upgrades that may impact the other Party's facilities as necessary to perform maintenance or testing or to install or replace equipment. Absent an Emergency Condition, the Party scheduling a removal of such facility(ies) from service will use Reasonable Efforts to schedule such removal on a date and time mutually acceptable to the Parties. In all circumstances, any Party planning to remove such facility(ies) from service shall use Reasonable Efforts to minimize the effect on the other Party of such removal.

9.7.1.2 **Outage Schedules.** Transmission Provider shall post scheduled outages of its transmission facilities on the OASIS. Interconnection Customer shall submit its planned maintenance schedules for the Large Generating Facility to Transmission Provider for a minimum of a rolling twenty-four month period. Interconnection Customer shall update its planned maintenance schedules as necessary. Transmission Provider may request Interconnection Customer to reschedule its maintenance as necessary to maintain the reliability of the Transmission System; provided, however, adequacy of generation supply shall not be a criterion in determining Transmission System reliability. Transmission Provider shall compensate Interconnection Customer for any additional direct costs that Interconnection Customer incurs as a result of having to reschedule maintenance, including any additional overtime, breaking of maintenance contracts or other costs above and beyond the cost Interconnection Customer would have incurred absent Transmission Provider's request to reschedule maintenance. Interconnection Customer will not be eligible to receive compensation, if during the twelve (12) months prior to the date of the scheduled maintenance, Interconnection Customer had modified its schedule of maintenance activities.

9.7.1.3 Outage Restoration. If an outage on a Party's Interconnection Facilities or Network Upgrades adversely affects the other Party's operations or facilities, the Party that owns or controls the facility that is out of service shall use Reasonable Efforts to promptly restore such facility(ies) to a normal operating condition consistent with the nature of the outage. The Party that owns or controls the facility that is out of service shall provide the other Party, to the extent such information is known, information on the nature of the Emergency Condition, an estimated time of restoration, and any corrective actions required. Initial verbal notice shall be followed up as soon as practicable with written notice explaining the nature of the outage.

9.7.2 Interruption of Service. If required by Good Utility Practice to do so, Transmission Provider may require Interconnection Customer to interrupt or reduce deliveries of electricity if such delivery of electricity could adversely affect Transmission Provider's ability to perform such activities as are necessary to safely and reliably operate and maintain the Transmission System. The following provisions shall apply to any interruption or reduction permitted under this Article 9.7.2:

9.7.2.1 The interruption or reduction shall continue only for so long as reasonably necessary under Good Utility Practice;

9.7.2.2 Any such interruption or reduction shall be made on an equitable, non-discriminatory basis with respect to all generating facilities directly connected to the Transmission System;

9.7.2.3 When the interruption or reduction must be made under circumstances which do not allow for advance notice, Transmission Provider shall notify Interconnection Customer by telephone as soon as practicable of the reasons for the curtailment, interruption, or reduction, and, if known, its expected duration. Telephone notification shall be followed by written notification as soon as practicable;

9.7.2.4 Except during the existence of an Emergency Condition, when the interruption or reduction can be scheduled without advance notice, Transmission Provider shall notify Interconnection Customer in advance regarding the timing of such scheduling and further notify Interconnection Customer of the expected duration. Transmission Provider shall coordinate with Interconnection Customer using Good Utility Practice to schedule the interruption or reduction during periods of least impact to Interconnection Customer and Transmission Provider;

9.7.2.5 The Parties shall cooperate and coordinate with each other to the extent necessary in order to restore the Large Generating

Facility, Interconnection Facilities, and the Transmission System to their normal operating state, consistent with system conditions and Good Utility Practice.

9.7.3 **Under-Frequency and Over Frequency Conditions.** The Transmission System is designed to automatically activate a load-shed program as required by the Applicable Reliability Council in the event of an under-frequency system disturbance. Interconnection Customer shall implement under-frequency and over-frequency relay set points for the Large Generating Facility as required by the Applicable Reliability Council to ensure "ride through" capability of the Transmission System. Large Generating Facility response to frequency deviations of pre-determined magnitudes, both under-frequency and over-frequency deviations, shall be studied and coordinated with Transmission Provider in accordance with Good Utility Practice. The term "ride through" as used herein shall mean the ability of a Generating Facility to stay connected to and synchronized with the Transmission System during system disturbances within a range of under-frequency and over-frequency conditions, in accordance with Good Utility Practice.

9.7.4 **System Protection and Other Control Requirements.**

9.7.4.1 **System Protection Facilities.** Interconnection Customer shall, at its expense, install, operate and maintain System Protection Facilities as a part of the Large Generating Facility or Interconnection Customer's Interconnection Facilities. Transmission Provider shall install at Interconnection

Customer's expense any System Protection Facilities that may be required on Transmission Provider's Interconnection Facilities or the Transmission System as a result of the interconnection of the Large Generating Facility and Interconnection Customer's Interconnection Facilities.

9.7.4.2 Each Party's protection facilities shall be designed and coordinated with other systems in accordance with Good Utility Practice.

9.7.4.3 Each Party shall be responsible for protection of its facilities consistent with Good Utility Practice.

9.7.4.4 Each Party's protective relay design shall incorporate the necessary test switches to perform the tests required in Article 6. The required test switches will be placed such that they allow operation of lockout relays while preventing breaker failure schemes from operating and causing unnecessary breaker operations and/or the tripping of Interconnection Customer's units.

9.7.4.5 Each Party will test, operate and maintain System Protection Facilities in accordance with Good Utility Practice.

9.7.4.6 Prior to the In-Service Date, and again prior to the Commercial Operation Date, each Party or its agent shall perform a complete calibration test and functional trip test of the System Protection Facilities. At intervals suggested by Good Utility Practice and following any apparent malfunction of the System Protection Facilities, each Party shall perform both calibration and functional trip tests of its System Protection Facilities. These tests do not require the tripping of any in-service generation unit. These tests do, however, require that all protective relays and lockout contacts be activated.

9.7.5 Requirements for Protection. In compliance with Good Utility Practice, Interconnection Customer shall provide, install, own, and maintain relays, circuit breakers and all other devices necessary to remove any fault contribution of the Large Generating Facility to any short circuit occurring on the Transmission System not otherwise isolated by Transmission Provider's equipment, such that the removal of the fault contribution shall be coordinated with the protective requirements of the Transmission System. Such protective equipment shall include, without limitation, a disconnecting device or switch with load-interrupting capability located between the Large Generating Facility and the Transmission System at a site selected upon mutual agreement (not to be unreasonably withheld, conditioned or delayed) of the Parties. Interconnection Customer shall be responsible for protection of the Large Generating Facility and Interconnection Customer's other equipment from such conditions as negative sequence currents, over- or under-frequency, sudden load rejection, over- or under-voltage, and generator loss-of-field. Interconnection Customer shall be solely responsible to disconnect the Large Generating Facility and Interconnection Customer's other equipment if conditions on the Transmission System could adversely affect the Large Generating Facility.

9.7.6 Power Quality. Neither Party's facilities shall cause excessive voltage flicker nor introduce excessive distortion to the sinusoidal voltage or current waves as defined by ANSI Standard C84.1-1989, in accordance with IEEE Standard 519, or any applicable superseding electric industry standard. In the event of a conflict between ANSI Standard C84.1-1989, or any applicable superseding electric industry standard, ANSI Standard C84.1-1989, or the applicable superseding electric industry standard, shall control.

9.8 **Switching and Tagging Rules.** Each Party shall provide the other Party a copy of its switching and tagging rules that are applicable to the other Party's activities. Such switching and tagging rules shall be developed on a non-discriminatory basis. The Parties shall comply with applicable switching and tagging rules, as amended from time to time, in obtaining clearances for work or for switching operations on equipment.

9.9 **Use of Interconnection Facilities by Third Parties.**

9.9.1 **Purpose of Interconnection Facilities.** Except as may be required by Applicable Laws and Regulations, or as otherwise agreed to among the Parties, the Interconnection Facilities shall be constructed for the sole purpose of interconnecting the Large Generating Facility to the Transmission System and shall be used for no other purpose.

9.9.2 **Third Party Users.** If required by Applicable Laws and Regulations or if the Parties mutually agree, such agreement not to be unreasonably withheld, to allow one or more third parties to use Transmission Provider's Interconnection Facilities, or any part thereof, Interconnection Customer will be entitled to compensation for the capital expenses it incurred in connection with the Interconnection Facilities based upon the pro rata use of the Interconnection Facilities by Transmission Provider, all third party users, and Interconnection Customer, in accordance with Applicable Laws and Regulations or upon some other mutually-agreed upon methodology. In addition, cost responsibility for ongoing costs, including operation and maintenance costs associated with the Interconnection Facilities, will be allocated between Interconnection Customer and any third party users based upon the pro rata use of the Interconnection Facilities by Transmission Provider, all third party users, and Interconnection Customer, in accordance with Applicable Laws and Regulations or upon some other mutually agreed upon methodology. If the issue of such compensation or allocation cannot be resolved through such negotiations, it shall be submitted to FERC for resolution.

9.10 Disturbance Analysis Data Exchange. The Parties will cooperate with one another in the analysis of disturbances to either the Large Generating Facility or Transmission Provider's Transmission System by gathering and providing access to any information relating to any disturbance, including information from oscillography, protective relay targets, breaker operations and sequence of events records, and any disturbance information required by Good Utility Practice.

Article 10. Maintenance

10.1 Transmission Provider Obligations. Transmission Provider shall maintain the Transmission System and Transmission Provider's Interconnection Facilities in a safe and reliable manner and in accordance with this LGIA.

10.2 Interconnection Customer Obligations. Interconnection Customer shall maintain the Large Generating Facility and Interconnection Customer's Interconnection Facilities in a safe and reliable manner and in accordance with this LGIA.

10.3 Coordination. The Parties shall confer regularly to coordinate the planning, scheduling and performance of preventive and corrective maintenance on the Large Generating Facility and the Interconnection Facilities.

10.4 Secondary Systems. Each Party shall cooperate with the other in the inspection, maintenance, and testing of control or power circuits that operate below 600 volts, AC or DC, including, but not limited to, any hardware, control or protective devices, cables, conductors, electric raceways, secondary equipment panels, transducers, batteries, chargers, and voltage and current transformers that directly affect the operation of a Party's facilities and equipment which may reasonably be expected to impact the other Party. Each Party shall provide advance notice to the other Party before undertaking any work on such circuits, especially on electrical circuits involving circuit breaker trip and close contacts, current transformers, or potential transformers.

10.5 Operating and Maintenance Expenses. Subject to the provisions herein addressing the use of facilities by others, and except for operations and maintenance expenses associated with modifications made for providing interconnection or transmission service to a third party and such third party pays for such expenses, Interconnection Customer shall be responsible for all reasonable expenses including overheads, associated with: (1) owning, operating, maintaining, repairing, and replacing Interconnection Customer's Interconnection Facilities; and (2) operation, maintenance, repair and replacement of Transmission Provider's Interconnection Facilities.

Article 11. Performance Obligation

11.1 Interconnection Customer Interconnection Facilities. Interconnection Customer shall design, procure, construct, install, own and/or control Interconnection Customer Interconnection Facilities described in Appendix A, Interconnection Facilities, Network Upgrades and Distribution Upgrades, at its sole expense.

11.2 Transmission Provider's Interconnection Facilities. Transmission Provider or Transmission Owner shall design, procure, construct, install, own and/or control the Transmission Provider's Interconnection Facilities described in Appendix A, Interconnection Facilities, Network Upgrades and Distribution

Upgrades, at the sole expense of the Interconnection Customer.

11.3 Network Upgrades and Distribution Upgrades. Transmission Provider or Transmission Owner shall design, procure, construct, install, and own the Network Upgrades and Distribution Upgrades described in Appendix A, Interconnection Facilities, Network Upgrades and Distribution Upgrades. The Interconnection Customer shall be responsible for all costs related to Distribution Upgrades. Unless Transmission Provider or Transmission Owner elects to fund the capital for the Network Upgrades, they shall be solely funded by Interconnection Customer.

11.4 Transmission Credits.

11.4.1 Repayment of Amounts Advanced for Network Upgrades. Interconnection Customer shall be entitled to a cash repayment, equal to the total amount paid to Transmission Provider and Affected System Operator, if any, for the Network Upgrades, including any tax gross-up or other tax-related payments associated with Network Upgrades, and not refunded to Interconnection Customer pursuant to Article 5.17.8 or otherwise, to be paid to Interconnection Customer on a dollar-for-dollar basis for the non-usage sensitive portion of transmission charges, as payments are made under Transmission Provider's Tariff and Affected System's Tariff for transmission services with respect to the Large Generating Facility. Any repayment shall include interest calculated in accordance with the methodology set forth in FERC=s regulations at 18 C.F.R. § 35.19a(a)(2)(iii) from the date of any payment for Network Upgrades through the date on which the Interconnection Customer receives a repayment of such payment pursuant to this subparagraph. Interconnection Customer may assign such repayment rights to any person.

Notwithstanding the foregoing, Interconnection Customer, Transmission Provider, and Affected System Operator may adopt any alternative payment schedule that is mutually agreeable so long as Transmission Provider and Affected System Operator take one of the following actions no later than five years from the Commercial Operation Date: (1) return to Interconnection Customer any amounts advanced for Network Upgrades not previously repaid, or (2) declare in writing that Transmission Provider or Affected System Operator will continue to provide payments to Interconnection Customer on a dollar-for-dollar basis for the non-usage sensitive portion of transmission charges, or develop an alternative schedule that is mutually agreeable and provides for the return of all amounts advanced for Network Upgrades not previously repaid; however, full reimbursement shall not extend beyond twenty (20) years from the Commercial Operation Date.

If the Large Generating Facility fails to achieve commercial operation, but it or another Generating Facility is later constructed and makes use of the Network Upgrades, Transmission Provider and Affected System Operator shall at that time reimburse Interconnection Customer for the amounts advanced for the Network Upgrades. Before any such reimbursement can occur, the Interconnection Customer, or the entity that ultimately constructs the Generating Facility, if different, is responsible for identifying the entity to which reimbursement must be made.

11.4.2 Special Provisions for Affected Systems. Unless Transmission Provider provides, under the LGIA, for the repayment of amounts advanced to Affected System Operator for Network Upgrades, Interconnection Customer and Affected

System Operator shall enter into an agreement that provides for such repayment. The agreement shall specify the terms governing payments to be made by Interconnection Customer to the Affected System Operator as well as the repayment by the Affected System Operator.

11.4.3 Notwithstanding any other provision of this LGIA, nothing herein shall be construed as relinquishing or foreclosing any rights, including but not limited to firm transmission rights, capacity rights, transmission congestion rights, or transmission credits, that Interconnection Customer, shall be entitled to, now or in the future under any other agreement or tariff as a result of, or otherwise associated with, the transmission capacity, if any, created by the Network Upgrades, including the right to obtain cash reimbursements or transmission credits for transmission service that is not associated with the Large Generating Facility.

11.5 Provision of Security. At least thirty (30) Calendar Days prior to the commencement of the design, procurement, installation, or construction of a discrete portion of a Transmission Provider's Interconnection Facilities, Network Upgrades, or Distribution Upgrades, Interconnection Customer shall provide Transmission Provider, at Interconnection Customer's option, a guarantee, a surety bond, letter of credit or other form of security that is reasonably acceptable to Transmission Provider and is consistent with the Uniform Commercial Code of the jurisdiction identified in Article 14.2.1. Such security for payment shall be in an amount sufficient to cover the costs for constructing, designing, procuring, and installing the applicable portion of Transmission Provider's Interconnection Facilities, Network Upgrades, or Distribution Upgrades and shall be reduced on a dollar-for-dollar basis for payments made to Transmission Provider for these purposes.

In addition:

11.5.1 The guarantee must be made by an entity that meets the creditworthiness requirements of Transmission Provider, and contain terms and conditions that guarantee payment of any amount that may be due from Interconnection Customer, up to an agreed-to maximum amount.

11.5.2 The letter of credit must be issued by a financial institution reasonably acceptable to Transmission Provider and must specify a reasonable expiration date.

11.5.3 The surety bond must be issued by an insurer reasonably acceptable to Transmission Provider and must specify a reasonable expiration date.

11.6 Interconnection Customer Compensation. If Transmission Provider requests or directs Interconnection Customer to provide a service pursuant to Articles 9.6.3 (Payment for Reactive Power), or 13.5.1 of this LGIA, Transmission Provider shall compensate Interconnection Customer in accordance with Interconnection Customer's applicable rate schedule then in effect unless the provision of such service(s) is subject to an RTO or ISO FERC-approved rate schedule. Interconnection Customer shall serve Transmission Provider or RTO or ISO with any filing of a proposed rate schedule at the time of such filing with FERC. To the extent that no rate schedule is in effect at the time the Interconnection Customer is required to provide or absorb any Reactive Power under this LGIA, Transmission Provider agrees to compensate Interconnection Customer in such amount as would have been due Interconnection Customer had the rate schedule been in effect at the time service commenced; provided, however, that such rate schedule must be filed at FERC or other appropriate Governmental Authority within sixty (60) Calendar Days of the commencement of service.

11.6.1 Interconnection Customer Compensation for Actions During Emergency Condition. Transmission Provider or RTO or ISO shall compensate Interconnection Customer for its provision of real and reactive power and other Emergency Condition services that Interconnection Customer provides to support the Transmission System during an Emergency Condition in accordance with Article 11.6.

Article 12. Invoice

12.1 General. Each Party shall submit to the other Party, on a monthly basis, invoices of amounts due for the preceding month. Each invoice shall state the month to which the invoice applies and fully describe the services and equipment provided. The Parties may discharge mutual debts and payment obligations due and owing to each other on the same date through netting, in which case all amounts a Party owes to the other Party under this LGIA, including interest payments or credits, shall be netted so that only the net amount remaining due shall be paid by the owing Party.

12.2 Final Invoice. Within six months after completion of the construction of Transmission Provider's Interconnection Facilities and the Network Upgrades, Transmission Provider shall provide an invoice of the final cost of the construction of Transmission Provider's Interconnection Facilities and the Network Upgrades and shall set forth such costs in sufficient detail to enable Interconnection Customer to compare the actual costs with the estimates and to ascertain deviations, if any, from the cost estimates. Transmission Provider shall refund to Interconnection Customer any amount by which the actual payment by Interconnection Customer for estimated costs exceeds the actual costs of construction within thirty (30) Calendar Days of the issuance of such final construction invoice.

12.3 Payment. Invoices shall be rendered to the paying Party at the address specified in Appendix F. The Party receiving the invoice shall pay the invoice within thirty (30) Calendar Days of receipt. All payments shall be made in immediately available funds payable to the other Party, or by wire transfer to a bank named and account designated by the invoicing Party. Payment of invoices by either Party will not constitute a waiver of any rights or claims either Party may have under this LGIA.

12.4 Disputes. In the event of a billing dispute between Transmission Provider and Interconnection Customer, Transmission Provider shall continue to provide Interconnection Service under this LGIA as long as Interconnection Customer: (i) continues to make all payments not in dispute; and (ii) pays to Transmission Provider or into an independent escrow account the portion of the invoice in dispute, pending resolution of such dispute. If Interconnection Customer fails to meet these two requirements for continuation of service, then Transmission Provider may provide notice to Interconnection Customer of a Default pursuant to Article 17. Within thirty (30) Calendar Days after the resolution of the dispute, the Party that owes money to the other Party shall pay the amount due with interest calculated in accord with the methodology set forth in FERC's regulations at 18 CFR § 35.19a(a)(2)(iii).

Article 13. Emergencies

13.1 Definition. "Emergency Condition" shall mean a condition or situation: (i) that in the judgment of the Party making the claim is imminently likely to endanger life or property; or (ii) that, in the case of Transmission Provider, is imminently likely (as determined in a non-discriminatory manner) to cause a material adverse effect on the security of, or damage to the Transmission System, Transmission Provider's Interconnection Facilities or the Transmission Systems of others to which the Transmission System is directly connected; or (iii) that, in the case of Interconnection Customer, is imminently likely (as determined in a non-discriminatory manner) to cause a material adverse effect on the security of, or damage to, the Large Generating Facility or Interconnection Customer's Interconnection Facilities' System restoration and black start shall be considered Emergency Conditions; provided, that Interconnection Customer is not obligated by this LGIA to possess black start capability.

13.2 Obligations. Each Party shall comply with the Emergency Condition procedures of the applicable ISO/RTO, NERC, the Applicable Reliability Council, Applicable Laws and Regulations, and any emergency procedures agreed to by the Joint Operating Committee.

13.3 Notice. Transmission Provider shall notify Interconnection Customer promptly when it becomes aware of an Emergency Condition that affects Transmission Provider's Interconnection Facilities or the Transmission System that may reasonably be expected to affect Interconnection Customer's operation of the Large Generating Facility or Interconnection Customer's Interconnection Facilities. Interconnection Customer shall notify Transmission Provider promptly when it becomes aware of an Emergency Condition that affects the Large Generating Facility or Interconnection Customer's Interconnection Facilities that may reasonably be expected to affect the Transmission System or Transmission Provider's Interconnection Facilities. To the extent information is known, the notification shall describe the Emergency Condition, the extent of the damage or deficiency, the expected effect on the operation of Interconnection Customer's or Transmission Provider's facilities and operations, its anticipated duration and the corrective action taken and/or to be taken. The initial notice shall be followed as soon as practicable with written notice.

13.4 Immediate Action. Unless, in Interconnection Customer's reasonable judgment, immediate action is required, Interconnection Customer shall obtain the consent of Transmission Provider, such consent to not be unreasonably withheld, prior to performing any manual switching operations at the Large Generating Facility or Interconnection Customer's Interconnection Facilities in response to an Emergency Condition either declared by Transmission Provider or otherwise regarding the Transmission System.

13.5 Transmission Provider Authority.

13.5.1 General. Transmission Provider may take whatever actions or inactions with regard to the Transmission System or Transmission Provider's Interconnection Facilities it deems necessary during an Emergency Condition in order to (i) preserve public health and safety, (ii) preserve the reliability of the Transmission System or Transmission Provider's Interconnection Facilities, (iii) limit or prevent damage, and (iv) expedite restoration of service.

Transmission Provider shall use Reasonable Efforts to minimize the effect of such actions or inactions on the Large Generating Facility or Interconnection Customer's Interconnection Facilities. Transmission Provider may, on the basis of technical considerations, require the Large Generating Facility to mitigate an Emergency Condition by taking actions necessary and limited in scope to remedy the Emergency Condition, including, but not limited to, directing Interconnection Customer to shut-down, start-up, increase or decrease the real or reactive power output of the Large Generating Facility; implementing a reduction or disconnection pursuant to Article 13.5.2; directing Interconnection Customer to assist with blackstart (if available) or restoration efforts; or altering the outage schedules of the Large Generating Facility and Interconnection Customer's Interconnection Facilities. Interconnection Customer shall comply with all of Transmission Provider's operating instructions concerning Large Generating Facility real power and reactive power output within the manufacturer's design limitations of the Large Generating Facility's equipment that is in service and physically available for operation at the time, in compliance with Applicable Laws and Regulations.

13.5.2 **Reduction and Disconnection**. Transmission Provider may reduce Interconnection Service or disconnect the Large Generating Facility or Interconnection Customer's Interconnection Facilities, when such, reduction or disconnection is necessary under Good Utility Practice due to Emergency Conditions. These rights are separate and distinct from any right of curtailment of Transmission Provider pursuant to Transmission Provider's Tariff. When Transmission Provider can schedule the reduction or disconnection in advance, Transmission Provider shall notify Interconnection Customer of the reasons, timing and expected duration of the reduction or disconnection. Transmission Provider shall coordinate with Interconnection Customer using Good Utility Practice to schedule the reduction or disconnection during periods of least impact to Interconnection Customer and Transmission Provider. Any reduction or disconnection shall continue only for so long as reasonably necessary under Good Utility Practice. The Parties shall cooperate with each other to restore the Large Generating Facility, the Interconnection Facilities, and the Transmission System to their normal operating state as soon as practicable consistent with Good Utility Practice.

13.6 **Interconnection Customer Authority**. Consistent with Good Utility Practice and the LGIA and the LGIP, Interconnection Customer may take actions or inactions with regard to the Large Generating Facility or Interconnection Customer's Interconnection Facilities during an Emergency Condition in order to (i) preserve public health and safety, (ii) preserve the reliability of the Large Generating Facility or Interconnection Customer's Interconnection Facilities, (iii) limit or prevent damage, and (iv) expedite restoration of service. Interconnection Customer shall use Reasonable Efforts to minimize the effect of such actions or inactions on the Transmission System and Transmission Provider's

Interconnection Facilities. Transmission Provider shall use Reasonable Efforts to assist Interconnection Customer in such actions.

13.7 Limited Liability. Except as otherwise provided in Article 11.6.1 of this LGIA, neither Party shall be liable to the other for any action it takes in responding to an Emergency Condition so long as such action is made in good faith and is consistent with Good Utility Practice.

Article 14. Regulatory Requirements and Governing Law

14.1 Regulatory Requirements. Each Party's obligations under this LGIA shall be subject to its receipt of any required approval or certificate from one or more Governmental Authorities in the form and substance satisfactory to the applying Party, or the Party making any required filings with, or providing notice to, such Governmental Authorities, and the expiration of any time period associated therewith. Each Party shall in good faith seek and use its Reasonable Efforts to obtain such other approvals. Nothing in this LGIA shall require Interconnection Customer to take any action that could result in its inability to obtain, or its loss of, status or exemption under the Federal Power Act, the Public Utility Holding Company Act of 1935, as amended, or the Public Utility Regulatory Policies Act of 1978.

14.2 Governing Law.

14.2.1 The validity, interpretation and performance of this LGIA and each of its provisions shall be governed by the laws of the state where the Point of Interconnection is located, without regard to its conflicts of law principles.

14.2.2 This LGIA is subject to all Applicable Laws and Regulations.

14.2.3 Each Party expressly reserves the right to seek changes in, appeal, or otherwise contest any laws, orders, rules, or regulations of a Governmental Authority.

Article 15. Notices.

15.1 General. Unless otherwise provided in this LGIA, any notice, demand or request required or permitted to be given by either Party to the other and any instrument required or permitted to be tendered or delivered by either Party in writing to the other shall be effective when delivered and may be so given, tendered or delivered, by recognized national courier, or by depositing the same with the United States Postal Service with postage prepaid, for delivery by certified or registered mail, addressed to the Party, or personally delivered to the Party, at the address set out in Appendix F, Addresses for Delivery of Notices and Billings.

Either Party may change the notice information in this LGIA by giving five (5) Business Days written notice prior to the effective date of the change.

15.2 Billings and Payments. Billings and payments shall be sent to the addresses set out in Appendix F.

15.3 Alternative Forms of Notice. Any notice or request required or permitted to be given by a Party to the other and not required by this Agreement to be given in writing may be so given by telephone, facsimile or email to the telephone numbers and email addresses set out in Appendix F.

15.4 Operations and Maintenance Notice. Each Party shall notify the other Party in writing of the identity of the person(s) that it designates as the point(s) of contact with respect to the implementation of Articles 9 and 10.

Article 16. Force Majeure

16.1 Force Majeure.

16.1.1 Economic hardship is not considered a Force Majeure event.

16.1.2 Neither Party shall be considered to be in Default with respect to any obligation hereunder, (including obligations under Article 4), other than the obligation to pay money when due, if prevented from fulfilling such obligation by Force Majeure. A Party unable to fulfill any obligation hereunder (other than an obligation to pay money when due) by reason of Force Majeure shall give notice and the full particulars of such Force Majeure to the other Party in writing or by telephone as soon as reasonably possible after the occurrence of the cause relied upon. Telephone notices given pursuant to this article shall be confirmed in writing as soon as reasonably possible and shall specifically state full particulars of the Force Majeure, the time and date when the Force Majeure occurred and when the Force Majeure is reasonably expected to cease. The Party affected shall exercise due diligence to remove such disability with reasonable dispatch, but shall not be required to accede or agree to any provision not satisfactory to it in order to settle and terminate a strike or other labor disturbance.

Article 17. Default

17.1 Default

17.1.1 **General.** No Default shall exist where such failure to discharge an obligation (other than the payment of money) is the result of Force Majeure as defined in this LGIA or the result of an act of omission of the other Party. Upon a Breach, the non-breaching Party shall give written notice of such Breach to the breaching Party. Except as provided in Article 17.1.2, the breaching Party shall have thirty (30) Calendar Days from receipt of the Default notice within which to cure such Breach; provided however, if such

Breach is not capable of cure within thirty (30) Calendar Days, the breaching Party shall commence such cure within thirty (30) Calendar Days after notice and continuously and diligently complete such cure within ninety (90) Calendar Days from receipt of the Default notice; and, if cured within such time, the Breach specified in such notice shall cease to exist.

17.1.2 **Right to Terminate.** If a Breach is not cured as provided in this article, or if a Breach is not capable of being cured within the period provided for herein, the non-breaching Party shall have the right to declare a Default and terminate this LGIA by written notice at any time until cure occurs, and be relieved of any further obligation hereunder and, whether or not that Party terminates this LGIA, to recover from the breaching Party all amounts due hereunder, plus all other damages and remedies to which it is entitled at law or in equity. The provisions of this article will survive termination of this LGIA.

Article 18. Indemnity, Consequential Damages and Insurance

18.1 **Indemnity.** The Parties shall at all times indemnify, defend, and hold the other Party harmless from, any and all damages, losses, claims, including claims and actions relating to injury to or death of any person or damage to property, demand, suits, recoveries, costs and expenses, court costs, attorney fees, and all other obligations by or to third parties, arising out of or resulting from the other Party's action or inactions of its obligations under this LGIA on behalf of the Indemnifying Party, except in cases of gross negligence or intentional wrongdoing by the Indemnified Party.

18.1.1 **Indemnified Person.** If an Indemnified Person is entitled to indemnification under this Article 18 as a result of a claim by a third party, and the indemnifying Party fails, after notice and reasonable opportunity to proceed under Article 18.1, to assume the defense of such claim, such Indemnified Person may at the expense of the indemnifying Party contest, settle or consent to the entry of any judgment with respect to, or pay in full, such claim.

18.1.2 **Indemnifying Party.** If an Indemnifying Party is obligated to indemnify and hold any Indemnified Person harmless under this Article 18, the amount owing to the Indemnified Person shall be the amount of such Indemnified Person's actual Loss, net of any insurance or other recovery.

18.1.3 **Indemnity Procedures.** Promptly after receipt by an Indemnified Person of any claim or notice of the commencement of any action or administrative or legal proceeding or investigation as to which the indemnity provided for in Article 18.1 may apply, the Indemnified Person shall notify the Indemnifying Party of such fact. Any failure of or delay in such notification shall not affect a Party's indemnification obligation unless such failure or delay is materially prejudicial to the indemnifying Party.

The Indemnifying Party shall have the right to assume the defense thereof with counsel designated by such Indemnifying Party and reasonably satisfactory to the Indemnified Person. If the defendants in any such action include one or more Indemnified Persons and the Indemnifying Party and if the Indemnified Person reasonably concludes that there may be legal defenses available to it and/or other Indemnified Persons which are different from or additional to those available to the Indemnifying Party, the Indemnified Person shall have the right to select separate counsel to assert such legal defenses and to otherwise participate in the defense of such action on its own behalf. In such instances, the Indemnifying Party shall only be required to pay the fees and expenses of one additional attorney to represent an Indemnified Person or Indemnified Persons having such differing or additional legal defenses.

The Indemnified Person shall be entitled, at its expense, to participate in any such action, suit or proceeding, the defense of which has been assumed by the Indemnifying Party. Notwithstanding the foregoing, the Indemnifying Party (i) shall not be entitled to assume and control the defense of any such action, suit or proceedings if and to the extent that, in the opinion of the Indemnified Person and its counsel, such action, suit or proceeding involves the potential imposition of criminal liability on the Indemnified Person, or there exists a conflict or adversity of interest between the Indemnified Person and the Indemnifying Party, in such event the Indemnifying Party shall pay the reasonable expenses of the Indemnified Person, and (ii) shall not settle or consent to the entry of any judgment in any action, suit or proceeding without the consent of the Indemnified Person, which shall not be reasonably withheld, conditioned or delayed.

18.2 Consequential Damages. Other than the Liquidated Damages heretofore described, in no event shall either Party be liable under any provision of this LGIA for any losses, damages, costs or expenses for any special, indirect, incidental, consequential, or punitive damages, including but not limited to loss of profit or revenue, loss of the use of equipment, cost of capital, cost of temporary equipment or services, whether based in whole or in part in contract, in tort, including negligence, strict liability, or any other theory of liability;

provided, however, that damages for which a Party may be liable to the other Party under another agreement will not be considered to be special, indirect, incidental, or consequential damages hereunder.

18.3 **Insurance**. Each party shall, at its own expense, maintain in force throughout the period of this LGIA, and until released by the other Party, the following minimum insurance coverages, with insurers authorized to do business in the state where the Point of Interconnection is located:

18.3.1 Employers' Liability and Workers' Compensation Insurance providing statutory benefits in accordance with the laws and regulations of the state in which the Point of Interconnection is located.

18.3.2 Commercial General Liability Insurance including premises and operations, personal injury, broad form property damage, broad form blanket contractual liability coverage (including coverage for the contractual indemnification) products and completed operations coverage, coverage for explosion, collapse and underground hazards, independent contractors coverage, coverage for pollution to the extent normally available and punitive damages to the extent normally available and a cross liability endorsement, with minimum limits of One Million Dollars ($1,000,000) per occurrence/One Million Dollars ($1,000,000) aggregate combined single limit for personal injury, bodily injury, including death and property damage.

18.3.3 Comprehensive Automobile Liability Insurance for coverage of owned and non-owned and hired vehicles, trailers or semi-trailers designed for travel on public roads, with a minimum, combined single limit of One Million Dollars ($1,000,000) per occurrence for bodily injury, including death, and property damage.

18.3.4 Excess Public Liability Insurance over and above the Employers' Liability Commercial General Liability and Comprehensive Automobile Liability Insurance coverage, with a minimum combined single limit of Twenty Million Dollars ($20,000,000) per occurrence/Twenty Million Dollars ($20,000,000) aggregate.

18.3.5 The Commercial General Liability Insurance, Comprehensive Automobile Insurance and Excess Public Liability Insurance policies shall name the other Party, its parent, associated and Affiliate companies and their respective directors, officers, agents, servants and employees ("Other Party Group") as additional insured. All policies shall contain provisions whereby the insurers waive all rights of subrogation in accordance with the provisions of this LGIA against the Other Party Group and provide thirty (30) Calendar Days advance written notice to the Other Party Group prior to anniversary date of cancellation or any material change in coverage or condition.

18.3.6 The Commercial General Liability Insurance, Comprehensive Automobile Liability Insurance and Excess Public Liability Insurance policies shall contain provisions that specify that the policies are primary and shall apply to such extent without consideration for other policies separately carried and shall state that each insured is provided coverage as though a separate policy had been issued to each, except the insurer's liability shall not be increased beyond the amount for which the insurer would have been liable had only one insured been covered. Each Party shall be responsible for its respective deductibles or retentions.

18.3.7 The Commercial General Liability Insurance, Comprehensive Automobile Liability Insurance and Excess Public Liability Insurance policies, if written on a Claims First Made Basis, shall be maintained in full force and effect for two (2) years after termination of this LGIA, which coverage may be in the form of tail coverage or extended reporting period coverage if agreed by the Parties.

18.3.8 The requirements contained herein as to the types and limits of all insurance to be maintained by the Parties are not intended to and shall not in any manner, limit or qualify the liabilities and obligations assumed by the Parties under this LGIA.

18.3.9 Within ten (10) days following execution of this LGIA, and as soon as practicable after the end of each fiscal year or at the renewal of the insurance policy and in any event within ninety (90) days thereafter, each Party shall provide certification of all insurance required in this LGIA, executed by each insurer or by an authorized representative of each insurer.

18.3.10 Notwithstanding the foregoing, each Party may self-insure to meet the minimum insurance requirements of Articles 18.3.2 through 18.3.8 to the extent it maintains a self-insurance program; provided that, such Party's senior secured debt is rated at investment grade or better by Standard & Poor's and that its self-insurance program meets the minimum insurance requirements of Articles 18.3.2 through 18.3.8. For any period of time that a Party's senior secured debt is unrated by Standard & Poor's or is rated at less than investment grade by Standard & Poor's, such Party shall comply with the insurance requirements applicable to it under Articles 18.3.2 through 18.3.9. In the event that a Party is permitted to self-insure pursuant to this article, it shall notify the other Party that it meets the requirements to self-insure and that its self-insurance program meets the minimum insurance requirements in a manner consistent with that specified in Article 18.3.9.

18.3.11 The Parties agree to report to each other in writing as soon as practical all accidents or occurrences resulting in injuries to any person, including death, and any property damage arising out of this LGIA.

Article 19. Assignment

19.1 Assignment. This LGIA may be assigned by either Party only with the written consent of the other; provided that either Party may assign this LGIA without the consent of the other Party to any Affiliate of the assigning Party with an equal or greater credit rating and with the legal authority and operational ability to satisfy the obligations of the assigning Party under this LGIA; and provided further that Interconnection Customer shall have the right to assign this LGIA, without the consent of Transmission Provider, for collateral security purposes to aid in providing financing for the Large Generating Facility, provided that Interconnection Customer will promptly notify Transmission Provider of any such assignment. Any financing arrangement entered into by Interconnection Customer pursuant to this article will provide that prior to or upon the exercise of the secured Party's, trustee's or mortgagee's assignment rights pursuant to said arrangement, the secured creditor, the trustee or mortgagee will notify Transmission Provider of the date and particulars of any such exercise of assignment right(s), including providing the Transmission Provider with proof that it meets the requirements of Articles 11.5 and 18.3. Any attempted assignment that violates this article is void and ineffective. Any assignment under this LGIA shall not relieve a Party of its obligations, nor shall a Party's obligations be enlarged, in whole or in part, by reason thereof. Where required, consent to assignment will not be unreasonably withheld, conditioned or delayed.

Article 20. Severability

20.1 Severability. If any provision in this LGIA is finally determined to be invalid, void or unenforceable by any court or other Governmental Authority having jurisdiction, such determination shall not invalidate, void or make unenforceable any other provision, agreement or covenant of this LGIA; provided that if Interconnection Customer (or any third party, but only if such third party is not acting at the direction of Transmission Provider) seeks and obtains such a final determination with respect to any provision of the Alternate Option (Article 5.1.2), or the Negotiated Option (Article 5.1.4), then none of these provisions shall thereafter have any force or effect and the Parties' rights and obligations shall be governed solely by the Standard Option (Article 5.1.1).

Article 21. Comparability

21.1 Comparability. The Parties will comply with all applicable comparability and code of conduct laws, rules and regulations, as amended from time to time.

Article 22. Confidentiality

22.1 Confidentiality. Confidential Information shall include, without limitation, all information relating to a Party's technology, research and development, business affairs, and pricing, and any information supplied by either of the Parties to the other prior to the execution of this LGIA.

Information is Confidential Information only if it is clearly designated or marked in writing as confidential on the face of the document, or, if the information is conveyed orally or by inspection, if the Party providing the information orally informs the Party receiving the information that the information is confidential.

If requested by either Party, the other Party shall provide in writing, the basis for asserting that the information referred to in this Article 22 warrants confidential treatment, and the requesting Party may disclose such writing to the appropriate Governmental Authority. Each Party shall be responsible for the costs associated with affording confidential treatment to its information.

22.1.1 **Term**. During the term of this LGIA, and for a period of three (3) years after the expiration or termination of this LGIA, except as otherwise provided in this Article 22, each Party shall hold in confidence and shall not disclose to any person Confidential Information.

22.1.2 **Scope**. Confidential Information shall not include information that the receiving Party can demonstrate: (1) is generally available to the public other than as a result of a disclosure by the receiving Party; (2) was in the lawful possession of the receiving Party on a non-confidential basis before receiving it from the disclosing Party; (3) was supplied to the receiving Party without restriction by a third party, who, to the knowledge of the receiving Party after due inquiry, was under no obligation to the disclosing Party to keep such information confidential; (4) was independently developed by the receiving Party without reference to Confidential Information of the disclosing Party; (5) is, or becomes, publicly known, through no wrongful act or omission of the receiving Party or Breach of this LGIA; or (6) is required, in accordance with Article 22.1.7 of the LGIA, Order of Disclosure, to be disclosed by any Governmental Authority or is otherwise required to be disclosed by law or subpoena, or is necessary in any legal proceeding establishing rights and obligations under this LGIA. Information designated as Confidential Information will no longer be deemed confidential if the Party that designated the information as confidential notifies the other Party that it no longer is confidential.

22.1.3 **Release of Confidential Information.** Neither Party shall release or disclose Confidential Information to any other person, except to its Affiliates (limited by the Standards of Conduct requirements), subcontractors, employees, consultants, or to parties who may be or considering providing financing to or equity participation with Interconnection Customer, or to potential purchasers or assignees of Interconnection Customer, on a need-to-know basis in connection with this LGIA, unless such person has first been advised of the confidentiality provisions of this Article 22 and has agreed to comply with such provisions. Notwithstanding the foregoing, a Party providing Confidential Information to any person shall remain primarily responsible for any release of Confidential Information in contravention of this Article 22.

22.1.4 **Rights.** Each Party retains all rights, title, and interest in the Confidential Information that each Party discloses to the other Party. The disclosure by each Party to the other Party of Confidential Information shall not be deemed a waiver by either Party or any other person or entity of the right to protect the Confidential Information from public disclosure.

22.1.5 **No Warranties.** By providing Confidential Information, neither Party makes any warranties or representations as to its accuracy or completeness. In addition, by supplying Confidential Information, neither Party obligates itself to provide any particular information or Confidential Information to the other Party nor to enter into any further agreements or proceed with any other relationship or joint venture.

22.1.6 **Standard of Care.** Each Party shall use at least the same standard of care to protect Confidential Information it receives as it uses to protect its own Confidential Information from unauthorized disclosure, publication or dissemination. Each Party may use Confidential Information solely to fulfill its obligations to the other Party under this LGIA or its regulatory requirements.

22.1.7 **Order of Disclosure.** If a court or a Government Authority or entity with the right, power, and apparent authority to do so requests or requires either Party, by subpoena, oral deposition, interrogatories, requests for production of documents, administrative order, or otherwise, to disclose Confidential Information, that Party shall provide the other Party with prompt notice of such request(s) or requirement(s) so that the other Party may seek an appropriate protective order or waive compliance with the terms of this LGIA.

Notwithstanding the absence of a protective order or waiver, the Party may disclose such Confidential Information which, in the opinion of its counsel, the Party is legally compelled to disclose. Each Party will use Reasonable Efforts to obtain reliable assurance that confidential treatment will be accorded any Confidential Information so furnished.

22.1.8 **Termination of Agreement.** Upon termination of this LGIA for any reason, each Party shall, within ten (10) Calendar Days of receipt of a written request from the other Party, use Reasonable Efforts to destroy, erase, or delete (with such destruction, erasure, and deletion certified in writing to the other Party) or return to the other Party, without retaining copies thereof, any and all written or electronic Confidential Information received from the other Party.

22.1.9 **Remedies**. The Parties agree that monetary damages would be inadequate to compensate a Party for the other Party's Breach of its obligations under this Article 22. Each Party accordingly agrees that the other Party shall be entitled to equitable relief, by way of injunction or otherwise, if the first Party Breaches or threatens to Breach its obligations under this Article 22, which equitable relief shall be granted without bond or proof of damages, and the receiving Party shall not plead in defense that there would be an adequate remedy at law. Such remedy shall not be deemed an exclusive remedy for the Breach of this Article 22, but shall be in addition to all other remedies available at law or in equity. The Parties further acknowledge and agree that the covenants contained herein are necessary for the protection of legitimate business interests and are reasonable in scope. No Party, however, shall be liable for indirect, incidental, or consequential or punitive damages of any nature or kind resulting from or arising in connection with this Article 22.

22.1.10 **Disclosure to FERC, its Staff, or a State**. Notwithstanding anything in this Article 22 to the contrary, and pursuant to 18 CFR section 1b.20, if FERC or its staff, during the course of an investigation or otherwise, requests information from one of the Parties that is otherwise required to be maintained in confidence pursuant to this LGIA, the Party shall provide the requested information to FERC or its staff, within the time provided for in the request for information. In providing the information to FERC or its staff, the Party must, consistent with 18 CFR section 388.112, request that the information be treated as confidential and non-public by FERC and its staff and that the information be withheld from public disclosure. Parties are prohibited from notifying the other Party to this LGIA prior to the release of the Confidential Information to FERC or its staff. The Party shall notify the other Party to the LGIA when it is notified by FERC or its staff that a request to release Confidential Information has been received by FERC, at which time either of the Parties may respond before such information would be made public, pursuant to 18 CFR section 388.112. Requests from a state regulatory body conducting a confidential investigation shall be treated in a similar manner if consistent with the applicable state rules and regulations.

22.1.11 Subject to the exception in Article 22.1.10, any information that a Party claims is competitively sensitive, commercial or financial information under this LGIA ("Confidential Information") shall not be disclosed by the other Party to any person not employed or retained by the other Party, except to the extent disclosure is (i) required by law; (ii) reasonably deemed by the disclosing Party to be required to be disclosed in connection with a dispute between or among the Parties, or the defense of litigation or dispute; (iii) otherwise permitted by consent of the other Party, such consent not to be unreasonably withheld; or (iv) necessary to fulfill its obligations under this LGIA or as a transmission service provider or a Control Area operator including disclosing the Confidential Information to an RTO or ISO or to a regional or national reliability organization. The Party asserting confidentiality shall notify the other Party in writing of the information it claims is confidential. Prior to any disclosures of the other Party's Confidential Information under this subparagraph, or if any third party or Governmental Authority makes any request or demand for any of the information described in this subparagraph, the disclosing Party agrees to promptly notify the other Party in writing and agrees to assert confidentiality and cooperate with the other Party in seeking to protect the Confidential Information from public disclosure by confidentiality agreement, protective order or other reasonable measures.

Article 23. Environmental Releases

23.1 Each Party shall notify the other Party, first orally and then in writing, of the release of any Hazardous Substances, any asbestos or lead abatement activities, or any type of remediation activities related to the Large Generating Facility or the Interconnection Facilities, each of which may reasonably be expected to affect the other Party. The notifying Party shall: (i) provide the notice as soon as practicable, provided such Party makes a good faith effort to provide the notice no later than twenty-four hours after such Party becomes aware of the occurrence; and (ii) promptly furnish to the other Party copies of any publicly available reports filed with any Governmental Authorities addressing such events.

Article 24. Information Requirements

24.1 **Information Acquisition.** Transmission Provider and Interconnection Customer shall submit specific information regarding the electrical characteristics of their respective facilities to each other as described below and in accordance with Applicable Reliability Standards.

24.2 Information Submission by Transmission Provider. The initial information submission by Transmission Provider shall occur no later than one hundred eighty (180) Calendar Days prior to Trial Operation and shall include Transmission System information necessary to allow Interconnection Customer to select equipment and meet any system protection and stability requirements, unless otherwise agreed to by the Parties. On a monthly basis Transmission Provider shall provide Interconnection Customer a status report on the construction and installation of Transmission Provider's Interconnection Facilities and Network Upgrades, including, but not limited to, the following information: (1) progress to date; (2) a description of the activities since the last report; (3) a description of the action items for the next period; and (4) the delivery status of equipment ordered.

24.3 Updated Information Submission by Interconnection Customer. The updated information submission by Interconnection Customer, including manufacturer information, shall occur no later than one hundred eighty (180) Calendar Days prior to the Trial Operation. Interconnection Customer shall submit a completed copy of the Large Generating Facility data requirements contained in Appendix 1 to the LGIP. It shall also include any additional information provided to Transmission Provider for the Feasibility and Facilities Study. Information in this submission shall be the most current Large Generating Facility design or expected performance data. Information submitted for stability models shall be compatible with Transmission Provider standard models. If there is no compatible model, Interconnection Customer will work with a consultant mutually agreed to by the Parties to develop and supply a standard model and associated information.

If Interconnection Customer's data is materially different from what was originally provided to Transmission Provider pursuant to the Interconnection Study Agreement between Transmission Provider and Interconnection Customer, then Transmission Provider will conduct appropriate studies to determine the impact on Transmission Provider Transmission System based on the actual data submitted pursuant to this Article 24.3. The Interconnection Customer shall not begin Trial Operation until such studies are completed.

24.4 Information Supplementation. Prior to the Operation Date, the Parties shall supplement their information submissions described above in this Article 24 with any and all "as-built" Large Generating Facility information or "as-tested" performance information that differs from the initial submissions or, alternatively, written confirmation that no such differences exist. The Interconnection Customer shall conduct tests on the Large Generating Facility as required by Good Utility Practice such as an open circuit "step voltage" test on the Large Generating Facility to verify proper operation of the Large Generating Facility's automatic voltage regulator.

Unless otherwise agreed, the test conditions shall include: (1) Large Generating Facility at synchronous speed; (2) automatic voltage regulator on and in voltage control mode; and (3) a five percent change in Large Generating Facility terminal voltage initiated by a change in the voltage regulators reference voltage. Interconnection Customer shall provide validated test recordings showing the responses of Large Generating Facility terminal and field voltages. In the event that direct recordings of these voltages is impractical, recordings of other voltages or currents that mirror the response of the Large Generating Facility's terminal or field voltage are acceptable if information necessary to translate these alternate quantities to actual Large Generating Facility terminal or field voltages is provided. Large Generating Facility testing shall be conducted and results provided to Transmission Provider for each individual generating unit in a station.

Subsequent to the Operation Date, Interconnection Customer shall provide Transmission Provider any information changes due to equipment replacement, repair, or adjustment. Transmission Provider shall provide Interconnection Customer any information changes due to equipment replacement, repair or adjustment in the directly connected substation or any adjacent Transmission Provider-owned substation that may affect Interconnection Customer's Interconnection Facilities equipment ratings, protection or operating requirements. The Parties shall provide such information no later than thirty (30) Calendar Days after the date of the equipment replacement, repair or adjustment.

Article 25. Information Access and Audit Rights

25.1 Information Access. Each Party (the "disclosing Party") shall make available to the other Party information that is in the possession of the disclosing Party and is necessary in order for the other Party to: (i) verify the costs incurred by the disclosing Party for which the other Party is responsible under this LGIA; and (ii) carry out its obligations and responsibilities under this LGIA. The Parties shall not use such information for purposes other than those set forth in this Article 25.1 and to enforce their rights under this LGIA.

25.2 Reporting of Non-Force Majeure Events. Each Party (the "notifying Party") shall notify the other Party when the notifying Party becomes aware of its inability to comply with the provisions of this LGIA for a reason other than a Force Majeure event. The Parties agree to cooperate with each other and provide necessary information regarding such inability to comply, including the date, duration, reason for the inability to comply, and corrective actions taken or planned to be taken with respect to such inability to comply. Notwithstanding the foregoing, notification, cooperation or information provided under this article shall not entitle the Party receiving such notification to allege a cause for anticipatory breach of this LGIA.

25.3 Audit Rights. Subject to the requirements of confidentiality under Article 22 of this LGIA, each Party shall have the right, during normal business hours, and upon prior reasonable notice to the other Party, to audit at its own expense the other Party's accounts and records pertaining to either Party's performance or either Party's satisfaction of obligations under this LGIA. Such audit rights shall include audits of the other Party's costs, calculation of invoiced amounts, Transmission Provider's efforts to allocate responsibility for the provision of reactive support to the Transmission System, Transmission Provider's efforts to allocate responsibility for interruption or reduction of generation on the Transmission System, and each Party's actions in an Emergency Condition. Any audit authorized by this article shall be performed at the offices where such accounts and records are maintained and shall be limited to those portions of such accounts and records that relate to each Party's performance and satisfaction of obligations under this LGIA. Each Party shall keep such accounts and records for a period equivalent to the audit rights periods described in Article 25.4.

25.4 Audit Rights Periods.

25.4.1 **Audit Rights Period for Construction-Related Accounts and Records.** Accounts and records related to the design, engineering, procurement, and construction of Transmission Provider's Interconnection Facilities and Network Upgrades shall be subject to audit for a period of twenty-four months following Transmission Provider's issuance of a final invoice in accordance with Article 12.2.

25.4.2 **Audit Rights Period for All Other Accounts and Records.** Accounts and records related to either Party's performance or satisfaction of all obligations under this LGIA other than those described in Article 25.4.1 shall be subject to audit as follows: (i) for an audit relating to cost obligations, the applicable audit rights period shall be twenty-four months after the auditing Party's receipt of an invoice giving rise to such cost obligations; and (ii) for an audit relating to all other obligations, the applicable audit rights period shall be twenty-four months after the event for which the audit is sought.

25.5 Audit Results. If an audit by a Party determines that an overpayment or an underpayment has occurred, a notice of such overpayment or underpayment shall be given to the other Party together with those records from the audit which support such determination.

Article 26. Subcontractors

26.1 General. Nothing in this LGIA shall prevent a Party from utilizing the services of any subcontractor as it deems appropriate to perform its obligations under this LGIA; provided, however, that each Party shall require its subcontractors to comply with all applicable terms and conditions of this LGIA in providing such services and each Party shall remain primarily liable to the other Party for the performance of such subcontractor.

26.2 Responsibility of Principal. The creation of any subcontract relationship shall not relieve the hiring Party of any of its obligations under this LGIA. The hiring Party shall be fully responsible to the other Party for the acts or omissions of any subcontractor the hiring Party hires as if no subcontract had been made; provided, however, that in no event shall Transmission Provider be liable for the actions or inactions of Interconnection Customer or its subcontractors with respect to obligations of Interconnection Customer under Article 5 of this LGIA. Any applicable obligation imposed by this LGIA upon the hiring Party shall be equally binding upon, and shall be construed as having application to, any subcontractor of such Party.

26.3 No Limitation by Insurance. The obligations under this Article 26 will not be limited in any way by any limitation of subcontractor's insurance.

Article 27. Disputes

27.1 Submission. In the event either Party has a dispute, or asserts a claim, that arises out of or in connection with this LGIA or its performance, such Party (the "disputing Party") shall provide the other Party with written notice of the dispute or claim

("Notice of Dispute"). Such dispute or claim shall be referred to a designated senior representative of each Party for resolution on an informal basis as promptly as practicable after receipt of the Notice of Dispute by the other Party. In the event the designated representatives are unable to resolve the claim or dispute through unassisted or assisted negotiations within thirty (30) Calendar Days of the other Party's receipt of the Notice of Dispute, such claim or dispute may, upon mutual agreement of the Parties, be submitted to arbitration and resolved in accordance with the arbitration procedures set forth below. In the event the Parties do not agree to submit such claim or dispute to arbitration, each Party may exercise whatever rights and remedies it may have in equity or at law consistent with the terms of this LGIA.

27.2 External Arbitration Procedures. Any arbitration initiated under this LGIA shall be conducted before a single neutral arbitrator appointed by the Parties. If the Parties fail to agree upon a single arbitrator within ten (10) Calendar Days of the submission of the dispute to arbitration, each Party shall choose one arbitrator who shall sit on a three-member arbitration panel. The two arbitrators so chosen shall within twenty (20) Calendar Days select a third arbitrator to chair the arbitration panel. In either case, the arbitrators shall be knowledgeable in electric utility matters, including electric transmission and bulk power issues, and shall not have any current or past substantial business or financial relationships with any party to the arbitration (except prior arbitration). The arbitrator(s) shall provide each of the Parties an opportunity to be heard and, except as otherwise provided herein, shall conduct the arbitration in accordance with the Commercial Arbitration Rules of the American Arbitration Association ("Arbitration Rules") and any applicable FERC regulations or RTO rules; provided, however, in the event of a conflict between the Arbitration Rules and the terms of this Article 27, the terms of this Article 27 shall prevail.

27.3 Arbitration Decisions. Unless otherwise agreed by the Parties, the arbitrator(s) shall render a decision within ninety (90) Calendar Days of appointment and shall notify the Parties in writing of such decision and the reasons therefore. The arbitrator(s) shall be authorized only to interpret and apply the provisions of this LGIA and shall have no power to modify or change any provision of this Agreement in any manner. The decision of the arbitrator(s) shall be final and binding upon the Parties, and judgment on the award may be entered in any court having jurisdiction. The decision of the arbitrator(s) may be appealed solely on the grounds that the conduct of the arbitrator(s), or the decision itself, violated the standards set forth in the Federal Arbitration Act or the Administrative Dispute Resolution Act. The final decision of the arbitrator must also be filed with FERC if it affects jurisdictional rates, terms and conditions of service, Interconnection Facilities, or Network Upgrades.

27.4 Costs. Each Party shall be responsible for its own costs incurred during the arbitration process and for the following costs, if applicable: (1) the cost of the arbitrator chosen by the Party to sit on the three member panel and one half of the cost of the third arbitrator chosen; or (2) one half the cost of the single arbitrator jointly chosen by the Parties.

Article 28. Representations, Warranties, and Covenants

28.1 General. Each Party makes the following representations, warranties and covenants:

28.1.1 Good Standing. Such Party is duly organized, validly existing and in good standing under the laws of the state in which it is organized, formed, or incorporated, as applicable; that it is qualified to do business in the state or states in which the Large Generating Facility, Interconnection Facilities and Network Upgrades owned by such Party, as applicable, are located; and that it has the corporate power and authority to own its properties, to carry on its business as now being conducted and to enter into this LGIA and carry out the transactions contemplated hereby and perform and carry out all covenants and obligations on its part to be performed under and pursuant to this LGIA.

28.1.2 **Authority**. Such Party has the right, power and authority to enter into this LGIA, to become a Party hereto and to perform its obligations hereunder. This LGIA is a legal, valid and binding obligation of such Party, enforceable against such Party in accordance with its terms, except as the enforceability thereof may be limited by applicable bankruptcy, insolvency, reorganization or other similar laws affecting creditors' rights generally and by general equitable principles (regardless of whether enforceability is sought in a proceeding in equity or at law).

28.1.3 **No Conflict**. The execution, delivery and performance of this LGIA does not violate or conflict with the organizational or formation documents, or bylaws or operating agreement, of such Party, or any judgment, license, permit, order, material agreement or instrument applicable to or binding upon such Party or any of its assets.

28.1.4 **Consent and Approval**. Such Party has sought or obtained, or, in accordance with this LGIA will seek or obtain, each consent, approval, authorization, order, or acceptance by any Governmental Authority in connection with the execution, delivery and performance of this LGIA, and it will provide to any Governmental Authority notice of any actions under this LGIA that are required by Applicable Laws and Regulations.

Article 29. Joint Operating Committee

29.1 Joint Operating Committee. Except in the case of ISOs and RTOs, Transmission Provider shall constitute a Joint Operating Committee to coordinate operating and technical considerations of Interconnection Service. At least six (6) months prior to the expected Initial Synchronization Date, Interconnection Customer and Transmission Provider shall each appoint one representative and one alternate to the Joint Operating Committee. Each Interconnection Customer shall notify Transmission Provider of its appointment in writing. Such appointments may be changed at any time by similar notice. The Joint Operating Committee shall meet as necessary, but not less than once each calendar year, to carry out the duties set forth herein. The Joint Operating Committee shall hold a meeting at the request of either Party, at a time and place agreed upon by the representatives. The Joint Operating Committee shall perform all of its duties consistent with the provisions of this LGIA. Each Party shall cooperate in providing to the Joint Operating Committee all information required in the performance of the Joint Operating Committee's duties. All decisions and agreements, if any, made by the Joint Operating Committee, shall be evidenced in writing. The duties of the Joint Operating Committee shall include the following:

29.1.1 Establish data requirements and operating record requirements.

29.1.2 Review the requirements, standards, and procedures for data acquisition equipment, protective equipment, and any other equipment or software.

29.1.3 Annually review the one (1) year forecast of maintenance and planned outage schedules of Transmission Provider's and Interconnection Customer's facilities at the Point of Interconnection.

29.1.4 Coordinate the scheduling of maintenance and planned outages on the Interconnection Facilities, the Large Generating Facility and other facilities that impact the normal operation of the interconnection of the Large Generating Facility to the Transmission System.

29.1.5 Ensure that information is being provided by each Party regarding equipment availability.

29.1.6 Perform such other duties as may be conferred upon it by mutual agreement of the Parties.

Article 30. Miscellaneous

30.1 Binding Effect. This LGIA and the rights and obligations hereof, shall be binding upon and shall inure to the benefit of the successors and assigns of the Parties hereto.

30.2 Conflicts. In the event of a conflict between the body of this LGIA and any attachment, appendices or exhibits hereto, the terms and provisions of the body of this LGIA shall prevail and be deemed the final intent of the Parties.

30.3 Rules of Interpretation. This LGIA, unless a clear contrary intention appears, shall be construed and interpreted as follows: (1) the singular number includes the plural number and vice versa; (2) reference to any person includes such person's successors and assigns but, in the case of a Party, only if such successors and assigns are permitted by this LGIA, and reference to a person in a particular capacity excludes such person in any other capacity or individually; (3) reference to any agreement (including this LGIA), document, instrument or tariff means such agreement, document, instrument, or tariff as amended or modified and in effect from time to time in accordance with the terms thereof and, if applicable, the terms hereof; (4) reference to any Applicable Laws and Regulations means such Applicable Laws and Regulations as amended, modified, codified, or reenacted, in whole or in part, and in effect from time to time, including, if applicable, rules and regulations promulgated thereunder; (5) unless expressly stated otherwise, reference to any Article, Section or Appendix means such Article of this LGIA or such Appendix to this LGIA, or such Section to the LGIP or such Appendix to the LGIP, as the case may be; (6) "hereunder", "hereof", "herein", "hereto" and words of similar import shall be deemed references to this LGIA as a whole and not to any particular Article or other provision hereof or thereof; (7) "including" (and with correlative meaning "include") means including without limiting the generality of any description preceding such term; and (8) relative to the determination of any period of time, "from" means "from and including", "to" means "to but excluding" and "through" means "through and including".

30.4 Entire Agreement. This LGIA, including all Appendices and Schedules attached hereto, constitutes the entire agreement between the Parties with reference to the subject matter hereof, and supersedes all prior and contemporaneous understandings or agreements, oral or written, between the Parties with respect to the subject matter of this LGIA. There are no other agreements, representations, warranties, or covenants which constitute any part of the consideration for, or any condition to, either Party's compliance with its obligations under this LGIA.

30.5 No Third Party Beneficiaries. This LGIA is not intended to and does not create rights, remedies, or benefits of any character whatsoever in favor of any persons, corporations, associations, or entities other than the Parties, and the obligations herein assumed are solely for the use and benefit of the Parties, their successors in interest and, where permitted, their assigns.

30.6 Waiver. The failure of a Party to this LGIA to insist, on any occasion, upon strict performance of any provision of this LGIA will not be considered a waiver of any obligation, right, or duty of, or imposed upon, such Party. Any waiver at any time by either Party of its rights with respect to this LGIA shall not be deemed a continuing waiver or a waiver with respect to any other failure to comply with any other obligation, right, duty of this LGIA. Termination or Default of this LGIA for any reason by Interconnection Customer shall not constitute a waiver of Interconnection Customer's legal rights to obtain an interconnection from Transmission Provider. Any waiver of this LGIA shall, if requested, be provided in writing.

30.7 Headings. The descriptive headings of the various Articles of this LGIA have been inserted for convenience of reference only and are of no significance in the interpretation or construction of this LGIA.

30.8 Multiple Counterparts. This LGIA may be executed in two or more counterparts, each of which is deemed an original but all constitute one and the same instrument.

30.9 Amendment. The Parties may by mutual agreement amend this LGIA by a written instrument duly executed by the Parties.

30.10 Modification by the Parties. The Parties may by mutual agreement amend the Appendices to this LGIA by a written instrument duly executed by the Parties. Such amendment shall become effective and a part of this LGIA upon satisfaction of all Applicable Laws and Regulations.

30.11 Reservation of Rights. Transmission Provider shall have the right to make a unilateral filing with FERC to modify this LGIA with respect to any rates, terms and conditions, charges, classifications of service, rule or regulation under section 205 or any other applicable provision of the Federal Power Act and FERC's rules and regulations thereunder, and Interconnection Customer shall have the right to make a unilateral filing with FERC to modify this LGIA pursuant to section 206 or any other applicable provision of the Federal Power Act and FERC's rules and regulations thereunder; provided that each Party shall have the right to protest any such filing by the other Party and to participate fully in any proceeding before FERC in which such modifications may be considered. Nothing in this LGIA shall limit the rights of the Parties or of FERC under sections 205 or 206 of the Federal Power Act and FERC's rules and regulations thereunder, except to the extent that the Parties otherwise mutually agree as provided herein.

30.12 No Partnership. This LGIA shall not be interpreted or construed to create an association, joint venture, agency relationship, or partnership between the Parties or to impose any partnership obligation or partnership liability upon either Party. Neither Party shall have any right, power or authority to enter into any agreement or undertaking for, or act on behalf of, or to act as or be an agent or representative of, or to otherwise bind, the other Party.

IN WITNESS WHEREOF, the Parties have executed this LGIA in duplicate originals, each of which shall constitute and be an original effective Agreement between the Parties.

PACIFICORP, ON BEHALF OF ITS TRANSMISSION FUNCTION

By: ______________________

Title: John A. Cupparo
Vice President, Transmission

Date: Dec 20, 2010

PACIFICORP, ON BEHALF OF ITS PACIFICORP ENERGY BUSINESS DIVISION

By: ______________________

Title: VP, Resource Development & Construction

Date: Dec. 14, 2010

Appendix A to LGIA

Interconnection Facilities, Network Upgrades and Distribution Upgrades

1. **Interconnection Facilities:**

   (a) **Interconnection Customer's Interconnection Facilities:** 3-345 kV circuit breakers and associated switches on the high side of the Interconnection Customer's step-up transformers and a 345 kV radial transmission line to the Transmission Provider's take off tower in Transmission Provider's Point of Interconnection Substation. See Exhibit 1 to Appendix A.

   (b) **Transmission Provider's Interconnection Facilities:** A take off tower, line switch and bi-directional metering facilities in Transmission Provider's Point of Interconnection Substation. See Exhibit 1 to Appendix A.

2. **Network Upgrades:**

   (a) **Stand Alone Network Upgrades:** There are no Stand Alone Network Upgrades.

   (b) **Other Network Upgrades:** A 345 kV three breaker ring bus substation; loop-in of the 345 kV Camp Williams-Emery transmission line; protection and control and communications upgrades at Camp Williams and Emery Substations; and communications upgrades at Sigurd and Timp Substations and Salt Lake Control Center. All Other Network Upgrades shall be designed, procured and constructed by Transmission Provider.

3. **Distribution Upgrades:** There are no Distribution Upgrades.

4. Point of Interconnection: The Point of Interconnection is the point where the Transmission Provider's Interconnection Facilities connects to the 345 kV bus in

Transmission Provider's Point of Interconnection Substation. See Exhibit 1 to Appendix A.

5. Point of Change of Ownership: The Point of Change of Ownership is the point where the Interconnection Customer's 345 kV radial transmission line connects to the transmission Provider's line switch in the Point of Interconnection Substation, except that Transmission Provider shall own and maintain, at Interconnection Customer's expense under separate maintenance agreement, line protection relay panel, bi-directional metering panel and fiber optic cable termination panel located in the Interconnection Customer's Interconnection Substation. See Exhibit 1 to Appendix A.

6. One-Line Diagram: A one-line diagram showing the Generating Facility, Interconnection Customer Interconnection Facilities, Transmission Provider's Interconnection Facilities, Point of Interconnection and Point of Change of Ownership is attached hereto as Exhibit 1 to Appendix A.

7. Tax Gross-Up Amount: There is currently no tax gross-up anticipated for the Network Upgrades and Transmission Provider's Interconnection Facilities installed under this Agreement. The estimated tax liability, in the event that Transmission Provider is assessed a tax liability for the Network Upgrades and Transmission Provider's Interconnection Facilities, is calculated pursuant to the formula in Article 5.17.4 of this Agreement as follows:

Current Tax Rate - 37.95%
Gross Income Amount - $23,536,000
Present Value of Tax Depreciation - $12,480,172

Estimated Tax Liability - 37.95% x ($23,536,000-$12,480,712)/(1-37.95%) = $6,761,784

The above tax liability calculation is an example only. In the event Transmission Provider is assessed a tax liability for the Network Upgrades and Transmission Provider's Interconnection Facilities installed pursuant to this LGIA, the actual tax liability will be calculated at that time based upon the actual values then obtaining for current tax rate, gross income amount and present value of the tax depreciation.

Appendix B To LGIA

Milestones

Transmission Provider commences engineering
of Transmission Provider's scope of work: March 1, 2011

Transmission Provider commences procurement of
long lead material and equipment to be provided
by Transmission Provider: March 1, 2011

Interconnection Customer provides authorization
to commence construction: March 1, 2012

In-Service Date (Backfeed): May 1, 2013

> Interconnection Customer shall request permission to backfeed in writing, including by e-mail, and wait to receive written permission from the Transmission Provider.

First Synchronization date: February 4, 2014

> Interconnection Customer shall request permission for initial synchronization in writing, including by e-mail, and wait to receive written permission from the Transmission Provider.

Commercial Operation Date: June 1, 2014

> Interconnection Customer shall request permission for commercial operation in writing, Including by e-mail, and wait to receive written permission from the Transmission Provider. As soon as possible, but in no longer than five days following commercial operation, Interconnection Customer shall confirm the actual commercial operations date by submitting Appendix E to the Transmission Provider.

Term of Agreement: With reference to LGIA Article 2.2, the Parties agree that the term of the LGIA shall be ten (10) years from the Effective Date and shall be automatically renewed for each successive one-year period thereafter.

Construction Option:

Interconnection Customer and Transmission Provider agree to proceed under the Standard Option, Article 5.1.1, for the design, procurement and construction of the Other Network Upgrades, as set forth in Appendix A and Exhibit 1 to Appendix B (Scope of Work).

Estimated Project Cost

Network Upgrades:	$20,475,000
Direct Assigned	$ 3,061,000
Total	$23,536,000

Appendix C To LGIA

Interconnection Details

Description of the Large Generating Facility: A 670 MW thermal generating facility, called Lake Side 2 Power Plant, located in Utah County, Utah, consisting of two Siemens Westinghouse 501-F combustion turbines, each with a 156/207/260 MVA - 18.0/345 kV step-up transformer and associated facilities and one Siemens Westinghouse KN steam turbine, with a 228/303/381 MVA - 18.0/345 kV step-up transformer and associated facilities.

Control Area Requirements: Interconnection Customer shall interconnect and operate the Large Generating Facility in accordance with the Transmission Provider's Facility Connection Requirements for Transmission Systems, attached hereto as Exhibit 1 to Appendix C and by this reference incorporated herein.

Interconnection Details:

Reactive Power. Transmission Provider will require the facility to operate in voltage control mode with the ability to deliver 100% of the power to the point of interconnection at a +/- 0.95 power factor (See Article 9.6.1 and 9.6.2 of this LGIA.

During normal voltage conditions, the voltage control scheme should operate to minimize the reactive exchange between the Interconnection Customer's Generating Facility and Transmission Provider system or as directed by the system operator.

Appendix D To LGIA

Security Arrangements Details

Infrastructure security of Transmission System equipment and operations and control hardware and software is essential to ensure day-to-day Transmission System reliability and operational security. FERC will expect all Transmission Providers, market participants, and Interconnection Customers interconnected to the Transmission System to comply with the recommendations offered by the President's Critical Infrastructure Protection Board and, eventually, best practice recommendations from the electric reliability authority. All public utilities will be expected to meet basic standards for system infrastructure and operational security, including physical, operational, and cyber-security practices.

Automatic Data Transfer. Throughout the term of this Agreement, Interconnection Customer shall, at its sole expense, provide the data specified below by automatic data transfer to the PacifiCorp Control Center specified by Transmission Provider or to a Third-Party System Operator designated by Transmission Provider (or both):

> Total MW and MVAR for each Unit of the generating facility; and 345 kV voltage at each Unit of the generating facility.

Additional Data. Interconnection Customer shall, at its sole expense, provide any additional Generating Facility data reasonably required and necessary for the Transmission Provider to operate the Transmission System in accordance with Good Utility Practice and Exhibit 1 to Appendix C, Facility Connection Requirements for Transmission Systems.

Appendix E To LGIA

Commercial Operation Date

This Appendix E is a part of the LGIA between Transmission Provider and Interconnection Customer.

[Date]

PacifiCorp
Director Transmission Services
825 N.E. Multnomah St, Suite 1600
Portland, Oregon 97232

Re: Lake Side 2 Large Generating Facility

Dear Sir:

On **[Date] [Interconnection Customer]** has completed Trial Operation of Unit No. __. This letter confirms that [Interconnection Customer] commenced Commercial Operation of Unit No. ___ at the Large Generating Facility, effective as of **[Date plus one day]**.

Thank you.

[Signature]

[Interconnection Customer Representative]

Appendix F to LGIA

Addresses for Delivery of Notices and Billings

Notices:

Transmission Provider:

US Mail Deliveries: PacifiCorp Transmission
PO Box 2757
Portland, OR 97208-2757

Other Deliveries: PacifiCorp Transmission
Attn: Central Cashiers
1033 NE 6th Ave
Portland OR 97232

Phone Number: (503) 813-6774

Interconnection Customer:

PacifiCorp Energy
Attn: Vice President, Generation
1407 West North Temple, Suite 320
Salt Lake City, Utah 84116
Phone: (801) 220-4017
FAX: (801) 220-5128

Billings and Payments:

Transmission Provider:

US Mail Deliveries: PacifiCorp Transmission
PO Box 2757
Portland, OR 97208-2757

Other Deliveries: PacifiCorp Transmission
Attn: Central Cashiers
1033 NE 6th Ave
Portland OR 97232

Phone Number: (503) 813-6774

Interconnection Customer:

PacifiCorp Energy
Attn: Vice President, Generation
1407 West North Temple, Suite 320
Salt Lake City, Utah 84116
Phone: (801) 220-4017
FAX: (801) 220-5128

Alternative Forms of Delivery of Notices (telephone, facsimile or email):

Transmission Provider:

Director, Transmission Services	(503) 813-6712
Manager, Transmission Scheduling	(503) 251-5162
Manager, Interconnection Services	(503) 813-6079
Manager, Transmission Services	(503) 813-6079
Transmission Business Facsimile	(503) 813-6893

OASIS Address:
http://www.oasis.pacificorp.com/oasis/ppw/main.htmlx

Interconnection Customer:

PacifiCorp Energy
Attn: Vice President, Generation
1407 West North Temple, Suite 320
Salt Lake City, Utah 84116
Phone: (801) 220-4017
FAX: (801) 220-5128

Appendix G to LGIA

INTERCONNECTION REQUIREMENTS FOR A WIND GENERATING PLANT

Appendix G sets forth requirements and provisions specific to a wind generating plant. All other requirements of this LGIA continue to apply to wind generating plant interconnections.

A. Technical Standards Applicable to a Wind Generating Plant

i. Low Voltage Ride-Through (LVRT) Capability

A wind generating plant shall be able to remain online during voltage disturbances up to the time periods and associated voltage levels set forth in the standard below. The LVRT standard provides for a transition period standard and a post-transition period standard.

Transition Period LVRT Standard

The transition period standard applies to wind generating plants subject to FERC Order 661 that have either: (i) interconnection agreements signed and filed with the Commission, filed with the Commission in unexecuted form, or filed with the Commission as non-conforming agreements between January 1, 2006 and December 31, 2006, with a scheduled in-service date no later than December 31, 2007, or (ii) wind generating turbines subject to a wind turbine procurement contract executed prior to December 31, 2005, for delivery through 2007.

1. Wind generating plants are required to remain in-service during three-phase faults with normal clearing (which is a time period of approximately 4 - 9 cycles) and single line to ground faults with delayed clearing, and subsequent post-fault voltage recovery to prefault voltage unless clearing the fault effectively disconnects the generator from the system. The clearing time requirement for a three-phase fault will be specific to the wind generating plant substation location, as determined by and documented by the transmission provider. The maximum clearing time the wind generating plant shall be required to withstand for a three-phase fault shall be 9 cycles at a voltage as low as 0.15 p.u., as measured at the high side of the wind generating

plant step-up transformer (i.e. the transformer that steps the voltage up to the transmission interconnection voltage or "GSU"), after which, if the fault remains following the location-specific normal clearing time for three-phase faults, the wind generating plant may disconnect from the transmission system.

2. This requirement does not apply to faults that would occur between the wind generator terminals and the high side of the GSU or to faults that would result in a voltage lower than 0.15 per unit on the high side of the GSU serving the facility.

3. Wind generating plants may be tripped after the fault period if this action is intended as part of a special protection system.

4. Wind generating plants may meet the LVRT requirements of this standard by the performance of the generators or by installing additional equipment (e.g., Static VAr Compensator, etc.) within the wind generating plant or by a combination of generator performance and additional equipment.

5. Existing individual generator units that are, or have been, interconnected to the network at the same location at the effective date of the Appendix G LVRT Standard are exempt from meeting the Appendix G LVRT Standard for the remaining life of the existing generation equipment. Existing individual generator units that are replaced are required to meet the Appendix G LVRT Standard.

Post-transition Period LVRT Standard

All wind generating plants subject to FERC Order No. 661 and not covered by the transition period described above must meet the following requirements:

1. Wind generating plants are required to remain in-service during three-phase faults with normal clearing (which is a time period of approximately 4 - 9 cycles) and single line to ground faults with delayed clearing, and subsequent post-fault voltage recovery to prefault voltage unless clearing the

fault effectively disconnects the generator from the system. The clearing time requirement for a three-phase fault will be specific to the wind generating plant substation location, as determined by and documented by the transmission provider. The maximum clearing time the wind generating plant shall be required to withstand for a three-phase fault shall be 9 cycles after which, if the fault remains following the location-specific normal clearing time for three-phase faults, the wind generating plant may disconnect from the transmission system. A wind generating plant shall remain interconnected during such a fault on the transmission system for a voltage level as low as zero volts, as measured at the high voltage side of the wind GSU.

2. This requirement does not apply to faults that would occur between the wind generator terminals and the high side of the GSU.

3. Wind generating plants may be tripped after the fault period if this action is intended as part of a special protection system.

4. Wind generating plants may meet the LVRT requirements of this standard by the performance of the generators or by installing additional equipment (e.g., Static VAr Compensator) within the wind generating plant or by a combination of generator performance and additional equipment.

5. Existing individual generator units that are, or have been, interconnected to the network at the same location at the effective date of the Appendix G LVRT Standard are exempt from meeting the Appendix G LVRT Standard for the remaining life of the existing generation equipment. Existing individual generator units that are replaced are required to meet the Appendix G LVRT Standard.

ii. <u>Power Factor Design Criteria (Reactive Power)</u>

A wind generating plant shall maintain a power factor within the range of 0.95 leading to 0.95 lagging, measured at the Point of Interconnection as defined in this LGIA, if the Transmission Provider's System Impact Study shows that such a requirement is necessary to ensure safety or reliability. The power factor range standard can be met by using, for example, power electronics designed to supply this level of reactive capability (taking into account any limitations due to voltage level, real power output, etc.) or fixed and switched capacitors if agreed to by the Transmission Provider, or a combination of the two. The Interconnection Customer shall not disable power factor equipment while the wind plant is in operation. Wind plants shall also be able to provide sufficient dynamic voltage support in lieu of the power system stabilizer and automatic voltage regulation at the generator excitation system if the System Impact Study shows this to be required for system safety or reliability.

iii. Supervisory Control and Data Acquisition (SCADA) Capability

The wind plant shall provide SCADA capability to transmit data and receive instructions from the Transmission Provider to protect system reliability. The Transmission Provider and the wind plant Interconnection Customer shall determine what SCADA information is essential for the proposed wind plant, taking into account the size of the plant and its characteristics, location, and importance in maintaining generation resource adequacy and transmission system reliability in its area.

Exhibit 1 to Appendix A to LGIA

One-Line Diagram

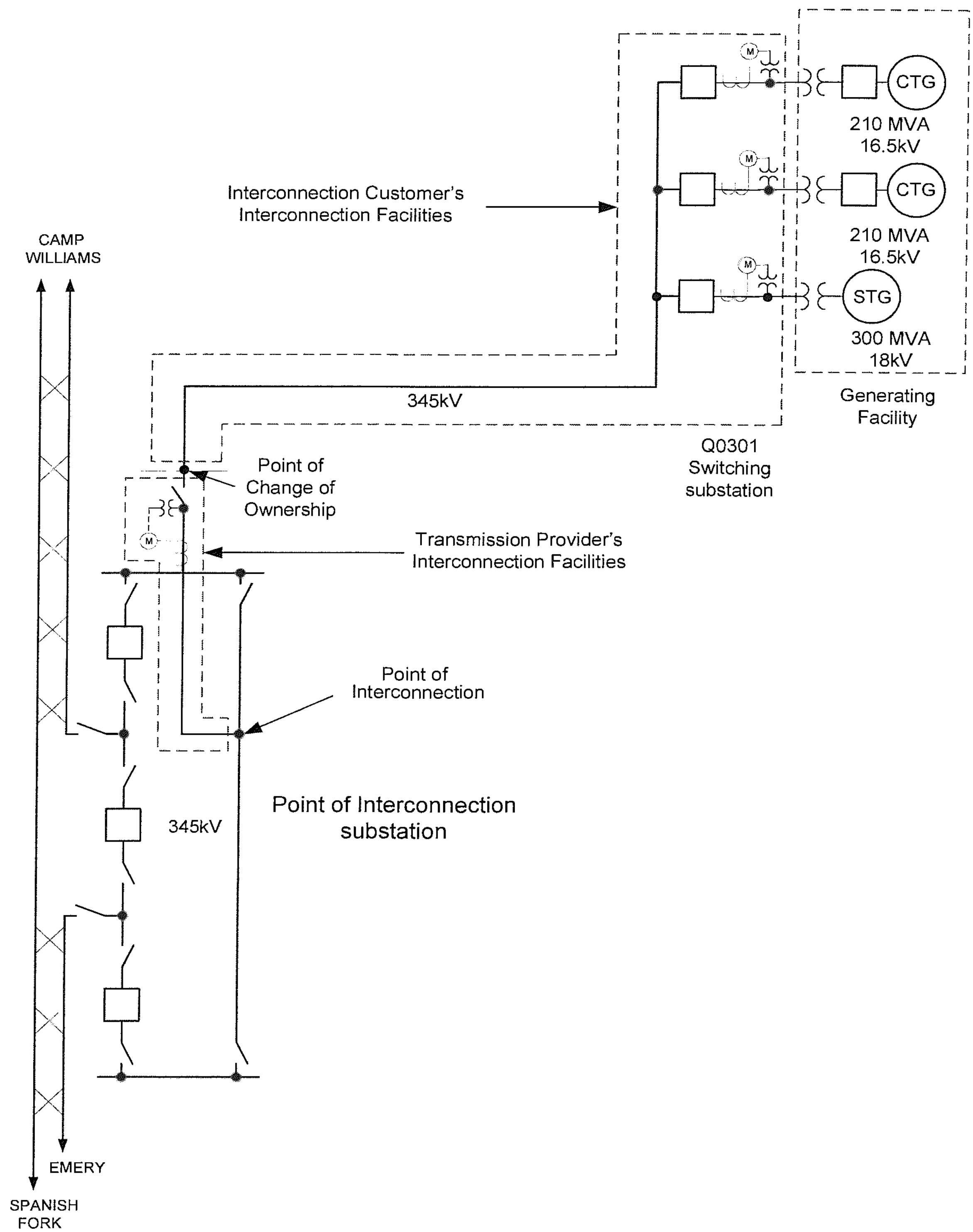

Exhibit 1 to Appendix B to LGIA

Scope of Work

Interconnection Customer's Generating Facility Switchyard

Work to be completed by the Interconnection Customer

- Engineer, procure, and construct all facilities required for the Q0301 Interconnection Customer switching substation except for those facilities/components indicated as supplied by the Transmission Provider. Interconnection Customer shall submit, on forms provided by the Transmission Provider, information specific to equipment designed, purchased, and installed by the Interconnection Customer that will be owned and maintained by the transmission provider. The completed forms are to be returned to the Transmission Providers project manager or designated representative.

- Install 362kV, 3000A circuit breakers at the Interconnection Customer's generating facility switchyard for connection to the 345kV radial interconnect line. The Transmission Provider will review the Interconnection Customers specifications for the breakers to ensure compatibility with the Transmission Providers control and protection schemes.

- Provide space in the Interconnection Customer's generating facility switchyard control building for installation of any Transmission Provider owned and maintained panels and racks. Front and rear access will be required for this equipment.

- The following equipment, installed in the Interconnection Customer's generating facility switchyard, will be owned and maintained by the transmission Provider: line protection relay panels, metering panels, and fiber optic termination panels.

- Procure the power supplies for Transmission Provider equipment at configurations and voltages specified by the Transmission Provider. Note the Q0301 Interconnection Customer's generating facility switchyard battery system should be sized to support the relay and communications system loads. The Transmission Provider will own and maintain the communication battery system.

- Design, purchase, and install the necessary splice boxes, patch panels, and racks required for terminating the fiber cables installed between the Interconnection Customer's generating facility switchyard and the point of interconnection substation. Fiber optic cable, splice boxes, and termination panels will be owned by the Transmission Provider.

- Install an OPGW fiber optic cable in the static wire position on the 345kV radial interconnection line between the point of interconnection substation and the Interconnection Customer's Q0301 switching substation. Terminate the cable in the fiber splice boxes mounted on the final Interconnection Customer owned take off structure at the Interconnection Customer's Q0301 switching substation.

- Design, purchase, and install an ADSS fiber optic cable from the fiber optic splice box located on the final 345kV transmission line dead-end structure into the Interconnection Customer's generating facility switchyard control building in an underground raceway. The raceway from the splice box (3" conduit minimum) terminates in a fiber optic patch panel in the control building. The Transmission Provider will own and maintain the ADSS fiber between the Interconnection Customer's Q0301 switching substation and the point of interconnection substation.

- Design, purchase, and install a second ADSS (redundant) fiber optic cable in an underground raceway (3" conduit minimum) from the Interconnection Customer's Q0301 control house to the existing Dynamo substation. This redundant ADSS fiber will continue on from the Dynamo substation to the Transmission Provider's Q0301 point of interconnection substation.

- Terminate both of the fiber cables installed between the Interconnection Customer's generating facility switchyard and the point of interconnection substation and perform continuity and final testing to ensure installation meets specifications and standards provided by the Transmission Provider.

- Design, purchase, install a GE D20 data concentrator digital communications system. This links the Interconnection Customer's generating facility switchyard with the Transmission Providers remote terminal unit located in the point of interconnection substation control building. This digital link will use DNP-3.0 protocol. The Transmission Provider will own and maintain the data concentrator in the Interconnection Customer's Q0301 switching substation control house.

- Data will be required from the Interconnection Customer's generation facility for the Transmission Provider's operation of the Transmission Provider's transmission system. The data concentrator will communicate to the RTU at the point of interconnection substation through a digital data port using the DNP 3.0 protocol.

- The following data from the generation facility will need to be provided to the Transmission Provider by the Interconnection Customer:

From the generation facility to the point of interconnection substation:

List of data interchange between the generators and the Transmission Provider's control center

Analogs:

- Real power from Generator 1
- Reactive power from Generator 1
- Real power from Generator 2
- Reactive power from Generator 2
- Real power from Generator 3
- Reactive power from Generator 3

Status:

- All 16.5, 18 and 345kV breakers

Control Analog Output:
- Target Real Power Output
- Target Reactive Power Output

- Terminate all field I/O connections required to provide data and control in accordance with safe system operation and in compliance with the Interconnection Agreement. Transmission Provider will complete wiring of outputs to the fiber communications system.

- Supply a dialup phone line or equivalent communications path for retail sales metering and generational accounting via the MV-90 translation system. This may be provided by using the Transmission Providers digital communications system.

- Construct/provide foundations to Transmission provider's specifications for metering equipment located in the Interconnection Customer's generating facility switchyard yard.

- Design, procure, and install the raceways for the metering secondary leads based on design data supplied by the Transmission Provider. Raceways shall be a minimum of 3″ conduit; larger if dictated by the length of the metering leads. Transmission Provider will supply the metering current and voltage secondary leads.

Work to be completed by the Transmission Provider

- Provide a list of data inputs and outputs required for protection, control, and data collection in accordance with the interconnection agreement.

- Supply all specifications required for the Transmission Provider's equipment to facilitate design of the Interconnection Customer's generating facility switchyard.

- Terminate the fiber communications system to the end use equipment.

- Perform final checkout and testing/commissioning of the interconnecting line protection control and metering systems in the Interconnection Customer's generating facility switchyard.

- Design, procure, install, own and maintain the metering CTs/VTs in the Interconnection Customer's Q0301 switching substation.

- Design, procure, install, and own the revenue metering panel and meters for the Interconnection Customer's generating facility switchyard. Each individual generator will have high accuracy extended range revenue class metering instrument transformers located on the high side of the transformer for per unit net generation.

- Supply the metering current and voltage secondary wire leads along with design specifications for raceway sizing and lead wiring connections between the metering panels and instrument transformers.

- Perform final checkout and testing/commissioning of the metering system in the Interconnection Customer's generating facility switchyard.

Radial Interconnection Line

<u>Work to be completed by the Interconnection Customer</u>

- Interconnection Customer will obtain all necessary permits, easements, and rights of way for the construction of the 345kV radial interconnection line from the point of interconnection substation to the Interconnection Customer's switching substation.

- Design, procure, construct, own, and maintain the 345kV transmission line from a full tension dead-end structure located at least 20 feet outside the point of interconnection substation fence to the Interconnection Customer's switching substation. The line will be slack spanned from the dead-end structure and terminated on the point of interconnection substation bus. Interconnection Customer will coil sufficient wire outside the point of interconnection substation fence to make up this connection.

- OPGW fiber optic cable will be installed on the 345kV radial interconnect line between the point of interconnection and Interconnection Customer's Q0301 switching substation and be terminated in fiber splice boxes on the dead-end structures at both end of the line. The OPGW fiber will be owned and maintained by the Transmission Provider.

- Install ADSS fiber optic cable from the splice boxes located adjacent to the point of interconnection substation and Interconnection Customer's Q0301 switching substation control buildings. This cable will be used for the line protection systems and to communicate status and loading information back to the Transmission Provider's energy control center.

- Note: The customer will also be responsible to engineer, procure and install a redundant fiber communication path from the Interconnection Customer's Q0301 switching substation to the point of interconnection substation. This communication path will need to run from the Interconnection customer's Q0301 switching substation, to the Dynamo substation and then on to the Q0301 point of interconnection substation. This fiber will also be owned by the Transmission Provider.

- All fiber cable, splice boxes, and patch panels will be owned and maintained by the transmission provider.

<u>Work to be completed by the Transmission Provider</u>

- Review the design of the Q0301 345kV line dead-end structure outside of the point of interconnection substation fence-line to ensure compatibility with the substation bus.

- Provide specifications for the installation and testing of the fiber optic cable installation between the Interconnection Customer's generating facility switchyard and the Q0301 point of interconnection substation.

- Transmission Provider will review the fiber optic installation on the transmission line to ensure compliance with transmission providers operational and installation standards.

Point of Interconnection Substation

Work to be completed by the Interconnection Customer

- Obtain all necessary permits, lands, Rights of way and easements required for the construction and continued maintenance of the new point of interconnection substation. The Transmission Provider's point of interconnection substation property requirements are defined in Appendix 1.

- All easements and permits will be recorded in the name of the Transmission Provider and will be on forms acceptable to the transmission provider. All easements and rights of way will be obtained for durations acceptable to the transmission provider. This includes all permits/easements for ingress and egress.

Work to be completed by the Transmission Provider

- Design, procure, construct, own and operate a new 345kV point of interconnection substation to allow for the connection of the Q0301 Project to the existing Camp Williams-Hunter/Emery 345kV transmission line. The new substation is to be designed and constructed as a six (6) breaker ring bus with only three (3) breakers installed for this project. The entire facility is to be fenced and will have two (2) 24' doublewide gates and one (1) personnel access gate.

A list of the major equipment required is as follows:

- 3 - 362kV, 3000A circuit breaker
- 8 - 345kV, 3000A TPST, manually operated, vertical break switch
- 3 - 345kV, 3000A TPST, manually operated, vertical break switch equipped with grounding blades.

- 9 - 209kV MCOV surge arresters
- 2 - 345kV Voltage transformers
- 2 - Manually operated A/C throw over switch
- 6 - 345kV CCVT's (two are to be equipped with carrier accessories)
- 3 - 345kV CT/VT Combination metering units
- 1 - 40' x 28' Control building
- 1 lot - Cable trench with covers
- 1 - 125VDC, 100AH battery system with a seismic zone 4 battery rack
- 1 - 120/208/240VAC, 130VDC, 16Amp battery charger

- Design, purchase, install and own two underground raceways (3" conduit minimum) for the installation of the ADSS cable from fiber patch panels in the point of interconnection control building to the point of interconnection substation fence. The conduits will connect to the Interconnection Customers raceways.

- Design, procure, install, own and maintain two (2) PLC wave traps on B & C phases for the Emery transmission line.

- Design, procure, install own and maintain station service back-up transformers on each line segment. This includes the 345kV voltage transformers with manually operated throw-over switches.

- Design, purchase, install, own and maintain a GE D20 RTU and all associated communications equipment including a 48VDC battery system with charger.

- Design, procure, install, and own the revenue metering panel, meters and CTs/VTs for the Q0301 point of interconnection substation. The metering will be designed for the total net generation of the project. The metering is to be installed between two of the specified disconnect switches. The switch that will be located on the Interconnection Customer's side of the metering package is to be equipped with grounding blades.

- The Transmission Provider 's metering equipment at the point of interconnection substation will accumulate the following values:

  Analogs:
  - Net Generation MW
  - Net Generator MVAr
  - 345kV A Phase Voltage
  - 345kV B Phase Voltage
  - 345kV C Phase Voltage

  Accumulator Pulses:
  - Interchange metering kWH

- Provide a dial-up phone line, or equivalent communications path, at the Q0301 point of interconnection substation for retail sales and generation accounting via the MV-90 translation system.

- Perform final checkout and testing/commissioning of the interconnecting line protection, control, and metering systems in the point of interconnection substation.

Transmission Specifications

Work to be completed by the Interconnection Customer
- No work required.

Work to be completed by the Transmission Provider
- Design, purchase, and construct four (4) steel 345kV structures in the main Camp Williams-Emery and Camp Williams-Spanish Fork 345kV lines into the point of interconnection substation. Two (2) of the structures will be in the main line and two (2) will be located in front of the substation bays.

- The two structures in the main line shall be TJ- 285 structures capable of looping in both lines: Camp Williams-Spanish Fork and Camp Williams-Emery 345kV carried as double circuits on the same structure. One TJ-285 will go at the north end of the substation and the other shall go at the south end of the substation.

- Between each TJ-285 and the substation bay, on the north and south, shall be another dead-end structure, a TJ 285, which shall bring only the Camp Williams - Emery Line into the point of interconnection substation. The four loop-in structures shall be Transmission Provider's standard structures.

Protection and Control Specifications

Work to be completed by the Interconnection Customer

- A dual pilot protective relay system will be required for fault detection on the 345kV radial interconnection line from the point of interconnection substation to the Interconnection Customer's switching substation. Each relay system will use an independent communications path created by the redundant fiber runs installed by the Interconnection Customer.

Work to be completed by the Transmission Provider

- Design, purchase, install, and maintain the transmission line dual pilot protective relay system for fault detection on the 345kV radial interconnection line from the point of interconnection substation to the Interconnection Customer's Q0301 switching substation. Each relay system will use an independent communications path.

- Design, purchase, and install two (2) transmission line protective relay systems for fault detection on the 345kV line from the point of interconnection substation to the Emery substation. These relays will coordinate with the protective relays at Emery substation. One of the relay systems will communicate over power line carrier and the other will use a digital communication path. This communication path uses a combination of microwave and optical fiber. Power line carrier is currently being used on this line so the Emery substation terminal is equipped for it. The digital communication path is also already in place between Dynamo substation and Camp Williams substation. The two fiber optical cables between the point of interconnection substation and the Dynamo substation will provide the links to the existing systems.

- Design, purchase, and install two (2) transmission line protective relay systems for fault detection on the line between the point of interconnection substation and Camp Williams substation. The communications link will use the existing fiber optic systems between the Dynamo and Camp Williams substations. The line relays at the Camp Williams substation on the Emery line and at Emery substation on the Camp Williams line will need to be replaced with line relays that are compatible with the new line relays to be installed at the Q0301 point of interconnection substation.

- Design, purchase, and install a relay for under/over voltage and over/under frequency protection of the system at the Q0301 point of interconnection substation. If an out of operating range condition occurs, a signal will be sent over the fiber optic cable to trip all of the Q0301 generators offline.

Other Substations / Remote Sites

Work to be completed by the Interconnection Customer

- No work required.

Work to be completed by the Transmission Provider

- Camp Williams substation: Remove the Emery line wave traps on B & C phases and install 1272kcm wire jumpers to complete the circuit.

- Camp Williams substation: Replace the line protection relays on the Emery line with relays that are compatible with the relays installed at the Q0301 point of interconnection substation.

- Emery substation: Replace the line protection relays on the Camp Williams line with relays that are compatible with the relays installed at the Q0301 point of interconnection substation

- Communications upgrades at PCC and Salt Lake Control Centers, and also at the Timp, Sigurd, and Emery substations.

Communications Specifications [past the point of interconnection]

<u>Work to be completed by the Interconnection Customer</u>

- No work required.

<u>Work to be completed by the Transmission Provider</u>

- Camp Williams substation - Update the channel equipment for line protection.

- Emery substation - Update the channel equipment and power line carrier equipment with redundant traps, tuners, etc., for line protection to the Q0301 point of interconnection substation.

- Sigurd substation - Update the channel and telemetry equipment for redundant interchange real power MW.

- Salt Lake Control Center - Update the SCADA interface equipment and voice and network communications interface for channels to the Q0301 site locations.

- Dynamo substation - Add redundant fiber termination and telemetry channel interface.

- Timp substation - Add back to back channels for redundant path line protection to Camp Williams.

Exhibit 1 to Appendix C to LGIA

Facility Connection Requirements for Transmission Systems

Policy

Facility Connection Requirements for Transmission Systems
(46 kV and Above)

Author:	Paul Della, Dennis Desmarais
Approval:	Greg Lyons
Authoring Department:	Standards Engineering
Approved File Location:	\\PdxShrn104\Srh04\Eng\Publications\PLN\POL
File Number-Name:	139-Facility Interconnection Requirements for Xmsn Systems.doc
Revision Number:	4
Revision Date:	3//30/2010

Policy

Facility Connection Requirements for Transmission Systems
(46 kV and Above)

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Facility Connection Requirements for Transmission Systems
(46 kV and Above)

1 INTRODUCTION

This policy addresses the requirements for generation facilities, transmission facilities, and end-user facilities that are interconnected to PacifiCorp's transmission system. This policy, along with PacifiCorp's OATT, ensures that adverse impacts on reliability of the transmission system is avoided. In addition to ensuring reliability, this policy is consistent with safety requirements for PacifiCorp employees and the general public. This document is maintained by Technology Development and Standards group and is published on PacifiCorp's internal and external websites. PacifiCorp will make a copy of this document available to qualified entities with five business days of the request.

Although this policy addresses certain aspects of interconnection cost responsibility, its scope is primarily technical and does not include the commercial requirements for connecting generators or transmission facilities. Tariffs and rules filed with FERC and jurisdictional state regulatory agencies address the rates, terms, and conditions under which PacifiCorp provides these services. If there are any inconsistencies between this policy and the tariffs and rules, the tariffs and rules shall apply.

1.1 Introductory Definitions

PacifiCorp Transmission System: For the purposes of this policy document, the PacifiCorp transmission system is defined as electric transmission facilities owned by PacifiCorp typically 46kV and above.

Customer Load: A person, company, or corporation interconnected to PacifiCorp's transmission system owning or operating only power-consuming facilities.

Facility Interconnection Customer: A person, company, partnership or corporation interconnecting to PacifiCorp's transmission system owning or operating generation facilities, transmission facilities, and end user facilities.

Any connected entity owning or operating both power-consuming and power-generating facilities shall be considered a Facility Interconnection Customer for the purposes of this policy. The technical requirements for interconnection of generation sources are generally more comprehensive. Any load-only entity which is interconnected to a third-party electric system having generation capabilities shall also be considered a Facility Interconnection Customer for the purposes of this policy. Technical requirements for multi-interconnected systems (systems interconnected to the PacifiCorp power system in addition to a third-party system) will be determined by PacifiCorp on a case-by-case basis.

1.2 Applicability

This standard applies to generation, transmission, and end user facilities that are physically connected to, or desire to physically connect to, PacifiCorp's transmission system. Applicability is further defined by the categories below:

1.2.1 Generation Facilities

All requirements described or referred to in this policy apply to new and decommissioned generation facilities. New generation facilities are facilities that have not been and are not yet connected with the PacifiCorp transmission system. Decommissioned generation facilities are facilities that were actively connected to PacifiCorp's electrical system in the past but presently are not connected nor actively producing power. Additional technical requirements may apply to special business arrangements or electrical configurations of PacifiCorp's transmission system or the interconnection point(s). Any such technical specifications would be documented within the interconnection agreement and the operation and maintenance agreement. All decommissioned generators must comply with all requirements contained in this policy document. It may be necessary for the decommissioned generator to upgrade existing equipment to adhere to this policy.

1.2.2 Transmission Facilities

Any proposed transmission facility interconnecting into PacifiCorp's transmission system shall be coordinated and reviewed through the Pacificorp's transmission planning process. The transmission facility addition shall maintain or improve the level of system reliability that existed prior to the interconnection. Power flows as a result of the transmission interconnection shall not overload or adversely affect the PacifiCorp transmission system or the WECC regional transmission system.

1.2.3 End-user Facilities

Any proposed load customer interconnecting into PacifiCorp's high voltage transmission system shall be coordinated and reviewed through the New Large Load Process.

1.2.4 Existing Facilities

To the extent this handbook contains more stringent requirements than were in place at the time that existing facilities were initially connected, the existing entity shall be responsible for adhering to current requirements only to the extent that the safety and reliability of the power system or the safety of utility employees would be jeopardized by not adhering to the current requirements and standards. The cost for any upgrading shall be borne by either the Facility Interconnection Customer or by PacifiCorp pursuant to applicable electric rules and/or the terms of any executed agreements between the Facility Customer and PacifiCorp.

1.3 Policy for Interconnection of Transmission Facilities

PacifiCorp has established this policy for operating, metering, and equipment protection requirements for the interconnection of new generation, transmission, and end user facilities. This policy covers the requirements for all facilities wishing to interconnect to the PacifiCorp transmission system. Additional project specific requirements may apply. These additional requirements may vary according to the specifications of the interconnection as well as local configuration of the PacifiCorp transmission system.

The technical studies will determine whether PacifiCorp will be required to modify its transmission system to interconnect the requested facilities. Parties requesting interconnection are responsible for the cost of these technical studies. Please contact the PacifiCorp Transmission Account Manager for details about the study process and additional data requirements which may apply.

1.4 Security Access to Facilities

PacifiCorp personnel will honor all reasonable requests from the facility owner when accessing PacifiCorp equipment located within a facility owner's premises. The facility owner will grant PacifiCorp 24-hour access to PacifiCorp-owned equipment on the facility owner's premises. If this access is not allowed for the reasonable day-to-day operation of PacifiCorp's power system affecting PacifiCorp's customers, including emergency incidents or other power delivery-related activities, PacifiCorp reserves the right to exercise the disconnection provision of the facility interconnection agreement.

1.5 Facility Connection Customer Equipment Requirements

Interconnected parties are responsible for designing, installing, operating, and maintaining interconnection equipment that they own (i.e., generators, transformers, switches, relays, breakers, etc). All protective devices necessary to protect the interconnected facilities are the responsibility of the Customer.

PacifiCorp's requirements specified in this policy are designed to protect PacifiCorp facilities and maintain grid reliability pursuant to applicable reliability criteria; **they are not designed to protect the facilities of interconnected customers.**

Interconnected Customers must satisfy the requirements in 1) this policy, 2) applicable rules and tariffs of jurisdictional state regulatory agencies and FERC, 3) applicable policies of the Western Electricity Coordinating Council (WECC), the North American Electric Reliability Council (NERC), or their successor organizations, and 4) PacifiCorp's project-specific requirements. PacifiCorp's review and written acceptance of the interconnected entity's equipment specifications and plans shall not be construed as confirming or endorsing the interconnected entity's design, as warranting the equipment's safety and durability, or in any way relieving the interconnecting entity from its responsibility to meet the above requirements. PacifiCorp shall not, by reason of such review or lack of review, be responsible for strength, details of design, adequacy, or capacity of equipment built to such specifications, nor shall PacifiCorp's acceptance be deemed an endorsement of such equipment.

Readers should be aware that the information in this policy document is subject to change. The latest version of this document is available at http://www.oasis.pacificorp.com/oasis/ppw/main.htmlx

PacifiCorp will not agree to interconnect new facilities unless all technical and contractual requirements are met. Copies of this policy will be supplied upon request. Contact the PacifiCorp Transmission Account Manager for referrals to the PacifiCorp employee who can respond to questions concerning PacifiCorp's policy for facility interconnection coordination procedures or additional copies of this document:

Director, Transmission Services
PacifiCorp
825 N.E. Multnomah Blvd. Suite 1600
Portland, Oregon 97232
(503) 813-6079

The document can also be obtained by emailing transmission.services@pacificorp.com.

2 OWNERSHIP POLICY AND OPERATION OF INTERCONNECTION EQUIPMENT

PacifiCorp shall own all interconnection facilities and system upgrades necessary to assure reliable service to PacifiCorp customers. This may include, but is not limited to: relaying, control systems, breakers, switches, bus work, and transmission lines. In all cases, revenue metering and communications circuits for the purpose of breaker status and transfer trip will be owned and maintained by PacifiCorp. PacifiCorp may, at its option, contract with the Facility Interconnection Customer, or a third party, for construction of any or all of these facilities.

2.1 Applicant Construction of PacifiCorp Facilities

When it is mutually agreed by PacifiCorp and the faciity interconnection customer, the customer shall design and build PacifiCorp facilities using a PacifiCorp approved engineering firm. The customer shall provide PacifiCorp with design drawings prior to the start of construction and shall continue to provide PacifiCorp with the latest revisions sent to the contractor for construction. Within 30 days of the completion of construction, the interconnect customer shall provide PacifiCorp with a complete set of design drawings revised to reflect as-built conditions. In addition, the interconnect customer shall be responsible for obtaining SAP numbers and equipment memorandum forms from PacifiCorp and for completing the equipment memorandums for all major equipment identified by PacifiCorp as requiring setup in SAP to provide the means for scheduling future maintenance. The interconnect customer shall provide PacifiCorp with the completed equipment memorandums upon the installation of the major equipment for which they are required.

3 INTERCONNECTION PROCESS, STUDIES, AND REQUIREMENTS

3.1 Facility Interconnection Process Summary

FERC provides procedures which govern generation facility interconnections where a generator chooses to sell power to the bulk power market or a transmission customer/end user chooses to take unbundled or wholesale electric service from a FERC jurisdictional transmission line. A FERC jurisdictional line is defined as a line or interconnection classified as FERC transmission by the host utility or by using the FERC Seven Factor Test. Generators, transmission line, and end users must follow all FERC procedures when using or interconnecting with FERC jurisdictional transmission.

1. The FERC processes and procedures have been incorporated into PacifiCorp's OATT which may be accessed at: http://www.oasis.pacificorp.com/

   If the generator, transmission line, or end user are not FERC jurisdictional, PacifiCorp applies applicable state processes, if they exist, and voluntarily applies the same processes and procedures for consistency and ease of processing when state rules do not exist.

2. Generators, transmission line, and end users must follow all FERC interconnection procedures and processes when they are FERC jurisdictional. The following FERC orders govern the interconnection processes and procedures:

   Generators with nameplate ratings greater than 20 MW are governed by the FERC Large Generator Interconnection Procedures and Agreements (LGIP/LGIA) process. These are incorporated into Section IV *Large Generator Interconnection Service* of PacifiCorp's OATT.

Generators rated from 10 kW to 20,000 kW (20 MW) are governed by FERC Small Generator Interconnection Procedures and Agreements (SGIP/SGIA) process. These are incorporated into Section V *Small Generator Interconnection Service* of PacifiCorp's OATT.

Line/End Users who choose to take unbundled or wholesale electric service are governed by PacifiCorp's (OATT).

3. Generators not governed by FERC procedures and agreements shall be governed by PacifiCorp procedures and agreements. Line/end users not governed by the PacifiCorp OATT shall be governed the corresponding PacifiCorp state tariffs (bundled electric service) and procedures.
4. All interconnecting customers will be required to meet all applicable standards, which include, but are not limited to NERC Reliability Standards, WECC Reliability Standards, FERC Generator Interconnection Procedures, FERC Generator Interconnection Agreements, Pacific Northwest Security Council requirements, Northwest Power Pool Requirements, and PacifiCorp planning criteria and facility connection requirements

3.2 Coordinated Joint Studies

3.2.1 Procedures for Coordinated Joint Studies

Unless there are conflicts with FERC or state standards (such as Critical Energy Infrastructure Information (CEII) and/or standards or code of conduct issues) PacifiCorp will form ad hoc groups, distribute results, and facilitate any required meetings between Facility Interconnection Customer, PacifiCorp, potentially affected electric systems, and any governing authorities in accordance with the FERC Large Generation Interconnection Procedures/Agreements (LGIP/LGIA) or other applicable procedures. This includes requesting potentially affected parties to participate in joint studies and following accepted WECC regional planning practices. If a potential CEII conflict arises such as an unknown consultant requesting critical system data, PacifiCorp would require FERC approval and a confidentiality agreement. If, in the opinion of PacifiCorp, a potential standard or code of conduct issue arises which may involve parties that 1) are not FERC jurisdictional public utilities, or 2) decline to sign a confidentiality agreement, PacifiCorp will provide system criteria violations (thermal, voltage, or stability) specific to affected system only.

Results of coordinated joint studies shall be documented along with any conclusions and recommendations. Such documentation shall be retained by PacifiCorp shall be made available if requested by WECC or NERC, or any other entities responsible for the reliability of the interconnected transmission system as soon as feasible.

3.2.2 Procedures for Notification of New or Modified Facilities

PacifiCorp shall disseminate notification of new or modified facilities to the WECC, and NERC in accordance with notification procedures that such entities have established.

Facility Interconnection Customers that are seeking to integrate new facilities with PacifiCorp should contact:

Director, Transmission Services
PacifiCorp
825 N.E. Multnomah Blvd. Suite 1600
Portland, Oregon 97232
(503) 813-6079
transmission.services@pacificorp.com

3.2.3 Additional Requirements

1. All transmission facilities, whether owned by PacifiCorp or the Facility Interconnection Customer must be in complaince with all NERC reliability requirements. NERC reliability standards may be accessed on the internet at:

   http://www.nerc.com/~filez/standards/Reliability_Standards.html

   Some specific NERC standards which may apply are:

   - BAL Resource and Demand Balancing
   - CIP Critical Infrastructure Protection
   - COM Communications
   - EOP Emergency Preparedness and Operations
   - FAC Facilities Design, Connections and Maintenance
   - INT Interchange Scheduling and Coordination
   - IRO Interconnection Reliability Operations and Coordination
   - MOD Modeling, Data, and Analysis
   - ORG Organization Certification
   - PER Personnel Performance, Training, and Qualifications
   - PRC Protection and Control
   - TOP Transmission Operations
   - TPL Transmission Planning
   - VAR Voltage and Reactive

2. If the Facility Interconnection Customer interconnection is to a point on the transmission system that is 100 kV and greater, the Facility Interconnection Customer must then comply with the NERC reliability standards.

3. PacifiCorp may revise the technical requirements periodically to comply with new requirements from FERC, NERC, state, other governmental authorities. PacifiCorp may require that all generator, transmission line, and end user interconnections comply with new regulations by implementing similar procedures and/or upgrades as would be expected on PacifiCorp facilities in a non-discriminatory manner. If the Facility Interconnection Customer does not comply, PacifiCorp may upgrade the Facility Interconnection Customer's facilities as necessary to be compliant. Any such upgrades shall be executed at the customer's expense. Alternately, PacifiCorp may disconnect the Facility Interconnection Customer after proper notification according to OATT requirements and procedures.

4. The PacifiCorp “bulk power network” is defined in this document as all 100 kV and greater lines which serve more than local load. This may include participation in the transport of long-distance power transfers according to the FERC Seven Factor Test.
5. The term "Facility Interconnection Customer" refers to the new generation, transmission, and end user facilities requesting authorization to interconnect with the PacifiCorp electric system where FERC has jurisdiction.
6. Generators interconnecting to the PacifiCorp electric system are governed by the most current version of the PacifiCorp OATT.
7. This document complies with NERC requirements to document, maintain, and publish facility connection requirements for NERC/FERC jurisdictional generation facilities (rated at 10 – 20,000 kW), and transmission/end user facilities to ensure compliance with:
   - NERC Reliability Standards
   - FERC Small Generator Interconnection Procedures and Agreements
   - Applicable Regional Reliability Organization Requirements
   - Sub-regional, Power Pool Requirements
   - PacifiCorp Requirements
8. These technical requirements specify the minimum technical requirements intended to ensure a safe, effective, and reliable interconnection. These requirements are intended to supplement, but not replace, information contained in regulatory codes, PacifiCorp’s OATT, PacifiCorp electric service tariffs, and specific interconnection agreements. The requirements outlined in this document may not cover all details in specific cases.
9. Additional information regarding parallel operation of generation with the PacifiCorp system can be obtained by contacting the Transmission Account Manager.

3.3 General Requirements

1. The Facility Interconnection Customer shall identify the voltage level and capacity or demand at the point of interconnection in MW and MVAr.
2. The Facility Interconnection Customer shall interconnect to the PacifiCorp electric system at the nominal voltage at the agreed-to point of interconnection. PacifiCorp, at its sole discretion, may elect to upgrade or change the voltage level of the PacifiCorp electric system serving the Facility Interconnection Customer. Any costs to upgrade or change the Facility Interconnection Customer’s equipment to maintain an interconnection with PacifiCorp shall be the responsibility of the Interconnection Customer. All direct assigned facilities required to interconnect to 46 kV systems will be designed and built to 138 kV standards in anticipation of future conversion of all 46 kV systems to 138 kV.
3. The customer shall obtain PacifiCorp's acceptance of those portions of design documents that apply to protection and security of the PacifiCorp electric system according to OATT requirements and procedures. The customer is solely responsible for the design that affects the facility.

Protection of the Facility Interconnection Customer's overall electrical system, including generation and connected load, is the sole responsibility of the Facility Interconnection Customer.

4. The customer will follow all FERC, NERC, and Regional Reliability Organization (RRO) requirements for review and approval of the facility interconnection and any required system changes or upgrades. This may include the development of such studies and data as a WECC subcommittee shall reasonably request.
5. PacifiCorp and/or its consultant shall conduct all electric system studies and issue reports required by FERC, NERC, RRO, PacifiCorp, and any other regulatory body for authorization and justification of the proposed interconnection to the PacifiCorp electric system. The customer shall reimburse PacifiCorp for all costs incurred for these studies and reports according to OATT requirements and procedures.
6. The customer shall comply with PacifiCorp, WECC, and industry design, construction, operating standards, and procedures.
7. The Facility Interconnection Customer's installation shall meet all applicable national, state, and local construction and safety codes.
8. The interconnection design shall be capable of accommodating PacifiCorp electric system reclosing practices.
9. The interconnection design shall incorporate equipment to detect system abnormalities or disturbances in either the Facility Interconnection Customer's system or the PacifiCorp system. This equipment shall have the capability to isolate the sources of the disturbance.
10. The interconnection design shall be such that failure of the generator, transformer, and other auxiliary equipment shall result in the automatic isolation of the affected equipment.
11. The customer shall design the facility to meet all current WECC reliability standards including the WECC System Performance Table as accessed on the WECC website or upon request from PacifiCorp.
12. The customer shall design the facility to meet technical requirements and facility rating standards as shown on the PacifiCorp website.
13. The customer shall not cause the PacifiCorp electric system to violate NERC voltage criteria or voltage ranges defined in ANSI Standard C84.1, Range A (plus or minus 5 percent of nominal).
14. The customer shall interconnect to the PacifiCorp electric system at the nominal voltage at the agreed to point of interconnection. PacifiCorp, at its sole discretion, may elect to upgrade or change the voltage level of the PacifiCorp electric system serving the Facility Interconnection Customer. Costs for upgrading the Customer's facility are the responsibility of the Customer.
15. The customer shall control the electrical real (MW) and reactive (MVAr) power output such that it will not exceed the capacity of the interconnection facilities.

16. The Facility Interconnection Customer 's three-phase generation shall be connected to the PacifiCorp power system with three-phase automatic disconnecting devices (circuit breakers), which are intended to significantly reduce the possibility of damaging the Facility Interconnection Customer 's generation equipment due to single-phase operation. These disconnecting devices shall be equipped with auxiliary contacts that indicate the actual status of the devices' main contacts.
17. A isolating device, typically a switch, must be installed to physically and visibly isolate the customer and PacifiCorp systems. The disconnect will serve as the point of change of ownership between the customer and PacifiCorp and will be labeled as such both on drawings and on-site signage. The disconnect shall be installed by the customer and shall be accessible to both PacifiCorp and the customer at all times with the ability to be padlocked open by either party. The disconnect shall be owned and operated by PacifiCorp to provide a visible air gap with clearances for adequate grounding, maintenance, and repairs of the PacifiCorp electric system. PacifiCorp may require the capability to apply safety grounds on the PacifiCorp side of the disconnect. The customer shall not remove any PacifiCorp padlocks or safety tags as per the Occupational Safety and Health Administration (OSHA) lockout/tagout requirements. In any case the device:
    - Must simultaneously open all phases (gang operated) to the interconnected facilities;
    - Must be accessible by PacifiCorp and must be under PacifiCorp Dispatcher jurisdiction;
    - Must be lockable in the open position by PacifiCorp;
    - Shall not be operated without advance notice to affected parties, unless an emergency condition requires that the device be opened to isolate the interconnected facilities; and
    - Must be suitable for safe operation under all foreseeable operating conditions.

    PacifiCorp personnel may lock the device in the open position and install safety grounds:
    - If it is necessary for the protection of maintenance personnel when working on de-energized circuits;
    - If the interconnected facilities or PacifiCorp equipment presents a hazardous condition;
    - If the interconnected facilities jeopardize the operation of the PacifiCorp Electric System.
18. System flows as a result of the interconnection shall not overload nor adversely impact PacifiCorp’s transmission system, nor neighboring transmission system. Where the Facility Interconnection Customer 's generation or transmission facilities supply fault currents to the PacifiCorp electric system in excess of breaker or other interrupting device maximum-rated interrupting capability, the customer shall be required to install and pay for fault-limiting equipment or pay for breaker or other interrupting-device replacements according to OATT requirements and procedures.

19. The harmonic content of the voltage and current wave forms of both the Facility Interconnection Customer 's and PacifiCorp's systems shall comply with the latest version of the IEEE Standard 519, Recommended Practices and Requirements for Harmonic Control in Electric Power Systems.
20. Industry standard basic insulation level ratings shall be used for electric system additions and electric system interface equipment. The electric equipment shall meet IEEE C62.41 or C37.90.1, V&I Withstand Requirements.
21. The customer shall be capable of withstanding electromagnetic interference environments in accordance with ANSI/IEEE Standard C37.90.2. The interconnection system and protection system shall not mis-operate due to electromagnetic interference, including hand-held communication devices.
22. PacifiCorp may install disturbance-recording equipment at the system interface according to NERC, OATT, or regional requirements and procedures.
23. The interconnection design shall incorporate adequate facilities to enable the on-site generation to be synchronized with the PacifiCorp electric system. The customer shall be solely responsible for synchronizing the generator to the system. At PacifiCorp's discretion, all occurrences of synchronizing the generator to the system shall be preceded with advance notification of not less than one full clock hour to be provided to PacifiCorp's Portland or Salt Lake City dispatch centers.
24. All points at which the generator can be paralleled with the PacifiCorp electric distribution system must be clearly defined as synchronization points in the submittal documentation. A given installation may be designed such that there are several synchronization points.
25. For insulation and insulation coordination on transmission facilities 34.5 kV and above, PacifiCorp's Engineering Handbook, Section 1.B.7 shall govern facility design.
26. Determination of Equipment Rating: All series elements that together make up a line section or bulk power substation transformer circuit are reviewed to determine which facility has the most limiting rating. In the event that a line section or bulk power transformer terminates on a ring bus or a breaker-and-a-half, the facility rating will be determined assuming a closed ring bus or closed breaker-and-a-half. The most limiting facility rating of the entire ring bus or the most limiting facility rating of the breaker positions adjacent to the line section or bulk power transformer in a breaker-and-a-half scheme are considered in determining the rating of the line section or bulk power transformer. In order to account for the flow split when entering a closed-ring or a closed breaker-and-a-half, a multiplier is used to adjust the ratings of the ring bus or breaker-and-a-half facilities. The multiplier assumes a conservative split of 75/25 percent, meaning that 75 percent of the line section flow or bulk transformer flow is assumed to be transferred onto one leg of the ring bus or breaker-and-a-half. This means that an equivalent line section or bulk power transformer flow of 133 percent (100/75 percent) can be accommodated before exceeding the facility rating of the ring-bus limit or breaker-and-a-half limit. The most limiting series element facility rating, and where applicable, 133 percent of the most limiting ring-bus facility rating, or

133 percent of the most limiting facility rating of the adjacent breaker positions in a breaker-and-a-half is then used in the WECC model data submittal and in operations of PacifiCorp's system. In cases where a facility is jointly owned, the operator of the facility determines the facility rating and shares this rating information with the other joint owners. In cases where a facility is owned in segments (such as a transmission line terminal being owned by one party and the transmission line itself owned by another party), PacifiCorp coordinates with the owners of the other segments of the facility to insure that the most limiting rating is used by all parties.

27. For further information on general technical requirements for facility interconnections, see the appendices at the end of this document.

4 METERING POLICY FOR FACILITY INTERCONNECTION CUSTOMERS

4.1 General

The purpose of this section is to assist the customer in accommodating PacifiCorp metering for the measurement of electricity supplied to the PacifiCorp transmission system. This section is applicable only to those providing power to the PacifiCorp transmission system. The general requirements are similar to, if not identical to, the general requirements for metering the supply of electrical service by PacifiCorp.

Usually, when a generator is installed with the intent of providing power to the PacifiCorp transmission system, electric service to the auxiliary load associated with the generator plant is also needed. As such, power may flow into or out of the plant at different times. Deliveries to and from the plant (bi-directional metering) must be separately recorded and treated as separate transactions under PacifiCorp's tariffs.

All meters and instrument transformers will be provided, installed, owned, and maintained by PacifiCorp at the Facility Interconnection Customer's expense. Unless other arrangements have been made, the customer will provide, install, own, and maintain all mounting structures, conduits, meter sockets, meter socket enclosures, metering transformer cabinets, and switchboard service sections of the size and type approved by PacifiCorp.

PacifiCorp will require Generation Interconnection Customer's with multiple generators to install revenue net metering at each generator, to satisfy that hourly revenue data will be available at all times to validate the official metering at the point of interconnection. This is to eliminate estimating data during periods when the official meteing is questioned or lost. Any net generation metering used for any PacifiCorp revenue purpose or data validation will be tested and maintained identically to the official interconnect revenue metering.

For larger wind farms with multiple collector stations, metering will be required on the high side of each step up transformer, as well as at the point of interconnection. The general requirements for the collector metering are the same as the requirements for revenue metering at the point of interconnection.

Metering will be programmed such that the generators are only charged for consuming VArs when the project is drawing MWs; i.e., not generating.

4.2 Basic Metering Requirements for Generators

4.2.1 Metering Requirements

The standard PacifiCorp meter used for all generation and transmission interchange projects is the Landis & Gyr, Maxsys 2510 meter. The meter will be programmed with a standardized PacifiCorp internal program that will include bidirectional kWh and kVArh energy and kW and kVAr sliding 15-minute demand quantities, with instantaneous MW MVAr data. The meters will be programmed to record 15-minute interval profile demand that includes bidirectional kWh and kVArh and per-phase volt-hour demand interval recording. Additional quantities can be added if necessary to the basic program.

Metering data collected will include working meter register reads, monthly register freeze reads, and 15-minute demand interval profile data. The meter will perform a self-freeze read at midnight each month. The meters shall be compatible with the PacifiCorp MV-90™ system and shall be interrogated daily or whenever necessary for maintenance purposes.

All meters will include both analog and digital output boards following current standard PacifiCorp specifications. The metering design will include a test switch with all data inputs and outputs terminated at a utility interposition block.

The final metering design requirements including hardware I/O and software specifications will be written into the specific project's scoping documentation. Requests from foreign utilities for digital or analog metering outputs must be made prior to final design. A second or backup meter will be added when needed or if there are additional metering outputs required beyond what is possible from the primary meter.

4.2.2 Meter Testing

PacifiCorp and the generation customer agree that a certification of the meter system accuracy be done at least biannually or as specifically agreed upon in the interchange agreement. PacifiCorp shall give all interested parties notification of at least two weeks for the impending test. A copy of the test results shall be available to all parties involved or on file for review.

4.3 Metering Installations ≥ 5 MW

PacifiCorp standard metering installation for 5 MW and above net generation facilities is required to be wye-connected on the high-voltage side of the step-up transformer. Primary and backup metering which will meter the net generation is required. Revenue metering must be installed at the physical point of interconnection with the PacifiCorp transmission system. If it is not possible to install metering at the physical point of interconnect, PacifiCorp will require that line losses be calculated. The calculated loss algorithm may be additive or subtractive depending upon current flow through the meter. The calculated loss algorithm will be programmed within the meter(s) firmware to adjust the registers, load profile, and any digital or analog outputs. PacifiCorp requires that any applicable line-loss compensation be performed in the meter, rather than calculated in the billing system.

4.3.1 Conduit for Revenue Metering Secondary Leads

For secondary metering leads between the connections at the meters and the instrument transformers located in the substation yard, the generation customer is to provide a minimum size of three-inch conduit. When the distance between the revenue instrument transformers and meter panel is greater than 250 feet, it may be necessary to increase the conduit size to accommodate paralleled CT metering secondaries to reduce the burden to the current transformers.

PacifiCorp shall procure all conductors and the generation customer shall install meter-wiring cable from the transformers to the revenue metering panel located in the substation. The conduit shall be PVC, rigid steel, or IMC and must be installed with long-radius sweeps. The customer contractor is responsible for proper installation practices.

4.3.2 Indoor Panel Applications

When indoor panels are required to mount meters and metering hardware, PacifiCorp will specify, order, and install all revenue panels and accessories. The meter panels will be 12” wide by 90” high and shall require a clear work space 36” wide by 90” high by 48” deep in front and to the rear of the panel.

4.3.3 Outdoor Meter Enclosure Applications

When it is necessary to mount meters and metering hardware in outdoor locations, PacifiCorp will specify and order the metering box enclosure. The enclosure will be mounted and installed by the customer’s contractor. When outside meter enclosures are used they typically serve both as the junction box and meter socket enclosure. The meter enclosure box will be NEMA 3R-rated, and shall have sealing provisions.

4.3.4 Sealable Junction Box

The junction box provides a means of terminating the revenue metering service conductors within the substation yard for indoor panel applications. The use of this junction box shall be coordinated with PacifiCorp prior to installation. The junction box will be NEMA 3R-rated, and shall have sealing provisions.

4.3.5 Secondary Leads and Termination

The secondary circuits must be designed such that the maximum possible burden on any transformer will not exceed its rating. All metering secondary leads or cable will be provided by PacifiCorp. The secondary leads will conform to PacifiCorp standards and color-code requirements. Wire terminations may be done by manufacturer or contractor, but all will be inspected and approved by PacifiCorp.

4.3.6 Metering Bypass Switch

When applicable, the requirements for metering bypass switches will be provided by PacifiCorp to the customer. The generation customer shall purchase, install, and own switches which will isolate and bypass the metering transformers when necessary to allow for maintenance.

4.3.7 Primary Metering Structures

The high-side primary metering structure must be designed to accommodate the standard PacifiCorp wye-connected instrument transformers. The physical location will be determined during the design phase of the project. When requested by the customer, PacifiCorp will supply outside parties with design details of the standard metering system.

4.3.7.1 Metering Disconnects

High-side metering shall have a minimum of two gang-operated, lockable disconnect devices to facilitate establishing a visual open(s). Disconnect devices are necessary at the following locations:

1. At the point of interconnection with PacifiCorp (this switch is PacifiCorp-operated).
2. Between the generator side of PacifiCorp's metering and the Facility Interconnection Customer Facility Interconnection Customer's electrical facility (this switch is owned and operated by the Facility Interconnection Customer Facility Interconnection Customer).
3. If the generator is selling power to PacifiCorp on a surplus-sale basis, a separate disconnect device (generator or host-site owned and operated) is required on the metering side of the load. Refer to Figure 1 for typical interconnections. Distribution pole-top metering requires only one switch located on the load side of the metering.

4.4 Metering Installations < 5 MW

For 46 kV and above and the total net generation output is less than 5 MW, it is acceptable for the revenue metering to be located on the low side of the step-up transformer. All low side metering must be wye-connected and installed on the unregulated side of the voltage regulator. For this application the metering installation is normally inside the customer facility and PacifiCorp-approved metering enclosures are required. Instrument transformers shall be located inside an approved PacifiCorp metering enclosure. It is not acceptable for meters, metering transformers, and accessories to be located on outside structures.

4.4.1 Metering Enclosures > 600 volts for Underground and Overhead Applications

To meter medium-voltage interchange services, customers shall meet the requirements of the Electric Utility Service Equipment Requirements Code, EUSERC Section 400. The customer shall provide all necessary hardware per EUSERC Section 400. A clear work space 78" high by 36" wide by 48" deep in front of distribution metering equipment (per current NEC regulations) is required. A concrete mounting pad is required for the switchgear metering enclosure. The mounting pad shall be a minimum of 4" thick. The metering instrument transformers will be specified by PacifiCorp and shall be provided and installed by the manufacturer of the switchgear. The meter, test switch, and any specialized hardware will be specified, ordered, and installed by PacifiCorp.

4.4.2 Overhead Pole-Mounted Metering

Pole-mounted metering would be unusual inside a generation substation facility. To establish a mutually suitable location for pole-mounted metering, the customer shall consult with PacifiCorp before construction begins.

4.4.3 Metering < 600 volts

The service and metering installation requirements for all installations shall conform to the applicable standards of PacifiCorp's *Six State Electric Service Requirements*. Generation metering requirements for secondary below 600 volts, self-contained and instrument-rated metering are the same as commercial installations.

4.5 Metering for Station-Service Power

Depending upon the generation facility's electrical sources, the station service power for connecting substation facilities may also require revenue metering. The same metering requirements as generation meters apply to station-service metering.

4.6 Meter Communication Requirements

All generation metering will require a dedicated voice grade data phone line for use with the PacifiCorp MV-90 meter data collection system. It will be the responsibility of the generation customer to supply both the land line and any communication protection devices necessary for PacifiCorp to remotely interrogate the meter through a dial-up connection.

The following sections describe the detailed requirements for metering electricity supplied by generators connected to the PacifiCorp system:

Surplus-Sale Operation Co-Generation: Meters shall be required to measure both the net generator output and the surplus generation delivered to the PacifiCorp system.

Net-Sale Operation: Meters shall be required at the point of interconnection.

No-Sale Operation: Revenue metering will not be required for the measurement of power delivered into the PacifiCorp system, except that load profile and net generator profile metering may be required for standby service. The existing service metering shall be replaced with metering equipped with multiple register to separately measure all required quantities.

Wheeling Service: Wheeling service under certain existing agreements on the PacifiCorp system require two sets of revenue-metering equipment which may be totalized to accommodate various line and switch configurations. Import metering is required to the point of import (received) to (on) the PacifiCorp system. Export metering is required at the point of export (delivery) from (off) the PacifiCorp system.

Where non-utility generators (i.e., emergency generators, peak-shaving generators, etc.) or portable plug-ins (generators not permanently wired to the outlet) are connected via an electrical outlet or automatically connected via an automatic transfer switch, a visible disconnect shall be required. A visible disconnect can be a disconnect knife switch or a combination of a manual disconnect circuit breaker, built-in switch, and red light indicators. The disconnect shall be visible at all times, and shall have one red light bulb per conductor indicating energized/de-energized conditions of the utility and generator source conductors on the line side of the main disconnect or circuit breaker.

All generators must meet applicable standards of the Western Electric Coordinating Council (WECC).

4.7 Instrument Transformers ≥ 5 MW

Voltage and current instrument transformers are required to be a wye-connected, wire-wound, extended-range type with 0.15 percent metering accuracy class. The instrument transformers will maintain their accuracy ranging from 1 amp to 4,000 amps Type-1 class and from 0.25 amps to 750 amps Type-3 primary current. The accuracy class addresses both ratio error and phase-angle error over the burden range of the installed metering circuit. Instrument transformers shall be stand alone, located on the line at the delivery point such that the metering is not interrupted during possible switching configurations at the delivery point unless the metering is being removed for service. Paralleling CTs and internal CTs located inside breakers and power transformers for the purpose of revenue metering will not be permitted.

4.8 Instrument Transformers < 5 MW

For low-side metering exceptions, it is not required for the metering transformer’s accuracy to be extended-range. Voltage and current instrument transformers are required to be 0.3 percent standard metering accuracy class for both ratio error and phas- angle error over the burden range of the installed metering circuit. Instrument transformers shall be an approved PacifiCorp design and shall be located within the metering switchboard or switchgear enclosures.

4.9 Instrument Transformer Verification

At least once during the life of the transformer, a documented verification of instrument transformer ratios shall be performed. This requires measurement of primary current simultaneously with secondary current to determine actual ratio to within 10 percent of marked nameplate ratio. Transformer turns ratio (TTR) on voltage transformers or CT tester check shall substitute if in-service primary measuring equipment is unavailable. The objective is to ensure that the instrument transformer ratios are documented and are connected to known taps under known burden conditions. This test shall be performed during a scheduled bi-annual test (if there is no record of a verification being performed) and when instrument transformers are replaced.

4.10 Telemetering Requirements for Generator Monitoring

4.10.1 For New Generation Facilities ≥ 3 MW

For generating facilities totaling 3 MW or greater, the following real-time data is to be telemetered to PacifiCorp's Control Center for each generating unit (both wind and non-wind units):

- kW
- kVAr
- kWh
- generator terminal voltage (kV)

A generator equipped with a voltage regulator and power system stabilizer (PSS) must also provide telemetry indicating the status of both the regulator and the PSS. In addition, transmission kW, kVAr, kV, and breaker status may be required, depending on the number of generators and transmission configurations. A telemetering circuit to the designated PacifiCorp Control Center is also required. A minimum number of alarms to be transmitted include the following:

- breaker trip
- transfer trip receive
- channel/equipment failure

Unless other arrangements are made, the customer must provide communication lines with the following minimum specifications: VG36, Class B, Type-3, 4-wire, full-duplex (1200 baud).

Telemetering equipment (usually a dual-ported RTU) shall be located in the metering enclosure. At the entity's expense, PacifiCorp will supply telemetering equipment at the Facility Interconnection Customer Facility Interconnection Customer 's site, at PacifiCorp's Control Center and at a designated PacifiCorp Alternate Control Center.

5 TELECOMMUNICATION REQUIREMENTS FOR FACILITY INTERCONNECTION

5.1 Application

Before a new facility is interconnected to the PacifiCorp power system, PacifiCorp will specify the metering, protection, supervisory control and data acquisition (SCADA), telemetering, and telecommunications channels required. Due to the highly specialized and critical nature of the protection, metering, SCADA, and telemetering equipment, PacifiCorp requires that all such equipment be owned, installed, and maintained by PacifiCorp at the generation facility's expense. Also, due to the critical protection requirements for the interconnection of the generation facility to PacifiCorp's system as well as the varied PacifiCorp internal telecommunications systems which may be available for the specific generation facility, the telecommunication channels described below must be defined on a case-by-case basis.

5.2 General Requirements

The interconnection facility customer will be responsible for acquiring the communication lines from the local telephone company or multiple telephone companies as required to meet the telecommunications required of the new generation facility with the exception that if tele-protected (requires communications channel) relay channels are required, PacifiCorp will provide them at the cost of the generation facility. Due to the critical nature of the protection, metering, SCADA, and telemetering requirements, PacifiCorp will define the technical requirements and may provide, at its option, all or portions of the telecommunication channels on its existing internal telecommunication network at the cost of the generation facility.

5.3 Telecommunication Circuit Requirements

5.3.1 New Generation Facilities < 3 MW with No Teleprotection Requirement

5.3.1.1 Remote Metering Business Telephone Line

A business telephone line at the location of the interconnect point metering equipment is required for remote revenue-metering reading and maintenance work.

5.3.2 New Generation Facilities ≥ 3 MW or New Generation Facilities < 3 MW with Teleprotection Requirement

5.3.2.1 Remote Metering Business Telephone Line

A business telephone line is required at the location of the interconnect point metering equipment for remote revenue-metering reading. The generation entity must provide land-line telephone access, if possible. If local telco facilities are not available, other options for providing dial-up access to the meter will be considered.

5.3.2.2 Dispatch Business Telephone Line

A business telephone line is required so operating instructions from PacifiCorp can be given to the designated operator of the generation facility equipment. Unless other arrangements are made to use PacifiCorp's existing telecommunications network, the generation entity must provide a local telephone.

5.3.2.3 Protective Relay Remote Access Business Telephone Line

A business telephone line is required at the location of the protective relay equipment for remote maintenance of the protective relay equipment. Unless other arrangements are made to use PacifiCorp's existing telecommunications network, the generation entity must provide a local telephone.

5.3.2.4 Protective Relays

PacifiCorp will determine if non-pilot protective relays will be adequate for emergency tripping of the generation facility and/or protection of the distribution or transmission system or if tele-protected-type protection equipment is required. PacifiCorp will design and provide telecommunications channels suitable for the protective relay package required at the cost of the generation facility. Local telephone company leased lines are not acceptable for protective relay channels. Telecommunication channels for protective relay equipment may consist of fiber optic system, power line carrier, microwave radio, or a combination of these systems.

5.3.2.5 SCADA Remote Terminal Unit (RTU)

Real-time data and/or control via a SCADA RTU is be communicated to PacifiCorp's Control Center. Unless other arrangements are made to use PacifiCorp's existing telecommunications network, the generation entity must provide a local telephone company VG36, Class B, Type-3, 4-wire, full-duplex communication line from the generation facility to PacifiCorp's Control Center. PacifiCorp will specify the location where the communication line will terminate. Telecommunication channels for SCADA RTU equipment, when using PacifiCorp's telecommunications network, may consist of fiber optic system, microwave radio, other radio system, or a combination of these systems.

5.3.2.6 Analog Telemetering

Analog telemetering of the total generation facility's kW output to one of PacifiCorp's alternate control sites (Medford, Oregon; Yakima, Washington; Goshen, Idaho; or Sigurd, Utah) is required as an interim solution per NERC Standard EOP-008-0, *Plans for Loss of Control Center Functionality*. Unless other arrangements are made to use PacifiCorp's existing telecommunications network, the generation entity must provide a local telephone company VG36, Class-B, Type-3, 2-wire, communication line from the generation facility to PacifiCorp's alternate control site. PacifiCorp will specify the location of the closest alternate control site where the communication line will terminate. Telecommunications channel for analog telemetering equipment, when using PacifiCorp's telecommunications network, may consist of fiber optic cable, power line carrier, microwave radio, or a combination of these systems. The analog telemetering channel may use the same telecommunications system as the SCADA RTU channel providing it is not routed through PacifiCorp's Control Centers.

5.4 Telephone Company Line Treatment Equipment

Proper cable and protection equipment may be required at substations and other high-voltage electric facilities for expected ground potential rise (GPR). The GPR testing required to determine the required telephone line protection may be performed by

PacifiCorp at the cost of the generation facility or may be performed by generation facility itself. The calculated GPR value will determine what grade of telephone cable high-voltage protection equipment is required, as well as the distance from the facility at which the telco pedestal will be located. The local telephone company must be informed in advance (up to six months) so outside plant facilities can be engineered to serve the generation facility location. Some independent telephone companies are not tariffed to provide protection equipment. In this case, the generation facility will be required to purchase and install the necessary telephone line protection equipment.

5.5 Communication Operating Conditions

5.5.1 Normal Operating Conditions

The customer shall provide to PacifiCorp the information necessary to communicate with the equipment and/or personnel at the generation facility during routine operating conditions. This information shall be updated as soon as a material change becomes available for use by notifying PacifiCorp's grid operations centers in either Salt Lake City, Utah or Portland, Oregon, depending on the facility's operating area.

5.5.2 Emergency Operating Conditions

The Facility Interconnection Customer shall provide to PacifiCorp the information necessary to communicate with the equipment and/or personnel at the generation facility during the loss of the primary communication medium. This would be considered the emergency operating condition. This information is also to be updated as soon as a material change becomes available for use by notifying PacifiCorp's grid operations centers in either Salt Lake City, Utah or Portland, Oregon, depending on the facility's operating area.

6 PROTECTION AND CONTROL POLICY

This section specifies the protective and control requirements for Facility Interconnection Customers to PacifiCorp's transmission system.

6.1 Applicability

The applicable protective standards of this section apply to all facilities interconnecting to any portion of PacifiCorp's transmission system. These policies, which govern the design, construction, inspection, and testing of protective devices, have been developed by PacifiCorp to be consistent with applicable reliability criteria.

6.2 Protective Requirements

An important objective in the interconnection of facilities to PacifiCorp's system is minimizing the potential hazard to life and property. A primary safety requirement is the ability to disconnect immediately when a fault is detected. Facility developers desiring interconnection with PacifiCorp's transmission system must comply with all applicable jurisdictional state regulatory agency rules in this regard.

The protection equipment for an interconnection facility must protect against faults within that facility and faults on the PacifiCorp system. As a general rule, an interconnection facility must also trip off-line (disconnect from the PacifiCorp system automatically) when PacifiCorp's transmission system is disconnected from the line into which the facility is connected.

In view of these objectives, PacifiCorp requires line-protective equipment to either 1) automatically clear a fault and restore power, or 2) isolate only the faulted section.

Due to the high-energy capacity of the PacifiCorp transmission system, high-speed fault clearing may be required to minimize equipment damage and potential impact to system stability. The requirement of high-speed fault clearing will be determined by PacifiCorp on a case-by-case basis. To achieve these results, relays and protective devices are needed. The requirements are outlined in the following pages. Some protection requirements can be standardized, however most line relaying depends on generator size and type, number of generators, line characteristics (i.e., voltage, impedance, and ampacity), and the existing protection equipment connected to the PacifiCorp system.

PacifiCorp's minimum protection requirements are designed and intended to protect PacifiCorp's system only. As a general rule, neither party should depend on the other for the protection of its own equipment. Interconnected Facilities are required to provide their own high side protection for their facilities. Additional protective relays are typically needed to protect the Interconnection Customer 's facility adequately. It is the Facility Interconnection Customer 's responsibility to protect their own system and equipment. PacifiCorp insists that the entity hire a qualified electrical engineer (with a PE license in electrical engineering) to review and stamp the electrical design of the proposed generation facility and ensure that it will be adequately protected.

The Facility Interconnection Customer must provide PacifiCorp test reports for all relays before PacifiCorp will allow the facility to parallel. Refer to Section 10.2 for information regarding pre-parallel inspections. Every four years thereafter, the Facility Interconnection Customer must test relays and provide written proof of the testing, that the relays are operable and within calibration. PacifiCorp will not test the entity's equipment, but may witness the testing performed by a qualified testing firm retained by the entity. The testing firm will be approved by PacifiCorp prior to the actual test. On-site power (typically 120 V) is required for the test equipment. Circuit breakers must be tested at least every eight years after the pre-parallel inspection. It is also in the Facility Interconnection Customer 's best interest to make sure all of its protective equipment is operating properly, since significant equipment damage and liability can result from failures of the entity's protective equipment. The Facility Interconnection Customer shall report relay problems to PacifiCorp and shall resolve problems in a reasonable time (within one year at a minimum). If this places PacifiCorp or the Facility Interconnection Customer in a compromised position of liability, the generation shall be disconnected until the relay issue(s) is/are resolved to PacifiCorp’s satisfaction.

6.3 Reliability and Redundancy

The Facility Interconnection Customer shall design the protection system with sufficient redundancy or relay coordination such that the failure of any one component will still permit the Facility Interconnection Customer's facility to be isolated from the PacifiCorp system under a fault condition. Multi-function three-phase protective relays must have redundant relay(s) for back up unless otherwise agreed to by PacifiCorp. The required breakers must be trip-tested by the Facility Interconnection Customer at least once a year.

6.4 Relay Elements

The following is a description of the relay elements shown in Figure 1.

21 – Distance relay is a relay that functions when the circuit admittance, impedance, or reactance increases or decreases beyond a predetermined value. This type of relay may be required when the Generation Entity is connecting two (2) or more generators to The PacifiCorp power system. This determination is made during the System Impact Study and is based on minimum peak loading of the feeder tow which the Generator Entity will connect.

27 – Undervoltage relay is a relay that operates when its input voltage is less than a predetermined value. PacifiCorp requires three (3) undervoltage elements with time delay. Settings will be determined during the System Impact Study.

50P – Phase instantaneous overcurrent relay is a relay that functions instantaneously on an excessive value of phase current. The requirement for this element is based on minimum peak loading of the feeder tow which the Generator Entity will connect.

59N – 3V0 overvoltage relay is a relay that functions instantaneously on an excessive value of 3V0 voltage. This element utilizes the second coil of the potential transformer wired in a broken delta. Settings will be determined during the System Impact Study.

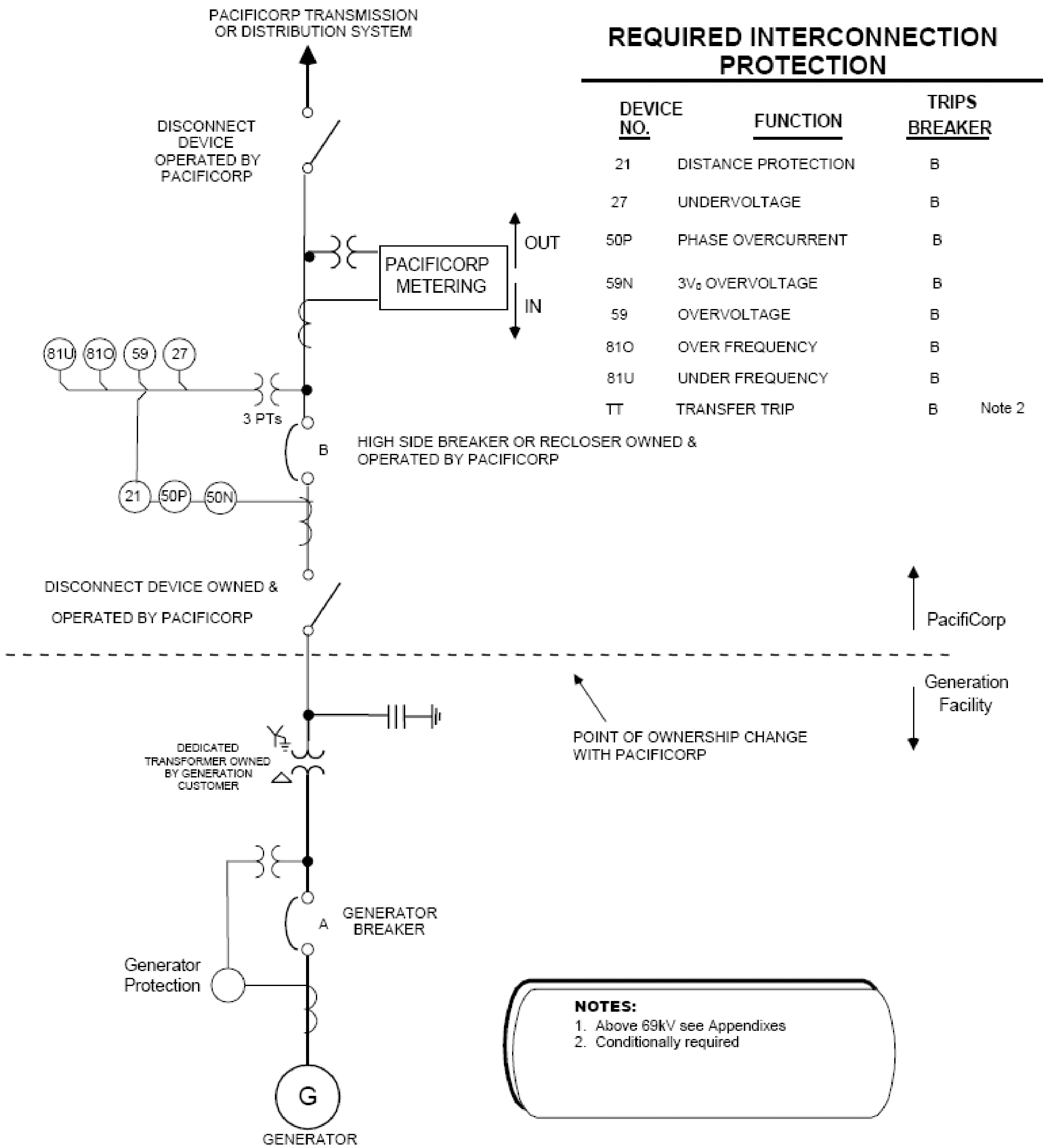
59 – Overvoltage relay is a relay that operates when its input voltage is higher than a predetermined value. This element is utilizes a current transformer between the transformer and the high side breaker. Settings will be determined during the System Impact Study.

81O – Overfrequency relay is a relay that responds to the frequency of an electrical quantity, operating when the frequency or rate of change of frequency exceeds a predetermined value. PacifiCorp requires three (3) overfrequency elements with time delay. Settings will be determined during the System Impact Study and are based on radial or non-radial connections.

81U – Underfrequency relay is a relay that responds to the frequency of an electrical quantity, operating when the frequency or rate of change of frequency is less than a predetermined value. PacifiCorp requires three (3) underfrequency elements with time delay. Settings will be determined during the System Impact Study and are based on radial or non-radial connections.

TT – Transfer Trip is a scheme that operates based on a remote signal. Transfer trip could utilize, fiber, leased line, microwave, etc. as determined by PacifiCorp. Transfer trip may be required depending on PacifiCorp circuit configuration and loading, as determined by PacifiCorp. Typically, transfer trip shall be required if PacifiCorp determines that a generation facility cannot detect and trip on PacifiCorp end-of-line faults within an acceptable time frame or if the generation facility may be capable of keeping a PacifiCorp line energized with the PacifiCorp source disconnected. It may be in the generation facility's best interest to purchase relays capable of communications in the event transfer trip is later required.

Figure 1–Typical Interconnection for Protection and Metering Installation 69 kV and Below



REQUIRED INTERCONNECTION PROTECTION

DEVICE NO.	FUNCTION	TRIPS BREAKER	
21	DISTANCE PROTECTION	B	
27	UNDERVOLTAGE	B	
50P	PHASE OVERCURRENT	B	
59N	$3V_0$ OVERVOLTAGE	B	
59	OVERVOLTAGE	B	
81O	OVER FREQUENCY	B	
81U	UNDER FREQUENCY	B	
TT	TRANSFER TRIP	B	Note 2

6.5 Approved Vendors

PacifiCorp is familiar with all major utility-grade relay manufacturers. Below is a sample list of major vendors; it is not intended to be an exhaustive listing.

- ABB
- Areva
- Beckwith
- Basler
- Cooper
- GE
- Schweitzer
- Siemens

PacifiCorp will accept any utility-grade relay or combination of relays from this list provided that all required relay elements are fulfilled. All relays must be utility-grade, no other grade will be acceptable.

PacifiCorp approval does not indicate the quality or reliability of a product or service, and no endorsements or warranties shall be implied.

6.6 Line Protection

Many factors are considered when determining the protective relaying requirements needed by Facility Interconnection Customer to protect PacifiCorp facilities and customers' equipment. Some of these factors are: the zone of protection, location of connection to PacifiCorp system, location of customers relative to the location of connection, and type of protection system used on the PacifiCorp transmission system.

The zone of protection refers to the area in PacifiCorp's system where the Facility Interconnection Customer's facility must provide fault protection. When a fault occurs, the Facility Interconnection Customer's protective relays are to cause the isolation of the Facility Interconnection Customer's facilities from PacifiCorp's or the Facility Interconnection Customer's system. If there are any PacifiCorp customers connected to the system in the zone of protection, the protection system is designed so that the service to those customers is not diminished by the addition of the Facility Interconnection Customer's facilities. This includes the amount of delay in automatic testing of the zone of protection by PacifiCorp's equipment following a fault.

There are many options for providing the protective relay system for the zone of protection. These options will affect the up-front cost and the reliability of the Facility Interconnection Customer's facilities. The use of pilot relaying or direct transfer trip communication may increase the cost to the Facility Interconnection Customer, but the use of these systems will limit the number of times the facility is forced offline to protect PacifiCorp's system. This is especially true when a PacifiCorp customer is connected to the system in the zone of protection. The protective relays at the Facility Interconnection Customer's facility will need to be set to detect any fault in the zone of protection and isolate the Facility Interconnection Customer's generator from PacifiCorp's system with no delay. Since the protective relays cannot be set to detect 100 percent of the faults without detecting and operating for faults outside the zone of protection, the Customer's interconnection facilities will be disconnected for fault conditions that normally would not require isolation of the facilities. With the use of a pilot relaying system or direct transfer trip, the number of these unnecessary operations can be greatly reduced. In addition, line-protection relays must coordinate with the protective relays at the PacifiCorp breakers for the line on which the generating facility is connected. The typical protective zone is a two-terminal line section with a breaker on each end. In the simplest case of a load on a radial line, current can flow in one direction only, so protective relays need to be coordinated in one direction and do not need directional elements. However, on the typical transmission system, where current may flow in either direction depending on system conditions, relays must be directional. Also, the complexity and the required number of protective devices increase dramatically with increases in the number of terminals in each protective zone. With two terminals in a protective zone, there are two paths of current flow. With three terminals there are six paths of current flow, and so on. Coordinating a multi-terminal scheme may sometimes require installation of a transmission line protective relay at the Facility Interconnection Customer 's sub-site. This is commonly the case whenever three-terminal permissive overreach transfer trip (POTT) schemes are employed to protect the line. Because this line relay participates in a scheme to protect the PacifiCorp transmission system, PacifiCorp must ensure the maintenance, testing, and reliability of this particular type of relay.

In addition, the breaker's relays must be set to have overlapping zones of protection in case a breaker within any given zone fails to clear. The line protection schemes must be able to distinguish between generation, inrush, and fault currents. Multiple terminal lines become even more complex to protect. Existing relay schemes may have to be reset, replaced, or augmented with additional relays at the Facility Interconnection Customer 's expense to coordinate with the Facility Interconnection Customer 's new facility.

The PacifiCorp-required relays must be located so that a fault in the zone of protection on any phase of the PacifiCorp line shall be detected. If transfer trip protection is required by PacifiCorp, the Facility Interconnection Customer shall provide at its expense a voice-grade communications circuit. This circuit may be a communication line from the telephone company or a dedicated cable. The line must have high-voltage protection equipment on the entrance cable so the transfer trip equipment will operate properly during fault conditions.

The PacifiCorp transmission system is designed for high reliability via multiple sources and paths to supply customers. Due to the multiple sources and paths, more complex protection schemes are required to properly detect and isolate faults. The addition of any new generation facility to the PacifiCorp system must not degrade the existing protection and control schemes or cause existing PacifiCorp customers to suffer lower levels of safety and/or reliability.

Table 1 lists the minimum protection that PacifiCorp typically uses on its own installations. Higher voltage interconnections require additional protection due to the greater potential for adverse impact to system stability, and the greater number of customers who would be affected. Special cases such as distribution-level network interconnections, if acceptable, may have additional requirements. The acceptability and additional requirements of these interconnection proposals shall be determined by PacifiCorp on a case-by-case basis.

6.7 PacifiCorp Protection and Control System Changes

PacifiCorp will perform a detailed interconnection study to identify the cost of any required modifications to PacifiCorp's protection and control systems are required to interconnect a new facility. These protection and control system modifications are in addition to any transmission and distribution system upgrades identified in the system impact or facilities studies for interconnection of the new facilities.

The following is a partial list of protection system modifications which may be required:

1. PacifiCorp's automatic restoration equipment shall be prevented from operating until the generator is below 25 percent of nominal voltage as measured at the restoration equipment. Generator damage and system disturbances may result from the restoration of power by automatically re-energizing PacifiCorp's facilities. This modification shall be required when the generator(s) has the capability of energizing a line when the PacifiCorp system is disconnected. PacifiCorp will not allow the Facility Interconnection Customer Facility Interconnection Customer 's generator(s) to automatically re-energize PacifiCorp facilities.
2. For generation facilities greater than 1,000 kW aggregate nameplate rating, all existing single-phase fault-interrupting devices (fuses) located in series between the generator and PacifiCorp's substation shall be replaced with three-phase interrupting device to prevent possible single-phasing of other customers.
3. The PacifiCorp substation transformer high-side fuses must be replaced with a three-phase interrupting device when the generator is on a distribution circuit fed from a fused PacifiCorp substation transformer bank and the bank's minimum load is equal to or less than 200 percent of the generator's nameplate rating.
4. A transfer trip scheme from the high-side circuit breaker/circuit switcher to the generator shall be installed if necessitated by PacifiCorp. An associated alarm circuit is required between the Facility Interconnection Customer Facility Interconnection Customer 's site and the PacifiCorp Control Center.

6.8 Warning Label for Protective Relays

A warning label shall be affixed within 6 inches of any relay in the Facility Interconnection Customer’s control house (or similiar enclosure containing protective relays) **which affects the operation of PacifiCorp's electrical circuits**. The warning label shall state the following:

> ***Warning !!!*** *Do not alter or change any settings on this relay without first receiving approval from PacifiCorp's Protection and Control Engineering Dept. in Portland, Oregon. Failure to give notification to PacifiCorp of this action may result in damaged or destroyed electrical equipment, possible physical injury or fatality, facility disconnection, and/or legal action.*

Table 1–Line Protection Devices

Line Protection Device	Device[1] Number	34.5kV or less	46kV, 57kV or 69kV	115kV	230kV & above
Phase Overcurrent (Radial systems)	50/51	X	X		
Ground Overcurrent (Radial systems)	50/51N	X	X		
Phase Directional Overcurrent	67		X	X	
Ground Directional Overcurrent or Transformer Neutral	67N 50/51N		X	X	X
Distance Relay Zone I	21ZI		X[2]	X	X
Distance Relay Zone 2	21Z2		X[2]	X[2]	X
Distance Relay Carrier	21Z2C			X[2]	X
Ground Directional Overcurrent Carrier	67NC			X[2]	X
Pilot Wire	87L			X[2]	X
Permissive Overreaching Transfer Trip (POTI) or Hybrid	21/67T			X[2]	X
Direct Transfer Trip	TT	X[3]		X[3]	X[3]

Notes:
1. Refer to Section 6.4 for device number definitions and functions.
2. May be required on transmission or distribution interconnections depending on local circuit configurations, as determined by PacifiCorp.
3. Transfer trip may be required on transmission- level or distribution- level interconnections depending on PacifiCorp circuit configuration and loading, as determined by PacifiCorp. Typically, transfer trip shall be required if PacifiCorp determines that a generation facility cannot detect and trip on PacifiCorp end-of-line faults within an acceptable time frame or if the generation facility may be capable of keeping a PacifiCorp line energized with the PacifiCorp source disconnected (Appendix F).

6.9 Manual Disconnect Switch Requirements

A manual load-break disconnect switch is required for all interconnected facilities. For connections to the PacifiCorp transmission grid, a tap line switch may also be required if, in PacifiCorp's judgment, sufficient tap line exposure exists to warrant it. Refer to Appendix D for more details on tap line switches. For transmission line taps, two additional line switches, one on each side of the tap, are required to provide the facility better service and operating flexibility. Note that the installation of line switches may impact the protection requirements for the interconnection, specifically the need for direct transfer trip.

A PacifiCorp-operated disconnect device must be provided as a means of electrically isolating the PacifiCorp transmission system from the interconnected facilities. This device shall be used to establish visually-open working clearance for maintenance and repair work in accordance with PacifiCorp safety rules and practices. A disconnect device must be located at the point of interconnection with PacifiCorp. PacifiCorp shall own, operate, and maintain all disconnect switches for generation interconnection facilities. The disconnect switch shall be specified by the appropriate PacifiCorp engineers working on the interconnection project and shall come from PacifiCorp stock and be installed on PacifiCorp-owned facilities. PacifiCorp will notify the Facility Interconnection Customer in advance of the operation of the disconnect switch and follow all work practices associated with this procedure. In the event of an urgent incident or emergency, PacifiCorp may not be able to notify the developer in a timely fashion that it intends to operate a switch. Any deviation from this policy shall be signed off by a Vice-President of Engineering at PacifiCorp along with corporate legal counsel and shall be included in the interconnection agreement between PacifiCorp and the generator developer with an explanation of why this policy was not followed for the specific project.

For cases in which the state or federal regulatory policy conflicts with PacifiCorp's policy, the state and federal regulatory policy shall prevail.

The developer may at its option install other disconnect switch(es) on its property to operate as its sees fit. PacifiCorp asks that the developer notify a PacifiCorp dispatch center before operation of their disconnect switch(es).

PacifiCorp personnel shall inspect and approve the installation before parallel operation is permitted. If the disconnect device is in the Facility Interconnection Customer Facility Interconnection Customer 's substation, it should be located on the substation dead-end structure and must have a PacifiCorp-approved operating platform.

The disconnect device must not be used to make or break parallels between the PacifiCorp system and the generator(s). The device enclosure and operating handle (when present) shall be kept locked at all times with PacifiCorp padlocks.

The disconnect device shall be physically located for ease of access and visibility to PacifiCorp personnel. When installed on the Facility Interconnection Customer 's side of the interconnection, the device shall normally be installed close (within one foot) to the metering. The PacifiCorp-operated disconnect shall be identified with a PacifiCorp-designated switch number plate.

For transmission voltage interconnections, metering is normally on the high side of the Facility Interconnection Customer 's step-up transformers. Between the metering units and the circuit breaker, a second disconnect device is required; it shall not have a PacifiCorp lock and may be operated by the Facility Interconnection Customer.

Notes:

1. Disconnect switches must be rated for the voltage and current requirements of the particular installation.
2. Disconnect switches must be gang-operated unless otherwise agreed to by PacifiCorp.
3. Disconnect switches must be weatherproof or designed to withstand exposure to weather.
4. Disconnect switches must be lockable in both the open/closed positions with a standard PacifiCorp lock unless otherwise agreed to by PacfiCorp.

6.9.1 High-Voltage Disconnects

The Facility Interconnection Customer shall submit a proposed switch specification to PacifiCorp. It shall be reviewed and approved in writting by a PacifiCorp engineering manager prior to its purchase and installation.

6.9.2 Conditions for Manual Disconnection

Producers must discontinue parallel operation when requested by PacifiCorp under the following conditions:

1. To facilitate maintenance, test, or repair of PacifiCorp's facilities. PacifiCorp will coordinate this with each producer.
2. During system emergencies.
3. When a generator is interfering with other PacifiCorp customers or producers on the system.
4. When inspection of a generator reveals either a condition hazardous to PacifiCorp's system or personnel or a lack of scheduled maintenance or maintenance records for equipment necessary to protect PacifiCorp's system.

6.10 Fault-Interrupting Devices

The fault-interrupting device selected by the Facility Interconnection Customer must be reviewed and approved by PacifiCorp for each particular application.

There are three basic types of fault-interrupting devices:

- Circuit Breakers
- Circuit Switchers
- Fuses

PacifiCorp will determine the type of fault-interrupting device required for a generation facility based on the size and type of generation, the available fault duty, the local circuit configuration, and the existing PacifiCorp protection equipment.

6.10.1 Circuit Breakers

Three-phase circuit breaker(s) at the point of interconnection automatically separate the facility from the PacifiCorp system upon detection of a circuit fault. Additional breakers and protective relays may be installed in the generation facility for ease in operating and protecting the facility. The interconnection breakers must have sufficient capacity to interrupt maximum available fault current at its location and shall be equipped with accessories to:

1. Trip the breaker with an external trip signal supplied through a battery (shunt trip).
2. Telemeter the breaker status when it is required.
3. Lockout if operated by protective relays required for interconnection.

Generally, a three-phase circuit breaker is the required fault interruption device at the point of interconnection, due to its simultaneous three-phase operation and ability to coordinate with PacifiCorp line-side devices. However, fuses are allowed as high-side protection for the dedicated transformer at generation facilities of less than 1,000 kW connected on the distribution-level system, provided that coordination can be obtained with existing PacifiCorp phase and ground protection. If fuses are used, the Facility Interconnection Customer should consider installing a negative sequence relay and/or other devices to protect the facility against single phase conditions. If fuses are used for high-side transformer protection, a separate generator breaker will be required to isolate the generator from the PacifiCorp system under a fault or abnormal system conditions.

6.10.2 Circuit Switchers

A circuit switcher is a three-phase fault-interrupter with limited fault interrupting capability. These devices have typically been used at voltages of 115 kV and below and may substitute for circuit breakers when the fault duty is within the interrupting rating of the circuit switcher. With PacifiCorp approval, some circuit switchers with blades can double as the visual open disconnect switch between the metering transformers and the main transformer. Since circuit switchers do not have integral current transformers, they must be installed within 30 feet of the associated current transformers to minimize the length of the unprotected line/bus section.

6.10.2.1 Fuses

Fuses are single-phase, direct-acting sacrificial links that melt to interrupt fault current and protect the equipment. Blown fuses need to be replaced manually after each fault before the facility can return to service. Overhead primary fuses shall be replaced by trained personnel. Since fuses are single phase devices, they may not all melt during a fault, and may not automatically separate the generation facility from PacifiCorp. Fuses cannot be operated by the protective relays, hence they cannot be used as the primary protection for three-phase generation facilities. However, they may be used for high-side transformer protection for generation less than 1,000 kW, provided coordination can be obtained with the existing PacifiCorp phase and ground protection, and if a separate breaker provides the required primary protection. Fuses are not permitted for high side transformer protection for facilities of 1,000 kW or greater.

Large primary fuses which do not coordinate with the PacifiCorp substation breaker ground relays shall not be allowed. Such use could cause all the customers on the circuit to lose power due to a fault inside the generating facility.

7 GENERATOR PROTECTION AND CONTROL

Single-phase generators must be connected in multiple units so that an equal amount of generation capacity is applied to each phase of a three-phase circuit.

All synchronous, induction, and single-phase generators shall comply with the latest ANSI Standards C50.10 and C50.13, dealing with waveform and telephone interference.

Synchronous generators of any size require: a) synchronizing relays (Device No.25) to supervise generator breaker closing, and b) reclose blocking at the PacifiCorp side of the line to which the generator is connected (applies to substation breaker/recloser). Standard device numbers for commonly used protective elements are defined in Table 3. Direct transfer trip is preferred if coordinated protection is desired by the Facility Interconnection Customer. Coordinated protection will minimize the number of times the generator is forced offline without a dedicated feed.

The generator protection equipment listed in Section 6.4 is required to permit safe and reliable parallel operation of the Facility Interconnection Customer's equipment with the PacifiCorp system. Additional or alternate generator protection requirements for generators utilizing induction-type generator(s) or other specific situations shall be determined by PacifiCorp on a case by case basis.

7.1 Generator Requirements

7.1.1 Low Voltage Ride-Through (LVRT) Requirements for Generators

A generating plant shall be able to remain online during voltage disturbances up to the time periods and associated voltage levels set forth below. The LVRT standard is divided into three classifications by generation plant size.

7.1.1.1 Generating Plants with Capacity > 20 MW

7.1.1.1.1 Transition Requirements

For generators with interconnection agreements signed and filed with FERC between January 1, 2006 and December 31, 2006 with a scheduled in-service date no later than December 31, 2007 *or* for generating turbines subject to a turbine procurement contract executed prior to December 31, 2005 for delivery through 2007, the following requirement applies:

Generating plants are required to remain in-service during three-phase faults with normal clearing (which is a time period of approximately 4-9 cycles) and single line–to-ground faults with delayed clearing, as well as subsequent post-fault voltage recovery to pre-fault voltage unless clearing the fault effectively clears the generator from the system. The clearing time requirement for a three-phase fault will be specific to the generating plant substation location as determined by and documented by the transmission provider. The maximum clearing time the generating plant shall be required to withstand for a three-phase fault shall be nine cycles at a voltage as low as 0.15 pu, as measured at the high side of the generating plant step-up transformer (i.e., the transformer that steps the voltage up to the transmission interconnection voltage or GSU), after which, if the fault remains following the location-specific normal clearing time for three-phase faults, the generating plant may disconnect from the transmission system.

Notes:

1. This requirement does not apply to faults occurring between the generator terminals and the high side of the GSU or to faults that would result in a voltage lower than 0.15 pu on the high side of the GSU serving the facility.
2. Generating plants may be tripped after the fault period if this action is intended as part of a special protection system.
3. Generating plants may meet this LVRT standard by performance of the generators or by installing additional equipment (e.g., static VAR compensator, etc.) within the generating plant or by a combination of generator performance and additional equipment.
4. Any existing individual generator units that are, or have been, interconnected to the network at the same location before this requirement was written, are exempt from this requirement for the remaining life of the generation equipment. Existing individual generator units that are replaced must meet the requirements listed above.

7.1.1.1.2 Post-Transition Period

For all generators with capacity greater than 20 MW not subject to the transition period requirement above, the following requirement applies:

Generating plants are required to remain in-service during three-phase faults with normal clearing (which is a time period of approximately 4-9 cycles) and single line-to-ground faults with delayed clearing, as well as subsequent post-fault voltage recovery to pre-fault voltage unless clearing the fault effectively clears the generator from the system. The clearing time requirement for a three-phase fault will be specific to the generating plant substation location as determined by and documented by the transmission provider. The maximum clearing time the generating plant shall be required to withstand a three-phase fault shall be nine cycles, after which, if the fault remains following the location-specific normal clearing time for three-phase faults, the generating plant may disconnect from the transmission system. A generating plant shall remain interconnected during such a fault on the transmission system for a voltage level as low as zero volts, as measured at the high side of the GSU.

Notes:

1. This requirement does not apply to faults that would occur between the generator terminals and the high side of the GSU or to faults that would result in a voltage lower than 0.15 pu on the high side of the GSU serving the facility.
2. Generating plants may be tripped after the fault period if this action is intended as part of a special protection system.
3. Generating plants may meet this LVRT standard by performance of the generators or by installing additional equipment (e.g., static

VAR compensator, etc.) within the generating plant or by a combination of generator performance and additional equipment.

4. Any existing individual generator units that are, or have been, interconnected to the network at the same location before this requirement was written are exempt from this requirement for the remaining life of the generation equipment. Existing individual generator units that are replaced are required to meet the requirements listed above.

7.1.1.2 Generating Plants with Capacity ≥ 10 MVA and ≤ 20 MW

Generators are required to remain in-service during system faults (three-phase faults with normal clearing and single line-to-ground faults with delayed clearing) unless clearing the fault effectively disconnects the generator from the system. This requirement does not apply to faults that would occur between the generator terminals and the high side of the generator step-up transformer or to faults that would result in a voltage lower than 0.15 pu on the high side of the generator step-up transformer. In the post-fault transient period, generators are required to remain in-service for the low voltage excursions specified in the Table 4 as applied to a load bus.

Notes:

1. These performance criteria are applied to the generator interconnection point, not the generator terminals.
2. Generators may be tripped after the fault period if this action is intended as part of a special protection system.
3. This standard applies to any generation independent of the interconnected voltage level.
4. This standard can be met by the performance of the generators or by installing additional equipment (e.g., SVC, etc.).
5. Existing individual generator units that are interconnected to the network at the time of the adoption of this standard are exempt from meeting this standard for the remaining life of the existing generation equipment. Existing individual generator units that are replaced must meet the requirements listed above.

7.1.1.3 Generating Plants with Capacity < 10 MVA

Generators are required to remain in-service during system faults (three-phase faults with normal clearing and single line-to-ground faults with delayed clearing) unless clearing the fault effectively disconnects the generator from the system. This requirement does not apply to faults that would occur between the generator terminals and the high side of the generator step-up transformer or to faults that would result in a voltage lower than 0.15 pu on the high side of the generator step-up transformer. In the post-fault transient period, generators are required to remain in-service for the low voltage excursions specified in Table 4 as applied to a load bus.

Notes:

1. These performance criteria are applied to the generator interconnection point, not the generator terminals.

2. Generators may be tripped after the fault period if this action is intended as part of a special protection system.
3. This standard applies to any generation independent of the interconnected voltage level.
4. This standard can be met by the performance of the generators or by installing additional equipment (e.g., SVC, etc.).
5. Existing individual generator units that are interconnected to the network at the time of the adoption of this standard are exempt from meeting this standard for the remaining life of the existing generation equipment. Existing individual generator units that are replaced must meet these requirements.

7.1.2 High Voltage Ride-Through (HVRT) Requirements for Generators

7.1.2.1 Generating Plants with Capacity > 20 MW

Generators are required to stay online indefinitely for dynamic voltages ≤ 1.1 pu at the point of interconnect. For dynamic voltages > 1.1 pu and ≤ 1.15 pu at the point of interconnect, generators are required to delay tripping one second to allow for fault clearing. For dynamic voltages > 1.15 pu and ≤ 1.2 pu, generators are required to delay tripping for 0.30 seconds to allow for fault clearing. For dynamic voltages > 1.2 pu at the point of interconnect, generators may trip without delay.

7.1.2.2 Generating Plants with Capacity ≥ 10 MVA and ≤ 20 MW

Generators are required to stay online indefinitely for dynamic voltages ≤ 1.1 pu at the point of interconnect. For dynamic voltages > 1.1 pu and ≤ 1.15 pu at the point of interconnect, generators are required to delay tripping one second to allow for fault clearing. For dynamic voltages > 1.15 pu and ≤ 1.2 pu, generators are required to delay tripping for 0.30 seconds to allow for fault clearing. For dynamic voltages > 1.2 pu at the point of interconnect, generators may trip without delay.

7.1.2.3 Generating Plants with Capacity < 10 MVA

Generators are required to stay online indefinitely for dynamic voltages ≤ 1.1 pu at the point of interconnect. For dynamic voltages > 1.1 pu and ≤ 1.15 pu at the point of interconnect, generators are required to delay tripping one second to allow for fault clearing. For dynamic voltages > 1.15 pu and ≤ 1.2 pu, generators are required to delay tripping for 0.30 seconds to allow for fault clearing. For dynamic voltages > 1.2 pu at the point of interconnect, generators may trip without delay.

7.1.3 Ride-through and Trip Voltage/Frequency Settings

The required devices and settings will be installed at the point of interconnection. The protection devices at the point of interconnection will send trip signals to the generator breakers (or to the wind turbine feeder breakers if in a wind plant). The Facility Interconnection Customer may also have frequency and voltage protection at its generating facility. The Facility Interconnection Customer's local protection settings must be compatible with the voltage ride-through requirements in Table 2.

In Table 3, separate transmission frequency settings are specified for a generation interconnection to an integrated network and for a generation interconnection to a radial transmission line. The voltage/frequency performance for each of the two transmission interconnection types is expected to be different.

Table 2–Ride-Through and Trip Voltage Relay Settings

Low Voltage Ride-Through Required	High Voltage Ride-Through Required		Trip Required	
	pu	delay(sec)	pu	delay(sec)
For Gen > 20 MW	> 1.20	0	> 1.50	0.1
See sec. 7.1.1.1	1.151-1.199	0.3	1.15-1.499	2.0
	1.101-1.15	1.0	1.101-1.149	4.0
For Gen 10 MVA - 20 MW	≤ 1.1	No trip	0.899-0.871	600.0[1]
See sec. 7.1.1.2			0.87-0.671	2.0
For Gen < 10 MVA			< 0.671	0.5
See sec. 7.1.1.3				

Table 3–Ride-Through and Trip Frequency Relay Settings

	Ride-Through Required		Trip Required	
	Hz	delay(sec)	Hz	delay(sec)
Integrated	> 61.8	0.0		
	61.6-61.7	30.0		
	60.6-61.5	180.0		
	59.5-60.5	infinite	None	
	59.4-58.5	180.0		
	58.4-57.9	30.0		
	57.8-57.4	7.5		
	57.3-56.9	0.75		
	≤ 57.0	0.0		
Radial			> 61.6	0.0
			61.0-61.6	0.5
			> 60.5-60.9	180.0
	60.5-59.5	infinite	< 59.5-59.1	180.0
			59.0-58.4	0.5
			< 58.3	0.0

Table 4–WECC Disturbance-Performance Table of Allowable Effects on Other Systems

NERC and WECC Categories	Outage Frequency Associated with Performance Category (outage/year)	Transient Voltage Dip Standard	Minimum Transient Frequency Standard
A	Not Applicable	Nothing in addition to NERC	
B	≥ 0.33	Not to exceed 25% at load buses or 30% at non-load buses Not to exceed 20% for more than 20 cycles at load buses	Not below 59.6 Hz for 6 cycles or more at a load bus
C	0.033 - 0.33	Not to exceed 30% at any bus Not to exceed 20% for more than 40 cycles at load buses	Not below 59.0 Hz for 6 cycles or more at a load bus
D	< 0.033	Nothing in addition to NERC	

Notes:
1. The WECC Disturbance-Performance Table applies equally to either a system with all elements in service, or a system with one element removed and the system adjusted.
2. As an example in applying the WECC Disturbance-Performance Table, a Category B disturbance in one system shall not cause a transient voltage dip in another system that is greater than 20% for more than 20 cycles at load buses, or exceed 25% at load buses or 30% at non-load buses at any time other than during the fault.
3. Additional voltage requirements associated with voltage stability are specified in WECC Standard I-D. If it can be demonstrated that post-transient voltage deviations that are less than the values in the table will result in voltage instability, the system in which the disturbance originated and the affected system(s) should cooperate in mutually resolving the problem.

7.2 Phase Overcurrent

Instantaneous overcurrent, or rate-of-rise relay is a device (50) which functions instantaneously on an excessive value of current or on an excessive rate of current rise, thus indicating a fault in the apparatus or circuit being protected.

AC time overcurrent relay is a device (51) with either a definite or inverse time characteristic which functions when the current in an AC circuit exceeds a pre-determined value.

7.3 Over/Undervoltage Relay

This protection is used to trip the circuit breaker when the voltage is above or below PacifiCorp's normal operating level (126 V – 114 V). It is used for generator protection and backup protection in the event that the generator is carrying load that has become isolated from the PacifiCorp system.

7.4 Over/Underfrequency Relay

This protection device is used to trip the circuit breaker when the frequency is above or below PacifiCorp's normal operating level. It is used for generator/turbine protection and backup protection.

Generator underfrequency relay settings are coordinated with other utilities in the Western Electricity Coordinating Council (WECC) to maintain generation online during system disturbances. Without prior written approval by PacifiCorp, settings should not be set for a higher frequency or shorter time delay than specified by PacifiCorp's Protection and Control Engineer.

7.5 Overcurrent Relay with Voltage Restraint/Voltage Control or Impedance Relay

These relays are used to detect phase–to-phase faults and initiate a circuit breaker trip. The relays must be located on the individual generator feeder. A group of generators aggregating over 400 kW must have an impedance relay or an overcurrent relay with voltage restraint located on each generator greater than 100 kW. Generators equal to or greater than 400 kW must have an impedance relay or an overcurrent relay with voltage restraint. As determined by PacifiCorp, an overcurrent relay with voltage control may also be acceptable if it can be set to adequately detect end-of-line faults.

7.6 Dedicated Step-Up Transformer

The dedicated transformer matches the generator voltage to the utility voltage and steps up the generator voltage to the interconnection level. It also serves to isolate the Facility Interconnection Customer from other customers to a small degree.

The impedance of a dedicated transformer limits fault currents on the generator bus from the PacifiCorp system and also limits fault currents on the PacifiCorp system from the generator. Hence, it reduces the potential damage to both parties due to faults. The transformer must have a delta winding to reduce the generator harmonics entering the PacifiCorp system unless otherwise agreed to by PacifiCorp. The delta winding will also reduce the PacifiCorp system harmonics entering the generation facility.

Generators of more than 10 kW require the use of a dedicated transformer. Generators of 10 kW or less and generating at a secondary voltage level may require a dedicated transformer. This need can be determined and identified in a detailed study.

A high-side fault-interrupting device such as a breaker or recloser is required for transformer protection. It is also required that the device be gang-operated so as to avoid the possibility of ferroresonance or loss of phase condition.

A three-phase circuit breaker is recommended, but fuses are acceptable for generation facilities of less than 1,000 kW provided that coordination can be obtained with the existing PacifiCorp protection equipment. If fuses are used, it is recommended that the generating entity install single-phase protection for its equipment.

Lightning arrestors, if the Facility Interconnection Customer chooses to install them, must be installed between the transformer and the fault-interrupting devices and shall be encompassed by the generator's relay protection zone.

7.7 Generators

The generating unit must meet all applicable American National Standards Institute (ANSI) and Institute of Electrical and Electronic Engineers (IEEE) standards. The prime mover and the generator should also be able to operate within the full range of voltage and frequency excursions that may exist on the PacifiCorp system without damage to them. To enhance system stability during a system disturbance, the generating unit must be able to operate through the specified frequency ranges for the time durations listed in Table 2.

7.7.1 Synchronous Generators

7.7.1.1 Synchronizing Relays

Synchronous generators and other generators with stand alone capability must use one of the following methods to synchronize with the PacifiCorp system:

1. Automatic Synchronization with Automatic Synchronizing (Device 25)

   The automatic synchronizing relay must have a slip frequency-matching window of 0.1 Hz or less, a voltage-matching window of ± 10 percent or less, a phase angle-acceptance window of ± 10 degrees or less, and breaker-closure time compensation.

   The automatic synchronizing relay sends a close signal to the breaker after the above conditions are met.

2. Automatic Synchronization with Automatic Synchronizer (Device 15/25)

   The automatic synchronizing relay must have a slip frequency-matching window of 0.1 Hz or less, a voltage-matching window of ± 10 percent or less, a phase angle-acceptance window of ± 10 degrees or less, and breaker-closure time compensation. For an automatic synchronizer which does not have breaker-closure time compensation, a tighter frequency window (± 5 degrees) with a one-second time-acceptance window shall be used to achieve synchronization within ± 10 degrees phase angle.

   In addition to the above characteristics, this automatic synchronizer has the ability to adjust generator voltage and frequency automatically to match system voltage and frequency.

3. Manual Synchronization with Synchroscope and Synch Check (Device 25) Relay Supervision

   The synch check relay must have a voltage-matching window of ± 10 percent or less and a phase angle-acceptance window of ± 10 degrees or less.

   Generators with greater than 1,000 kW aggregate nameplate rating must have automatic synchronizing relay or automatic synchronizer.

7.7.1.2 Frequency/Speed Control

Unless otherwise specified by PacifiCorp, a governor shall be required on the prime mover to enhance system stability. Governor characteristics shall be set to provide a five percent droop characteristic (a 0.15 Hz change in the generator speed shall cause a five percent change in the generator load). Governors on the prime mover must be operated unrestrained to help regulate PacifiCorp's system frequency.

7.7.1.3 Excitation System Requirements

An excitation system is required to regulate generator output voltage.

Static systems shall have a minimum ceiling voltage of 150 percent of rated full-load field voltage with 70 percent of generator terminal voltage and a maximum response time of two cycles (0.033 seconds).

Rotating systems shall have an ANSI voltage response ratio of 2.0 or faster.

Excitation systems shall respond to system disturbances equally in both the buck and boost directions.

Under certain conditions, PacifiCorp may grant an exemption for generation facilities which have excitation systems not meeting these requirements. Requests for exemption should be sent to PacifiCorp Transmission Account Manager.

7.7.1.4 Voltage Regulator

The regulator must be able to maintain the generator voltage under steady-state conditions without hunting and within ± 0.5 percent of any voltage level between 95 percent and 105 percent of the rated generator. The point of voltage sensing should be at the same point as the PacifiCorp revenue metering. As determined by the PacifiCorp Control Center, the generator shall be operated at either a voltage or a power factor schedule.

At various times, the generating facility may also be requested by the PacifiCorp Control Center to produce more or less reactive power from that indicated on the regular schedule in order to meet the system needs.

7.7.1.5 Power-Factor Controller

The controller must be able to maintain a power-factor setting within ± 1 percent of the setting at full load at any set point between 90 percent lagging and 95 percent leading. In addition, all power-factor controllers for synchronous generators greater than 1MW must have programmable capability to vary hourly settings.

7.7.1.6 Power-System Stabilizer (PSS)

Generators with properly tuned and calibrated PSS provide damping to electric power oscillations. Such damping improves stability in the electrical system and may also prevent an individual generator from unnecessary tripping. The current WECC policy requires that the PSS be an integral part of the voltage regulator and be incorporated into the excitation systems for all new generating units with suitable excitation systems. PacifiCorp can help determine, at the Facility Interconnection Customer Facility Interconnection Customer 's expense, the suitability of an excitation system for PSS.

The PSS must be calibrated and operated in accordance with the latest standard procedures for calibration, testing, and operation of such equipment. These procedures are available from PacifiCorp. In addition, the calibration and test reports must be submitted to PacifiCorp's Transmission Account Manager.

The facility shall not be considered operational until PSS has been calibrated to PacifiCorp's satisfaction. A copy of the PSS calibration and operation procedures, as well as the suitability requirements, may be obtained from the PacifiCorp Transmission Account Manager. Additional information on PSS can be found in Appendix A.

The following criteria shall be used to determine when a PSS shall be installed on a synchronous generator, regardless of ownership, connected to the transmission system (by generator step-up transformer to 60 kV or higher voltage):

1. A PSS shall be installed on every existing synchronous generator that is larger than 75 MVA and is equipped with a suitable excitation system as defined in the WECC report, *Criteria to Determine Excitation System Suitability for PSS* available from the WECC web site.
2. A PSS shall be installed on every existing synchronous generator larger than 30 MVA or part of a complex that has an aggregate capacity larger than 75 MVA, or if the excitation system is updated so that it becomes a suitable excitation system as defined in the report mentioned in 1a above. This section applies to all machines whose excitation system is updated at any time after November 18, 1993.
3. A PSS shall be installed on every synchronous generator that is larger than 30 MVA or part of a complex that has an aggregate capacity larger than 75 MVA, and is equipped with suitable excitation systems as defined in paragraph 1a, and is commissioned after November 18, 1993.
4. A PSS is not required on a station service generator.

When a generator equipped with a functional PSS is online, the PSS shall be in operation except for the following reasons:

1. Maintenance and testing.
2. PSS exhibits instability due to nonstandard transmission line configuration.
3. PSS does not operate properly due to a failed component.
4. Unit is operating in the synchronous condenser mode (very near zero power level).
5. When a unit is generating less power than its design limit for effective PSS operation.
6. When a unit is passing through a range of output that is a known “rough zone.”

The aggregate MVA of the synchronous machines tonline and equipped with a functioning PSS shall not fall below the level identified in the most recent power system stabilizer study commissioned by the WECC.

When a synchronous generator equipped with a PSS is operating in the pump mode (P/G unit), and is connected to a transmission system such that the PSS does not produce negative damping, the PSS should be in service.

PSS equipment shall be tested and calibrated in conjunction with AVR testing and calibration. This will be done as often as is necessary to maintain reliable PSS performance in accordance with WECC *PSS Tuning Criteria*. PSS recalibration must be performed if AVR response parameters are modified. When a PSS is taken out of service because of a failed component, the party responsible will be expected to perform the needed repairs (or replacement) in a responsible and timely manner.

A PSS is not required for a synchronous condenser.

7.7.1.7 Power-Quality Analysis

At the discretion of the Area Planning Engineer, unattended generation facilities with capacity greater than 250 kW and with automatic or remotely-initiated paralleling capability may require a power-quality investigation analysis performed by PacifiCorp or a power-quality consulting firm. The analysis shall provide PacifiCorp with sufficient information to determine the status of the generation facility during system disturbances. The analyzer may provide remote access from PacifiCorp's Control Center or engineering offices.

7.7.1.8 Generator Testing

Testing of the generator and excitation system must be performed to verify proper parameters of the generator and exciter. Testing shall meet the requirements of the WECC Generator Testing Program. Copies of the test reports with appropriate powerflow and stability data parameters identified shall be provided to the PacifiCorp Transmission Account Manager. If a stability model is not available, the interconnection entity will be responsible for developing a suitable model for use in PacifiCorp's transient stability program, which currently uses the Power Technologies, Inc. PSSE version 27.1 program.

7.7.1.9 Direct Digital Control (DDC)

Dispatchable generators larger than 10,000 kW are required to have real-time direct digital control of unit output from PacifiCorp's Control Center. This allows generation units to respond to power system load/frequency changes.

7.7.2 Induction Generators

Induction generators, and other generators with no inherent VAr (reactive power) control capability, shall be required to provide power to the unity point of interconnection. Such generators shall operate in as near a range of ± 0.95 power factor as is technically feasible without risk of self-excitation to provide an amount of reactive power equivalent to that required for a synchronous generator. They may also be required to follow a PacifiCorp-specified voltage or VAr schedule on an hourly, daily, or seasonal basis, depending on the location of the installation. Specific instructions shall be provided on a case-by-case basis by the PacifiCorp Control Center.

7.7.3 DC Generators

7.7.3.1 Inverters Capable of Stand-Alone Operation

Inverters capable of stand-alone operation are capable of islanding operation and shall have similar functional requirements as synchronous generators. For units less than 100 kW, usually it is acceptable to have the frequency and voltage functions built into the electronics of the inverter if the set points of these built-in protective functions are tamperproof and can be easily and reliably tested. The total harmonic distortion in the output current of the inverters must meet IEEE Standard 519, *Harmonics Requirements*. Inverter-type generators connected to the PacifiCorp system must be pre-approved by PacifiCorp. For units over 10 kW, a dedicated transformer will be required to minimize the harmonics entering into the PacifiCorp system.

7.7.3.2 Inverters Incapable of Stand-Alone Operation

Inverters rated 10 kW or less which have been tested and certified by Underwriter Laboratories (UL) as 1741, are non-islanding, and meet IEEE Standard 519 harmonic requirements, may be interconnected to the PacifiCorp system as is. **No inverter(s) will be permitted to interconnect with PacifiCorp's electrical system that are not certified and will be disconnected until they are brought into compliance with this policy.** Certified inverters have a label affixed to the equipment which shall be inspected as part of the commissioning process before energization. These inverters are generally used in combination with wind turbines and solar-based generators. Inverters over 10 kW will require a dedicated transformer and may have other requirements depending on the installation location and local generation penetration.

7.8 Remedial Action Scheme (RAS) Participation Requirement for Generation Facilities

A RAS is a special protection system which automatically initiates one or more pre-planned corrective measures to restore acceptable power system performance following a disturbance. Application of RAS mitigates the impact of system disturbances and improves system reliability.

The output of electric generators may flow over the entire interconnected transmission system. A generation facility is therefore required to participate in remedial action schemes to protect local transmission lines and the entire system as PacifiCorp determines necessary.

A typical disturbance, as it is considered in the planning and design of the electric transmission system, is the sudden loss of one or more critical transmission lines or transformers. A widely applied corrective measure is to instantaneously drop a sufficient amount of generation on the sending end of the lost transmission facility. This is known as generation dropping, and a participating generation facility may be disconnected from the transmission by the automatic RAS controller in much the same way as by a transfer trip scheme. A generation facility should therefore have full load rejection capability as needed both for local line protection and RAS. The RAS design must be such that any single-point failure will not prevent the effective operation of the scheme.

Whether RAS shall be required will depend on the overall location and size of the generator and load on the transmission system, the nature, consequences, and expected frequency of disturbances as well as the nature of potential alternative transmission reinforcements.

If PacifiCorp requires RAS participation for a particular generation facility, the Facility Interconnection Customer shall be responsible for all related costs.

7.9 Emergency Generator Requirement

There are two major methods of transferring electric power supply between the PacifiCorp source and the emergency generator system:

1. Open transition (break-before-make)
2. Closed transition (make-before-break)

The open transition method can be accomplished via a double-throw transfer switch or an interlock scheme which prevents the two systems from operating in parallel. The Facility Interconnection Customer Facility Interconnection Customer 's main breaker shall not be allowed to close until the generator breaker opens. This open transition method does not require any additional protection equipment, however it does cause the Facility Interconnection Customer 's load to experience an outage while transferring back to PacifiCorp. The length of this transfer outage depends on the transfer equipment involved.

Emergency systems are routinely tested by the Facility Interconnection Customer under load, usually once a month. With a break–before-make system, the Facility Interconnection Customer 's load, or most often a portion of it, is removed from the PacifiCorp system and the emergency generator is tested under load conditions. After successful completion of the test, the generator is taken offline and the Facility Interconnection Customer is transferred back to PacifiCorp. This testing procedure results in the test load experiencing two outages (when bringing the emergency generator on and when taking it off) whenever the system is tested.

For generation facilities that cannot tolerate this momentary loss of power, the closed transition (make-before-break) method is intended to provide transfer without interruption. For the closed-transition method, the maximum parallel time with the PacifiCorp system shall be less than 0.5 seconds, both to and from the emergency generator source. The protection requirements for synchronous generators will also apply to emergency generators any time a parallel is to be made with the PacifiCorp system. These would include, but are not limited to, a dedicated transformer and automatic synchronizing.

As an alternative to the normally required voltage, frequency, and ground relays, PacifiCorp may, at its discretion, allow installation of three very sensitive, single-phase, reverse-power relays (such as the Basler BE1-32R) for emergency generator installations. The reverse power relays shall be set to pick up on transformer magnetizing current with a time delay not to exceed 0.5 second. The reverse power relay, in this case, will protect PacifiCorp personnel and the general public by preventing the generator from keeping the PacifiCorp system energized in the event the PacifiCorp source substation(s) have tripped for a fault while the generator is paralleled. The relay output shall trip the circuit breaker on the PacifiCorp side of the transfer switch. This application can be used when the Facility Interconnection Customer 's emergency generator output is expected to be less than the entity's load.

7.9.1 Notification/Documentation

The Facility Interconnection Customer must notify its local PacifiCorp representative in writing of all new emergency generator installations or changes to the existing schemes regardless of method of interconnection or transfer.

Required documentation includes a description of generation and control system operation, single line diagrams, identification of all interlocks, sequence of events description for transfer operation, and specifications for any PacifiCorp-required protective devices. PacifiCorp may request additional documentation should it deem it necessary.

All documentation must be approved by PacifiCorp Engineering prior to installation.

7.9.2 Operation/Clearances

For the safety of PacifiCorp personnel and to ensure the proper operation of the PacifiCorp system, it is essential that the Facility Interconnection Customer notify the PacifiCorp Control Center of all emergency generator installations prior to paralleling. For operation and clearance purposes, emergency generator installations should be treated the same as any independent generation facility interconnected to the PacifiCorp system. A satisfactory visible open point shall be approved by PacifiCorp.

For all line work and clearances, the emergency generator shall be treated as a power source.

Facility interconnection customers using make-before-break transfer schemes are required to notify the PacifiCorp Control Center of their intent to transfer to their emergency generator and then again back to the PacifiCorp source, before any transfers are attempted. The notification of the make-before-break transfer scheme is necessary because such actions put another generation source in parallel with the PacifiCorp system. This notification is not essential on break-before-make schemes, but may be desirable in some instances.

7.10 Parallel-Only (No-Sale) Generator Requirement

Parallel-only generators shall have similar requirements as that of any other standard synchronous generator interconnection except that PacifiCorp may at its discretion allow the installation of three very sensitive, single-phase, reverse-power relays (such as the Basler BE 1 32R) along with the dedicated transformer as an alternative to the normally required ground relays. The reverse-power relays shall be set to pick up on transformer magnetizing current with a time delay not to exceed 0.5 second. This option may not be feasible on generating systems with a slow load rejection response since they may be tripped offline frequently for in-plant disturbances.

Owners of parallel-only generators must execute a parallel-only operating agreement with PacifiCorp prior to operation by the generation owner.

8 REACTIVE AND VOLTAGE RESTRICTIONS FOR FACILITY INTERCONNECTION CUSTOMERS

The purpose of this section is to help all customers satisfy applicable PacifiCorp policies and procedures with regard to voltage and reactive power flow.

The policies and procedures of this section apply to all facilities interconnecting with PacifiCorp's system. All facilities must meet applicable WECC standards.

Participating entities are required to schedule energy or ancillary services through a designated scheduling coordinator unless other arrangements have been made with PacifiCorp.

8.1 Reactive and Voltage Control Requirements

Reactive power (VAr) and voltage control are vital components of desired PacifiCorp system operation. It is essential that PacifiCorp receive both real and reactive power from interconnected generators. Where a generator is unable to furnish reactive power support due to interconnection limitations, type of generator, the generator loading, or other reasons, the Facility Interconnection Customer shall install equivalent reactive support at the Facility Interconnection Customer 's expense or make other arrangements with PacifiCorp.

How a generator meets PacifiCorp's reactive requirements depends on its type and size. Synchronous generators have an inherent reactive flexibility that allows them to operate within a range to either produce or absorb VArs. Induction generators operate at a power factor absorbing VArs and require reactive support from the interconnected system unless they have installed corrective equipment.

Generators 10 MVA and larger shall be equipped with automatic voltage-control equipment. All generating units with automatic voltage-control equipment shall normally be operated in voltage-control mode. These generating units shall not be operated in other control modes (e.g., constant power factor control) unless authorized in writing to do so by the host control area. The control mode of generating units shall be accurately represented in operating studies. The previous statements in this paragraph are consistent with the Western Electricity Coordinating Council (WECC)'s minimum operating reliability criteria.

Facility interconnection customers must provide reactive supply sufficient to operate at as near unity power factor as can be safely achieved without risk of self-excitation. Typically, the power factor should range from 97 percent leading power factor (absorbing VArs) and 1.0 (unity). PacifiCorp may further require the provision of reactive support equivalent to that provided by operating a synchronous generator anywhere within the range from 95 percent leading power factor (absorbing VArs) to 90 percent lagging power factor (producing VArs) within an operating range of ± 5 percent of rated generator terminal voltage and full load. This is typical of induction generators. Generators shall be equipped and operated to control voltage. If the facility is not capable of providing positive reactive support (i.e., supplying reactive power to the system) immediately following the removal of a fault or other transient low voltage perturbations, the facility may be required to add dynamic voltage support equipment. The general control requirements are discussed below.

8.1.1 Generator Control

8.1.1.1 Voltage Control

Voltage regulators are required for all generators larger than 100 kW unless otherwise agreed. In some cases, particularly for small units connected to the distribution system, a power-factor controller will also be required to provide operational flexibility.

Voltage regulators must be capable of maintaining the interconnection reactive interchange between 0.95 leading/lagging power factor measured at the point of interconnection unless otherwise agreed. For synchronous machines, the regulators and exciters will be required to react during faults (i.e., within cycles). For wind farms that will have induction machines installed, PacifiCorp may accept slower adjustments to voltage regulation on a case-by-case basis.

The generator shall normally be operated with the generator automatic voltage regulator in a constant voltage regulation mode. The voltage regulator shall be adjusted periodically throughout each day to maintain reactive output within a range defined by PacifiCorp and consistent with the reactive requirements for the local transmission system. This may be a voltage that minimizes the reactive interchange between PacifiCorp's system and the generating facility or, at PacifCorp's discretion, the PacifiCorp dispatcher may ask the plant operator to hold a higher or lower voltage so as to cause the facility to supply or absorb reactive power in support of specific system-control objectives. It is the owner's responsibility to insure that the transformer tap position and all other equipment are compatible with this objective.

8.1.2 Power Factor Control

For units smaller than 100 kW and/or in special cases as mutually agreed, a power factor controller shall be utilized to maintain a constant power factor at the point of interconnection by controlling the voltage regulator or other relevant equipment. The controller must be capable of maintaining a power factor within ± 1 percent at full load at any set point between 95 percent lagging (producing VArs) and 95 percent leading (absorbing VArs) measured at the point of interconnection. In addition, all power-factor controllers for generators larger than 1,000 kW must have programmable capability to vary hourly settings. The PacifiCorp Control Center shall specify required settings for voltage or power factor. Generally, as noted above, a voltage will be specified which minimizes the reactive interchange between PacifiCorp's system and the generating facility.

In the event that the generator by itself is not capable of providing sufficient reactive power at the point of interconnection so as meet the 0.95 leading/lagging power factor requirement, switched shunt compensation or dynamic VAr equipment may be required.

The programmable controller for units larger than 1,000 kW is normally obtained by combining a non-programmable controller and a general purpose programmable device.

Control over the VAr production associated with the delivery of power to PacifiCorp falls under the following general classifications, depending upon contractual arrangements:

Surplus-Sale Operation: When a Facility Interconnection Customer dedicates its generator to serving plant needs first, selling only the surplus to PacifiCorp, treatment differs depending on whether excess power is being sold *to* PacifiCorp or supplemental power (no-sale mode) is being purchased *from* PacifiCorp. In no-sale mode, the Facility Interconnection Customer has sole control over VAr production, however the customer shall meet the power factor requirements for its overall facility as described by applicable tariff(s). When surplus power is being sold, PacifiCorp has operational control of the power factor at which the power is delivered.

Net-Sale Operation: All electricity produced, excluding station load, is sold to PacifiCorp. PacifiCorp therefore has operational control of VAr production within the generator operating range.

No-Sale Operation: When a Facility Interconnection Customer uses generation exclusively to offset load, the customer has sole control of the generator power factor, however the customer shall meet the power factor requirements for its overall facility as described by applicable tariff(s).

For generation connected to the PacifiCorp transmission system at less than 1 MW with the total output being sold to PacifiCorp, all electricity produced, excluding station load, is sold to PacifiCorp. PacifiCorp therefore has operational control of VAr production within the generator operating range.

8.2 Synchronous Generator Frequency/Speed Control

To enhance system stability, a governor is required on the prime mover, set to provide a 5 percent droop characteristic (a 0.15 Hz change in the generator speed will cause a 5 percent change in the generator load). Exceptions must be approved by PacifiCorp. Governors shall be operated unrestrained to regulate system frequency.

8.2.1 Non-Synchronous Generator Control (without VAr Control)

Induction generators or other generators without VAr control absorb VArs and therefore require reactive power support from PacifiCorp's system. For facilities larger than 40 kW, PacifiCorp will require power factor correction. Power factor correction or capacitors must be installed either by the Facility Interconnection Customer or as part of the special facilities installed by PacifiCorp at customer expense. Care must be exercised by the Facility Interconnection Customer in connecting capacitors directly to the generator terminals to avoid self-excitation. Stand-alone switched capacitors supplied by the Facility Interconnection Customer that are not an integral part of the generator control system shall be switched on and off at the request of PacifiCorp.

8.2.2 Induction Generators

Switched capacitors may be required by PacifiCorp in areas where severe reactive limitations exist. The Facility Interconnection Customer must provide reactive supply sufficient to operate at as near-unity power factor as can be safely achieved without risk of self-excitation. Typically the power factor should range from 97 percent leading power factor (absorbing VArs) and 1.0 (unity). PacifiCorp may further require the provision of reactive support equivalent to that provided by operating a synchronous generator anywhere within the range from 95 percent leading power factor (absorbing VArs) to 95 percent lagging power factor (producing VArs) within an operating range of ± 5 percent of rated generator terminal voltage and full load. (This is typical if the induction project is greater than 1,000 kW.)

8.3 Generator Step-Up Transformer

The available voltage taps of a Facility Interconnection Customer 's step-up transformer must be reviewed by PacifiCorp for their suitability with PacifiCorp's system. The Facility Interconnection Customer is expected to have this reviewed before acquiring the transformer.

PacifiCorp shall determine which voltage taps would be suitable for a step-up transformer for the Facility Interconnection Customer 's proposed project. Suitable taps are required to give the transformer the essential capacity for the generator to:

- Deliver maximum reactive power to PacifiCorp's system at the point of interconnection (generator operating at 95 percent lagging power factor) and,
- Absorb maximum reactive power from the PacifiCorp system (generator operating at 95 percent leading power factor).

The Facility Interconnection Customer 's transformer, with correct voltage taps, helps maintain a specified voltage profile on PacifiCorp's system for varying operating conditions. Actual voltage tap settings can be different for transformers connected at the same voltage level, depending upon their geographic location.

8.4 Grid Operations

The following data will be gathered by PacifiCorp in order to fully comply with NERC Standard TOP-005-1, *Operational Reliability Information* and FAC-001-0, *Facility Connection Requirements*. Grid operations will need the following SCADA and tone-telemetered generator data for 3 MW and higher plants connected to PacifiCorp transmission system voltages (46KV and higher):

1. Status (of breakers).
2. MW and MVAr capability.
3. MW and MVAr net output.
4. Status of automatic voltage-control facilities (capacitors, reactors, dynamic VAr devices).

   The same standard requires that key voltages be metered (and PacifiCorp's voltage requirements adequately address this need).
5. Tone telemetry.

Note that in WECC units, 10 MVA and above must have automatic voltage requlation (AVR) installed on them.

8.5 Direct Digital Control

Dispatchable generator units larger than 10,000 kW are required to have real-time direct-digital control of unit output from the PacifiCorp Control Center. This will allow generation units to respond to system load/frequency changes.

8.6 Power System Stabilizer Operating Requirements for Generators

If a power system stabilizer (PSS) is a required part of the generator's voltage regulator, it must be operated and maintained in accordance with the standard procedures developed by WECC. Recalibration and testing of the PSS is required at least every five years, with data submitted for approval to PacifiCorp's Transmission Account Manager

PacifiCorp is responsible for the safe and reliable operation of the electric system. Because failure of the Facility Interconnection Customer to recalibrate and test its PSS could adversely impact system operation, PacifiCorp reserves the right either to disconnect from, or refuse to parallel with, any Facility Interconnection Customer which does not operate and maintain its generator control systems in accordance with applicable reliability criteria or standards. Any sanctions or penalties assessed due to failure to meet WECC Reliability Management System (RMS) operating requirements (available from the WECC website at *http://www.wecc.biz*) for units equipped with PSS shall be the sole responsibility of the Facility Interconnection Customer.

8.7 Power Quality Policy

8.7.1 Voltage Fluctuation Limits

A customer connected to the PacifiCorp system must not cause harmful voltage fluctuations or interference with service and communication facilities. Any generation facility that does so is subject to being disconnected from the PacifiCorp system until the condition has been corrected.

8.7.2 Harmonic Limits

All customers shall comply with the voltage and current harmonic limits specified in IEEE Standard 519 1992, *Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems*.

The harmonic content of the voltage and current waveforms in the PacifiCorp system must be restricted to levels which do not cause interference or equipment operating problems for PacifiCorp or its customers.

Any harmonic problems shall be handled on a case-by-case basis. A customer facility causing harmonic interference is considered by PacifiCorp as a serious interference with service and is subject to disconnection from the PacifiCorp system until the condition has been corrected. If the cause of the problem is traceable to the Facility Interconnection Customer 's facilities, all costs associated with determining and correcting problems shall be at the customer's expense.

Many methods may be used to restrict harmonics. The preferred method is to install a transformer with at least one delta connection between the interconnected facility and the PacifiCorp system. This method significantly limits the amount of voltage and current harmonics entering the PacifiCorp system. Generation system configuration with a star-grounded generator and a two-winding (both star-grounded) transformer shall not be allowed.

8.7.3 Voltage Flicker Limits

PacifiCorp's Engineering Handbook Section 1C.5.1, *Voltage Fluctuation and Light Flicker* will be utilized to evaluate any voltage flicker issue that may arise during the interconnection study process for transmission voltages. This subject typically arises on wind-turbine installations. It is usually rare that voltage flicker is an issue on transmission voltages. It could become problematic on the very rare 34.5 kV transmission lines and 46 kV transmission lines PacifiCorp owns and/or in single-turbine installations.

All generation interconnection projects must comply with this standard. The cost of corrective measures necessary for a project that does not comply with this standard will be borne solely by the Facility Interconnection Customer. It is necessary to acquire written review and approval from PacifiCorp before any corrective equipment is purchased and installed.

9 OPERATING REQUIREMENTS

1. The Facility Interconnection Customer shall not commence parallel operation of interconnected facility(s) until final written acceptance has been given by PacifiCorp. PacifiCorp reserves the right to inspect the Facility Interconnection Customer's facility and witness testing of any equipment or devices associated with the interconnection. The Facility Interconnection Customer shall submit a written, detailed procedure with specific requirements for initial commissioning of the Facility Interconnection Customer's generation and interconnecting facilities for PacifiCorp approval. PacifiCorp and the Facility Interconnection Customer shall each identify one representative to serve as a coordination contact to be the initial point of contact and coordinate communications between the parties for both normal and emergency conditions. PacifiCorp and the Facility Interconnection Customer shall notify each other in writing of the personnel that it has appointed as its coordination contact. PacifiCorp and the Facility Interconnection Customer shall abide by their respective switching and tagging rules for obtaining clearances for work or for switching operations on equipment. Such switching and tagging rules shall be developed in accordance with OSHA standards. PacifiCorp and the Facility Interconnection Customer shall develop mutually acceptable switching and tagging rules for PacifiCorp's and the Facility Interconnection Customer 's facilities that involve common clearance requirements. The Facility Interconnection Customer shall follow PacifiCorp directives with regard to emergencies on the PacifiCorp system.
2. The following are required before the Customer will be given permission for each operational milestone:
   a. Back feed requires that protection and metering to be complete and operational.
   b. First synchronization requires that all protection, metering, *and communications* be complete and operational. Power delivered to the system after first synchronization but prior to commercial operations is test energy.
   c. Commercial operations requires that the customer all testing be complete and the customer is ready to deliver commercial power.
3. The Facility Interconnection Customer shall not be permitted to energize a de-energized PacifiCorp circuit and will follow lockout/tagout procedures.
4. The operation of the Facility Interconnection Customer's on-site equipment shall not result in unacceptable service to other PacifiCorp customers, such as voltage and frequency fluctuations or harmonic currents on the PacifiCorp system. The Facility Interconnection Customer shall comply with the latest revision of PacifiCorp's allowable voltage flicker standards
5. The operation of the Facility Interconnection Customer's on-site generation shall not cause the service voltage for other PacifiCorp customers to go outside the requirements of ANSI C84.1, Range A.
6. The operation of the Facility Interconnection Customer's on-site generation shall not adversely affect the voltage regulation of the PacifiCorp system.
7. The operation of the Facility Interconnection Customer's on-site generation shall be conducted in a manner that minimizes reactive flow from the on-site generation to the PacifiCorp system, except when requested to assist in voltage control on the PacifiCorp system.

8. The Facility Interconnection Customer shall design the large generating facility to maintain a composite power delivery at continuous rated power output measured at the generator terminals at a power factor within the range of 0.90 leading to 0.95 lagging, unless the transmission provider has established different requirements that apply to all generators in the control area on a comparable basis. This shall apply to all units unless specifically exempted by FERC, NERC, or PacifiCorp. The Facility Interconnection Customer's voltage regulation equipment will be designed and operated to limit VAr flow to a power factor between 0.90 leading and 0.95 lagging except for units connected to the PacifiCorp distribution system rated at 15 kV and less. These generators are to maintain unity power factor and shall not regulate the distribution system voltage unless requested or required to do so by PacifiCorp per IEEE 1547 Standards.
9. The operation of the Facility Interconnection Customer's on-site induction machines or other non-synchronous generation shall be required to provide the same VAr support as synchronous machines unless specifically exempted by FERC or other governmental authority.
10. Operation of the Facility Interconnection Customer 's equipment shall not adversely affect the voltage regulation of the PacifiCorp system. The Facility Interconnection Customer shall minimize the reactive flow, except when requested to assist in voltage control on the PacifiCorp system. The Facility Interconnection Customer shall provide adequate voltage control to minimize voltage regulation on the PacifiCorp system caused by generator loading conditions.
11. In cases where starting or load-changing on induction generators will have an adverse impact on PacifiCorp system voltage, step-switched capacitors or other techniques may be required to attenuate the voltage changes to acceptable levels.
12. For synchronous generators, sufficient generator reactive power capability shall be provided to withstand normal voltage changes on the PacifiCorp system. The generator voltage-VAr schedule, voltage regulator, and transformer ratio settings will be jointly determined by PacifiCorp and the Facility Interconnection Customer to ensure proper coordination of voltages and regulator action. The Facility Interconnection Customer is encouraged to genrate their own VAr requirements to minimize power factor adjustment charges and enhance generator stability.
13. Induction or other non-synchronous generating installations shall provide the same voltage and VAr support as synchronous installations referenced in Section 7.10, except where specifically exempted by FERC or other governmental authorities.
    a. Where the Facility Interconnection Customer's installation does not comply with this requirement, and the existing PacifiCorp system can reliably supply the VARs for voltage support without installations of reactive compensation, the Facility Interconnection Customer may either purchase the reactive requirements for voltage support from PacifiCorp or supply such requirements with its own compensation. The reactive supply obtained from PacifiCorp shall be billed on a tariff to be determined during contract discussions.
    b. Where the Facility Interconnection Customer's installation does not comply with this requirement and the existing PacifiCorp system cannot reliably supply the VArs for voltage support, PacifiCorp shall install apparatus on the PacifiCorp system to supply the required VArs. The cost of the apparatus, controls, installation, and operation shall be paid according to OATT requirements and procedures.

14. Reactive power supply requirements for inverter systems are similar to those for induction generators and the preceding comments apply except where specifically exempted by FERC or other governmental authorities.
15. To avoid self-excitation, care shall be exercised in applying power factor correction capacitors directly to or electrically near induction generator terminals.
16. The Facility Interconnection Customer shall discontinue parallel operation when requested by PacifiCorp for the following purposes:
    a. To facilitate maintenance, tests, or repairs of the PacifiCorp electric system.
    b. During emergencies on the PacifiCorp system.
    c. When the Facility Interconnection Customer generating equipment is interfering with customers on the PacifiCorp system.
    d. When an inspection of the Facility Interconnection Customer reveals a condition hazardous to the PacifiCorp system or a lack of scheduled maintenance records is found.
17. WECC requires all members to share in an operating reserve or Generation Reserve Sharing Pool. PacifiCorp shall require a specific agreement to supply operating reserve to cover the Facility Interconnection Customer 's generation to load at that site. The generator will provide or contract for adequate generation to meet WECC or power pool generation reserve, spinning reserve, and load-following requirements.
18. The Facility Interconnection Customer shall comply with all NERC, WECC, and PacifiCorp Underfrequency Load Shedding requirements. During any underfrequency situation, the Facility Interconnection Customer shall agree to immediately make available to PacifiCorp any spinning or operating reserves that exist on their generation.
19. The Facility Interconnection Customer shall adhere to WECC Operating Standards, any PacifiCorp Operating Guides, and any additional operating requirements either stated herein or mutually agreed to elsewhere. The latest revision of all applicable documents shall serve as the minimum requirements for system operation. These documents are available at the publishing organizations respective website. Contact the Transmission Account Manager for further details.
20. PacifiCorp and the Facility Interconnection Customer may, in accordance with good utility practice, remove from service facilities or network upgrades as necessary to perform maintenance, test, and install or replace equipment. PacifiCorp and the Facility Interconnection Customer will use reasonable efforts to coordinate outages for maintenance on dates and times mutually acceptable to both parties.
21. The Facility Interconnection Customer shall compensate PacifiCorp for any incremental energy or reactive losses and incremental demand charges resulting from changes in system power flow caused by the Facility Interconnection Customer 's system addition in accordance with OATT requirements and procedures.
22. The Facility Interconnection Customer shall operate the interconnection facilities in compliance with the latest revision of the National Electric Safety Code, applicable state codes, PacifiCorp safety rules, and IEEE Std 519. Failure to comply with said safety policies and power-quality standards will result in the interconnection being opened. The interconnection will not be re-established until compliance has been determined.
23. The Facility Interconnection Customer shall maintain its interconnection facilities and any generating equipment that could negatively impact the PacifiCorp system in good order.

PacifiCorp reserves the right to inspect the Facility Interconnection Customer's facilities on a periodic basis or whenever it appears that the Facility Interconnection Customer is operating in a manner hazardous to PacifiCorp's system integrity.

9.1 Specific Generator Interconnection Requirements

The following requirements apply specifically to generation interconnections. The equipment associated with the Facility Interconnection Customer's generation equipment should be protected in accordance with the practices described in the latest revision of the following ANSI/IEEE standards or guides. There may be special requirements imposed by PacifiCorp due to the specific project or application.

ANSI C50.10-1990, *General Requirements for Synchronous Machines*

ANSI 50.12-1982, *Requirements for Salient Pole Synchronous Generators and Condensers*

ANSI C50.13-1989, *Requirements for Cylindrical-Rotor Synchronous Generators*

ANSI C50.14-1977, *Requirements for Combustion Gas Turbine Driven Cylindrical-Rotor Synchronous Generators*

ANSI/IEEE C37.101, *Guide for Generator Ground Protection*

ANSI/IEEE C37.102, *Guide for AC Generator Protection*

ANSI/IEEE C37.106, *Guide for Abnormal Frequency Protection for Power Generating Plants*

ANSI/IEEE Std 1001, *Guide for Interfacing Dispersed Storage and Generation Facilities with Electric Utility Systems*

IEEE 1547, *Standard for Interconnecting Distributed Resources with Electric Power Systems*

In addition to the above-listed requirements, the following standards apply:

1. Any generating unit or line/end user interconnection to the PacifiCorp electric system with its output purchased by PacifiCorp or another network customer shall be considered a "Network Resource" under the terms of Part III of the OATT.
2. Generator installations requesting WECC accreditation must meet all NERC, WECC, and PacifiCorp requirements, including WECC Generation Reserve Sharing Pool requirements, URGE testing, and any reactive testing requirements.
3. The generator step-up (GSU) transformer connection will be determined by the system impact study. In general, the GSU must be effectively grounded on the utility side providing an adequate ground reference and will isolate the generator's zero sequence current from the PacifiCorp system through the use of an ungrounded connection on the generator side. The transformer shall be equipped with a no-load tap changer covering the range of ± 5 percent in 2.5 percent steps from the nominal voltage of the interconnection.
4. PacifiCorp requires synch-check relays to be installed on all circuit breakers interconnecting a generating unit to the PacifiCorp electric system.
5. Induction generators may use a speed-matching relay (Device 15) as a means of synchronization and to limit the magnetizing inrush current/voltage drop. The speed matching must keep voltage flicker at the point of interconnection within PacifiCorp voltage flicker requirement and within IEEE 519 requirements.

6. Generation operated in parallel with the PacifiCorp electric system may supply additional fault current energy which shall be disconnected in case of a disturbance on PacifiCorp's system. The existence of parallel generation may alter the operation of protective devices normally used by PacifiCorp to protect the system.
7. Equipment shall be provided to detect system abnormalities in the Facility Interconnection Customer 's or PacifiCorp's system, and shall have the capability to isolate the sources of the disturbance. At a minimum, the Facility Interconnection Customer shall provide adequate protective devices to:
   a. Detect and clear the generator(s) from short circuits on PacifiCorp facilities serving the interconnecting facilities.
   b. Detect the voltage and frequency changes which can occur if PacifiCorp facilities serving the interconnecting facilities are disconnected from the main system, and clear any Facility Interconnection Customer generation/load from the isolated system if necessary.
   c. Prevent reclosing the Facility Interconnection Customer's generation to PacifiCorp after an incident of trouble, until authorized to recluse by PacifiCorp's Portland or Salt Lake City dispatch centers.
   d. Isolate Facility Interconnection Customer's generation from the PacifiCorp electric system upon:
      - Receipt of a direct trip signal from an upstream PacifiCorp substation.
      - Failure of the communications channel used for direct tripping.
      - Receipt of a trip command from the Portland or Salt Lake City dispatch center via SCADA.
8. PacifiCorp, at its discretion, may require out-of-step protection and/or loss of excitation protection and/or overexcitation protection to trip or block-trip the Facility Interconnection Customer 's interconnection. The requirement for this protection will be determined during system studies.
9. The Facility Interconnection Customer should be aware that certain conditions on PacifiCorp's system can cause negative sequence currents to flow in the generator. It is the sole responsibility of the Facility Interconnection Customer to protect the Facility Interconnection Customer's equipment from excessive negative sequence currents.
10. The Facility Interconnection Customer shall design its facilities (generation or otherwise) to avoid causing dynamic voltage excursions above 1.2 and below 0.7 pu according to WECC performance design standards (see the WECC Reliability Handbook for NERC/WECC Planning Standards, Guidelines, and System Performance Table). The WECC Reliability Handbook may be accessed via the WECC website or may be obtained upon request from the Transmission Account Manager.
11. The Facility Interconnection Customer shall design its generation to remain online for faults and for any resulting low voltages to maintain system reliability. Generation must remain online for the duration of a normally-cleared (single- or three-phase) fault on the electric system up to a maximum of nine cycles, as well as for the recovery from such a normally-cleared fault even where the voltage drops to zero during the clearing of the fault.

12. Generators must be designed to remain online for normal clearing system faults within close proximity to the plant switchyard. Voltage may approach zero at the switchyard bus for nine cycles for some types of faults. Control systems, contactors, motors, and auxiliary loads which are critical to the operation of the plant must not drop out under these conditions. Critical 480 V supply contactors must be provided with ride-through capability where required. Additionally, generator protection systems such as the Load Drop Anticipator, Early Valve Actuator, or Power Load Unbalance should not be designed to trip a generator for normal clearing external faults or stable swings.
13. The Facility Interconnection Customer shall design its generation to remain online for off-nominal frequency operation according to IEEE C.37.106 or the following time frames in accordance with PacifiCorp and WECC region over/underfrequency requirements:

Table 5–Over/Underfrequency Requirements

Underfrequency Range (Hz)	Overfrequency Range (Hz)	Time
60.0 - 59.7	60.0 - 60.3	Continuous
59.7 - 59.5	60.4 - 61.5	Continuous Governor action
59.4 - 58.7	61.6 - 61.8	10 minutes
58.6 - 58.5	61.9 - 62.0	30 seconds
58.5 - 57.4	–	7.5 seconds
57.3 - 56.9	–	45 cycles
56.8 - 56.5	–	7.2 cycles
< 56.4	> 62.0	Instantaneous trip

14. Only solid state microprocessor underfrequency relays shall be used on generators to provide off-nominal frequency protection.
15. Synchronous generators with a nameplate rating greater than 20.0 MVA shall have generator protection set such that it does not result in tripping of the generator for the following conditions:
    a. Generator terminal voltages that are within five percent of the rated nominal design voltage.
    b. Generator terminal voltage deviations that exceed five percent but are within 10 percent of the rated nominal design voltage and persist for less than 10 seconds.
    c. Generator volts per hertz conditions that are less than 116 percent (of generator nominal voltage) that last for less than 1.5 seconds.
    d. Generator overexcited stator currents (or generator apparent impedance) less than 150 percent of nameplate rating persisting for less than five seconds.
16. Documentation of the generator protection and controls that could respond to these conditions by tripping the generator shall be provided to PacifiCorp. In the event the generating equipment owner cannot correct or mitigate these potential generator trip conditions, a request for a waiver may be made to PacifiCorp. A waiver may be

justified in certain special circumstances such as low adverse reliability consequences from generator tripping.

17. All synchronous generators connected to the PacifiCorp transmission system are to be equipped with automatic voltage regulators (AVR). Generators must operate with their excitation system in the automatic voltage control mode unless otherwise approved by the PacifiCorp system operator. Generating equipment owners shall maintain a log which records the date, time, duration and reason for not being in the automatic voltage control mode when operating in parallel with the PacifiCorp system. Generating equipment owners shall make this log available to PacifiCorp on request.
18. All synchronous generators connected to the PacifiCorp transmission system must maintain a network voltage or reactive power output as specified by the PacifiCorp system operator within the reactive power capability of the generating equipment. Generating equipment owners shall maintain a log which records the date, time, duration, and reason for not meeting the network voltage schedule or desired reactive power output when operating in parallel with the PacifiCorp system. Generating equipment owners shall make this log available to PacifiCorp on request.
19. The generator step-up and auxiliary transformer tap settings shall be coordinated with PacifiCorp transmission systems voltage requirements. Generating equipment owners shall provide PacifiCorp with generator step-up and auxiliary transformer tap settings and available ranges.
20. The AVR's control and limiting functions must coordinate with the generator's short time capabilities and protective relay settings. The generating equipment owner shall provide PacifiCorp with the AVR's control and limiter settings as well as the protection settings which coordinate with AVR control and limiting functions.
21. All new synchronous generators connected to the PacifiCorp transmission system with a nameplate rating greater than 20 MVA shall be equipped with a speed/load governing control that has a speed droop characteristic in the three to six percent range. The preferred droop characteristic setting is five percent. Notification of changes in the status of the speed/load governing controls must be provided to the PacifiCorp System Operator.
22. Prior to commercial operation, the generating equipment owner shall provide PacifiCorp with open circuit, step-in voltage test results. Recording of generator terminal voltage and field voltages shall be clearly labeled so that initial and final values can be identified in physical units.
23. Generating equipment owners shall annually test the gross and net dependable summer and winter capability of their units. These test results shall be provided to PacifiCorp.
24. Generating equipment owners shall test the gross and net reactive capability of their units at least every five years. These test results shall be provided to PacifiCorp.
25. Generating equipment owners shall test the AVR control and limit functions of their units at least every five years. An initial test result shall be provided to PacifiCorp prior to commercial operation and every five years thereafter. The initial test results shall include documentation of the settings AVR control and limit functions. Typical AVR limit functions are maximum and minimum excitation limiters and volts per hertz limiters. Documentation of the generator protection that coordinates with these limit

functions shall also be provided. Typical generator protection of this type includes overexcitition protection and loss of field protection.

26. The Facility Interconnection Customer generator shall meet all WECC requirements for providing an appropriate high-response excitation system and shall make provisions for a Power System Stabilizer (PSS) on all units rated at 70 MW and greater. The exciter shall meet the following requirements:
    a. The response ratio less is less than 2.0 as demonstrated through calculations consistent with IEEE Standard 421.2-1990.
    b. The response time is less than 0.1 second as demonstrated through the completion of a response ratio test.
    c. The open circuit step-response test is satisfactory; where satisfactory means that the response is not oscillatory in nature.
27. The Facility Interconnection Customer shall demonstrate that they have the appropriate exciter model by providing P/SSE or other plots of generator response ratio tests and opencircuit step tests that demonstrate the unit meets the criteria in item 29 below.
28. The Facility Interconnection Customer generator shall meet all WECC requirements for the installation and tuning of PSS where appropriate long-term dynamic stability and eigen value studies show a positive contribution to the damping torque in the frequency range from 0.25 Hz to 2.0 Hz.
29. Where stabilizing equipment is installed on generating equipment for the purpose of maintaining generator or transmission system stability, the generating equipment owner is responsible for maintaining the stabilizing equipment in good working order and promptly reporting to the PacifiCorp system operator any problems interfering with its proper operation.
30. PacifiCorp will maintain a contact list of all Facility Interconnection Customers tied to PacifiCorp's transmission circuits for routine and emergency grid operation use. This list will compile the normal and emergency phone numbers for the Facility Interconnection Customer's facilities and an e-mail address if available. It will be the responsibility of the Facility Interconnection Customer to notify PacifiCorp in a timely fashion when any of this information is altered or changed for whatever reason. To keep the list current, the new updated information will be supplied to:

Transmission Interconnection Account Manager
825 N.E. Multnomah Blvd. Suite 1600
Portland, Oregon 97232
(503) 813-6102

10 COMMISSIONING FOR FACILITY INTERCONNECTIONS

The following outlines PacifiCorp's procedure for performing commissioning activities. All time requirements must be met for PacifiCorp to provide the Facility Interconnection Customer with timely service. Any inspections required by local government agencies must be completed and permits signed off prior to the pre-parallel date.

Since the meter installed for the facility interconnection is PacifiCorp-owned, a PacifiCorp meter/relay technician will be the only person authorized to test the meter. Coordination between the developer and PacifiCorp's project manager is recommended at least two months before the start-up date to assure that timelines for project completion are met. The owner/developer will provide unrestricted access for PacifiCorp's employees or vendor employees (whichever are utilized) to the equipment to be commissioned.

PacifiCorp will either utilize its own qualified employees or a contractor from its approved contractor list. Commissioning of any relays which tie with the PacifiCorp system and affect PacifiCorp's customer must be certified by a Professional Engineer licensed in the state in which the interconnection project is located.

It is the Facility Interconnection Customer's responsibility to provide adequate notification through the PacifiCorp project manager for commissioning activities.

It shall be the owner/developer's responsibility to pay for all commissioning costs

Commissioning testing, where required on either PacifiCorp-owned equipment or equipment that affects the operational integrity of the electrical circuit, will be performed on site to verify protective settings and functionality. Upon initial parallel operation of a generating facility, or any time interface hardware or software is changed which may affect the functions listed below, a commissioning test must be performed. Individual qualified in testing protective equipment (a Professional Engineer, factory-certified technician, or licensed electrician with verifiable experience in testing the protective equipment) must perform commissioning testing in accordance with the manufacturer's recommended test procedure to prove that the settings and requirements of PacifiCorp's interconnection study report are met. PacifiCorp reserves the right to witness commissioning tests listed below and requires written certification stamped by a Professional Engineer from the state in which the project resides describing which tests were performed and their accompanying results.

10.1 Test Results

All tests outlined below must be complete and two copies of the test reports submitted to a PacifiCorp representative a minimum of 15 working days before the requested energize date unless otherwise agreed to by PacifiCorp. All test reports require header information reflecting the equipment identification matching the one- or three-line diagrams. One-line and three-line diagrams of the facility are required to be submitted with the test reports. All requirements must be met and test reports approved at least three working days before the requested pre-parallel date.

10.1.1 Proving Insulation

For any of the megger tests referred to below a 2,500 V DC megger or a hi-pot is preferred, but a 1,000 V DC megger is acceptable.

1. All transformers connected to the primary bus and the main transformer must be meggered winding-to-winding and each winding to ground. For purposes of this document, "primary bus or PacifiCorp side of the bus or conductor" is

defined as the source-side bus or conductor from the primary interrupting device to the generating plant.

2. All circuit breakers and circuit switchers connected to the primary bus and at the interconnection point must be meggered in the following manner: breaker open each pole to ground, pole 1 2, pole 3 4, pole 5 6; breaker closed pole 1 ground, pole 3 ground, pole 5 ground and if the poles are in common tank or cell, pole 1 3, pole 3 5, pole 5 1.
3. All buses and cables shall be meggered phase–to-phase and phase-to-ground.
4. The main transformer(s) and main breaker(s) shall have a dielectric test performed on the insulating medium (gas or oil). The unit shall pass this test by keeping within the acceptable levels for all gasses or other elements in the oil as certified by the laboratory chemist before energization. This will not apply to factory-sealed circuit switcher interrupters.
5. The generator(s) must be meggered or hi-pot-tested phase-to-phase and phase-to-ground.

10.1.2 Proving Ratios

All ratios of transformers connected to the primary bus must be proven using either a turns ratio tester or a voltage ratios test. The main transformer must be tested on the final operating tap. This tap shall be recommended by PacifiCorp to best match current transmission system operating voltages.

10.1.3 Circuit Breakers and Circuit Switchers

1. A minimum to trip at 70 percent or less of the nominal DC control voltage must be performed on all circuit breakers and/or circuit switchers which are operated by PacifiCorp required relays. All units must pass this test.
2. A micro ohm test must be performed on all circuit breakers and circuit switchers. The units tested must pass the micro ohm test.
3. A timing test showing the time from trip initiation to main poles opening is required. All units must pass this test.
4. A timing test showing the time from close initiation to main poles closing is required. All units must pass this test.

10.1.4 Current Transformers and Current Circuits

1. A saturation check should be made on all current transformers (CTs) associated with the required PacifiCorp relays. If this is not possible, a manufacturer's curve is acceptable.
2. The ratio of all CTs must be proven by either a current (primary-to-secondary) or voltage (secondary-to-primary) test.
3. CT circuits must be checked for proper connections and continuity by applying primary current and reading the results in the relays. Each test must be performed in all combinations to prove proper connections to all phase and ground relays. Current must be applied or injected to achieve a secondary reading of five amps in each relay to ensure that no loose wiring or parallel current paths exists.

4. A single-phase burden check must be made on each phase of each current circuit feeding PacifiCorp required relays.
5. A megger check of the total circuit with the ground wire lifted must be done to prove that only one ground exists.

10.1.5 Relays

All relays must be field tested on site to their specified settings to verify the following:

1. Minimum operating point at which relay picks up (minimum pickup).
2. Time delay at three different current test points, in integral multiples of minimum pickup that closely characterize the relay time current curve.
3. Phase-angle characteristic of the directional relay.
4. Pickup points at maximum torque angle (MTA) and ± 30 degrees of MTA on impedance relays using the approved settings.
5. Slip-frequency, voltage-matching, phase angle-acceptance, and breaker compensation time on synchronizing relays.
6. PacifiCorp tolerances are listed below:

Table 6–PacifiCorp Relay Tolerances

Relay Type	Tolerance
Current / Voltage / Time	± 10.0 percent
Impedance / Phase Angle	± 0.05 percent
Frequency	± 0.05 percent

If a pilot relay system is required by PacifiCorp, signal level checks must be performed to PacifiCorp standards.

10.1.6 Primary Disconnect Switch

The primary disconnect switch at the point of interconnection shall be assigned a number by PacifiCorp. The switch, platform, and switch number plate bracket must be constructed to PacifiCorp Engineering Standards, Section TS. A switch number plate bracket shall be furnished by PacifiCorp.

10.1.7 Checklists and Forms for Equipment Commissioning

The Transmission Account Manager will have available for both internal and external use checklists and forms for all relevant facility interconnection equipment to be commissioned for the Facility Interconnection Customer.

The commissioning process will be coordinated through the Project Manager with other PacifiCorp employees in the field.

10.2 Pre-Parallel Test for Generator Developers

Where generation has a rated output in excess of 100 kW, the entity shall reimburse PacifiCorp for the cost of performing the pre-parallel inspection.

The Facility Interconnection Customer is responsible for ensuring that all relays and other protective devices are adjusted and working properly prior to the pre-parallel inspection. If problems arise with equipment during testing, the PacifiCorp protection representative may elect to cancel the test and reschedule.

All pre-parallel tests should be scheduled to begin at 9 a.m., Monday through Friday only. Functional tests shall be performed by the Facility Interconnection Customer and all tests shall be observed by PacifiCorp as outlined below. The Facility Interconnection Customer shall provide all test equipment and qualified personnel to perform the required tests. PacifiCorp shall be there strictly as an observer. The appropriate commissioning form shall be completed by the PacifiCorp representative on site at the time of the pre-parallel inspection.

10.2.1 Functional Tests

The following functional tests shall be performed after the equipment has been energized, but before the generator is paralleled with PacifiCorp's system:

1. Check that each protective relay trips the appropriate generator breaker and/or main breaker. This may require injecting a signal. **Jumpering across contact on the back of the relay is not acceptable.**
2. When first energized, check that proper secondary potential is applied to all voltage and frequency relays.
3. Check the synchronizing meter, synchronizing equipment, and phasing panel (if used) with the paralleling breaker closed and the generator offline. This typically requires lifting the generator leads. The equipment should show an "in-phase" condition.
4. Check the generator phase rotation. (PacifiCorp's phase rotation is A B C counterclockwise).
5. All three phases must be checked using hot sticks with a phasing tool or a phasing panel provided by the Facility Interconnection Customer. The synchronizing equipment typically checks one phase only. Phase rotation varies by area within the PacifiCorp system. Facility interconnection customers shall consult PacifiCorp for the correct rotation.

10.2.2 Impedance and Directional Relay Tests

Direction check all impedance and directional relays by doing the following:

1. Bring up load on the plant and/or generator.
2. Verify direction of power flow.
3. Measure the phase angle between the current and potential applied to the relay.
4. Observe the current action of the directional contacts according to the direction of power flow. Reverse either the potentials or current to prove contact operation for reverse power flow.

10.2.3 Generator Load Tests

For generators, the following load tests shall be performed after the generator picks up load:

1. Load check all PacifiCorp-required differential relays. The load current must balance to zero in all differential relays.

2. Load check voltage restraint overcurrent relays to prove correct connection of currents and potentials.
3. The generator(s) may have to be paralleled temporarily with PacifiCorp's system to run the load tests. Permission to do this shall be given by the PacifiCorp operations representative observing the test by PacifiCorp dispatch.
4. Verify operation of the generator at 90 percent lagging power factor and at 95 percent leading power factor at rated output.
5. Verify operation of the generator at 95 percent and 105 percent of per unit voltage while delivering rated output.
6. Typically, pre-parallel inspections can be performed within a normal working day. PacifiCorp shall dedicate one full work day to observe the tests. If a test cannot be completed by 6 p.m., the PacifiCorp representative may cancel the remainder of the test and reschedule it. In this case the Facility Interconnection Customer shall be charged another pre-parallel inspection fee.

10.3 Parallel Operation for Generator Developers

10.3.1 Clearance for Parallel Operation (For Testing Purposes Only)

The PacifiCorp representative shall contact the PacifiCorp Control Center at least 72 hours (3 days) before the pre-parallel test and obtain a clearance for parallel operation. The PacifiCorp representative shall provide the Control Center a drawing indicating which PacifiCorp circuit the generation facility will be connected to and which PacifiCorp operated disconnect will be identified with a PacifiCorp-designated number. When the pre-parallel test is passed, the generator may at PacifiCorp's discretion be allowed to operate in parallel with PacifiCorp for testing purposes only. This should not be mistaken as an official release for parallel operation. Once this testing only permission is granted, the generator may operate in accordance with a previously executed Generation Operating Agreement, or in the absence of such an agreement for a maximum of 14 days in accordance with good utility practice unless other arrangements are made with PacifiCorp.

10.3.2 Power System Stabilizer

During the 14-day testing period, the Power System Stabalizer (PSS) shall be calibrated and tested in accordance with the latest applicable WECC standard calibration and test procedures. The test report shall be submitted for approval to PacifiCorp's Transmission Account Manager. Adequate testing of the PSS can only occur on the generating unit(s) after pre-parallel inspection has been satisfactorily completed and the units are paralleled and supplying load. The generation facility shall not be considered officially operational until this PSS calibration and testing has been done to PacifiCorp's satisfaction.

10.3.3 Permission for Parallel Operation

At the end of this period, if the Facility Interconnection Customer has not received written permission from PacifiCorp to operate in parallel, the entity must isolate from PacifiCorp until written permission is received. Written permission to parallel shall be sent to the Facility Interconnection Customer via U.S. First Class mail. This shall be done after PacifiCorp has verified the following:

1. All proper contracts and documents have been executed and are in place.
2. The pre-parallel test has been passed.
3. PSS tests and calibration have been completed.
4. All other outstanding issues have been resolved, including rights-of-way, deeds of conveyance, insurance verification, and operating agreements.
5. PacifiCorp has received final copies of the one-line diagram and elementary diagrams that show as-built changes made during construction, as well as a completed finalized generator data sheet.
6. If applicable, firm capacity performance testing of new generators cannot begin until the Facility Interconnection Customer receives written permission from PacifiCorp to parallel.

10.4 General Notes

The PacifiCorp system has ABC counterclockwise rotation.

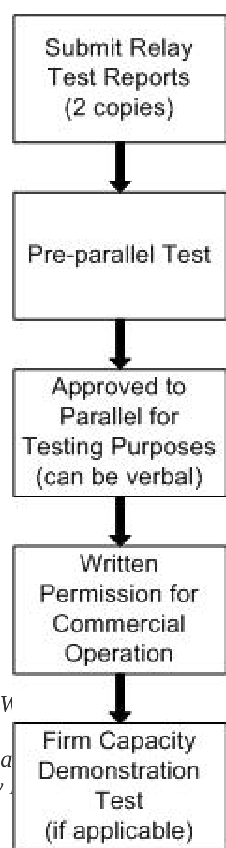
Any changes to PacifiCorp required protection equipment or major substation equipment (transformer, breaker, etc.) must be submitted to the PacifiCorp representative for review and approval by the appropriate PacifiCorp Engineer prior to the changes being made.

Routine maintenance on PacifiCorp-required protective relays and the breaker(s) must meet PacifiCorp's maintenance and test practices. After completion of these tests, test reports must be submitted to the PacifiCorp representative for review and approval by the appropriate PacifiCorp Engineer. A PacifiCorp technical representative shall then come to the customer's facilities and reseal the PacifiCorp required relays.

Questions should be directed to the PacifiCorp Transmission Account Manager.

10.5 Simplified Flow of Pre-Parallel/Parallel Test Procedure

Figure 2–Pre-Parallel/Parallel Test Procedure



11 GLOSSARY

A

Alternating Current (AC): That form of electric current that alternates or changes in magnitude and polarity (direction) in what is normally a regular pattern for a given time period called frequency.

Ampere: The unit of current flow of electricity. This is analogous to quantity per unit of time when referring to the flow of water. One ampere is equal to a flow of one coulomb per second.

Applicable Reliability Criteria: The reliability policies established by NERC, WECC, and local reliability criteria as amended from time to time, including any requirements of the NRC which are applicable to the particular type of generator and prime mover.

Automatic: Self-acting, operated by its own mechanism when actuated by some impersonal influence as, for example, a change in current strength; not manual; without personal intervention.

Automatic Control: An arrangement of electrical controls which provide for opening and/or closing in an automatic sequence and under predetermined conditions; the switches which then maintain the required character of service and provide adequate protection against all usual operating emergencies.

Automatic Generation Control (AGC): Generation equipment that automatically responds to signals from the EMS control in real time to control the power output of electric generators within a prescribed area in response to a change in system frequency, tie-line loading, or the relation of these to each other, so as to maintain the target system frequency and/or the established interchange with other areas within the predetermined limits.

Automatic Reclosing: A feature of some circuit breakers which allows them to reclose automatically after being tripped under abnormal conditions.

Automatic Tripping or Automatic Opening: The opening of a circuit breaker under predetermined conditions without the intervention of an operator.

B

Balanced Load: An equal distribution of load on all phases of an alternating current circuit.

Boost: To increase voltage.

Bundled Service or Bundled Utility Service: Traditional PacifiCorp service: transmission and distribution capacity for delivery, energy, and ancillary services.

Breaker: A switch which can open a circuit, usually designed for automatic operation.

C

Capacitance: Capacitance is developed when two charged or energized conductors are separated by a dielectric. An excess or deficiency of electrons is maintained on opposite plates of a charged capacitor. It may be said to be the property of an electrical circuit which opposes any change of voltage.

Capacity: The number of amperes of electric current a wire will carry without becoming unduly heated; the capacity of a machine, apparatus, or devices is the maximum of which it is capable under existing service conditions; the load for which a generator, turbine, transformer, transmission circuit, apparatus, station, or system is rated. Capacity is also used synonymously with capability.

Capacity Factor: The ratio of average load on a generating resource to its capacity rating during a specified period of time, expressed in percentages.

Circuit: A conducting part through which an electric current is intended to flow.

Circuit Breaker: A device for interrupting a circuit between separable contacts under normal or fault conditions.

Circuit Switcher: A device for interrupting a circuit between separable contacts under normal or fault conditions.

Class A Telephone Circuit: Service performance objective classification for a circuit which is non-interruptible before, during, and after a power fault condition.

Class B Telephone Circuit: Service performance objective classification for a circuit which is non-interruptible before and after a power fault condition exists.

Clearance: Permission to contact or to come in close proximity to wires, conductors, switches, or other equipment which normally might be energized at electrical, hydraulic, or pneumatic potential dangerous to human life. Conditions which must prevail before such permission can be granted are, in general, that the equipment or lines be completely isolated from all possible power sources and be tagged with properly filled out “man on line” tags.

Cogeneration: The sequential production of electricity and heat, steam, or useful work from the same fuel source.

Conductor: Material that can be used as a carrier of an electric current.

Control, Supervisory: A system for selecting control and automatic indication of remotely located units by electrical means, over a relatively small number of common transmission channels.

Control Switch: A switch controlling the circuit through circuit breakers or other switches which are magnetically operated.

Current: The part of a fluid (air, water, etc.) flowing in a certain direction. A flow of electric charge measured in amperes.

Current Transformer (CT): A transformer intended for metering, protective, or control purposes which is designed to have its primary winding connected in series with a circuit carrying the current to be measured or controlled. A current transformer normally steps down current values to safer levels. A CT secondary circuit must never be open-circuited while energized.

D

Dead-End Structure: The structure on which the last span of PacifiCorp-owned conductors terminates. Also called a landing structure. From the interconnection requester's point of view, it is sometimes called the take-off structure.

Delta-Connected Circuit: A three-phase circuit with three source windings connected in a closed delta (triangle). A closed delta is a connection in which each winding terminal is connected to the end (terminal) of another winding.

Demand: The rate at which electric energy is delivered to or by a system; normally expressed in kilowatts, megawatts, or kilovolt amperes.

Direct Access: Service election that allows customers to purchase electric power and additional related services from non-utility entities known as Energy Service Providers (ESPs).

Direct Current (DC): A unidirectional current in which the changes in value are either zero or so small that they may be neglected. (As ordinarily used, the term designates a practically non-pulsating current, such as the output of an electric battery.)

Disconnect: (noun) A device used to isolate a piece of equipment. A disconnect may be gang-operated (three operated together) or individually operated.

Dispatchability: Ability and availability of a generating facility to operate so that a utility can call upon it to increase or decrease deliveries of capacity to any level up to contract capacity.

Distribution Control Center: This center directs, coordinates, and implements routine and emergency switching activities on the PacifiCorp distribution system within its geographical jurisdiction.

Disturbance: Trouble (e.g., fault, sudden loss of load or generation, breaker operations, etc.) on the PacifiCorp power system resulting in abnormal performance of the system. See also System Emergency.

Droop: The slope of the prime mover's speed power characteristic curve. The speed droop, typically 5 percent, enables interconnected generators to operate in parallel with stable load division.

E

Electric Circuit: A path or group of interconnected paths capable of carrying electric current.

Electric Generator: See Generator.

Electric Substation: An assemblage of equipment for purposes other than generation or utilization, through which bulk electric energy is passed for the purpose of switching or modifying its characteristics. Service equipment, distribution transformer installations, and transmission equipment are not classified as substations.

End-Use Customer or End User: A purchaser of electric power who purchases such power to satisfy a load directly connected to the Electrical Power Grid and who does not resell the power.

Energize: To apply voltage to a circuit or piece of equipment; to connect a de-energized circuit or piece of equipment to a source of electric energy.

F

Fault Indicator: A device attached to lines which target when the current through the line exceeds the device setting.

Feeder: A circuit having as its primary purpose the distribution of electric energy.

FERC: Federal Energy Regulatory Commission.

Firm Capacity: Power committed to be available at all times during the period covered, except for forced outages and scheduled maintenance.

Forced Outage: Any unplanned outage resulting from a design defect, inadequate construction, operator error, or a breakdown of the mechanical or electrical equipment that fully or partially curtails the delivery of electricity between a load or Facility Interconnection Customer Facility Interconnection Customer 's facility and the PacifiCorp power system.

Frequency: The number of cycles occurring in a given interval of time (usually one second) in an electric current. Frequency is commonly expressed in Hertz (Hz).

Fuse: A short piece of conducting material of low melting point which is inserted in a circuit and will melt and open the circuit when the current reaches a certain value.

G

Generation Facility: A plant in which electric energy is produced from some other form of energy by means of suitable converting apparatus. The term includes the generation apparatus and all associated equipment owned, maintained, and operated by the Facility Interconnection Customer.

Generator: The physical electrical equipment that produces electric power. Sometimes used as a brief reference to a Facility Interconnection Customer.

Grid-Critical Protective Systems: Protective relay systems and Remedial Action Schemes that the may have a direct impact on the ability to maintain system security.

Ground: A term used to refer to the earth as a conductor or as the zero of potential. For safety purposes, circuits are grounded while any work is being done on or near a circuit or piece of equipment in the circuit; this is usually called protective grounding.

Ground Bank: A secondary transformer bank installed on delta-connected winding to provide a path to ground for relaying purposes.

Ground Fault: An unintentional electric current flow between one or more energized conductors and the ground.

Ground Potential Rise: A calculated value of the highest expected voltage due to a line-to-ground fault at or near the station (power switchyard). The value is calculated as follows:

GPR = 1.2 (DC Transient Factor) x 1.4. x Ground Fault Return Current (rms) x Ground Resistance

H

Hertz (Hz): The term denoting cycles per second or frequency; named after Heinrich Hertz, the pioneering German scientist who performed research on electrical power.

I

IEC: International Engineering Consortium.

IEEE: Institute of Electrical and Electronic Engineers.

Inductance: The property of an electric circuit which produces a voltage by electromagnetic induction when the current in the circuit changes or varies. It opposes any change of circuit current.

Induction Generator: Typically an induction motor that is being driven by a prime mover at a speed which is faster than the synchronous mechanical speed to generate electric power. It typically depends on the host system for its excitation and speed regulation.

Interconnection Agreement (IA): An agreement between the utility and the Facility Interconnection Customer specifying and outlining the terms and conditions of the interconnection of the generators to PacifiCorp's electrical system.

Facility interconnection customer: An entity interconnected to the PacifiCorp power system which has generation facilities (including back-up generation in parallel) on its side of the point of interconnection with the PacifiCorp power system.

Interconnection Facilities: All means required and apparatus installed to interconnect and deliver power from a load or Facility Interconnection Customer facility to the PacifiCorp power system including, but not limited to, connection, transformation, switching, metering, communications, and safety equipment, such as equipment required to protect: 1) the PacifiCorp power system and the load or Facility Interconnection Customer from faults occurring at the load or generation, and 2) the load or generation facility from faults occurring on the PacifiCorp power system or on the systems of others to which the PacifiCorp power system is directly or indirectly connected. Interconnected facilities also include any necessary additions and reinforcements by PacifiCorp to its system required as a result of the interconnection of a facility to the PacifiCorp power system.

Interconnection Study Agreement (ISA): An agreement between the Facility Interconnection Customer and PacifiCorp specifying what is to be done in the engineering interconnection study to interconnect the generator to PacifiCorp's system. This agreement specifies not only the items to be studied but the timeframe in which the study will be completed and the report results submitted to the applicant.

Interconnection Study: Those studies performed in conjunction with an interconnection request to determine the facilities needed to interconnect the load or Facility Interconnection Customer in accordance with applicable reliability requirements.

Interrupting Capacity: The amount of current a switch or circuit breaker can safely interrupt.

Interruption: A temporary discontinuance of the supply of electrical power.

K

Kilovolt (kV): 1,000 volts.

Kilovolt Ampere (kVa): The product of kilovolts times amperes. Used to refer to high voltage alternating current systems.

Kilovolt Ampere Reactive (kVAr): A measure of reactive power which is required to regulate system voltage.

Kilowatt (kW): An electrical unit of power which equals 1,000 watts.

Kilowatt-hour (kWh): 1,000 watts of energy supplied for I hour. A basic unit of electric energy equal to the use of I kilowatt for a period of I hour.

L

Lagging Power Factor: Occurs when reactive power flows in the same direction as real power. Stated with respect to the generator, lagging power factor occurs when the generator is producing VArs.

Leading Power Factor: Occurs when reactive power flows in the opposite direction to real power. Stated with respect to the generator, leading power factor occurs when the generator is absorbing VArs.

Line Losses: Electrical energy converted to heat in the resistance of all transmission and/or distribution lines and other electrical equipment (i.e., transformers) on the system.

Load-Only Entity or Customer Load: An entity interconnected to the PacifiCorp power system at a transmission or distribution voltage level which does not have generation of its own in parallel with the PacifiCorp power system and is not interconnected with any source of generation other than PacifiCorp's.

Log: A computer file, book, or loose leaf sheets for recording all station operations, clearances, readings, ratio reports, and other pertinent active daily data.

M

Maximum Torque Angle (MTA): The phase angle between the relay measured quantities at which the relay is the most sensitive.

Metering Services: Consists of removal, ensuring of meter design specifications, installation, calibration, and ongoing testing and maintenance of meters.

Meter Service Agreement (MSA): The agreement issued by PacifiCorp concerning meter services.

Megawatt (MW): 1 million watts.

Megger: An ohm meter device used to measure the ability of insulation to withstand voltage, as well as measuring the insulation resistance. A poor megger test would mean that the insulation is breaking down.

N

Nameplate Rating, Facility: Output rating information appearing on a generator nameplate or other electrical device, in accordance with applicable industry policies.

NEMA: National Electrical Manufacturers Association.

NERC: North American Electric Reliability Council or its successor.

Net Energy Output: The generation facility's gross output in kilowatt hours, less station use, to the point of delivery into the PacifiCorp power system.

Net Sale: The generation facility's gross output, in kW and kWh, less station use, to the point of delivery into the PacifiCorp power system.

Neutral: The common point of a star-connected transformer bank, a point which normally is at zero potential with reference to the earth.

No-Sale: The Facility Interconnection Customer desires to operate in parallel and not sell power to PacifiCorp.

O

Ohm: The unit of resistance of an electric circuit.

One-Line Diagram: A diagram in which several conductors are represented by a single line and various devices or pieces of equipment are denoted by simplified symbols. The purpose of such a diagram is to present an electrical circuit in a simple way so that its function and configuration can be readily grasped.

Operating Procedures: Policies and procedures governing the operation of the transmission grid as PacifiCorp, the WECC, or the NERC may from time to time develop as applicable to the particular type of generator and prime mover.

Operational Control: The rights of PacifiCorp to operate their transmission lines, facilities, and other electric plant equipment affecting the reliability of those lines and facilities for the purpose of affording comparable non-discriminatory transmission access and meeting applicable reliability criteria and policies.

Outage: A condition existing when a line or a substation is de-energized.

Output: The energy delivered by a generation facility during its operation.

Overload: A load in amperes greater than an electric device or circuit is designed to carry.

Overvoltage: Voltage higher than that desired or higher than that for which the equipment in question is designed.

P

PacifiCorp Control Center: The PacifiCorp location, manned 24 hours a day, which has been assigned operational jurisdiction over a load or Facility Interconnection Customer 's substation.

Parallel: (verb) To connect electrically a generator or energized source, operating at an acceptable frequency and voltage, with an adjacent generator or energized system, after matching frequency, voltage, and phase angle.

Parallel Operation: As used in this manual, the operation of a non-utility owned generator while connected to the utility's grid. Parallel operation may be required solely for the Facility Interconnection Customer’s operating convenience or for the purpose of delivering power to the utility's grid.

Peaking: Operation of generating facilities to meet maximum instantaneous electrical demands.

Permissive Overreach Transfer Trip Scheme (POTTS): A very secure line protection scheme for insuring that a fault is within the protected line section. It requires the presence of both a trip signal from a remote terminal and a trip signal from the local relay before tripping the local breaker.

PacifiCorp Power System: The electric transmission and distribution wires, and their related facilities owned by PacifiCorp.

Point of Interconnection (POI): The point where the load or Facility Interconnection Customer 's conductors or those of their respective agents meet the PacifiCorp power system (point-of-ownership change).

Potential Transformer (PT): A transformer intended to reproduce in its secondary circuit, in a known proportion, the voltage of the primary circuit; also known as a voltage transformer.

Power: The time rate of transferring or transforming energy.

Power Factor (PF): The ratio of real (MW) power to apparent power (MVA). Power factor is the cosine of the phase angle difference between the current and voltage of a given phase.

Power Purchase Agreement (PPA): An agreement/contract between the utility and Facility Interconnection Customer whereby the amount for the purchase of power has been determined and is contractually binding on both parties.

Primary: Normally considered as the high-voltage winding of a substation or distribution transformer; any voltage used for transmission of electric power in reasonably good-sized blocks and for some distance, as contrasted with low voltage for the immediate supply of power and light locally, such as the distribution within a building. The lowest voltage considered as a primary voltage is 2.4 kV although this is also used for some heavy-power requirements over short distances.

Primary System: A system of alternating current distribution for supplying the primaries of transformers from the generating station or distribution substation.

Protection: All of the relays and other equipment used to open the necessary circuit breakers to clear lines or equipment when trouble develops.

Protective Relay: A device whose function is to detect defective lines or apparatus, or other power system conditions of an abnormal or dangerous nature, and to initiate appropriate control circuit action.

R

Reactance: In an alternating current circuit, the opposition to the flow of current attributable to the inductance and capacitance of the circuit.

Reactive Component of Current: That part of a current that does no useful work because its phase is 90 degrees leading or lagging the voltage.

Reactive Load: In alternating current work, a load whose current is not in phase with the voltage across the load.

Reactor: A coil with no secondary winding provided. The primary use is to introduce inductance into the circuit for purposes such as starting motors, paralleling transformers, and controlling current. A current limiting reactor is a reactor for limiting the current that can flow in a circuit under short circuit conditions.

Reclose: To again close a circuit breaker after it has opened by relay action.

Recloser: A protective device designed to: 1) sense overcurrent, 2) time and interrupt the overcurrent according to a preset characteristic, and 3) reclose to test and possibly reenergize the line after a specified time interval.

Remedial Action Scheme (RAS): Protective systems that typically utilize a combination of conventional protective relays, computer based processors, and telecommunications to accomplish rapid, automated response to unplanned power system events; also refers to details of RAS logic and any special requirements for arming of RAS schemes or changes in RAS programming that may be required.

Remote Station Alarms: Alarms received at an attended location from unattended stations or plants.

Remote Terminal Unit (RTU): Remotely located equipment used for collecting data and/or for supervisory control via communication channel.

Residual Current: The current which flows in the neutral or wye-connected current transformers when the current in the three phases of a line are unbalanced.

Resistance: Anything placed or already located in an electric circuit which opposes the flow of electric current.

Resistor: A device whose primary purpose is to introduce resistance into an electric circuit. An adjustable resistor is one so constructed that its amount of resistance can be readily changed.

Retail Service: Electric sales to PacifiCorp's end-use or retail customers. Such service is regulated by the jurisdictional state regulatory agencies.

S

Schematic: A diagram showing the essential features of a piece of equipment or a control system.

Secondary: The winding of a transformer which is normally operated at a lower voltage than the primary winding.

Secondary Distribution System: A low-voltage alternating current system which connects the secondaries of distribution transformers to the consumer's services.

Self-Excited: A term to describe an electric machine in which the field current is secured from its own armature current. In the case of induction generators, it refers to the condition in which the induction generator is separated from its normal excitation source and is unintentionally excited by the power factor correction capacitors in the vicinity.

Separately-Excited: Use of an exciter for sending current through the field windings of an electric machine in place of taking the field current from its own armature current.

Service Reliability: The time an entity or group of entities is served compared to the amount of time the entity or entities are without service over a given time period.

Service Restoration: The switching procedure a system operator directs or executes to restore services to entities following an outage.

Setting: The values of current, voltage, or time at which a relay is adjusted.

Single-Phase Circuit: A circuit in which all current can be represented by only one regular sine-wave pattern. Differs from a three-phase circuit, where when all circuit current is plotted, it produces three regular sine-wave patterns 120 electrical degrees apart.

Special Facilities: Those additions and reinforcements to the PacifiCorp power system which are needed to accommodate the receipt and/or delivery of energy and capacity from and/or to the entity's facility(ies), and those parts of the interconnection facilities which are owned and maintained by PacifiCorp at the entity's request, including metering and data processing equipment.

Standby Capacity: The lesser of: 1) net generation capacity, 2) connected loads to generator, or 3) 80 percent of main switch rating.

Star-Connected Circuit (Wye-Connected Circuit): A term applied to the manner in which a motor's windings or a transformer's windings are connected, (i.e., star-connected armature having one end of each of the coils connected to a common junction). A star-connected transformer is one in which the primaries and secondaries are connected in a star grouping.

Station Use: Energy used to operate the generating facility's auxiliary equipment. Auxiliary equipment includes, but is not limited to: forced and induced draft fans, cooling towers, boiler feed pumps, lubricating oil systems, power plant lighting, fuel handling systems, control systems, and sump pumps.

Step-Down Transformer: A transformer in which the secondary winding has fewer turns than the primary, so that the secondary delivers a lower voltage than is supplied to the primary.

Step-Up Transformer: A transformer in which the secondary winding has more turns than the primary, so that the secondary delivers a higher voltage than is applied to the primary.

Supervisory Control: A system by which equipment is operated by remote control at a distance using some type of code transmitted by wire or electronic means.

Surplus Sale: The generator's gross output, in kW and kWh, less any plant load and transformation and transmission losses, delivered to the PacifiCorp system.

Switch: A device for making, breaking, or changing the connections in an electric circuit.

Switch, Air: A switch in which the arc interruption of the circuit occurs in the air.

Switch, Alarm: A form of auxiliary switch which closes the circuit to a bell or other audible signaling device upon automatic opening of the circuit breaker or other apparatus with which it is associated.

Switch, Auxiliary: A switch actuated by some main device such as a circuit breaker for signaling, interlocking, or other purpose.

Synchronism: The condition across an open circuit wherein the voltage sine wave on one side matches the voltage sine wave on the other side in frequency and without phase angle difference.

System: The entire generating, transmitting, and distributing facilities of an electric utility.

System Emergency: Conditions beyond the normal control that affect the ability of the control area to function normally, including any abnormal system condition which requires immediate manual or automatic action to prevent loss of load, equipment damage, or tripping of system elements which might result in cascading outages or to restore system operation to meet the minimum operating reliability criteria.

System Protection Facilities: The equipment required by the utility to protect: 1) the PacifiCorp power system from faults occurring at a load or Facility Interconnection Customer ' facility, and 2) the load or Facility Interconnection Customer 's generating facility from faults occurring on the PacifiCorp power system or on the system of others to which it is directly or indirectly connected.

T

Telephone Working Limit: A voltage potential of 300 V or less, so personnel can work on the telephone cable without rubber gloves.

Telemetering: Measurement with the aid of a communication channel that permits power metering measurements to be interpreted at a distance from the primary detector.

Transfer Trip (TT): A form of remote trip in which a communication channel is used to transmit the trip signal from the relay location to a remote location.

Transformer: An electric device without continuously moving parts in which electromagnetic induction transforms electric energy from one or more other circuits at the same frequency, usually with changes in value of voltage and current.

Transformer Efficiency: Ratio of the electric power of the current going into a transformer to the power of the secondary circuit from the transformer.

Transformer Loss: The difference between the input power to a transformer and the output power of the transformer.

Transformer Ratio: The ratio of the voltage secured from a transformer to the voltage supplied to that transformer.

Transmission Line: A line used for electric power transmission. Distinguished from a distribution line by voltage. Lines rated 46 kV and higher are transmission lines.

Transmission Control Center: This center implements switching operations on the PacifiCorp transmission system within a specific geographical area.

U

UL: Underwriters Laboratories.

Undervoltage Protection: Upon failure or reduction of voltage, the protection device interrupts power to the main circuit and maintains the interruption.

Undervoltage Release: Upon failure or reduction of voltage, the protective device interrupts power to the main circuit but does not prevent again completing the main circuit upon return to voltage.

Unity Power Factor: A power factor of 1.000 which exists in a circuit wherein the voltage and current are in phase. There are no VArs in this condition, only watts.

V

VAr: A unit of measurement of reactive power. It is an expression of the difference between current and voltage sine waves in a given circuit; short for volt amps reactive.

VA2 = (Watts)2 + (VArs)2

Volt: The unit of electrical pressure similar to the pounds per square inch pressure on a steam gauge.

Volt Ampere: A unit of apparent power in an alternating current circuit. Equal to the product of volts and amperes without reference to the phase difference, if any. At unity power factor, a volt ampere equals a watt. Whenever there is any phase difference between voltage and current, the true power in watts is less than the apparent power in volt amperes.

Voltage Drop: The difference in voltage level between one point and another in a circuit (see line voltage drop).

Voltage Loss: The drop of potential in an electric circuit due to the resistance and reactance of the conductor. This loss exists in every circuit.

Voltage Ratio of Transformer: The ratio of the effective primary voltage to the effective secondary voltage of a transformer.

Voltage Transformer: See potential transformer.

W

Watt: A unit of electric power.

Watts AC = volts x amperes x power factor (single phase circuits).

Watt Hour: A measure of electric power. The power of one watt used for one hour.

Watt Hour Meter: An electrical measuring instrument which indicates power in watt hours.

WECC: Western Systems Coordinating Council or its successor.

Wholesale Customer: A person wishing to purchase energy and ancillary services at a bulk supply point or a scheduling point for resale.

Wholesale Sales: The sale of energy and ancillary services at a bulk supply point or a scheduling point for resale.

Wholesale Service: Electric sales to wholesale customers for resale. Such service is regulated by FERC.

"Wye"-Connected Circuit: A three-phase circuit which is star-connected, meaning the windings of all three phases have one common connection which may be connected to ground.

12 Revision History

Revision	Date	Action	Name of Editor
0	08/31/07	1. Drafted and published original document	Paul Della
1	9/27/07	1. Changed title to Facility Connection Requirement to be consistent with NERC standards. 2. Modified introduction to include details about responsible parties and publishing. 3. Modified section 3.1.1 to clarify procedures. 4. Added details for procedures for inspecting end-use and transmission facilities. 5. Modified Section 4 to clarify telecommunications requirements.	Dennis Desmarais
2		1. General revision to clarify and add latest interconnection requirements.	Dennis Desmarais
3	10/09/09	1. General revision to clean up document and remove redundant material. 2. Revised Sections 6 & 7 to group generator specific requirements in Section 7.	Dennis Desmarais
4		1. General edits to clarify that standard applies to all facilities interconnected to PacifiCorp transmission system.	Dennis Desmarais

POWER SYSTEM STABILIZER
OPERATION AND PERFORMANCE REQUIREMENTS

The Power System Stabilizer (PSS) aids overall electric system stability by providing additional machine damping. It will supplement the proportional voltage control used on the excitation system.

There are several types of PSS. Each type uses a different input signal, such as frequency, shaft slip, or accelerating power. The most common type of PSS uses frequency as its input signal; it consists of a source-signal transducer providing frequency deviation of the generator bus from 60 Hz and derivative and lead-lag networks to provide proper phase advance. Generator excitation is controlled by a composite of voltage and frequency.

Figure H1 provides a mathematical control block diagram of a conventional excitation system which includes a PSS that uses frequency as its input signal. The transducer provides translation of bus frequency deviation into an appropriately noise-free electrical signal to serve as input to the derivative network.

The associated filtering and wave-shaping shall be designed to emit the following signal requirements:

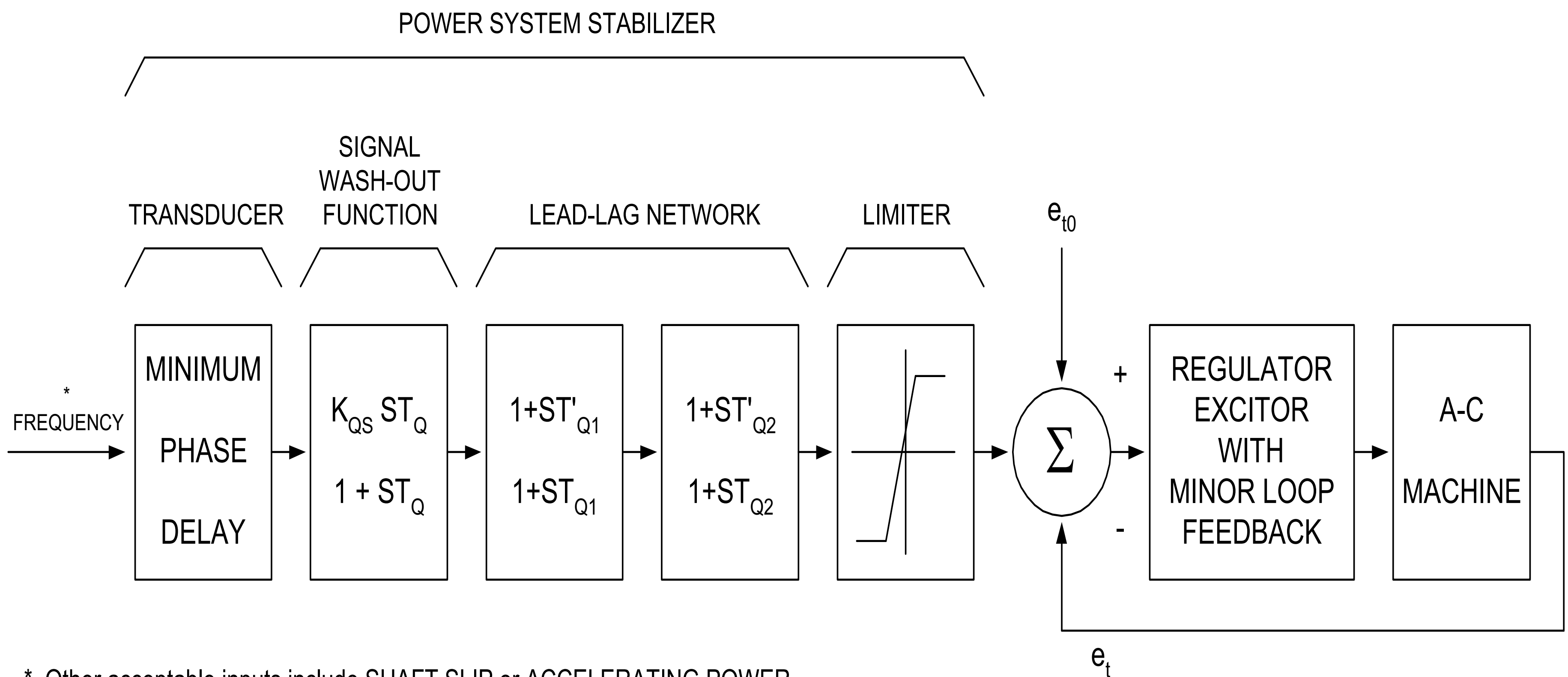
- Linearity between 59.5 and 60.5 Hz.
- Filtering and noise suppression to provide ripple shall not exceed one percent and a time constant less than 0.02 second.
- Large variations of power-supply voltage and frequency resulting from external or internal causes shall not affect performance of the PSS.

To provide the required phase lead, the PSS parameters shall be adjustable by calibrated dial settings. The parameter ranges shall be as follows:

KQs	0. 1 to 50 per unit
TQ	0. 1 to 60 seconds
T4QJ	0. 1 to 1. 5 seconds
TQi	0. 02 to 0. 1 second
T'Q2	0. 1 to 1. 5 seconds
TQ2	0.02 to 0. 1 second

FIGURE A-1

Block Diagram of Regulator-Exciter System with Power System Stabilizer



* Other acceptable inputs include SHAFT SLIP or ACCELERATING POWER

SITE DOCUMENTATION

PacifiCorp requires system drawings and relay instruction books from the dispersed generation facility. Sets of preliminary drawings are needed first. Sets of final drawings and equipment instruction books are required according to the timetable outlined below.

I. Provide one set of preliminary drawings one year prior to energizing the plant. The required drawings include:

   A. Station location plot plan.

   B. Station one-line.

II. Provide a set of final drawings and instruction books four months prior to energizing the plant.

   A. Provide three sets of the following:

      1. Station one-line.

      2. Tie breaker schematics, including:

         a. control schematics,

         b. current schematics, and

         c. potential schematics.

      3. Diagram of the relay panel arrangements.

One copy each of these drawings shall be routed to the Area Engineer, Relay and Protection Department, and the Transmission/Distribution Account Manager.

It is preferred that the copies be provided in paper format. Electronic files are acceptable if they are convertible to paper format in the size acceptable to the engineer assigned to the project. Please send all of these documents to the following address:

Pacificorp Transmission Account Manager
825 NE Multnomah Blvd., Suite 1600
Portland, Oregon 97272

TECHNICAL DATA SHEET

FOR

SYNCHRONOUS MACHINES

ON THE

PACIFICORP SYSTEM

FOR POWER FLOW, TRANSIENT STABILITY, AND FAULT ANALYSIS

Questions regarding this Technical Data Sheet should be directed to:

PacifiCorp Transmission Account Manager
830 NE Holladay, Suite 210
Portland, OR 97232
(503) 813-5738

NOTE 1: Please complete a separate data sheet for each generator that normally operates interconnected with PacifiCorp's Transmission System.

NOTE 2: This data sheet is for synchronous machines only, not induction machines

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

Project Name ________________Unit Number ____________Log Number ______________

Name of Person Completing Data Sheet ____

Telephone _________________ FAX ___________________ Email ___________________

GENERATOR DATA

1. Generator Manufacturer ___________________
2. Year Generator was Manufactured ___________________
3. Rated Generator MVA ___________________MVA
4. Rated Generator Terminal Voltage ___________________kV
5. Rated Generator Speed ___________________RPM
6. Number of Poles ___________________
7. Rated Generator Power Factor ___________________
8. Generator Efficiency at Rated Load ___________________%
9. Moment of Inertia (Turbine plus Generator) ωR^2: ___________________lb-ft^2
10. Inertia Time Constant (on machine base) H: ___________________sec. (MJ/MVA)
11. SCR (Short-Circuit Ratio - the ratio of the field current required for rated open-circuit voltage to the field current required for rated short-circuit current) ___________________
12. Typical Generator Auxiliary Load ___________________MW
13. Maximum Power Output ___________________MW
14. Please attach generator reactive capability curves. If these curves are not available give the maximum and minimum reactive limits. Q_{MAX} ___________________MVAR, lagging Q_{MIN}: ___________________MVAR, leading
15. Rated Hydrogen Coating Pressure (Steam Units) ___________________psig
16. Please attach a simple one-line diagram that includes the generator step-up transformer bark plant load, meter, and transmission-level bus.

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

GENERATOR DATA (continued)

All impedance data should be based on MVA given in (3) and on kV given in (4) an previous page.

17.	X_d	direct-axis unsaturated synchronous reactance	____________pu
18.	X_q	quadrature-axis unsaturated synchronous reactance	____________pu
19.	X'_d	direct-axis unsaturated transient reactance	____________pu
20.	X'_{ds}	direct-aids saturated transient reactance	____________pu
21.	X'_q	quadrature-Axis unsaturated transient reactance	____________pu
22.	X'_{qs}	quadrature-axis saturated transient reactance	____________pu
23.	X''_d	direct-axis unsaturated subtransient reactance	____________pu
24.	X''_{ds}	direct-axis saturated subtransient reactance	____________pu
25.	X''_q	quadrature-axis unsaturated subtransient reactance	____________pu
26.	X''_{qs}	quadrature-axis saturated subtransient reactance	____________pu
27.	X_L	stator leakage reactance or Potier reactance	____________pu
28.	R_a	armature resistance	____________pu
29.	T_{q0}	direct-axis transient open-circuit tin,* constant	____________sec
30.	T_{q0}	quadrature-axis open-circuit time constant	____________sec
31.	T'_{q0}	direct-axis subtransient open-circuit time Constant	____________sec
32.	T'_{q0}	quadrature-axis subtransient open-circuit time constant	____________sec
33.	TA_{GEN}	armature short-circuit time constant	____________sec
34.	T_D	direct-axis transient short-circuit time constant	____________sec
35.	T_Q	quadrature-axis transient short-circuit time constant	____________sec
36.	T'_D	direct-axis subtransient short-circuit fine constant	____________sec
37.	T'_Q	quadrature-exis subtransient short-circuit time constant	____________sec
38.	X_2	negative sequence reactance (sat./unsat.)	____________/____________pu
39.	X_0	zero sequence reactance (sat/unsat)	____________/____________pu

40. Please attach a plot of generator terminal voltage versus field current that shows the air gap line, the open-circuit saturation curve, and the saturation curve at full load and rated power factor.

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

EXCITATION SYSTEM INFORMATION

Listed below are the most common excitation systems used for voltage regulation of large synchronous generators. Each type of excitation system has been specified according to its manufacturer and name. In addition, the different excitation systems have been grouped together according to common characteristics.

Please indicate, in the space provided on the left, the excitation system used for your generator. if your type of excitation system is not listed, please write the manufacturer and exciter type under the category that most accurately describes your excitation system.

A. Rotating DC commutator exciter with continuously acting regulator. The regulator power source is independent of the generator terminal voltage and current.

______1. Allis Chalmers, Regulex regulator
______2. General Electric, Amplidyne regulator - NA101
______3. General Electric, Amplidyne regulator - NA108
______4 General Electric, Amplidyne regulator - NA143
______5. General Electric, GDA regulator
______6. Westinghouse, Mag-A-Stat regulator
______7. Westinghouse, Rototrol regulator
______8. Westinghouse, Silverstat regulator
______9. Westinghouse, TRA regulator
______10. Brown Boveri, Type AB or Type ABC regulator
______11. Brown Boveri, Type DC regulator
______12. Other. Manufacturer/Type: ______________________/_______________________

B. Rotating DC commutator exciter with continuously acting regulator. The regulator power source is bus fed from the generator terminal voltage

______1. Westinghouse, PRX-400 regulator
______ 2. Other. Manufacturer/Type ______________________/_______________________

C Rotating DC commutator exciter with non-continuously acting regulator (i.e., regulator adjustments are made in discrete increments

______1. General Electric, GFA4 regulator
______2. Westinghouse, BJ30 regulator
______3. Other. Manufacturer/Type ______________________/_______________________

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

EXCITATION SYSTEM INFORMATION (Continued)

D. Rotating AC Altemator Exciter with non-controlled (diode) rectifiers. The regulator power source is independent of the generator terminal voltage and current (not bus-fed).
______1. Westinghouse Brushless
______2. Westinghouse High Initial Response Brushless
______3. Other: Manufacturer/Type______________________/_______________________

E. Rotating AC Alternator Exciter with controlled (thrysistor) rectifiers. The regulator power source is fed from the exciter output voltage.
______1. General Electric Alterrex
______2. Other: Manufacturer/Type______________________/_______________________

F. Rotating AC Alternator Exciter with controlled (thyristor) rectifiers.
______1. General Electric Alterrex
______2. Other: Manufacturer/Type______________________/_______________________

G. Static Exciter with controlled (thyristor) rectifiers. The regulator power source is bus-fed from the generator terminal voltage.
______1. Canadian General Electric Silcomatic
______2. Westinghouse Canada Solid State Thyristor System
______3. Westinghouse Type PS Static System, Type WTA, WHS, WTA-300 regulators
______4. ASEA Static System
______5. Brown Boveri Static System
______6. Rayrolle-Parsons Static System
______7. GEC-Eliott Static System
______8. Toshiba Static System
______9. Mitsubishi Static System
______10. General Electric Potential Source Static System
______11. Hitachi Static System
______12. Other: Manufacturer/Type______________________/_______________________

H. Static Exciter with controlled (thyristor) rectifiers. The regulator power source is bus-fed from a combination of generator terminal voltage and current (compound-source controlled rectifiers system).
______1. General Electric SCT-PPT or SCPT System
______2. Other: Manufacturer/Type______________________/_______________________

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

Other Excitation System Information

I. Please attach a *copy of* the instruction manual for your excitation system. Make sure that a block diagram or schematic of the excitation system is included in the manual. The diagram should show the input, output, and all feedback loops of the excitation system.

J. If the manufacturer's data *for* the excitation system (i.e., time constants, gains, and saturation curves) are available, please attach these also.

K. What is the excitation system response ratio (ASA) ?
(See *Power System Control and Stability* by Anderson and Fouad, 1st ed., 1977, pg 456, Fig E.1, for a precise definition of ASA.)

L. What is the rated exciter output voltage at *full* load? ______________Volts

M. What is the maximum exciter output voltage (ceiling voltage)? ______________Volts

N. Other comments regarding the excitation system?

____

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Technical Data Sheet for Synchronous Machines on the PacifiCorp System

POWER SYSTEM STANTLTZER INFORMATION (supplementary excitation system)

(Note: Complete this section only if your machine has PSS control.)

A. Manufacturer.

______1. General Electric
______2. Westinghouse
______3. Toshiba
______4. TTI
______5. Alsthom
______6. Other: Manufacturer ___________________________

B. Is your PSS digital or analog? ________________

C. What is the actuating signal (the input signal) for your PSS?

___ Bus frequency ___ Shaft slip ___Accelerating power ___Other

If "Other", indicate signal: __________________

D. Please attach the instruction manual for your PSS. The manual should include a block diagram or schematic of the PSS and the correspondence between dial settings and the time constants or PSS gain.

E. Please attach a copy of the test report for your PSS. This report should contain the dial settings or time constants and TISS gain. If this report is not available, write the dial settings below:

1. T_1 washout or reset time constant dial setting __________
2. T_2 first lead time constant dial setting __________
3. T_3 first lag time constant dial setting __________
4. T_4 second lead time constant dial setting __________
5. T5 second lag time constant dial setting __________
6. K MS gain dial setting __________
7. V_{max} maximum PSS output dial setting __________
8. V_{cut} dial setting for which PSS is set to zero when generator terminal voltage deviation is too large __________
9. Other ___________________________________ / __________
10. Other ___________________________________ / __________

F. Who installed your PSS?

Name: ____

Company: ____

City, State: ____

Phone/Fax: _____________________/_________________________

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

POWER SYSTEM STABILIZER INFORMATION (continued)

C. Other comments regarding the PSS?

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

TURBINE-GOVERNOR INFORMATION

Please complete part A for steam, gas or combined-cycle turbines, part B for hydro turbines, and part C for both.

A. Steam, gas or combined-cycle turbines

1. Steam turbine, Gas turbine, or Combined-cycle: ___________________

2. If steam or combined-cycle, does the turbine system have a reheat process (i.e., both high and low pressure turbines) ? ___________________

3. If steam with reheat process, or if combined-cycle, indicate, in the space provided, the percent of full load power produced by each turbine:

   by low pressure turbine or gas turbine ___________________%

   by high pressure turbine or steam turbine ___________________%

B. Hydro turbines

1 What is the turbine efficiency at rated load ___________________%

2. What is the length of the penstock? ___________________ft

3. What is the average cross-sectional area of the penstock ___________________ft^2

4. What is the typical maximum head (vertical distance from the bottom of penstock, at the gate, to the water level)? ___________________ft

5. Is the water supply run-of-the-river or reservoir? ___________________

6. What is the water flow rate at the typical maximum head? ____________________ft^3/sec

7. What is the average energy rate? ____________________kW-hrs/acre-ft

8. What is the estimated yearly energy production? ____________________kW-hrs

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

C. Complete this section for each machine, independent of the turbine type.

1. Turbine manufacturer ______________________

2. Maximum turbine power output ___________________MW

3. Minimum turbine power-output (while on line) ___________________MW

4. Governor information:

   a. Droop setting (speed regulation) ______________________

   b. Is the governor mechanical-hydraulic or Electro-hydraulic? (Electrco-hydraulic governors have an electronic speed sensor and transducer.) ______________________

   c. Please provide below any time constants you have from the manufacturer describing the speed of response of the governor.
   Be sure to identify each time constant.

   ____ ________________sec

   ____ ________________sec

   ____ ________________sec

   ____ ________________sec

   d. Other comments regarding the turbine governor system?

   ____

   ____

   ____

   ____

   ____

   ____

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   ____

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

STEP-UP TRANSFORMER DATA

1. Transformer Bank No.________________________________

2. Rated MVA ________________MVA

3. Available H.V. Taps
   _________ kV
   _________ kV
   _________ kV
   _________ kV
   _________ kV
   _________ kV

   Available L.V. Taps
   _______ kV
   _______ kV
   _______ kV
   _______ kV
   _______ kV
   _______ kV

4. Please indicate present tap settings: H.V. Tap: __________kV
   L.V. Tap: __________kV

5. Does transformer have tap changing under load? ___________

6. Is transformer a regulating-type transformer? ___________

   If yes, please indicate regulating voltage range and the number of steps.
   ______kV to ______kV Number of steps: ________

7. Please indicate how the transformer windings are connected.

   H.V. Side: ________ Wye
   ________ Gumnded Wye
   ________ Delta

   LV. Side: _________ Wye
   _________ Grounded Wye
   _________ Delta

8. Please attach a copy of the transformer test report, if available.

9. If the transformer test report is not available, please provide the "lowing impedances using the IAVA base given in (2) above:
   R_T per unit resistance ____________PU
   XT per unit reactance ____________PU
   BT per unit magnetizing susceptance ____________PU
   CT per unit core loss conductance ____________PU

10. Other comments regarding the transformer?

____

____

____

____

OF OPERATING PRACTICE QUESTIONNAIRE
SYNCHRONOUS GENERATORS

NOTE: The information on this survey is used to improve transmission models used in engineering studies.

A. Generation and Plant Load (served by own generation) Pattern:

1. Generator Size _________MVA

2. Please indicate typical peak generation level (in MW). If generator serves plant load on the same side of the PacifiCorp meter, also indicate typical load level. (Metered power equals peak generation level minus corresponding plant load).

   a. Peak Generation Level ________MW

   b. Corresponding Plant Load ________MW

3. Please indicate typical planned seasonal and time period variations as percentage of levels specified in (2) above. Approximate a percentages in Increments; of 25% (0%, 25%,50%,75%, 100%)

	Summer April thru October		Winter November thru March	
Time of Day (24-Hr format)	Generation	Load	Generation	Load
06:00 - 12:00				
12:00 -18:00				
18:00 - 22:00				
22:00 - 06:00.				

B. Type of Regulation (Complete either Section 1 or 2)

1. Maintain Voltage ____________________________
   Typical Voltage Range ____kV to ____________kV
   Generator Rated Terminal Voltage _______________kV

   Standard PacifiCorp operation bandwidth is 0.90 lagging (producing vars) to 0.95 leading (absorbing vars). If actual operation (not capability) is typically narrower than these limits, please indicate range.

   ______Lagging (producing vars) to ___________Leading (absorbing vars)

   Do you ever operate with manual voltage control (excitation system bypassed)? ______________________

   If yes, what percent of the time? ______________________

   Under what conditions?

   ____

   ____

   ____

   ____

2. Maintain Power Factor ______________

   Typical Machine Power Factor Range ____________________________
   To ________________________

   Is this automatically controlled? ______

   If so, approximately how fast can the controller respond to a change in power factor?

   _________0 - 20 seconds
   _________20 seconds - 3 minutes
   _________greater than 3 minutes

   Standard Pacificorp bandwidth is 95 to 105% of rated voltage. If actual operation (not capability) is typically narrower than these limits please indicate range.

   ______________ to ________________ % of rated voltage

C. Governor Control

Do you operate with an automatic turbine speed controller (governor)? __________

If yes, do you operate with it blocked? _______

If yes, what percent of the time? _______%

Under what conditions?

____

____

____

D. Other comments regarding operation of your generator?

____

____

____

____

____

____

____

____

REQUIREMENTS FOR TRANSMISSION LINE SELECTOR SWITCHES AND ASSOCIATED COST RESPONSIBILITIES

Purpose

The purpose of this guideline is to: 1) ensure service availability can be maintained to single-tapped customers, 2) ensure system-wide consistency in the installation of selector switches on transmission lines, and 3) provide a clear understanding of the associated cost responsibilities wherever transmission lines are single-tapped.

Definition of Selector Switches

Line selector switches are installed on one or both sides of a single-tap in order to provide operational flexibility in service to customers on the tap line. Selector switches are operated to avoid customer outages for planned maintenance in the main line and to restore service in the case of an unplanned interruption of the main line (see Figure 1). Selector switches do not reduce the number of outages to the customer, but they do provide a relatively inexpensive way of reducing the duration of a sustained outage[1] by allowing the transmission line to be sectionalized. Selector switches cannot reduce the frequency of maintenance or unplanned outages on the single-tap line to the customer.

Applicability

Effective immediately, selector switches are a standard service requirement for all new single-tap interconnections to PacifiCorp's transmission system. This is applicable where a single-tap configuration is to be used to interconnect a new load or generation customer to a PacifiCorp-owned transmission line (46 kV and above) or when a change in service is requested by an existing load or generation customer. This guideline will also be incorporated into PacifiCorp's transmission interconnection requirements.

At PacifiCorp's discretion, a selector switch may not be required should the distance from the new single-tap interconnection to either end of the transmission line or to an existing selector switch on the line be approximately one mile or less, with minimal exposure to causes of outages (trees, traffic, etc.). Refer to Attachment 1 for a list of criteria in determining the need for selector switches.

---

[1] A sustained outage is an outage to a customer extending more than two minutes.

Single-Tap Configuration

For standard transmission tap interconnection to a customer-owned substation, a single-tap is provided from the most feasible transmission line to the customer's facility. With standard service, the customer will experience interruptions to their facility during a transmission line outage unless the customer has adequate on-site back-up generation.

The installation of selector switches reduces the duration of a sustained outage, but it does not eliminate momentary outages to a customer. For a sustained outage on the transmission line, service to the customer will be interrupted for the duration of time[2] it takes PacifiCorp to open the appropriate selector switch to isolate the faulted line section and close the breaker on the non-faulted line section. As an example, for a sustained outage between Station "B" and the tap point, selector switch "B" would be opened to isolate the problem and service to the customer would be restored by closing the circuit breaker at Station "A".

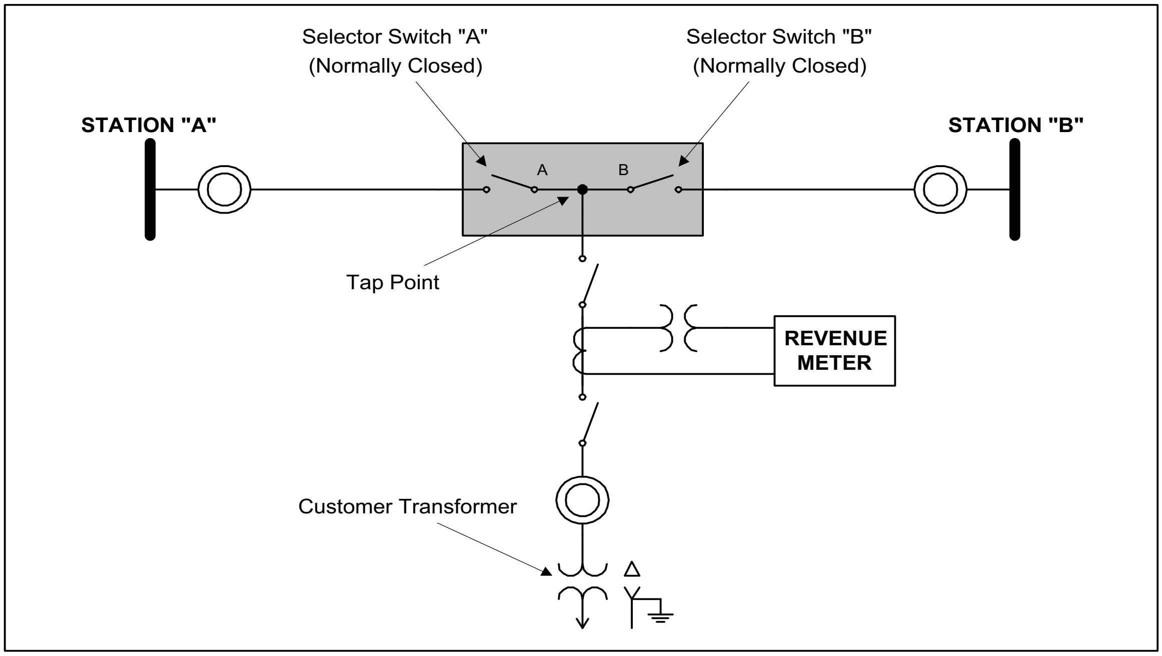


Figure 1–Typical Single-Tap Configuration with Selector Switches

Ownership and Accessibility

- Pacificorp shall own, operate, and maintain all selector switches in the system to serve customer-owned substations or customer load.

[2] Duration of time refers to the time it takes a Pacificorp operator to manually operate the selector switches from the time Pacificorp was notified of an outage. This time could vary from about a half hour to several hours depending on the nature of the outage. Should the outage be such that the customer could be energized from one end of the transmission line, the appropriate selector switch would be opened.

- PacifiCorp's personnel must be able to access all selector switches installation 24 hours a day.

Cost Responsibilities for New Single-Tap Interconnections[3]

Effective immediately, with the exception allowed in Attachment 1, line selector switches are a PacifiCorp requirement for all new single-tap interconnections to the transmission system as a means of providing adequate level of service availability. In accordance with PacifiCorp's electric tariff, if line selector switches are considered special facilities, the installation cost of the switches will be determined by the application of relevant jurisdictional state commision rules as appropriate[4].

For existing single-tap interconnections, refer to Attachment 2 for the need and installation cost responsibilities for line selector switches.

Selector Switches Capability

- PacifiCorp will determine on a case-by-case basis whether selector switches should be capable of line dropping and/or loop splitting and would specify the capabilities of the selector switches and any associated interrupting devices.
- PacifiCorp will identify locations with access difficulties, such as mountainous terrain, and may recommend that the selector switches be motor-operated and remotely controlled.

Selector Switches Installation

Selector switches must be located in close proximity (within one pole or tower structure) on either side of the single-tap on the transmission line. All structures used for mounting the selector switches will be determined and designed by PacifiCorp.

---

[3] New Single-Tap Interconnections: A customer requesting PacifiCorp's service who is not currently interconnected to PacifiCorp's transmission system.

[4] Unbundling of electric and transmission services may reqire the cost responsibilities be revised.

ATTACHMENT 1

Criteria for Determining When One or No Selector Switch Is Required

- Radial Transmission Line

  At PacifiCorp's discretion, only one selector switch may be required on the non-source side of the tapped transmission line.

- When One Selector Switch Is Sufficient

  At PacifiCorp's discretion, PacifiCorp may elect to install only one selector switch on one side of the single-tap provided that the line section without the selector switch is: 1) approximately one mile or less from the tap point to the end of the transmission line, with minimal exposure to causes of outages (trees, traffic, etc.), or 2) approximately one mile or less from the interconnection tap point of another customer with line selector switches, with minimal exposure to causes of outages.

- When No Selector Switches Are Required

  At PacifiCorp's discretion, selector switches may not be required on the transmission line if the distances on either side of the tap to the ends of the transmission line or other selector switches on the line are approximately one mile or less, with minimal exposure to causes of outages.

Criteria for Determining When Selector Switches Are Required

- Length of Transmission Line

  Long transmission lines have more exposure and have a greater frequency of being forced out of service for maintenance. Long lines are also at greater risk of experiencing sustained faults due to increased exposure to adverse elements.

- Location and Route of Transmission Line

  Geographic and environmental conditions affect the total exposure of the line to adverse elements. For example, transmission lines that traverse mountainous areas are subject to a greater number of outages due to exposure to trees and inclement weather.

- Multiple Customers on Transmission Line

  At PacifiCorp's discretion, PacifiCorp may require selector switches on a transmission line where multiple customers are tapped as a means of maintaining service availability.

ATTACHMENT 2
Need and Installation Cost Responsibilities for Existing Single-Tap Interconnections

This guideline is not intended for retroactive application to existing single-tap interconnections, however the installation of line selector switches on existing single-tap interconnections will be considered on a case-by-case basis based on the following:

Existing Single-Tap Customer's Request for Selector Switches

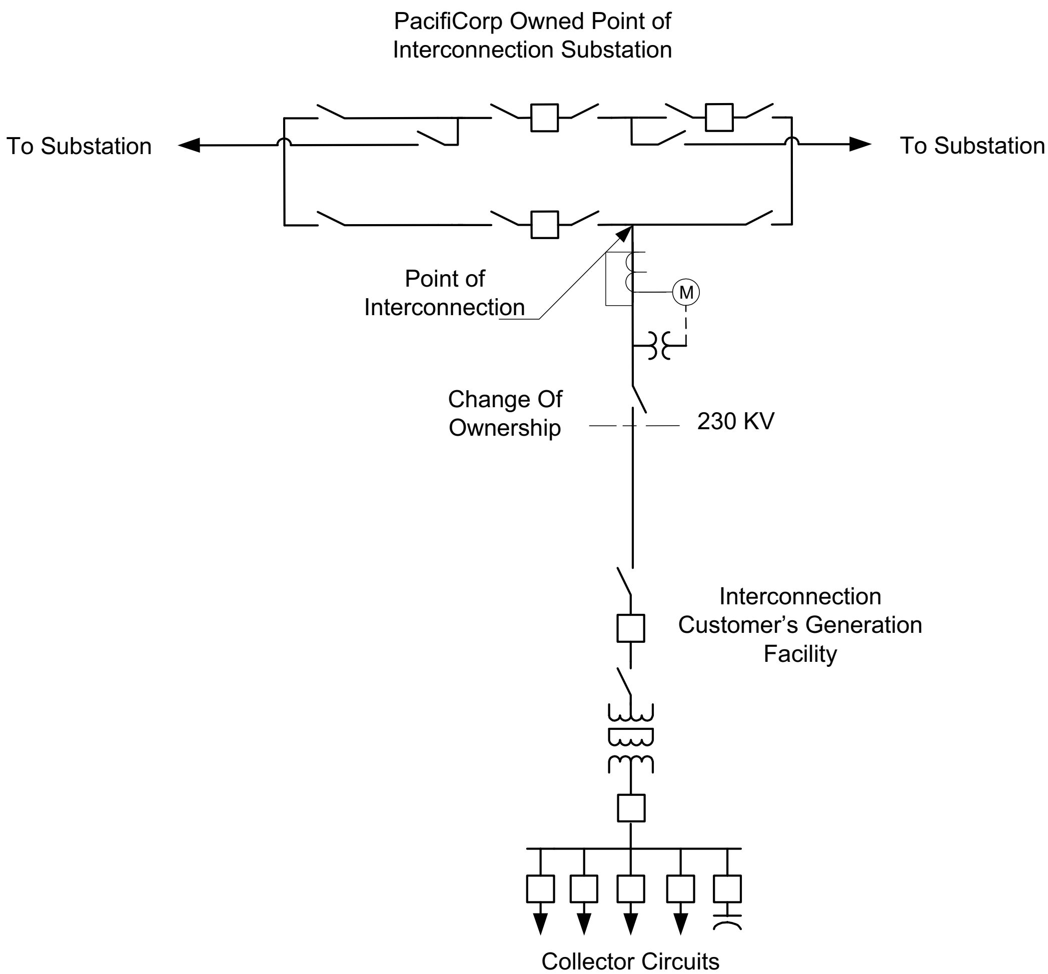
When an existing single-tap customer requests selector switches as a means of minimizing down time to his/her facility, the selector switches will be treated as Special Facilities and shall be paid for by the customer in accordance with applicable jurisdictional state utility commission rules.

PacifiCorp Determines When Selector Switches Are Necessary

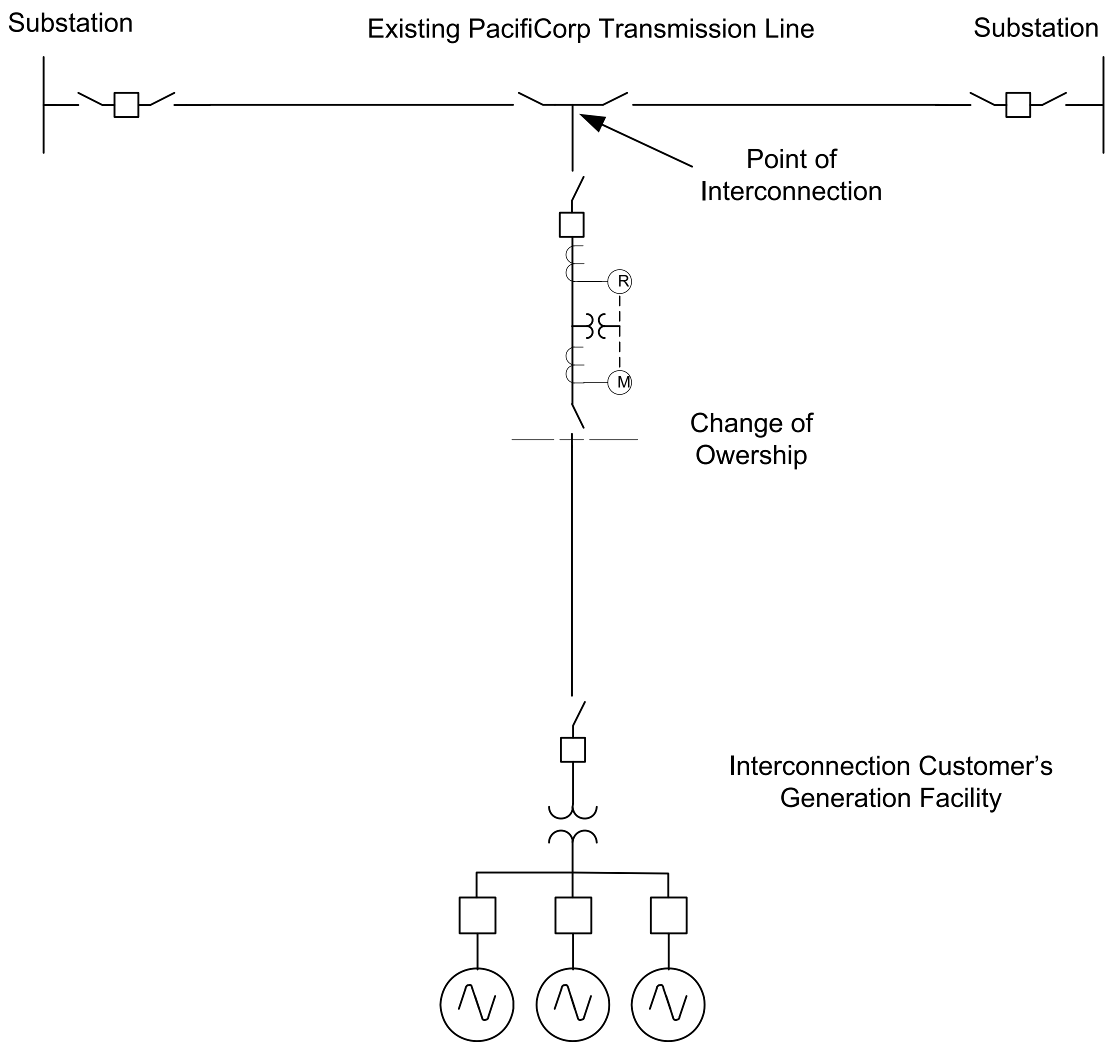
When line selector switches are determined by PacifiCorp to be needed for system benefits, the installed cost of the selector switches will be borne by PacifiCorp. System benefits include but are not limited to: 1) minimizing sustained outages to multiple customers on a single-tap line, and 2) avoiding difficult clearance coordination with multiple customers.

On existing single-tap interconnections, should the need for selector switches be identified, then the criteria outlined in Attachment I also applies.

Typical One Line
Generator Interconnection ≥ 230 kV



Typical One Line
Generator Interconnection < 230 kV



Policy

Facility Connection Requirements for Transmission Systems

(46 kV and Above)

Power Delivery Policy 139

Author:	Paul Della
Approval:	Tom Fishback, Dennis Desmarais, Greg Lyons
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Policy

Document Security Category			
	Confidential	X	External
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X	Internal		

Revision	Date	Action	Name of Editor
0	08/31/2007	1. Drafted and published original document	Paul Della
1	9/27/2007	1. Changed title to Facility Connection Requirement to be consistent with NERC standards. 2. Modified introduction to include details about responsible parties and publishing. 3. Modified section 3.1.1 to clarify procedures. 4. Added details for procedures for inspecting end-use and transmission facilities. 5. Modified Section 4 to clarify telecommunications requirements.	Dennis Desmarais
2	4/13/2009	1. General revision to clarify and add latest interconnection requirements.	Dennis Desmarais
3	10/09/2009	1. General revision to clean up document and remove redundant material. 2. Revised Sections 6 & 7 to group generator specific requirements in Section 7.	Dennis Desmarais
4	5/25/2010	1. General edits to clarify that standard applies to all facilities interconnected to PacifiCorp transmission system.	Dennis Desmarais
5	6/17/2011	1. Corrected contact information in Appendix B.	Tom Fishback

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Policy

Facility Connection Requirements for Transmission Systems
(46 kV and Above)
Power Delivery Policy 139

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1 INTRODUCTION

This policy addresses the requirements for generation facilities, transmission facilities, and end-user facilities that are interconnected to PacifiCorp's transmission system. This policy, along with PacifiCorp's OATT, ensures that adverse impacts on reliability of the transmission system is avoided. In addition to ensuring reliability, this policy is consistent with safety requirements for PacifiCorp employees and the general public. This document is maintained by Technology Development and Standards group and is published on PacifiCorp's internal and external websites. PacifiCorp will make a copy of this document available to qualified entities with five business days of the request.

Although this policy addresses certain aspects of interconnection cost responsibility, its scope is primarily technical and does not include the commercial requirements for connecting generators or transmission facilities. Tariffs and rules filed with FERC and jurisdictional state regulatory agencies address the rates, terms, and conditions under which PacifiCorp provides these services. If there are any inconsistencies between this policy and the tariffs and rules, the tariffs and rules shall apply.

1.1 Introductory Definitions

PacifiCorp Transmission System: For the purposes of this policy document, the PacifiCorp transmission system is defined as electric transmission facilities owned by PacifiCorp typically 46kV and above.

Customer Load: A person, company, or corporation interconnected to PacifiCorp's transmission system owning or operating only power-consuming facilities.

Facility Interconnection Customer: A person, company, partnership or corporation interconnecting to PacifiCorp's transmission system owning or operating generation facilities, transmission facilities, and end user facilities.

Any connected entity owning or operating both power-consuming and power-generating facilities shall be considered a Facility Interconnection Customer for the purposes of this policy. The technical requirements for interconnection of generation sources are generally more comprehensive. Any load-only entity which is interconnected to a third-party electric system having generation capabilities shall also be considered a Facility Interconnection Customer for the purposes of this policy. Technical requirements for multi-interconnected systems (systems interconnected to the PacifiCorp power system in addition to a third-party system) will be determined by PacifiCorp on a case-by-case basis.

1.2 Applicability

This standard applies to generation, transmission, and end user facilities that are physically connected to, or desire to physically connect to, PacifiCorp's transmission system. Applicability is further defined by the categories below:

1.2.1 Generation Facilities

All requirements described or referred to in this policy apply to new and decommissioned generation facilities. New generation facilities are facilities that have not been and are not yet connected with the PacifiCorp transmission system. Decommissioned generation facilities are facilities that were actively connected to PacifiCorp's electrical system in the past but presently are not connected nor actively producing power. Additional technical requirements may apply to special business arrangements or electrical configurations of PacifiCorp's transmission system or the interconnection point(s). Any such technical specifications would be documented within the interconnection agreement and the operation and maintenance agreement. All decommissioned generators must comply with all requirements contained in this policy document. It may be necessary for the decommissioned generator to upgrade existing equipment to adhere to this policy.

1.2.2 Transmission Facilities

Any proposed transmission facility interconnecting into PacifiCorp's transmission system shall be coordinated and reviewed through the Pacificorp's transmission planning process. The transmission facility addition shall maintain or improve the level of system reliability that existed prior to the interconnection. Power flows as a result of the transmission interconnection shall not overload or adversely affect the PacifiCorp transmission system or the WECC regional transmission system.

1.2.3 End-user Facilities

Any proposed load customer interconnecting into PacifiCorp's high voltage transmission system shall be coordinated and reviewed through the New Large Load Process.

1.2.4 Existing Facilities

To the extent this handbook contains more stringent requirements than were in place at the time that existing facilities were initially connected, the existing entity shall be responsible for adhering to current requirements only to the extent that the safety and reliability of the power system or the safety of utility employees would be jeopardized by not adhering to the current requirements and standards. The cost for any upgrading shall be borne by either the Facility Interconnection Customer or by PacifiCorp pursuant to applicable electric rules and/or the terms of any executed agreements between the Facility Customer and PacifiCorp.

1.3 Policy for Interconnection of Transmission Facilities

PacifiCorp has established this policy for operating, metering, and equipment protection requirements for the interconnection of new generation, transmission, and end user facilities. This policy covers the requirements for all facilities wishing to interconnect to the PacifiCorp transmission system. Additional project specific requirements may apply. These additional requirements may vary according to the specifications of the interconnection as well as local configuration of the PacifiCorp transmission system.

The technical studies will determine whether PacifiCorp will be required to modify its transmission system to interconnect the requested facilities. Parties requesting interconnection are responsible for the cost of these technical studies. Please contact the PacifiCorp Transmission Account Manager for details about the study process and additional data requirements which may apply.

1.4 Security Access to Facilities

PacifiCorp personnel will honor all reasonable requests from the facility owner when accessing PacifiCorp equipment located within a facility owner's premises. The facility owner will grant PacifiCorp 24-hour access to PacifiCorp-owned equipment on the facility owner's premises. If this access is not allowed for the reasonable day-to-day operation of PacifiCorp's power system affecting PacifiCorp's customers, including emergency incidents or other power delivery-related activities, PacifiCorp reserves the right to exercise the disconnection provision of the facility interconnection agreement.

1.5 Facility Connection Customer Equipment Requirements

Interconnected parties are responsible for designing, installing, operating, and maintaining interconnection equipment that they own (i.e., generators, transformers, switches, relays, breakers, etc). All protective devices necessary to protect the interconnected facilities are the responsibility of the Customer.

PacifiCorp's requirements specified in this policy are designed to protect PacifiCorp facilities and maintain grid reliability pursuant to applicable reliability criteria; **they are not designed to protect the facilities of interconnected customers.**

Interconnected Customers must satisfy the requirements in 1) this policy, 2) applicable rules and tariffs of jurisdictional state regulatory agencies and FERC, 3) applicable policies of the Western Electricity Coordinating Council (WECC), the North American Electric Reliability Council (NERC), or their successor organizations, and 4) PacifiCorp's project-specific requirements. PacifiCorp's review and written acceptance of the interconnected entity's equipment specifications and plans shall not be construed as confirming or endorsing the interconnected entity's design, as warranting the equipment's safety and durability, or in any way relieving the interconnecting entity from its responsibility to meet the above requirements. PacifiCorp shall not, by reason of such review or lack of review, be responsible for strength, details of design, adequacy, or capacity of equipment built to such specifications, nor shall PacifiCorp's acceptance be deemed an endorsement of such equipment.

Readers should be aware that the information in this policy document is subject to change. The latest version of this document is available at http://www.oasis.pacificorp.com/oasis/ppw/main.htmlx

PacifiCorp will not agree to interconnect new facilities unless all technical and contractual requirements are met. Copies of this policy will be supplied upon request. Contact the PacifiCorp Transmission Account Manager for referrals to the PacifiCorp employee who can respond to questions concerning PacifiCorp's policy for facility interconnection coordination procedures or additional copies of this document:

Director, Transmission Services
PacifiCorp
825 N.E. Multnomah Blvd. Suite 1600
Portland, Oregon 97232
(503) 813-6079

The document can also be obtained by emailing transmission.services@pacificorp.com.

2 OWNERSHIP POLICY AND OPERATION OF INTERCONNECTION EQUIPMENT

PacifiCorp shall own all interconnection facilities and system upgrades necessary to assure reliable service to PacifiCorp customers. This may include, but is not limited to: relaying, control systems, breakers, switches, bus work, and transmission lines. In all cases, revenue metering and communications circuits for the purpose of breaker status and transfer trip will be owned and maintained by PacifiCorp. PacifiCorp may, at its option, contract with the Facility Interconnection Customer, or a third party, for construction of any or all of these facilities.

2.1 Applicant Construction of PacifiCorp Facilities

When it is mutually agreed by PacifiCorp and the faciity interconnection customer, the customer shall design and build PacifiCorp facilities using a PacifiCorp approved engineering firm. The customer shall provide PacifiCorp with design drawings prior to the start of construction and shall continue to provide PacifiCorp with the latest revisions sent to the contractor for construction. Within 30 days of the completion of construction, the interconnect customer shall provide PacifiCorp with a complete set of design drawings revised to reflect as-built conditions. In addition, the interconnect customer shall be responsible for obtaining SAP numbers and equipment memorandum forms from PacifiCorp and for completing the equipment memorandums for all major equipment identified by PacifiCorp as requiring setup in SAP to provide the means for scheduling future maintenance. The interconnect customer shall provide PacifiCorp with the completed equipment memorandums upon the installation of the major equipment for which they are required.

3 INTERCONNECTION PROCESS, STUDIES, AND REQUIREMENTS

3.1 Facility Interconnection Process Summary

FERC provides procedures which govern generation facility interconnections where a generator chooses to sell power to the bulk power market or a transmission customer/end user chooses to take unbundled or wholesale electric service from a FERC jurisdictional transmission line. A FERC jurisdictional line is defined as a line or interconnection classified as FERC transmission by the host utility or by using the FERC Seven Factor Test. Generators, transmission line, and end users must follow all FERC procedures when using or interconnecting with FERC jurisdictional transmission.

1. The FERC processes and procedures have been incorporated into PacifiCorp's OATT which may be accessed at: http://www.oasis.pacificorp.com/

   If the generator, transmission line, or end user are not FERC jurisdictional, PacifiCorp applies applicable state processes, if they exist, and voluntarily applies the same processes and procedures for consistency and ease of processing when state rules do not exist.

2. Generators, transmission line, and end users must follow all FERC interconnection procedures and processes when they are FERC jurisdictional. The following FERC orders govern the interconnection processes and procedures:

   Generators with nameplate ratings greater than 20 MW are governed by the FERC Large Generator Interconnection Procedures and Agreements (LGIP/LGIA) process. These are incorporated into Section IV *Large Generator Interconnection Service* of PacifiCorp's OATT.

Generators rated from 10 kW to 20,000 kW (20 MW) are governed by FERC Small Generator Interconnection Procedures and Agreements (SGIP/SGIA) process. These are incorporated into Section V *Small Generator Interconnection Service* of PacifiCorp's OATT.

Line/End Users who choose to take unbundled or wholesale electric service are governed by PacifiCorp's (OATT).

3. Generators not governed by FERC procedures and agreements shall be governed by PacifiCorp procedures and agreements. Line/end users not governed by the PacifiCorp OATT shall be governed the corresponding PacifiCorp state tariffs (bundled electric service) and procedures.
4. All interconnecting customers will be required to meet all applicable standards, which include, but are not limited to NERC Reliability Standards, WECC Reliability Standards, FERC Generator Interconnection Procedures, FERC Generator Interconnection Agreements, Pacific Northwest Security Council requirements, Northwest Power Pool Requirements, and PacifiCorp planning criteria and facility connection requirements

3.2 Coordinated Joint Studies

3.2.1 Procedures for Coordinated Joint Studies

Unless there are conflicts with FERC or state standards (such as Critical Energy Infrastructure Information (CEII) and/or standards or code of conduct issues) PacifiCorp will form ad hoc groups, distribute results, and facilitate any required meetings between Facility Interconnection Customer, PacifiCorp, potentially affected electric systems, and any governing authorities in accordance with the FERC Large Generation Interconnection Procedures/Agreements (LGIP/LGIA) or other applicable procedures. This includes requesting potentially affected parties to participate in joint studies and following accepted WECC regional planning practices. If a potential CEII conflict arises such as an unknown consultant requesting critical system data, PacifiCorp would require FERC approval and a confidentiality agreement. If, in the opinion of PacifiCorp, a potential standard or code of conduct issue arises which may involve parties that 1) are not FERC jurisdictional public utilities, or 2) decline to sign a confidentiality agreement, PacifiCorp will provide system criteria violations (thermal, voltage, or stability) specific to affected system only.

Results of coordinated joint studies shall be documented along with any conclusions and recommendations. Such documentation shall be retained by PacifiCorp shall be made available if requested by WECC or NERC, or any other entities responsible for the reliability of the interconnected transmission system as soon as feasible.

3.2.2 Procedures for Notification of New or Modified Facilities

PacifiCorp shall disseminate notification of new or modified facilities to the WECC, and NERC in accordance with notification procedures that such entities have established.

Facility Interconnection Customers that are seeking to integrate new facilities with PacifiCorp should contact:

Director, Transmission Services
PacifiCorp
825 N.E. Multnomah Blvd. Suite 1600
Portland, Oregon 97232
(503) 813-6079
transmission.services@pacificorp.com

3.2.3 Additional Requirements

1. All transmission facilities, whether owned by PacifiCorp or the Facility Interconnection Customer must be in complaince with all NERC reliability requirements. NERC reliability standards may be accessed on the internet at:

   http://www.nerc.com/~filez/standards/Reliability_Standards.html

   Some specific NERC standards which may apply are:

   - BAL Resource and Demand Balancing
   - CIP Critical Infrastructure Protection
   - COM Communications
   - EOP Emergency Preparedness and Operations
   - FAC Facilities Design, Connections and Maintenance
   - INT Interchange Scheduling and Coordination
   - IRO Interconnection Reliability Operations and Coordination
   - MOD Modeling, Data, and Analysis
   - ORG Organization Certification
   - PER Personnel Performance, Training, and Qualifications
   - PRC Protection and Control
   - TOP Transmission Operations
   - TPL Transmission Planning
   - VAR Voltage and Reactive

2. If the Facility Interconnection Customer interconnection is to a point on the transmission system that is 100 kV and greater, the Facility Interconnection Customer must then comply with the NERC reliability standards.
3. PacifiCorp may revise the technical requirements periodically to comply with new requirements from FERC, NERC, state, other governmental authorities. PacifiCorp may require that all generator, transmission line, and end user interconnections comply with new regulations by implementing similar procedures and/or upgrades as would be expected on PacifiCorp facilities in a non-discriminatory manner. If the Facility Interconnection Customer does not comply, PacifiCorp may upgrade the Facility Interconnection Customer's facilities as necessary to be compliant. Any such upgrades shall be executed at the customer's expense. Alternately, PacifiCorp may disconnect the Facility Interconnection Customer after proper notification according to OATT requirements and procedures.

4. The PacifiCorp “bulk power network” is defined in this document as all 100 kV and greater lines which serve more than local load. This may include participation in the transport of long-distance power transfers according to the FERC Seven Factor Test.
5. The term "Facility Interconnection Customer" refers to the new generation, transmission, and end user facilities requesting authorization to interconnect with the PacifiCorp electric system where FERC has jurisdiction.
6. Generators interconnecting to the PacifiCorp electric system are governed by the most current version of the PacifiCorp OATT.
7. This document complies with NERC requirements to document, maintain, and publish facility connection requirements for NERC/FERC jurisdictional generation facilities (rated at 10 – 20,000 kW), and transmission/end user facilities to ensure compliance with:
   - NERC Reliability Standards
   - FERC Small Generator Interconnection Procedures and Agreements
   - Applicable Regional Reliability Organization Requirements
   - Sub-regional, Power Pool Requirements
   - PacifiCorp Requirements
8. These technical requirements specify the minimum technical requirements intended to ensure a safe, effective, and reliable interconnection. These requirements are intended to supplement, but not replace, information contained in regulatory codes, PacifiCorp’s OATT, PacifiCorp electric service tariffs, and specific interconnection agreements. The requirements outlined in this document may not cover all details in specific cases.
9. Additional information regarding parallel operation of generation with the PacifiCorp system can be obtained by contacting the Transmission Account Manager.

3.3 General Requirements

1. The Facility Interconnection Customer shall identify the voltage level and capacity or demand at the point of interconnection in MW and MVAr.
2. The Facility Interconnection Customer shall interconnect to the PacifiCorp electric system at the nominal voltage at the agreed-to point of interconnection. PacifiCorp, at its sole discretion, may elect to upgrade or change the voltage level of the PacifiCorp electric system serving the Facility Interconnection Customer. Any costs to upgrade or change the Facility Interconnection Customer’s equipment to maintain an interconnection with PacifiCorp shall be the responsibility of the Interconnection Customer. All direct assigned facilities required to interconnect to 46 kV systems will be designed and built to 138 kV standards in anticipation of future conversion of all 46 kV systems to 138 kV.
3. The customer shall obtain PacifiCorp's acceptance of those portions of design documents that apply to protection and security of the PacifiCorp electric system according to OATT requirements and procedures. The customer is solely responsible for the design that affects the facility. Protection of the Facility Interconnection Customer’s overall electrical system,

including generation and connected load, is the sole responsibility of the Facility Interconnection Customer.

4. The customer will follow all FERC, NERC, and Regional Reliability Organization (RRO) requirements for review and approval of the facility interconnection and any required system changes or upgrades. This may include the development of such studies and data as a WECC subcommittee shall reasonably request.
5. PacifiCorp and/or its consultant shall conduct all electric system studies and issue reports required by FERC, NERC, RRO, PacifiCorp, and any other regulatory body for authorization and justification of the proposed interconnection to the PacifiCorp electric system. The customer shall reimburse PacifiCorp for all costs incurred for these studies and reports according to OATT requirements and procedures.
6. The customer shall comply with PacifiCorp, WECC, and industry design, construction, operating standards, and procedures.
7. The Facility Interconnection Customer's installation shall meet all applicable national, state, and local construction and safety codes.
8. The interconnection design shall be capable of accommodating PacifiCorp electric system reclosing practices.
9. The interconnection design shall incorporate equipment to detect system abnormalities or disturbances in either the Facility Interconnection Customer's system or the PacifiCorp system. This equipment shall have the capability to isolate the sources of the disturbance.
10. The interconnection design shall be such that failure of the generator, transformer, and other auxiliary equipment shall result in the automatic isolation of the affected equipment.
11. The customer shall design the facility to meet all current WECC reliability standards including the WECC System Performance Table as accessed on the WECC website or upon request from PacifiCorp.
12. The customer shall design the facility to meet technical requirements and facility rating standards as shown on the PacifiCorp website.
13. The customer shall not cause the PacifiCorp electric system to violate NERC voltage criteria or voltage ranges defined in ANSI Standard C84.1, Range A (plus or minus 5 percent of nominal).
14. The customer shall interconnect to the PacifiCorp electric system at the nominal voltage at the agreed to point of interconnection. PacifiCorp, at its sole discretion, may elect to upgrade or change the voltage level of the PacifiCorp electric system serving the Facility Interconnection Customer. Costs for upgrading the Customer's facility are the responsibility of the Customer.
15. The customer shall control the electrical real (MW) and reactive (MVAr) power output such that it will not exceed the capacity of the interconnection facilities.
16. The Facility Interconnection Customer 's three-phase generation shall be connected to the PacifiCorp power system with three-phase automatic disconnecting devices (circuit breakers), which are intended to significantly

reduce the possibility of damaging the Facility Interconnection Customer 's generation equipment due to single-phase operation. These disconnecting devices shall be equipped with auxiliary contacts that indicate the actual status of the devices' main contacts.

17. A isolating device, typically a switch, must be installed to physically and visibly isolate the customer and PacifiCorp systems. The disconnect will serve as the point of change of ownership between the customer and PacifiCorp and will be labeled as such both on drawings and on-site signage. The disconnect shall be installed by the customer and shall be accessible to both PacifiCorp and the customer at all times with the ability to be padlocked open by either party. The disconnect shall be owned and operated by PacifiCorp to provide a visible air gap with clearances for adequate grounding, maintenance, and repairs of the PacifiCorp electric system. PacifiCorp may require the capability to apply safety grounds on the PacifiCorp side of the disconnect. The customer shall not remove any PacifiCorp padlocks or safety tags as per the Occupational Safety and Health Administration (OSHA) lockout/tagout requirements. In any case the device:

    - Must simultaneously open all phases (gang operated) to the interconnected facilities;
    - Must be accessible by PacifiCorp and must be under PacifiCorp Dispatcher jurisdiction;
    - Must be lockable in the open position by PacifiCorp;
    - Shall not be operated without advance notice to affected parties, unless an emergency condition requires that the device be opened to isolate the interconnected facilities; and
    - Must be suitable for safe operation under all foreseeable operating conditions.

    PacifiCorp personnel may lock the device in the open position and install safety grounds:

    - If it is necessary for the protection of maintenance personnel when working on de-energized circuits;
    - If the interconnected facilities or PacifiCorp equipment presents a hazardous condition;
    - If the interconnected facilities jeopardize the operation of the PacifiCorp Electric System.

18. System flows as a result of the interconnection shall not overload nor adversely impact PacifiCorp’s transmission system, nor neighboring transmission system. Where the Facility Interconnection Customer 's generation or transmission facilities supply fault currents to the PacifiCorp electric system in excess of breaker or other interrupting device maximum-rated interrupting capability, the customer shall be required to install and pay for fault-limiting equipment or pay for breaker or other interrupting-device replacements according to OATT requirements and procedures.

19. The harmonic content of the voltage and current wave forms of both the Facility Interconnection Customer 's and PacifiCorp's systems shall comply

with the latest version of the IEEE Standard 519, Recommended Practices and Requirements for Harmonic Control in Electric Power Systems.

20. Industry standard basic insulation level ratings shall be used for electric system additions and electric system interface equipment. The electric equipment shall meet IEEE C62.41 or C37.90.1, V&I Withstand Requirements.
21. The customer shall be capable of withstanding electromagnetic interference environments in accordance with ANSI/IEEE Standard C37.90.2. The interconnection system and protection system shall not mis-operate due to electromagnetic interference, including hand-held communication devices.
22. PacifiCorp may install disturbance-recording equipment at the system interface according to NERC, OATT, or regional requirements and procedures.
23. The interconnection design shall incorporate adequate facilities to enable the on-site generation to be synchronized with the PacifiCorp electric system. The customer shall be solely responsible for synchronizing the generator to the system. At PacifiCorp's discretion, all occurrences of synchronizing the generator to the system shall be preceded with advance notification of not less than one full clock hour to be provided to PacifiCorp's Portland or Salt Lake City dispatch centers.
24. All points at which the generator can be paralleled with the PacifiCorp electric distribution system must be clearly defined as synchronization points in the submittal documentation. A given installation may be designed such that there are several synchronization points.
25. For insulation and insulation coordination on transmission facilities 34.5 kV and above, PacifiCorp's Engineering Handbook, Section 1.B.7 shall govern facility design.
26. Determination of Equipment Rating: All series elements that together make up a line section or bulk power substation transformer circuit are reviewed to determine which facility has the most limiting rating. In the event that a line section or bulk power transformer terminates on a ring bus or a breaker-and-a-half, the facility rating will be determined assuming a closed ring bus or closed breaker-and-a-half. The most limiting facility rating of the entire ring bus or the most limiting facility rating of the breaker positions adjacent to the line section or bulk power transformer in a breaker-and-a-half scheme are considered in determining the rating of the line section or bulk power transformer. In order to account for the flow split when entering a closed-ring or a closed breaker-and-a-half, a multiplier is used to adjust the ratings of the ring bus or breaker-and-a-half facilities. The multiplier assumes a conservative split of 75/25 percent, meaning that 75 percent of the line section flow or bulk transformer flow is assumed to be transferred onto one leg of the ring bus or breaker-and-a-half. This means that an equivalent line section or bulk power transformer flow of 133 percent (100/75 percent) can be accommodated before exceeding the facility rating of the ring-bus limit or breaker-and-a-half limit. The most limiting series element facility rating, and where applicable, 133 percent of the most limiting ring-bus facility rating, or 133 percent of the most limiting facility rating of the adjacent breaker positions in a breaker-and-a-half is then used in the WECC model data

submittal and in operations of PacifiCorp's system. In cases where a facility is jointly owned, the operator of the facility determines the facility rating and shares this rating information with the other joint owners. In cases where a facility is owned in segments (such as a transmission line terminal being owned by one party and the transmission line itself owned by another party), PacifiCorp coordinates with the owners of the other segments of the facility to insure that the most limiting rating is used by all parties.

27. For further information on general technical requirements for facility interconnections, see the appendices at the end of this document.

4 METERING POLICY FOR FACILITY INTERCONNECTION CUSTOMERS

4.1 General

The purpose of this section is to assist the customer in accommodating PacifiCorp metering for the measurement of electricity supplied to the PacifiCorp transmission system. This section is applicable only to those providing power to the PacifiCorp transmission system. The general requirements are similar to, if not identical to, the general requirements for metering the supply of electrical service by PacifiCorp.

Usually, when a generator is installed with the intent of providing power to the PacifiCorp transmission system, electric service to the auxiliary load associated with the generator plant is also needed. As such, power may flow into or out of the plant at different times. Deliveries to and from the plant (bi-directional metering) must be separately recorded and treated as separate transactions under PacifiCorp's tariffs.

All meters and instrument transformers will be provided, installed, owned, and maintained by PacifiCorp at the Facility Interconnection Customer's expense. Unless other arrangements have been made, the customer will provide, install, own, and maintain all mounting structures, conduits, meter sockets, meter socket enclosures, metering transformer cabinets, and switchboard service sections of the size and type approved by PacifiCorp.

PacifiCorp will require Generation Interconnection Customer's with multiple generators to install revenue net metering at each generator, to satisfy that hourly revenue data will be available at all times to validate the official metering at the point of interconnection. This is to eliminate estimating data during periods when the official meteing is questioned or lost. Any net generation metering used for any PacifiCorp revenue purpose or data validation will be tested and maintained identically to the official interconnect revenue metering.

For larger wind farms with multiple collector stations, metering will be required on the high side of each step up transformer, as well as at the point of interconnection. The general requirements for the collector metering are the same as the requirements for revenue metering at the point of interconnection.

Metering will be programmed such that the generators are only charged for consuming VArs when the project is drawing MWs; i.e., not generating.

4.2 Basic Metering Requirements for Generators

4.2.1 Metering Requirements

The standard PacifiCorp meter used for all generation and transmission interchange projects is the Landis & Gyr, Maxsys 2510 meter. The meter will be programmed with a standardized PacifiCorp internal program that will include bidirectional kWh and kVArh energy and kW and kVAr sliding 15-minute demand quantities, with instantaneous MW MVAr data. The meters will be programmed to record 15-minute interval profile demand that includes bidirectional kWh and kVArh and per-phase volt-hour demand interval recording. Additional quantities can be added if necessary to the basic program.

Metering data collected will include working meter register reads, monthly register freeze reads, and 15-minute demand interval profile data. The meter will perform a self-freeze read at midnight each month. The meters shall be compatible with the PacifiCorp MV-90™ system and shall be interrogated daily or whenever necessary for maintenance purposes.

All meters will include both analog and digital output boards following current standard PacifiCorp specifications. The metering design will include a test switch with all data inputs and outputs terminated at a utility interposition block.

The final metering design requirements including hardware I/O and software specifications will be written into the specific project's scoping documentation. Requests from foreign utilities for digital or analog metering outputs must be made prior to final design. A second or backup meter will be added when needed or if there are additional metering outputs required beyond what is possible from the primary meter.

4.2.2 Meter Testing

PacifiCorp and the generation customer agree that a certification of the meter system accuracy be done at least biannually or as specifically agreed upon in the interchange agreement. PacifiCorp shall give all interested parties notification of at least two weeks for the impending test. A copy of the test results shall be available to all parties involved or on file for review.

4.3 Metering Installations ≥ 5 MW

PacifiCorp standard metering installation for 5 MW and above net generation facilities is required to be wye-connected on the high-voltage side of the step-up transformer. Primary and backup metering which will meter the net generation is required. Revenue metering must be installed at the physical point of interconnection with the PacifiCorp transmission system. If it is not possible to install metering at the physical point of interconnect, PacifiCorp will require that line losses be calculated. The calculated loss algorithm may be additive or subtractive depending upon current flow through the meter. The calculated loss algorithm will be programmed within the meter(s) firmware to adjust the registers, load profile, and any digital or analog outputs. PacifiCorp requires that any applicable line-loss compensation be performed in the meter, rather than calculated in the billing system.

4.3.1 Conduit for Revenue Metering Secondary Leads

For secondary metering leads between the connections at the meters and the instrument transformers located in the substation yard, the generation customer is to provide a minimum size of three-inch conduit. When the distance between the revenue instrument transformers and meter panel is greater than 250 feet, it may be necessary to increase the conduit size to accommodate paralleled CT metering secondaries to reduce the burden to the current transformers. PacifiCorp shall procure all conductors and the generation customer shall install meter-wiring cable from the transformers to the revenue metering panel located in the substation. The conduit shall be PVC, rigid steel, or IMC and must be installed with long-radius sweeps. The customer contractor is responsible for proper installation practices.

4.3.2 Indoor Panel Applications

When indoor panels are required to mount meters and metering hardware, PacifiCorp will specify, order, and install all revenue panels and accessories. The meter panels will be 12” wide by 90” high and shall require a clear work space 36” wide by 90” high by 48” deep in front and to the rear of the panel.

4.3.3 Outdoor Meter Enclosure Applications

When it is necessary to mount meters and metering hardware in outdoor locations, PacifiCorp will specify and order the metering box enclosure. The enclosure will be mounted and installed by the customer’s contractor. When outside meter enclosures are used they typically serve both as the junction box and meter socket enclosure. The meter enclosure box will be NEMA 3R-rated, and shall have sealing provisions.

4.3.4 Sealable Junction Box

The junction box provides a means of terminating the revenue metering service conductors within the substation yard for indoor panel applications. The use of this junction box shall be coordinated with PacifiCorp prior to installation. The junction box will be NEMA 3R-rated, and shall have sealing provisions.

4.3.5 Secondary Leads and Termination

The secondary circuits must be designed such that the maximum possible burden on any transformer will not exceed its rating. All metering secondary leads or cable will be provided by PacifiCorp. The secondary leads will conform to PacifiCorp standards and color-code requirements. Wire terminations may be done by manufacturer or contractor, but all will be inspected and approved by PacifiCorp.

4.3.6 Metering Bypass Switch

When applicable, the requirements for metering bypass switches will be provided by PacifiCorp to the customer. The generation customer shall purchase, install, and own switches which will isolate and bypass the metering transformers when necessary to allow for maintenance.

4.3.7 Primary Metering Structures

The high-side primary metering structure must be designed to accommodate the standard PacifiCorp wye-connected instrument transformers. The physical location will be determined during the design phase of the project. When requested by the customer, PacifiCorp will supply outside parties with design details of the standard metering system.

4.3.7.1 Metering Disconnects

High-side metering shall have a minimum of two gang-operated, lockable disconnect devices to facilitate establishing a visual open(s). Disconnect devices are necessary at the following locations:

1. At the point of interconnection with PacifiCorp (this switch is PacifiCorp-operated).

2. Between the generator side of PacifiCorp's metering and the Facility Interconnection Customer Facility Interconnection Customer's electrical facility (this switch is owned and operated by the Facility Interconnection Customer Facility Interconnection Customer).

3. If the generator is selling power to PacifiCorp on a surplus-sale basis, a separate disconnect device (generator or host-site owned and operated) is required on the metering side of the load. Refer to Figure 1 for typical interconnections. Distribution pole-top metering requires only one switch located on the load side of the metering.

4.4 Metering Installations < 5 MW

For 46 kV and above and the total net generation output is less than 5 MW, it is acceptable for the revenue metering to be located on the low side of the step-up transformer. All low side metering must be wye-connected and installed on the unregulated side of the voltage regulator. For this application the metering installation is normally inside the customer facility and PacifiCorp-approved metering enclosures are required. Instrument transformers shall be located inside an approved PacifiCorp metering enclosure. It is not acceptable for meters, metering transformers, and accessories to be located on outside structures.

4.4.1 Metering Enclosures > 600 volts for Underground and Overhead Applications

To meter medium-voltage interchange services, customers shall meet the requirements of the Electric Utility Service Equipment Requirements Code, EUSERC Section 400. The customer shall provide all necessary hardware per EUSERC Section 400. A clear work space 78" high by 36" wide by 48" deep in front of distribution metering equipment (per current NEC regulations) is required. A concrete mounting pad is required for the switchgear metering enclosure. The mounting pad shall be a minimum of 4" thick. The metering instrument transformers will be specified by PacifiCorp and shall be provided and installed by the manufacturer of the switchgear. The meter, test switch, and any specialized hardware will be specified, ordered, and installed by PacifiCorp.

4.4.2 Overhead Pole-Mounted Metering

Pole-mounted metering would be unusual inside a generation substation facility. To establish a mutually suitable location for pole-mounted metering, the customer shall consult with PacifiCorp before construction begins.

4.4.3 Metering < 600 volts

The service and metering installation requirements for all installations shall conform to the applicable standards of PacifiCorp's *Six State Electric Service Requirements*. Generation metering requirements for secondary below 600 volts, self-contained and instrument-rated metering are the same as commercial installations.

4.5 Metering for Station-Service Power

Depending upon the generation facility's electrical sources, the station service power for connecting substation facilities may also require revenue metering. The same metering requirements as generation meters apply to station-service metering.

4.6 Meter Communication Requirements

All generation metering will require a dedicated voice grade data phone line for use with the PacifiCorp MV-90 meter data collection system. It will be the responsibility of the generation customer to supply both the land line and any communication protection devices necessary for PacifiCorp to remotely interrogate the meter through a dial-up connection.

The following sections describe the detailed requirements for metering electricity supplied by generators connected to the PacifiCorp system:

Surplus-Sale Operation Co-Generation: Meters shall be required to measure both the net generator output and the surplus generation delivered to the PacifiCorp system.

Net-Sale Operation: Meters shall be required at the point of interconnection.

No-Sale Operation: Revenue metering will not be required for the measurement of power delivered into the PacifiCorp system, except that load profile and net generator profile metering may be required for standby service. The existing service metering shall be replaced with metering equipped with multiple register to separately measure all required quantities.

Wheeling Service: Wheeling service under certain existing agreements on the PacifiCorp system require two sets of revenue-metering equipment which may be totalized to accommodate various line and switch configurations. Import metering is required to the point of import (received) to (on) the PacifiCorp system. Export metering is required at the point of export (delivery) from (off) the PacifiCorp system.

Where non-utility generators (i.e., emergency generators, peak-shaving generators, etc.) or portable plug-ins (generators not permanently wired to the outlet) are connected via an electrical outlet or automatically connected via an automatic transfer switch, a visible disconnect shall be required. A visible disconnect can be a disconnect knife switch or a combination of a manual disconnect circuit breaker, built-in switch, and red light indicators. The disconnect shall be visible at all times, and shall have one red light bulb per conductor indicating energized/de-energized conditions of the utility and generator source conductors on the line side of the main disconnect or circuit breaker.

All generators must meet applicable standards of the Western Electric Coordinating Council (WECC).

4.7 Instrument Transformers ≥ 5 MW

Voltage and current instrument transformers are required to be a wye-connected, wire-wound, extended-range type with 0.15 percent metering accuracy class. The instrument transformers will maintain their accuracy ranging from 1 amp to 4,000 amps Type-1 class and from 0.25 amps to 750 amps Type-3 primary current. The accuracy class addresses both ratio error and phase-angle error over the burden range of the installed metering circuit. Instrument transformers shall be stand alone, located on the line at the delivery point such that the metering is not interrupted during possible switching configurations at the delivery point unless the metering is being removed for service. Paralleling CTs and internal CTs located inside breakers and power transformers for the purpose of revenue metering will not be permitted.

4.8 Instrument Transformers < 5 MW

For low-side metering exceptions, it is not required for the metering transformer's accuracy to be extended-range. Voltage and current instrument transformers are required to be 0.3 percent standard metering accuracy class for both ratio error and phas- angle error over the burden range of the installed metering circuit. Instrument transformers shall be an approved PacifiCorp design and shall be located within the metering switchboard or switchgear enclosures.

4.9 Instrument Transformer Verification

At least once during the life of the transformer, a documented verification of instrument transformer ratios shall be performed. This requires measurement of primary current simultaneously with secondary current to determine actual ratio to within 10 percent of marked nameplate ratio. Transformer turns ratio (TTR) on voltage transformers or CT tester check shall substitute if in-service primary measuring equipment is unavailable. The objective is to ensure that the instrument transformer ratios are documented and are connected to known taps under known burden conditions. This test shall be performed during a scheduled bi-annual test (if there is no record of a verification being performed) and when instrument transformers are replaced.

4.10 Telemetering Requirements for Generator Monitoring

4.10.1 For New Generation Facilities ≥ 3 MW

For generating facilities totaling 3 MW or greater, the following real-time data is to be telemetered to PacifiCorp's Control Center for each generating unit (both wind and non-wind units):

- kW
- kVAr
- kWh
- generator terminal voltage (kV)

A generator equipped with a voltage regulator and power system stabilizer (PSS) must also provide telemetry indicating the status of both the regulator and the PSS. In addition, transmission kW, kVAr, kV, and breaker status may be required, depending on the number of generators and transmission configurations. A telemetering circuit to the designated PacifiCorp Control Center is also required. A minimum number of alarms to be transmitted include the following:

- breaker trip
- transfer trip receive
- channel/equipment failure

Unless other arrangements are made, the customer must provide communication lines with the following minimum specifications: VG36, Class B, Type-3, 4-wire, full-duplex (1200 baud).

Telemetering equipment (usually a dual-ported RTU) shall be located in the metering enclosure. At the entity's expense, PacifiCorp will supply telemetering equipment at the Facility Interconnection Customer Facility Interconnection Customer 's site, at PacifiCorp's Control Center and at a designated PacifiCorp Alternate Control Center.

5 TELECOMMUNICATION REQUIREMENTS FOR FACILITY INTERCONNECTION

5.1 Application

Before a new facility is interconnected to the PacifiCorp power system, PacifiCorp will specify the metering, protection, supervisory control and data acquisition (SCADA), telemetering, and telecommunications channels required. Due to the highly specialized and critical nature of the protection, metering, SCADA, and telemetering equipment, PacifiCorp requires that all such equipment be owned, installed, and maintained by PacifiCorp at the generation facility's expense. Also, due to the critical protection requirements for the interconnection of the generation facility to PacifiCorp's system as well as the varied PacifiCorp internal telecommunications systems which may be available for the specific generation facility, the telecommunication channels described below must be defined on a case-by-case basis.

5.2 General Requirements

The interconnection facility customer will be responsible for acquiring the communication lines from the local telephone company or multiple telephone companies as required to meet the telecommunications required of the new generation facility with the exception that if tele-protected (requires communications channel) relay channels are required, PacifiCorp will provide them at the cost of the generation facility. Due to the critical nature of the protection, metering, SCADA, and telemetering requirements, PacifiCorp will define the technical requirements and may provide, at its option, all or portions of the telecommunication channels on its existing internal telecommunication network at the cost of the generation facility.

5.3 Telecommunication Circuit Requirements

5.3.1 New Generation Facilities < 3 MW with No Teleprotection Requirement

5.3.1.1 Remote Metering Business Telephone Line

A business telephone line at the location of the interconnect point metering equipment is required for remote revenue-metering reading and maintenance work.

5.3.2 New Generation Facilities ≥ 3 MW or New Generation Facilities < 3 MW with Teleprotection Requirement

5.3.2.1 Remote Metering Business Telephone Line

A business telephone line is required at the location of the interconnect point metering equipment for remote revenue-metering reading. The generation entity must provide land-line telephone access, if possible. If local telco facilities are not available, other options for providing dial-up access to the meter will be considered.

5.3.2.2 Dispatch Business Telephone Line

A business telephone line is required so operating instructions from PacifiCorp can be given to the designated operator of the generation facility equipment. Unless other arrangements are made to use PacifiCorp's existing telecommunications network, the generation entity must provide a local telephone.

5.3.2.3 Protective Relay Remote Access Business Telephone Line

A business telephone line is required at the location of the protective relay equipment for remote maintenance of the protective relay equipment. Unless other arrangements are made to use PacifiCorp's existing telecommunications network, the generation entity must provide a local telephone.

5.3.2.4 Protective Relays

PacifiCorp will determine if non-pilot protective relays will be adequate for emergency tripping of the generation facility and/or protection of the distribution or transmission system or if tele-protected-type protection equipment is required. PacifiCorp will design and provide telecommunications channels suitable for the protective relay package required at the cost of the generation facility. Local telephone company leased lines are not acceptable for protective relay channels. Telecommunication channels for protective relay equipment may consist of fiber optic system, power line carrier, microwave radio, or a combination of these systems.

5.3.2.5 SCADA Remote Terminal Unit (RTU)

Real-time data and/or control via a SCADA RTU is be communicated to PacifiCorp's Control Center. Unless other arrangements are made to use PacifiCorp's existing telecommunications network, the generation entity must provide a local telephone company VG36, Class B, Type-3, 4-wire, full-duplex communication line from the generation facility to PacifiCorp's Control Center. PacifiCorp will specify the location where the communication line will terminate. Telecommunication channels for SCADA RTU equipment, when using PacifiCorp's telecommunications network, may consist of fiber optic system, microwave radio, other radio system, or a combination of these systems.

5.3.2.6 Analog Telemetering

Analog telemetering of the total generation facility's kW output to one of PacifiCorp's alternate control sites (Medford, Oregon; Yakima, Washington; Goshen, Idaho; or Sigurd, Utah) is required as an interim solution per NERC Standard EOP-008-0, *Plans for Loss of Control Center Functionality*. Unless other arrangements are made to use PacifiCorp's existing telecommunications network, the generation entity must provide a local telephone company VG36, Class-B, Type-3, 2-wire, communication line from the generation facility to PacifiCorp's alternate control site. PacifiCorp will specify the location of the closest alternate control site where the communication line will terminate. Telecommunications channel for analog telemetering equipment, when using PacifiCorp's telecommunications network, may consist of fiber optic cable, power line carrier, microwave radio, or a combination of these systems. The analog telemetering channel may use the same telecommunications system as the SCADA RTU channel providing it is not routed through PacifiCorp's Control Centers.

5.4 Telephone Company Line Treatment Equipment

Proper cable and protection equipment may be required at substations and other high-voltage electric facilities for expected ground potential rise (GPR). The GPR testing required to determine the required telephone line protection may be performed by

PacifiCorp at the cost of the generation facility or may be performed by generation facility itself. The calculated GPR value will determine what grade of telephone cable high-voltage protection equipment is required, as well as the distance from the facility at which the telco pedestal will be located. The local telephone company must be informed in advance (up to six months) so outside plant facilities can be engineered to serve the generation facility location. Some independent telephone companies are not tariffed to provide protection equipment. In this case, the generation facility will be required to purchase and install the necessary telephone line protection equipment.

5.5 Communication Operating Conditions

5.5.1 Normal Operating Conditions

The customer shall provide to PacifiCorp the information necessary to communicate with the equipment and/or personnel at the generation facility during routine operating conditions. This information shall be updated as soon as a material change becomes available for use by notifying PacifiCorp's grid operations centers in either Salt Lake City, Utah or Portland, Oregon, depending on the facility's operating area.

5.5.2 Emergency Operating Conditions

The Facility Interconnection Customer shall provide to PacifiCorp the information necessary to communicate with the equipment and/or personnel at the generation facility during the loss of the primary communication medium. This would be considered the emergency operating condition. This information is also to be updated as soon as a material change becomes available for use by notifying PacifiCorp's grid operations centers in either Salt Lake City, Utah or Portland, Oregon, depending on the facility's operating area.

6 PROTECTION AND CONTROL POLICY

This section specifies the protective and control requirements for Facility Interconnection Customers to PacifiCorp's transmission system.

6.1 Applicability

The applicable protective standards of this section apply to all facilities interconnecting to any portion of PacifiCorp's transmission system. These policies, which govern the design, construction, inspection, and testing of protective devices, have been developed by PacifiCorp to be consistent with applicable reliability criteria.

6.2 Protective Requirements

An important objective in the interconnection of facilities to PacifiCorp's system is minimizing the potential hazard to life and property. A primary safety requirement is the ability to disconnect immediately when a fault is detected. Facility developers desiring interconnection with PacifiCorp's transmission system must comply with all applicable jurisdictional state regulatory agency rules in this regard.

The protection equipment for an interconnection facility must protect against faults within that facility and faults on the PacifiCorp system. As a general rule, an interconnection facility must also trip off-line (disconnect from the PacifiCorp system automatically) when PacifiCorp's transmission system is disconnected from the line into which the facility is connected.

In view of these objectives, PacifiCorp requires line-protective equipment to either 1) automatically clear a fault and restore power, or 2) isolate only the faulted section.

Due to the high-energy capacity of the PacifiCorp transmission system, high-speed fault clearing may be required to minimize equipment damage and potential impact to system stability. The requirement of high-speed fault clearing will be determined by PacifiCorp on a case-by-case basis. To achieve these results, relays and protective devices are needed. The requirements are outlined in the following pages. Some protection requirements can be standardized, however most line relaying depends on generator size and type, number of generators, line characteristics (i.e., voltage, impedance, and ampacity), and the existing protection equipment connected to the PacifiCorp system.

PacifiCorp's minimum protection requirements are designed and intended to protect PacifiCorp's system only. As a general rule, neither party should depend on the other for the protection of its own equipment. Interconnected Facilities are required to provide their own high side protection for their facilities. Additional protective relays are typically needed to protect the Interconnection Customer 's facility adequately. It is the Facility Interconnection Customer 's responsibility to protect their own system and equipment. PacifiCorp insists that the entity hire a qualified electrical engineer (with a PE license in electrical engineering) to review and stamp the electrical design of the proposed generation facility and ensure that it will be adequately protected.

The Facility Interconnection Customer must provide PacifiCorp test reports for all relays before PacifiCorp will allow the facility to parallel. Refer to Section 10.2 for information regarding pre-parallel inspections. Every four years thereafter, the Facility Interconnection Customer must test relays and provide written proof of the testing, that the relays are operable and within calibration. PacifiCorp will not test the entity's equipment, but may witness the testing performed by a qualified testing firm retained by the entity. The testing firm will be approved by PacifiCorp prior to the actual test. On-site power (typically 120 V) is required for the test equipment. Circuit breakers must be tested at least every eight years after the pre-parallel inspection. It is also in the Facility Interconnection Customer 's best interest to make sure all of its protective equipment is operating properly, since significant equipment damage and liability can result from failures of the entity's protective equipment. The Facility Interconnection Customer shall report relay problems to PacifiCorp and shall resolve problems in a reasonable time (within one year at a minimum). If this places PacifiCorp or the Facility Interconnection Customer in a compromised position of liability, the generation shall be disconnected until the relay issue(s) is/are resolved to PacifiCorp's satisfaction.

6.3 Reliability and Redundancy

The Facility Interconnection Customer shall design the protection system with sufficient redundancy or relay coordination such that the failure of any one component will still permit the Facility Interconnection Customer's facility to be isolated from the PacifiCorp system under a fault condition. Multi-function three-phase protective relays must have redundant relay(s) for back up unless otherwise agreed to by PacifiCorp. The required breakers must be trip-tested by the Facility Interconnection Customer at least once a year.

6.4 Relay Elements

The following is a description of the relay elements shown in Figure 1.

21 – Distance relay is a relay that functions when the circuit admittance, impedance, or reactance increases or decreases beyond a predetermined value. This type of relay may be required when the Generation Entity is connecting two (2) or more generators to The PacifiCorp power system. This determination is made during the System Impact Study and is based on minimum peak loading of the feeder tow which the Generator Entity will connect.

27 – Undervoltage relay is a relay that operates when its input voltage is less than a predetermined value. PacifiCorp requires three (3) undervoltage elements with time delay. Settings will be determined during the System Impact Study.

50P – Phase instantaneous overcurrent relay is a relay that functions instantaneously on an excessive value of phase current. The requirement for this element is based on minimum peak loading of the feeder tow which the Generator Entity will connect.

59N – 3V0 overvoltage relay is a relay that functions instantaneously on an excessive value of 3V0 voltage. This element utilizes the second coil of the potential transformer wired in a broken delta. Settings will be determined during the System Impact Study.

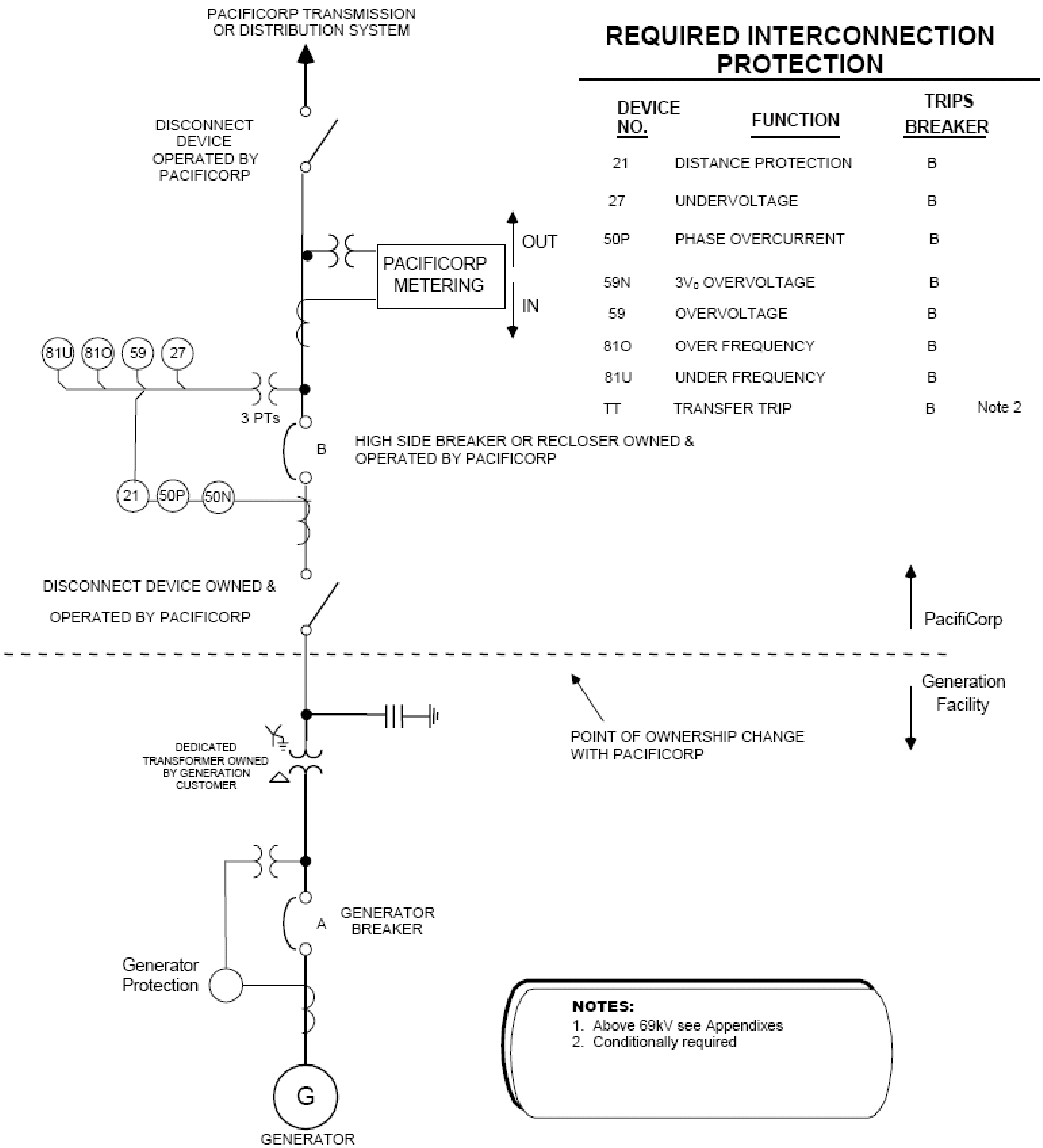
59 – Overvoltage relay is a relay that operates when its input voltage is higher than a predetermined value. This element is utilizes a current transformer between the transformer and the high side breaker. Settings will be determined during the System Impact Study.

81O – Overfrequency relay is a relay that responds to the frequency of an electrical quantity, operating when the frequency or rate of change of frequency exceeds a predetermined value. PacifiCorp requires three (3) overfrequency elements with time delay. Settings will be determined during the System Impact Study and are based on radial or non-radial connections.

81U – Underfrequency relay is a relay that responds to the frequency of an electrical quantity, operating when the frequency or rate of change of frequency is less than a predetermined value. PacifiCorp requires three (3) underfrequency elements with time delay. Settings will be determined during the System Impact Study and are based on radial or non-radial connections.

TT – Transfer Trip is a scheme that operates based on a remote signal. Transfer trip could utilize, fiber, leased line, microwave, etc. as determined by PacifiCorp. Transfer trip may be required depending on PacifiCorp circuit configuration and loading, as determined by PacifiCorp. Typically, transfer trip shall be required if PacifiCorp determines that a generation facility cannot detect and trip on PacifiCorp end-of-line faults within an acceptable time frame or if the generation facility may be capable of keeping a PacifiCorp line energized with the PacifiCorp source disconnected. It may be in the generation facility's best interest to purchase relays capable of communications in the event transfer trip is later required.

Figure 1–Typical Interconnection for Protection and Metering Installation 69 kV and Below



REQUIRED INTERCONNECTION PROTECTION

DEVICE NO.	FUNCTION	TRIPS BREAKER	
21	DISTANCE PROTECTION	B	
27	UNDERVOLTAGE	B	
50P	PHASE OVERCURRENT	B	
59N	$3V_0$ OVERVOLTAGE	B	
59	OVERVOLTAGE	B	
81O	OVER FREQUENCY	B	
81U	UNDER FREQUENCY	B	
TT	TRANSFER TRIP	B	Note 2

6.5 Approved Vendors

PacifiCorp is familiar with all major utility-grade relay manufacturers. Below is a sample list of major vendors; it is not intended to be an exhaustive listing.

- ABB
- Areva
- Beckwith
- Basler
- Cooper
- GE
- Schweitzer
- Siemens

PacifiCorp will accept any utility-grade relay or combination of relays from this list provided that all required relay elements are fulfilled. All relays must be utility-grade, no other grade will be acceptable.

PacifiCorp approval does not indicate the quality or reliability of a product or service, and no endorsements or warranties shall be implied.

6.6 Line Protection

Many factors are considered when determining the protective relaying requirements needed by Facility Interconnection Customer to protect PacifiCorp facilities and customers' equipment. Some of these factors are: the zone of protection, location of connection to PacifiCorp system, location of customers relative to the location of connection, and type of protection system used on the PacifiCorp transmission system.

The zone of protection refers to the area in PacifiCorp's system where the Facility Interconnection Customer's facility must provide fault protection. When a fault occurs, the Facility Interconnection Customer's protective relays are to cause the isolation of the Facility Interconnection Customer's facilities from PacifiCorp's or the Facility Interconnection Customer's system. If there are any PacifiCorp customers connected to the system in the zone of protection, the protection system is designed so that the service to those customers is not diminished by the addition of the Facility Interconnection Customer's facilities. This includes the amount of delay in automatic testing of the zone of protection by PacifiCorp's equipment following a fault.

There are many options for providing the protective relay system for the zone of protection. These options will affect the up-front cost and the reliability of the Facility Interconnection Customer's facilities. The use of pilot relaying or direct transfer trip communication may increase the cost to the Facility Interconnection Customer, but the use of these systems will limit the number of times the facility is forced offline to protect PacifiCorp's system. This is especially true when a PacifiCorp customer is connected to the system in the zone of protection. The protective relays at the Facility Interconnection Customer's facility will need to be set to detect any fault in the zone of protection and isolate the Facility Interconnection Customer's generator from PacifiCorp's system with no delay. Since the protective relays cannot be set to detect 100 percent of the faults without detecting and operating for faults outside the zone of protection, the Customer's interconnection facilities will be disconnected for fault conditions that normally would not require isolation of the facilities. With the use of a pilot relaying system or direct transfer trip, the number of these unnecessary operations can be greatly reduced. In addition, line-protection relays must coordinate with the protective relays at the PacifiCorp breakers for the line on which the generating facility is connected. The typical protective zone is a two-terminal line section with a breaker on each end. In the simplest case of a load on a radial line, current can flow in one direction only, so protective relays need to be coordinated in one direction and do not need directional elements. However, on the typical transmission system, where current may flow in either direction depending on system conditions, relays must be directional. Also, the complexity and the required number of protective devices increase dramatically with increases in the number of terminals in each protective zone. With two terminals in a protective zone, there are two paths of current flow. With three terminals there are six paths of current flow, and so on. Coordinating a multi-terminal scheme may sometimes require installation of a transmission line protective relay at the Facility Interconnection Customer 's sub-site. This is commonly the case whenever three-terminal permissive overreach transfer trip (POTT) schemes are employed to protect the line. Because this line relay participates in a scheme to protect the PacifiCorp transmission system, PacifiCorp must ensure the maintenance, testing, and reliability of this particular type of relay.

In addition, the breaker's relays must be set to have overlapping zones of protection in case a breaker within any given zone fails to clear. The line protection schemes must be able to distinguish between generation, inrush, and fault currents. Multiple terminal lines become even more complex to protect. Existing relay schemes may have to be reset, replaced, or augmented with additional relays at the Facility Interconnection Customer 's expense to coordinate with the Facility Interconnection Customer 's new facility.

The PacifiCorp-required relays must be located so that a fault in the zone of protection on any phase of the PacifiCorp line shall be detected. If transfer trip protection is required by PacifiCorp, the Facility Interconnection Customer shall provide at its expense a voice-grade communications circuit. This circuit may be a communication line from the telephone company or a dedicated cable. The line must have high-voltage protection equipment on the entrance cable so the transfer trip equipment will operate properly during fault conditions.

The PacifiCorp transmission system is designed for high reliability via multiple sources and paths to supply customers. Due to the multiple sources and paths, more complex protection schemes are required to properly detect and isolate faults. The addition of any new generation facility to the PacifiCorp system must not degrade the existing protection and control schemes or cause existing PacifiCorp customers to suffer lower levels of safety and/or reliability.

Table 1 lists the minimum protection that PacifiCorp typically uses on its own installations. Higher voltage interconnections require additional protection due to the greater potential for adverse impact to system stability, and the greater number of customers who would be affected. Special cases such as distribution-level network interconnections, if acceptable, may have additional requirements. The acceptability and additional requirements of these interconnection proposals shall be determined by PacifiCorp on a case-by-case basis.

6.7 PacifiCorp Protection and Control System Changes

PacifiCorp will perform a detailed interconnection study to identify the cost of any required modifications to PacifiCorp's protection and control systems are required to interconnect a new facility. These protection and control system modifications are in addition to any transmission and distribution system upgrades identified in the system impact or facilities studies for interconnection of the new facilities.

The following is a partial list of protection system modifications which may be required:

1. PacifiCorp's automatic restoration equipment shall be prevented from operating until the generator is below 25 percent of nominal voltage as measured at the restoration equipment. Generator damage and system disturbances may result from the restoration of power by automatically re-energizing PacifiCorp's facilities. This modification shall be required when the generator(s) has the capability of energizing a line when the PacifiCorp system is disconnected. PacifiCorp will not allow the Facility Interconnection Customer Facility Interconnection Customer 's generator(s) to automatically re-energize PacifiCorp facilities.
2. For generation facilities greater than 1,000 kW aggregate nameplate rating, all existing single-phase fault-interrupting devices (fuses) located in series between the generator and PacifiCorp's substation shall be replaced with three-phase interrupting device to prevent possible single-phasing of other customers.
3. The PacifiCorp substation transformer high-side fuses must be replaced with a three-phase interrupting device when the generator is on a distribution circuit fed from a fused PacifiCorp substation transformer bank and the bank's minimum load is equal to or less than 200 percent of the generator's nameplate rating.
4. A transfer trip scheme from the high-side circuit breaker/circuit switcher to the generator shall be installed if necessitated by PacifiCorp. An associated alarm circuit is required between the Facility Interconnection Customer Facility Interconnection Customer 's site and the PacifiCorp Control Center.

6.8 Warning Label for Protective Relays

A warning label shall be affixed within 6 inches of any relay in the Facility Interconnection Customer’s control house (or similiar enclosure containing protective relays) **which affects the operation of PacifiCorp's electrical circuits**. The warning label shall state the following:

> ***Warning !!!*** *Do not alter or change any settings on this relay without first receiving approval from PacifiCorp's Protection and Control Engineering Dept. in Portland, Oregon. Failure to give notification to PacifiCorp of this action may result in damaged or destroyed electrical equipment, possible physical injury or fatality, facility disconnection, and/or legal action.*

Table 1–Line Protection Devices

Line Protection Device	Device[1] Number	34.5kV or less	46kV, 57kV or 69kV	115kV	230kV & above
Phase Overcurrent (Radial systems)	50/51	X	X		
Ground Overcurrent (Radial systems)	50/51N	X	X		
Phase Directional Overcurrent	67		X	X	
Ground Directional Overcurrent or Transformer Neutral	67N 50/51N		X	X	X
Distance Relay Zone I	21ZI		X[2]	X	X
Distance Relay Zone 2	21Z2		X[2]	X[2]	X
Distance Relay Carrier	21Z2C			X[2]	X
Ground Directional Overcurrent Carrier	67NC			X[2]	X
Pilot Wire	87L			X[2]	X
Permissive Overreaching Transfer Trip (POTI) or Hybrid	21/67T			X[2]	X
Direct Transfer Trip	TT	X[3]		X[3]	X[3]

Notes:
1. Refer to Section 6.4 for device number definitions and functions.
2. May be required on transmission or distribution interconnections depending on local circuit configurations, as determined by PacifiCorp.
3. Transfer trip may be required on transmission- level or distribution- level interconnections depending on PacifiCorp circuit configuration and loading, as determined by PacifiCorp. Typically, transfer trip shall be required if PacifiCorp determines that a generation facility cannot detect and trip on PacifiCorp end-of-line faults within an acceptable time frame or if the generation facility may be capable of keeping a PacifiCorp line energized with the PacifiCorp source disconnected (Appendix F).

6.9 Manual Disconnect Switch Requirements

A manual load-break disconnect switch is required for all interconnected facilities. For connections to the PacifiCorp transmission grid, a tap line switch may also be required if, in PacifiCorp's judgment, sufficient tap line exposure exists to warrant it. Refer to Appendix D for more details on tap line switches. For transmission line taps, two additional line switches, one on each side of the tap, are required to provide the facility better service and operating flexibility. Note that the installation of line switches may impact the protection requirements for the interconnection, specifically the need for direct transfer trip.

A PacifiCorp-operated disconnect device must be provided as a means of electrically isolating the PacifiCorp transmission system from the interconnected facilities. This device shall be used to establish visually-open working clearance for maintenance and repair work in accordance with PacifiCorp safety rules and practices. A disconnect device must be located at the point of interconnection with PacifiCorp. PacifiCorp shall own, operate, and maintain all disconnect switches for generation interconnection facilities. The disconnect switch shall be specified by the appropriate PacifiCorp engineers working on the interconnection project and shall come from PacifiCorp stock and be installed on PacifiCorp-owned facilities. PacifiCorp will notify the Facility

Interconnection Customer in advance of the operation of the disconnect switch and follow all work practices associated with this procedure. In the event of an urgent incident or emergency, PacifiCorp may not be able to notify the developer in a timely fashion that it intends to operate a switch. Any deviation from this policy shall be signed off by a Vice-President of Engineering at PacifiCorp along with corporate legal counsel and shall be included in the interconnection agreement between PacifiCorp and the generator developer with an explanation of why this policy was not followed for the specific project.

For cases in which the state or federal regulatory policy conflicts with PacifiCorp's policy, the state and federal regulatory policy shall prevail.

The developer may at its option install other disconnect switch(es) on its property to operate as its sees fit. PacifiCorp asks that the developer notify a PacifiCorp dispatch center before operation of their disconnect switch(es).

PacifiCorp personnel shall inspect and approve the installation before parallel operation is permitted. If the disconnect device is in the Facility Interconnection Customer Facility Interconnection Customer 's substation, it should be located on the substation dead-end structure and must have a PacifiCorp-approved operating platform.

The disconnect device must not be used to make or break parallels between the PacifiCorp system and the generator(s). The device enclosure and operating handle (when present) shall be kept locked at all times with PacifiCorp padlocks.

The disconnect device shall be physically located for ease of access and visibility to PacifiCorp personnel. When installed on the Facility Interconnection Customer 's side of the interconnection, the device shall normally be installed close (within one foot) to the metering. The PacifiCorp-operated disconnect shall be identified with a PacifiCorp-designated switch number plate.

For transmission voltage interconnections, metering is normally on the high side of the Facility Interconnection Customer 's step-up transformers. Between the metering units and the circuit breaker, a second disconnect device is required; it shall not have a PacifiCorp lock and may be operated by the Facility Interconnection Customer.

Notes:

1. Disconnect switches must be rated for the voltage and current requirements of the particular installation.
2. Disconnect switches must be gang-operated unless otherwise agreed to by PacifiCorp.
3. Disconnect switches must be weatherproof or designed to withstand exposure to weather.
4. Disconnect switches must be lockable in both the open/closed positions with a standard PacifiCorp lock unless otherwise agreed to by PacfiCorp.

6.9.1 High-Voltage Disconnects

The Facility Interconnection Customer shall submit a proposed switch specification to PacifiCorp. It shall be reviewed and approved in writting by a PacifiCorp engineering manager prior to its purchase and installation.

6.9.2 Conditions for Manual Disconnection

Producers must discontinue parallel operation when requested by PacifiCorp under the following conditions:

1. To facilitate maintenance, test, or repair of PacifiCorp's facilities. PacifiCorp will coordinate this with each producer.
2. During system emergencies.
3. When a generator is interfering with other PacifiCorp customers or producers on the system.
4. When inspection of a generator reveals either a condition hazardous to PacifiCorp's system or personnel or a lack of scheduled maintenance or maintenance records for equipment necessary to protect PacifiCorp's system.

6.10 Fault-Interrupting Devices

The fault-interrupting device selected by the Facility Interconnection Customer must be reviewed and approved by PacifiCorp for each particular application.

There are three basic types of fault-interrupting devices:

- Circuit Breakers
- Circuit Switchers
- Fuses

PacifiCorp will determine the type of fault-interrupting device required for a generation facility based on the size and type of generation, the available fault duty, the local circuit configuration, and the existing PacifiCorp protection equipment.

6.10.1 Circuit Breakers

Three-phase circuit breaker(s) at the point of interconnection automatically separate the facility from the PacifiCorp system upon detection of a circuit fault. Additional breakers and protective relays may be installed in the generation facility for ease in operating and protecting the facility. The interconnection breakers must have sufficient capacity to interrupt maximum available fault current at its location and shall be equipped with accessories to:

1. Trip the breaker with an external trip signal supplied through a battery (shunt trip).
2. Telemeter the breaker status when it is required.
3. Lockout if operated by protective relays required for interconnection.

Generally, a three-phase circuit breaker is the required fault interruption device at the point of interconnection, due to its simultaneous three-phase operation and ability to coordinate with PacifiCorp line-side devices. However, fuses are allowed as high-side protection for the dedicated transformer at generation facilities of less than 1,000 kW connected on the distribution-level system, provided that coordination can be obtained with existing PacifiCorp phase and ground protection. If fuses are used, the Facility Interconnection Customer should consider installing a negative sequence relay and/or other devices to protect the facility against single phase conditions. If fuses are used for high-side transformer protection, a separate generator breaker will be required to isolate the generator from the PacifiCorp system under a fault or abnormal system conditions.

6.10.2 Circuit Switchers

A circuit switcher is a three-phase fault-interrupter with limited fault interrupting capability. These devices have typically been used at voltages of 115 kV and below and may substitute for circuit breakers when the fault duty is within the interrupting rating of the circuit switcher. With PacifiCorp approval, some circuit switchers with blades can double as the visual open disconnect switch between the metering transformers and the main transformer. Since circuit switchers do not have integral current transformers, they must be installed within 30 feet of the associated current transformers to minimize the length of the unprotected line/bus section.

6.10.2.1 Fuses

Fuses are single-phase, direct-acting sacrificial links that melt to interrupt fault current and protect the equipment. Blown fuses need to be replaced manually after each fault before the facility can return to service. Overhead primary fuses shall be replaced by trained personnel. Since fuses are single phase devices, they may not all melt during a fault, and may not automatically separate the generation facility from PacifiCorp. Fuses cannot be operated by the protective relays, hence they cannot be used as the primary protection for three-phase generation facilities. However, they may be used for high-side transformer protection for generation less than 1,000 kW, provided coordination can be obtained with the existing PacifiCorp phase and ground protection, and if a separate breaker provides the required primary protection. Fuses are not permitted for high side transformer protection for facilities of 1,000 kW or greater.

Large primary fuses which do not coordinate with the PacifiCorp substation breaker ground relays shall not be allowed. Such use could cause all the customers on the circuit to lose power due to a fault inside the generating facility.

7 GENERATOR PROTECTION AND CONTROL

Single-phase generators must be connected in multiple units so that an equal amount of generation capacity is applied to each phase of a three-phase circuit.

All synchronous, induction, and single-phase generators shall comply with the latest ANSI Standards C50.10 and C50.13, dealing with waveform and telephone interference.

Synchronous generators of any size require: a) synchronizing relays (Device No.25) to supervise generator breaker closing, and b) reclose blocking at the PacifiCorp side of the line to which the generator is connected (applies to substation breaker/recloser). Standard device numbers for commonly used protective elements are defined in Table 3. Direct transfer trip is preferred if coordinated protection is desired by the Facility Interconnection Customer. Coordinated protection will minimize the number of times the generator is forced offline without a dedicated feed.

The generator protection equipment listed in Section 6.4 is required to permit safe and reliable parallel operation of the Facility Interconnection Customer's equipment with the PacifiCorp system. Additional or alternate generator protection requirements for generators utilizing induction-type generator(s) or other specific situations shall be determined by PacifiCorp on a case by case basis.

7.1 Generator Requirements

7.1.1 Low Voltage Ride-Through (LVRT) Requirements for Generators

A generating plant shall be able to remain online during voltage disturbances up to the time periods and associated voltage levels set forth below. The LVRT standard is divided into three classifications by generation plant size.

7.1.1.1 Generating Plants with Capacity > 20 MW

7.1.1.1.1 Transition Requirements

For generators with interconnection agreements signed and filed with FERC between January 1, 2006 and December 31, 2006 with a scheduled in-service date no later than December 31, 2007 *or* for generating turbines subject to a turbine procurement contract executed prior to December 31, 2005 for delivery through 2007, the following requirement applies:

Generating plants are required to remain in-service during three-phase faults with normal clearing (which is a time period of approximately 4-9 cycles) and single line–to-ground faults with delayed clearing, as well as subsequent post-fault voltage recovery to pre-fault voltage unless clearing the fault effectively clears the generator from the system. The clearing time requirement for a three-phase fault will be specific to the generating plant substation location as determined by and documented by the transmission provider. The maximum clearing time the generating plant shall be required to withstand for a three-phase fault shall be nine cycles at a voltage as low as 0.15 pu, as measured at the high side of the generating plant step-up transformer (i.e., the transformer that steps the voltage up to the transmission interconnection voltage or GSU), after which, if the fault remains following the location-specific normal clearing time for three-phase faults, the generating plant may disconnect from the transmission system.

Notes:

1. This requirement does not apply to faults occurring between the generator terminals and the high side of the GSU or to faults that would result in a voltage lower than 0.15 pu on the high side of the GSU serving the facility.
2. Generating plants may be tripped after the fault period if this action is intended as part of a special protection system.
3. Generating plants may meet this LVRT standard by performance of the generators or by installing additional equipment (e.g., static VAR compensator, etc.) within the generating plant or by a combination of generator performance and additional equipment.
4. Any existing individual generator units that are, or have been, interconnected to the network at the same location before this requirement was written, are exempt from this requirement for the remaining life of the generation equipment. Existing individual generator units that are replaced must meet the requirements listed above.

7.1.1.1.2 Post-Transition Period

For all generators with capacity greater than 20 MW not subject to the transition period requirement above, the following requirement applies:

Generating plants are required to remain in-service during three-phase faults with normal clearing (which is a time period of approximately 4-9 cycles) and single line-to-ground faults with delayed clearing, as well as subsequent post-fault voltage recovery to pre-fault voltage unless clearing the fault effectively clears the generator from the system. The clearing time requirement for a three-phase fault will be specific to the generating plant substation location as determined by and documented by the transmission provider. The maximum clearing time the generating plant shall be required to withstand a three-phase fault shall be nine cycles, after which, if the fault remains following the location-specific normal clearing time for three-phase faults, the generating plant may disconnect from the transmission system. A generating plant shall remain interconnected during such a fault on the transmission system for a voltage level as low as zero volts, as measured at the high side of the GSU.

Notes:

1. This requirement does not apply to faults that would occur between the generator terminals and the high side of the GSU or to faults that would result in a voltage lower than 0.15 pu on the high side of the GSU serving the facility.
2. Generating plants may be tripped after the fault period if this action is intended as part of a special protection system.
3. Generating plants may meet this LVRT standard by performance of the generators or by installing additional equipment (e.g., static VAR compensator, etc.) within the generating plant or by a combination of generator performance and additional equipment.

4. Any existing individual generator units that are, or have been, interconnected to the network at the same location before this requirement was written are exempt from this requirement for the remaining life of the generation equipment. Existing individual generator units that are replaced are required to meet the requirements listed above.

7.1.1.2 Generating Plants with Capacity ≥ 10 MVA and ≤ 20 MW

Generators are required to remain in-service during system faults (three-phase faults with normal clearing and single line-to-ground faults with delayed clearing) unless clearing the fault effectively disconnects the generator from the system. This requirement does not apply to faults that would occur between the generator terminals and the high side of the generator step-up transformer or to faults that would result in a voltage lower than 0.15 pu on the high side of the generator step-up transformer. In the post-fault transient period, generators are required to remain in-service for the low voltage excursions specified in the Table 4 as applied to a load bus.

Notes:

1. These performance criteria are applied to the generator interconnection point, not the generator terminals.
2. Generators may be tripped after the fault period if this action is intended as part of a special protection system.
3. This standard applies to any generation independent of the interconnected voltage level.
4. This standard can be met by the performance of the generators or by installing additional equipment (e.g., SVC, etc.).
5. Existing individual generator units that are interconnected to the network at the time of the adoption of this standard are exempt from meeting this standard for the remaining life of the existing generation equipment. Existing individual generator units that are replaced must meet the requirements listed above.

7.1.1.3 Generating Plants with Capacity < 10 MVA

Generators are required to remain in-service during system faults (three-phase faults with normal clearing and single line-to-ground faults with delayed clearing) unless clearing the fault effectively disconnects the generator from the system. This requirement does not apply to faults that would occur between the generator terminals and the high side of the generator step-up transformer or to faults that would result in a voltage lower than 0.15 pu on the high side of the generator step-up transformer. In the post-fault transient period, generators are required to remain in-service for the low voltage excursions specified in Table 4 as applied to a load bus.

Notes:

1. These performance criteria are applied to the generator interconnection point, not the generator terminals.
2. Generators may be tripped after the fault period if this action is intended as part of a special protection system.

3. This standard applies to any generation independent of the interconnected voltage level.
4. This standard can be met by the performance of the generators or by installing additional equipment (e.g., SVC, etc.).
5. Existing individual generator units that are interconnected to the network at the time of the adoption of this standard are exempt from meeting this standard for the remaining life of the existing generation equipment. Existing individual generator units that are replaced must meet these requirements.

7.1.2 High Voltage Ride-Through (HVRT) Requirements for Generators

7.1.2.1 Generating Plants with Capacity > 20 MW

Generators are required to stay online indefinitely for dynamic voltages ≤ 1.1 pu at the point of interconnect. For dynamic voltages > 1.1 pu and ≤ 1.15 pu at the point of interconnect, generators are required to delay tripping one second to allow for fault clearing. For dynamic voltages > 1.15 pu and ≤ 1.2 pu, generators are required to delay tripping for 0.30 seconds to allow for fault clearing. For dynamic voltages > 1.2 pu at the point of interconnect, generators may trip without delay.

7.1.2.2 Generating Plants with Capacity ≥ 10 MVA and ≤ 20 MW

Generators are required to stay online indefinitely for dynamic voltages ≤ 1.1 pu at the point of interconnect. For dynamic voltages > 1.1 pu and ≤ 1.15 pu at the point of interconnect, generators are required to delay tripping one second to allow for fault clearing. For dynamic voltages > 1.15 pu and ≤ 1.2 pu, generators are required to delay tripping for 0.30 seconds to allow for fault clearing. For dynamic voltages > 1.2 pu at the point of interconnect, generators may trip without delay.

7.1.2.3 Generating Plants with Capacity < 10 MVA

Generators are required to stay online indefinitely for dynamic voltages ≤ 1.1 pu at the point of interconnect. For dynamic voltages > 1.1 pu and ≤ 1.15 pu at the point of interconnect, generators are required to delay tripping one second to allow for fault clearing. For dynamic voltages > 1.15 pu and ≤ 1.2 pu, generators are required to delay tripping for 0.30 seconds to allow for fault clearing. For dynamic voltages > 1.2 pu at the point of interconnect, generators may trip without delay.

7.1.3 Ride-through and Trip Voltage/Frequency Settings

The required devices and settings will be installed at the point of interconnection. The protection devices at the point of interconnection will send trip signals to the generator breakers (or to the wind turbine feeder breakers if in a wind plant). The Facility Interconnection Customer may also have frequency and voltage protection at its generating facility. The Facility Interconnection Customer's local protection settings must be compatible with the voltage ride-through requirements in Table 2.

In Table 3, separate transmission frequency settings are specified for a generation interconnection to an integrated network and for a generation interconnection to a radial transmission line. The voltage/frequency performance for each of the two transmission interconnection types is expected to be different.

Table 2–Ride-Through and Trip Voltage Relay Settings

Low Voltage Ride-Through Required	High Voltage Ride-Through Required		Trip Required	
	pu	delay(sec)	pu	delay(sec)
For Gen > 20 MW	> 1.20	0	> 1.50	0.1
See sec. 7.1.1.1	1.151-1.199	0.3	1.15-1.499	2.0
	1.101-1.15	1.0	1.101-1.149	4.0
For Gen 10 MVA - 20 MW	≤ 1.1	No trip	0.899-0.871	600.0[1]
See sec. 7.1.1.2			0.87-0.671	2.0
For Gen < 10 MVA			< 0.671	0.5
See sec. 7.1.1.3				

Table 3–Ride-Through and Trip Frequency Relay Settings

	Ride-Through Required		Trip Required	
	Hz	delay(sec)	Hz	delay(sec)
Integrated	> 61.8	0.0		
	61.6-61.7	30.0		
	60.6-61.5	180.0		
	59.5-60.5	infinite	None	
	59.4-58.5	180.0		
	58.4-57.9	30.0		
	57.8-57.4	7.5		
	57.3-56.9	0.75		
	≤ 57.0	0.0		
Radial			> 61.6	0.0
			61.0-61.6	0.5
			> 60.5-60.9	180.0
	60.5-59.5	infinite	< 59.5-59.1	180.0
			59.0-58.4	0.5
			< 58.3	0.0

Table 4–WECC Disturbance-Performance Table of Allowable Effects on Other Systems

NERC and WECC Categories	Outage Frequency Associated with Performance Category (outage/year)	Transient Voltage Dip Standard	Minimum Transient Frequency Standard
A	Not Applicable	Nothing in addition to NERC	
B	≥ 0.33	Not to exceed 25% at load buses or 30% at non-load buses Not to exceed 20% for more than 20 cycles at load buses	Not below 59.6 Hz for 6 cycles or more at a load bus
C	0.033 - 0.33	Not to exceed 30% at any bus Not to exceed 20% for more than 40 cycles at load buses	Not below 59.0 Hz for 6 cycles or more at a load bus
D	< 0.033	Nothing in addition to NERC	

Notes:
1. The WECC Disturbance-Performance Table applies equally to either a system with all elements in service, or a system with one element removed and the system adjusted.
2. As an example in applying the WECC Disturbance-Performance Table, a Category B disturbance in one system shall not cause a transient voltage dip in another system that is greater than 20% for more than 20 cycles at load buses, or exceed 25% at load buses or 30% at non-load buses at any time other than during the fault.
3. Additional voltage requirements associated with voltage stability are specified in WECC Standard I-D. If it can be demonstrated that post-transient voltage deviations that are less than the values in the table will result in voltage instability, the system in which the disturbance originated and the affected system(s) should cooperate in mutually resolving the problem.

7.2 Phase Overcurrent

Instantaneous overcurrent, or rate-of-rise relay is a device (50) which functions instantaneously on an excessive value of current or on an excessive rate of current rise, thus indicating a fault in the apparatus or circuit being protected.

AC time overcurrent relay is a device (51) with either a definite or inverse time characteristic which functions when the current in an AC circuit exceeds a pre-determined value.

7.3 Over/Undervoltage Relay

This protection is used to trip the circuit breaker when the voltage is above or below PacifiCorp's normal operating level (126 V – 114 V). It is used for generator protection and backup protection in the event that the generator is carrying load that has become isolated from the PacifiCorp system.

7.4 Over/Underfrequency Relay

This protection device is used to trip the circuit breaker when the frequency is above or below PacifiCorp's normal operating level. It is used for generator/turbine protection and backup protection.

Generator underfrequency relay settings are coordinated with other utilities in the Western Electricity Coordinating Council (WECC) to maintain generation online during system disturbances. Without prior written approval by PacifiCorp, settings should not be set for a higher frequency or shorter time delay than specified by PacifiCorp’s Protection and Control Engineer.

7.5 Overcurrent Relay with Voltage Restraint/Voltage Control or Impedance Relay

These relays are used to detect phase–to-phase faults and initiate a circuit breaker trip. The relays must be located on the individual generator feeder. A group of generators aggregating over 400 kW must have an impedance relay or an overcurrent relay with voltage restraint located on each generator greater than 100 kW. Generators equal to or greater than 400 kW must have an impedance relay or an overcurrent relay with voltage restraint. As determined by PacifiCorp, an overcurrent relay with voltage control may also be acceptable if it can be set to adequately detect end-of-line faults.

7.6 Dedicated Step-Up Transformer

The dedicated transformer matches the generator voltage to the utility voltage and steps up the generator voltage to the interconnection level. It also serves to isolate the Facility Interconnection Customer from other customers to a small degree.

The impedance of a dedicated transformer limits fault currents on the generator bus from the PacifiCorp system and also limits fault currents on the PacifiCorp system from the generator. Hence, it reduces the potential damage to both parties due to faults. The transformer must have a delta winding to reduce the generator harmonics entering the PacifiCorp system unless otherwise agreed to by PacifiCorp. The delta winding will also reduce the PacifiCorp system harmonics entering the generation facility.

Generators of more than 10 kW require the use of a dedicated transformer. Generators of 10 kW or less and generating at a secondary voltage level may require a dedicated transformer. This need can be determined and identified in a detailed study.

A high-side fault-interrupting device such as a breaker or recloser is required for transformer protection. It is also required that the device be gang-operated so as to avoid the possibility of ferroresonance or loss of phase condition.

A three-phase circuit breaker is recommended, but fuses are acceptable for generation facilities of less than 1,000 kW provided that coordination can be obtained with the existing PacifiCorp protection equipment. If fuses are used, it is recommended that the generating entity install single-phase protection for its equipment.

Lightning arrestors, if the Facility Interconnection Customer chooses to install them, must be installed between the transformer and the fault-interrupting devices and shall be encompassed by the generator's relay protection zone.

7.7 Generators

The generating unit must meet all applicable American National Standards Institute (ANSI) and Institute of Electrical and Electronic Engineers (IEEE) standards. The prime mover and the generator should also be able to operate within the full range of voltage and frequency excursions that may exist on the PacifiCorp system without damage to them. To enhance system stability during a system disturbance, the generating unit must be able to operate through the specified frequency ranges for the time durations listed in Table 2.

7.7.1 Synchronous Generators

7.7.1.1 Synchronizing Relays

Synchronous generators and other generators with stand alone capability must use one of the following methods to synchronize with the PacifiCorp system:

1. Automatic Synchronization with Automatic Synchronizing (Device 25)

   The automatic synchronizing relay must have a slip frequency-matching window of 0.1 Hz or less, a voltage-matching window of ± 10 percent or less, a phase angle-acceptance window of ± 10 degrees or less, and breaker-closure time compensation.

   The automatic synchronizing relay sends a close signal to the breaker after the above conditions are met.

2. Automatic Synchronization with Automatic Synchronizer (Device 15/25)

   The automatic synchronizing relay must have a slip frequency-matching window of 0.1 Hz or less, a voltage-matching window of ± 10 percent or less, a phase angle-acceptance window of ± 10 degrees or less, and breaker-closure time compensation. For an automatic synchronizer which does not have breaker-closure time compensation, a tighter frequency window (± 5 degrees) with a one-second time-acceptance window shall be used to achieve synchronization within ± 10 degrees phase angle.

   In addition to the above characteristics, this automatic synchronizer has the ability to adjust generator voltage and frequency automatically to match system voltage and frequency.

3. Manual Synchronization with Synchroscope and Synch Check (Device 25) Relay Supervision

   The synch check relay must have a voltage-matching window of ± 10 percent or less and a phase angle-acceptance window of ± 10 degrees or less.

   Generators with greater than 1,000 kW aggregate nameplate rating must have automatic synchronizing relay or automatic synchronizer.

7.7.1.2 Frequency/Speed Control

Unless otherwise specified by PacifiCorp, a governor shall be required on the prime mover to enhance system stability. Governor characteristics shall be set to provide a five percent droop characteristic (a 0.15 Hz change in the generator speed shall cause a five percent change in the generator load). Governors on the prime mover must be operated unrestrained to help regulate PacifiCorp's system frequency.

7.7.1.3 Excitation System Requirements

An excitation system is required to regulate generator output voltage.

Static systems shall have a minimum ceiling voltage of 150 percent of rated full-load field voltage with 70 percent of generator terminal voltage and a maximum response time of two cycles (0.033 seconds).

Rotating systems shall have an ANSI voltage response ratio of 2.0 or faster.

Excitation systems shall respond to system disturbances equally in both the buck and boost directions.

Under certain conditions, PacifiCorp may grant an exemption for generation facilities which have excitation systems not meeting these requirements. Requests for exemption should be sent to PacifiCorp Transmission Account Manager.

7.7.1.4 Voltage Regulator

The regulator must be able to maintain the generator voltage under steady-state conditions without hunting and within ± 0.5 percent of any voltage level between 95 percent and 105 percent of the rated generator. The point of voltage sensing should be at the same point as the PacifiCorp revenue metering. As determined by the PacifiCorp Control Center, the generator shall be operated at either a voltage or a power factor schedule.

At various times, the generating facility may also be requested by the PacifiCorp Control Center to produce more or less reactive power from that indicated on the regular schedule in order to meet the system needs.

7.7.1.5 Power-Factor Controller

The controller must be able to maintain a power-factor setting within ± 1 percent of the setting at full load at any set point between 90 percent lagging and 95 percent leading. In addition, all power-factor controllers for synchronous generators greater than 1MW must have programmable capability to vary hourly settings.

7.7.1.6 Power-System Stabilizer (PSS)

Generators with properly tuned and calibrated PSS provide damping to electric power oscillations. Such damping improves stability in the electrical system and may also prevent an individual generator from unnecessary tripping. The current WECC policy requires that the PSS be an integral part of the voltage regulator and be incorporated into the excitation systems for all new generating units with suitable excitation systems. PacifiCorp can help determine, at the Facility Interconnection Customer Facility Interconnection Customer 's expense, the suitability of an excitation system for PSS.

The PSS must be calibrated and operated in accordance with the latest standard procedures for calibration, testing, and operation of such equipment. These procedures are available from PacifiCorp. In addition, the calibration and test reports must be submitted to PacifiCorp’s Transmission Account Manager.

The facility shall not be considered operational until PSS has been calibrated to PacifiCorp's satisfaction. A copy of the PSS calibration and operation procedures, as well as the suitability requirements, may be obtained from the PacifiCorp Transmission Account Manager. Additional information on PSS can be found in Appendix A.

The following criteria shall be used to determine when a PSS shall be installed on a synchronous generator, regardless of ownership, connected to the transmission system (by generator step-up transformer to 60 kV or higher voltage):

1. A PSS shall be installed on every existing synchronous generator that is larger than 75 MVA and is equipped with a suitable excitation system as defined in the WECC report, *Criteria to Determine Excitation System Suitability for PSS* available from the WECC web site.
2. A PSS shall be installed on every existing synchronous generator larger than 30 MVA or part of a complex that has an aggregate capacity larger than 75 MVA, or if the excitation system is updated so that it becomes a suitable excitation system as defined in the report mentioned in 1a above. This section applies to all machines whose excitation system is updated at any time after November 18, 1993.
3. A PSS shall be installed on every synchronous generator that is larger than 30 MVA or part of a complex that has an aggregate capacity larger than 75 MVA, and is equipped with suitable excitation systems as defined in paragraph 1a, and is commissioned after November 18, 1993.
4. A PSS is not required on a station service generator.

When a generator equipped with a functional PSS is online, the PSS shall be in operation except for the following reasons:

1. Maintenance and testing.
2. PSS exhibits instability due to nonstandard transmission line configuration.
3. PSS does not operate properly due to a failed component.
4. Unit is operating in the synchronous condenser mode (very near zero power level).
5. When a unit is generating less power than its design limit for effective PSS operation.
6. When a unit is passing through a range of output that is a known “rough zone.”

The aggregate MVA of the synchronous machines tonline and equipped with a functioning PSS shall not fall below the level identified in the most recent power system stabilizer study commissioned by the WECC.

When a synchronous generator equipped with a PSS is operating in the pump mode (P/G unit), and is connected to a transmission system such that the PSS does not produce negative damping, the PSS should be in service.

PSS equipment shall be tested and calibrated in conjunction with AVR testing and calibration. This will be done as often as is necessary to maintain reliable PSS performance in accordance with WECC *PSS Tuning Criteria*. PSS recalibration must be performed if AVR response parameters are modified. When a PSS is taken out of service because of a failed component, the party responsible will be expected to perform the needed repairs (or replacement) in a responsible and timely manner.

A PSS is not required for a synchronous condenser.

7.7.1.7 Power-Quality Analysis

At the discretion of the Area Planning Engineer, unattended generation facilities with capacity greater than 250 kW and with automatic or remotely-initiated paralleling capability may require a power-quality investigation analysis performed by PacifiCorp or a power-quality consulting firm. The analysis shall provide PacifiCorp with sufficient information to determine the status of the generation facility during system disturbances. The analyzer may provide remote access from PacifiCorp's Control Center or engineering offices.

7.7.1.8 Generator Testing

Testing of the generator and excitation system must be performed to verify proper parameters of the generator and exciter. Testing shall meet the requirements of the WECC Generator Testing Program. Copies of the test reports with appropriate powerflow and stability data parameters identified shall be provided to the PacifiCorp Transmission Account Manager. If a stability model is not available, the interconnection entity will be responsible for developing a suitable model for use in PacifiCorp's transient stability program, which currently uses the Power Technologies, Inc. PSSE version 27.1 program.

7.7.1.9 Direct Digital Control (DDC)

Dispatchable generators larger than 10,000 kW are required to have real-time direct digital control of unit output from PacifiCorp's Control Center. This allows generation units to respond to power system load/frequency changes.

7.7.2 Induction Generators

Induction generators, and other generators with no inherent VAr (reactive power) control capability, shall be required to provide power to the unity point of interconnection. Such generators shall operate in as near a range of ± 0.95 power factor as is technically feasible without risk of self-excitation to provide an amount of reactive power equivalent to that required for a synchronous generator. They may also be required to follow a PacifiCorp-specified voltage or VAr schedule on an hourly, daily, or seasonal basis, depending on the location of the installation. Specific instructions shall be provided on a case-by-case basis by the PacifiCorp Control Center.

7.7.3 DC Generators

7.7.3.1 Inverters Capable of Stand-Alone Operation

Inverters capable of stand-alone operation are capable of islanding operation and shall have similar functional requirements as synchronous generators. For units less than 100 kW, usually it is acceptable to have the frequency and voltage functions built into the electronics of the inverter if the set points of these built-in protective functions are tamperproof and can be easily and reliably tested. The total harmonic distortion in the output current of the inverters must meet IEEE Standard 519, *Harmonics Requirements*. Inverter-type generators connected to the PacifiCorp system must be pre-approved by PacifiCorp. For units over 10 kW, a dedicated transformer will be required to minimize the harmonics entering into the PacifiCorp system.

7.7.3.2 Inverters Incapable of Stand-Alone Operation

Inverters rated 10 kW or less which have been tested and certified by Underwriter Laboratories (UL) as 1741, are non-islanding, and meet IEEE Standard 519 harmonic requirements, may be interconnected to the PacifiCorp system as is. **No inverter(s) will be permitted to interconnect**

with PacifiCorp's electrical system that are not certified and will be disconnected until they are brought into compliance with this policy. Certified inverters have a label affixed to the equipment which shall be inspected as part of the commissioning process before energization. These inverters are generally used in combination with wind turbines and solar-based generators. Inverters over 10 kW will require a dedicated transformer and may have other requirements depending on the installation location and local generation penetration.

7.8 Remedial Action Scheme (RAS) Participation Requirement for Generation Facilities

A RAS is a special protection system which automatically initiates one or more pre-planned corrective measures to restore acceptable power system performance following a disturbance. Application of RAS mitigates the impact of system disturbances and improves system reliability.

The output of electric generators may flow over the entire interconnected transmission system. A generation facility is therefore required to participate in remedial action schemes to protect local transmission lines and the entire system as PacifiCorp determines necessary.

A typical disturbance, as it is considered in the planning and design of the electric transmission system, is the sudden loss of one or more critical transmission lines or transformers. A widely applied corrective measure is to instantaneously drop a sufficient amount of generation on the sending end of the lost transmission facility. This is known as generation dropping, and a participating generation facility may be disconnected from the transmission by the automatic RAS controller in much the same way as by a transfer trip scheme. A generation facility should therefore have full load rejection capability as needed both for local line protection and RAS. The RAS design must be such that any single-point failure will not prevent the effective operation of the scheme.

Whether RAS shall be required will depend on the overall location and size of the generator and load on the transmission system, the nature, consequences, and expected frequency of disturbances as well as the nature of potential alternative transmission reinforcements.

If PacifiCorp requires RAS participation for a particular generation facility, the Facility Interconnection Customer shall be responsible for all related costs.

7.9 Emergency Generator Requirement

There are two major methods of transferring electric power supply between the PacifiCorp source and the emergency generator system:

1. Open transition (break-before-make)
2. Closed transition (make-before-break)

The open transition method can be accomplished via a double-throw transfer switch or an interlock scheme which prevents the two systems from operating in parallel. The Facility Interconnection Customer Facility Interconnection Customer 's main breaker shall not be allowed to close until the generator breaker opens. This open transition method does not require any additional protection equipment, however it does cause the Facility Interconnection Customer 's load to experience an outage while transferring back to PacifiCorp. The length of this transfer outage depends on the transfer equipment involved.

Emergency systems are routinely tested by the Facility Interconnection Customer under load, usually once a month. With a break–before-make system, the Facility Interconnection Customer 's load, or most often a portion of it, is removed from the PacifiCorp system and the emergency generator is tested under load conditions. After successful completion of the test, the generator is taken offline and the Facility Interconnection Customer is transferred back to PacifiCorp. This testing procedure results in the test load experiencing two outages (when bringing the emergency generator on and when taking it off) whenever the system is tested.

For generation facilities that cannot tolerate this momentary loss of power, the closed transition (make-before-break) method is intended to provide transfer without interruption. For the closed-transition method, the maximum parallel time with the PacifiCorp system shall be less than 0.5 seconds, both to and from the emergency generator source. The protection requirements for synchronous generators will also apply to emergency generators any time a parallel is to be made with the PacifiCorp system. These would include, but are not limited to, a dedicated transformer and automatic synchronizing.

As an alternative to the normally required voltage, frequency, and ground relays, PacifiCorp may, at its discretion, allow installation of three very sensitive, single-phase, reverse-power relays (such as the Basler BE1-32R) for emergency generator installations. The reverse power relays shall be set to pick up on transformer magnetizing current with a time delay not to exceed 0.5 second. The reverse power relay, in this case, will protect PacifiCorp personnel and the general public by preventing the generator from keeping the PacifiCorp system energized in the event the PacifiCorp source substation(s) have tripped for a fault while the generator is paralleled. The relay output shall trip the circuit breaker on the PacifiCorp side of the transfer switch. This application can be used when the Facility Interconnection Customer 's emergency generator output is expected to be less than the entity's load.

7.9.1 Notification/Documentation

The Facility Interconnection Customer must notify its local PacifiCorp representative in writing of all new emergency generator installations or changes to the existing schemes regardless of method of interconnection or transfer.

Required documentation includes a description of generation and control system operation, single line diagrams, identification of all interlocks, sequence of events description for transfer operation, and specifications for any PacifiCorp-required protective devices. PacifiCorp may request additional documentation should it deem it necessary.

All documentation must be approved by PacifiCorp Engineering prior to installation.

7.9.2 Operation/Clearances

For the safety of PacifiCorp personnel and to ensure the proper operation of the PacifiCorp system, it is essential that the Facility Interconnection Customer notify the PacifiCorp Control Center of all emergency generator installations prior to paralleling. For operation and clearance purposes, emergency generator installations should be treated the same as any independent generation facility interconnected to the PacifiCorp system. A satisfactory visible open point shall be approved by PacifiCorp.

For all line work and clearances, the emergency generator shall be treated as a power source.

Facility interconnection customers using make-before-break transfer schemes are required to notify the PacifiCorp Control Center of their intent to transfer to their emergency generator and then again back to the PacifiCorp source, before any transfers are attempted. The notification of the make-before-break transfer scheme is necessary because such actions put another generation source in parallel with the PacifiCorp system. This notification is not essential on break-before-make schemes, but may be desirable in some instances.

7.10 Parallel-Only (No-Sale) Generator Requirement

Parallel-only generators shall have similar requirements as that of any other standard synchronous generator interconnection except that PacifiCorp may at its discretion allow the installation of three very sensitive, single-phase, reverse-power relays (such as the Basler BE 1 32R) along with the dedicated transformer as an alternative to the normally required ground relays. The reverse-power relays shall be set to pick up on transformer magnetizing current with a time delay not to exceed 0.5 second. This option may not be feasible on generating systems with a slow load rejection response since they may be tripped offline frequently for in-plant disturbances.

Owners of parallel-only generators must execute a parallel-only operating agreement with PacifiCorp prior to operation by the generation owner.

8 REACTIVE AND VOLTAGE RESTRICTIONS FOR FACILITY INTERCONNECTION CUSTOMERS

The purpose of this section is to help all customers satisfy applicable PacifiCorp policies and procedures with regard to voltage and reactive power flow.

The policies and procedures of this section apply to all facilities interconnecting with PacifiCorp's system. All facilities must meet applicable WECC standards.

Participating entities are required to schedule energy or ancillary services through a designated scheduling coordinator unless other arrangements have been made with PacifiCorp.

8.1 Reactive and Voltage Control Requirements

Reactive power (VAr) and voltage control are vital components of desired PacifiCorp system operation. It is essential that PacifiCorp receive both real and reactive power from interconnected generators. Where a generator is unable to furnish reactive power support due to interconnection limitations, type of generator, the generator loading, or other reasons, the Facility Interconnection Customer shall install equivalent reactive support at the Facility Interconnection Customer 's expense or make other arrangements with PacifiCorp.

How a generator meets PacifiCorp's reactive requirements depends on its type and size. Synchronous generators have an inherent reactive flexibility that allows them to operate within a range to either produce or absorb VArs. Induction generators operate at a power factor absorbing VArs and require reactive support from the interconnected system unless they have installed corrective equipment.

Generators 10 MVA and larger shall be equipped with automatic voltage-control equipment. All generating units with automatic voltage-control equipment shall normally be operated in voltage-control mode. These generating units shall not be operated in other control modes (e.g., constant power factor control) unless authorized in writing to do so by the host control area. The control mode of generating units shall be accurately represented in operating studies. The previous statements in this paragraph are consistent with the Western Electricity Coordinating Council (WECC)’s minimum operating reliability criteria.

Facility interconnection customers must provide reactive supply sufficient to operate at as near unity power factor as can be safely achieved without risk of self-excitation. Typically, the power factor should range from 97 percent leading power factor (absorbing VArs) and 1.0 (unity). PacifiCorp may further require the provision of reactive support equivalent to that provided by operating a synchronous generator anywhere within the range from 95 percent leading power factor (absorbing VArs) to 90 percent lagging power factor (producing VArs) within an operating range of ± 5 percent of rated generator terminal voltage and full load. This is typical of induction generators. Generators shall be equipped and operated to control voltage. If the facility is not capable of providing positive reactive support (i.e., supplying reactive power to the system) immediately following the removal of a fault or other transient low voltage perturbations, the facility may be required to add dynamic voltage support equipment. The general control requirements are discussed below.

8.1.1 Generator Control

8.1.1.1 Voltage Control

Voltage regulators are required for all generators larger than 100 kW unless otherwise agreed. In some cases, particularly for small units connected to the distribution system, a power-factor controller will also be required to provide operational flexibility.

Voltage regulators must be capable of maintaining the interconnection reactive interchange between 0.95 leading/lagging power factor measured at the point of interconnection unless otherwise agreed. For synchronous machines, the regulators and exciters will be required to react during faults (i.e., within cycles). For wind farms that will have induction machines installed, PacifiCorp may accept slower adjustments to voltage regulation on a case-by-case basis.

The generator shall normally be operated with the generator automatic voltage regulator in a constant voltage regulation mode. The voltage regulator shall be adjusted periodically throughout each day to maintain reactive output within a range defined by PacifiCorp and consistent with the reactive requirements for the local transmission system. This may be a voltage that minimizes the reactive interchange between PacifiCorp's system and the generating facility or, at PacifCorp's discretion, the PacifiCorp dispatcher may ask the plant operator to hold a higher or lower voltage so as to cause the facility to supply or absorb reactive power in support of specific system-control objectives. It is the owner's responsibility to insure that the transformer tap position and all other equipment are compatible with this objective.

8.1.2 Power Factor Control

For units smaller than 100 kW and/or in special cases as mutually agreed, a power factor controller shall be utilized to maintain a constant power factor at the point of interconnection by controlling the voltage regulator or other relevant equipment. The controller must be capable of maintaining a power factor within ± 1 percent at full load at any set point between 95 percent lagging (producing VArs) and 95 percent leading (absorbing VArs) measured at the point of interconnection. In addition, all power-factor controllers for generators larger than 1,000 kW must have programmable capability to vary hourly settings. The PacifiCorp Control Center shall specify required settings for voltage or power factor. Generally, as noted above, a voltage will be specified which minimizes the reactive interchange between PacifiCorp's system and the generating facility.

In the event that the generator by itself is not capable of providing sufficient reactive power at the point of interconnection so as meet the 0.95 leading/lagging power factor requirement, switched shunt compensation or dynamic VAr equipment may be required.

The programmable controller for units larger than 1,000 kW is normally obtained by combining a non-programmable controller and a general purpose programmable device.

Control over the VAr production associated with the delivery of power to PacifiCorp falls under the following general classifications, depending upon contractual arrangements:

Surplus-Sale Operation: When a Facility Interconnection Customer dedicates its generator to serving plant needs first, selling only the surplus to PacifiCorp, treatment differs depending on whether excess power is being sold *to* PacifiCorp or supplemental power (no-sale mode) is being purchased *from* PacifiCorp. In no-sale mode, the Facility Interconnection Customer has sole control over VAr production, however the customer shall meet the power factor requirements for its overall facility as described by applicable tariff(s). When surplus power is being sold, PacifiCorp has operational control of the power factor at which the power is delivered.

Net-Sale Operation: All electricity produced, excluding station load, is sold to PacifiCorp. PacifiCorp therefore has operational control of VAr production within the generator operating range.

No-Sale Operation: When a Facility Interconnection Customer uses generation exclusively to offset load, the customer has sole control of the generator power factor, however the customer shall meet the power factor requirements for its overall facility as described by applicable tariff(s).

For generation connected to the PacifiCorp transmission system at less than 1 MW with the total output being sold to PacifiCorp, all electricity produced, excluding station load, is sold to PacifiCorp. PacifiCorp therefore has operational control of VAr production within the generator operating range.

8.2 Synchronous Generator Frequency/Speed Control

To enhance system stability, a governor is required on the prime mover, set to provide a 5 percent droop characteristic (a 0.15 Hz change in the generator speed will cause a 5 percent change in the generator load). Exceptions must be approved by PacifiCorp. Governors shall be operated unrestrained to regulate system frequency.

8.2.1 Non-Synchronous Generator Control (without VAr Control)

Induction generators or other generators without VAr control absorb VArs and therefore require reactive power support from PacifiCorp's system. For facilities larger than 40 kW, PacifiCorp will require power factor correction. Power factor correction or capacitors must be installed either by the Facility Interconnection Customer or as part of the special facilities installed by PacifiCorp at customer expense. Care must be exercised by the Facility Interconnection Customer in connecting capacitors directly to the generator terminals to avoid self-excitation. Stand-alone switched capacitors supplied by the Facility Interconnection Customer that are not an integral part of the generator control system shall be switched on and off at the request of PacifiCorp.

8.2.2 Induction Generators

Switched capacitors may be required by PacifiCorp in areas where severe reactive limitations exist. The Facility Interconnection Customer must provide reactive supply sufficient to operate at as near-unity power factor as can be safely achieved without risk of self-excitation. Typically the power factor should range from 97 percent leading power factor (absorbing VArs) and 1.0 (unity). PacifiCorp may further require the provision of reactive support equivalent to that provided by operating a synchronous generator anywhere within the range from 95 percent leading power factor (absorbing VArs) to 95 percent lagging power factor (producing VArs) within an operating range of ± 5 percent of rated generator terminal voltage and full load. (This is typical if the induction project is greater than 1,000 kW.)

8.3 Generator Step-Up Transformer

The available voltage taps of a Facility Interconnection Customer 's step-up transformer must be reviewed by PacifiCorp for their suitability with PacifiCorp's system. The Facility Interconnection Customer is expected to have this reviewed before acquiring the transformer.

PacifiCorp shall determine which voltage taps would be suitable for a step-up transformer for the Facility Interconnection Customer 's proposed project. Suitable taps are required to give the transformer the essential capacity for the generator to:

- Deliver maximum reactive power to PacifiCorp's system at the point of interconnection (generator operating at 95 percent lagging power factor) and,
- Absorb maximum reactive power from the PacifiCorp system (generator operating at 95 percent leading power factor).

The Facility Interconnection Customer 's transformer, with correct voltage taps, helps maintain a specified voltage profile on PacifiCorp's system for varying operating conditions. Actual voltage tap settings can be different for transformers connected at the same voltage level, depending upon their geographic location.

8.4 Grid Operations

The following data will be gathered by PacifiCorp in order to fully comply with NERC Standard TOP-005-1, *Operational Reliability Information* and FAC-001-0, *Facility Connection Requirements*. Grid operations will need the following SCADA and tone-telemetered generator data for 3 MW and higher plants connected to PacifiCorp transmission system voltages (46KV and higher):

1. Status (of breakers).
2. MW and MVAr capability.
3. MW and MVAr net output.
4. Status of automatic voltage-control facilities (capacitors, reactors, dynamic VAr devices).

   The same standard requires that key voltages be metered (and PacifiCorp's voltage requirements adequately address this need).
5. Tone telemetry.

Note that in WECC units, 10 MVA and above must have automatic voltage requlation (AVR) installed on them.

8.5 Direct Digital Control

Dispatchable generator units larger than 10,000 kW are required to have real-time direct-digital control of unit output from the PacifiCorp Control Center. This will allow generation units to respond to system load/frequency changes.

8.6 Power System Stabilizer Operating Requirements for Generators

If a power system stabilizer (PSS) is a required part of the generator's voltage regulator, it must be operated and maintained in accordance with the standard procedures developed by WECC. Recalibration and testing of the PSS is required at least every five years, with data submitted for approval to PacifiCorp's Transmission Account Manager

PacifiCorp is responsible for the safe and reliable operation of the electric system. Because failure of the Facility Interconnection Customer to recalibrate and test its PSS could adversely impact system operation, PacifiCorp reserves the right either to disconnect from, or refuse to parallel with, any Facility Interconnection Customer which does not operate and maintain its generator control systems in accordance with applicable reliability criteria or standards. Any sanctions or penalties assessed due to failure to meet WECC Reliability Management System (RMS) operating requirements (available from the WECC website at *http://www.wecc.biz*) for units equipped with PSS shall be the sole responsibility of the Facility Interconnection Customer.

8.7 Power Quality Policy

8.7.1 Voltage Fluctuation Limits

A customer connected to the PacifiCorp system must not cause harmful voltage fluctuations or interference with service and communication facilities. Any generation facility that does so is subject to being disconnected from the PacifiCorp system until the condition has been corrected.

8.7.2 Harmonic Limits

All customers shall comply with the voltage and current harmonic limits specified in IEEE Standard 519 1992, *Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems*.

The harmonic content of the voltage and current waveforms in the PacifiCorp system must be restricted to levels which do not cause interference or equipment operating problems for PacifiCorp or its customers.

Any harmonic problems shall be handled on a case-by-case basis. A customer facility causing harmonic interference is considered by PacifiCorp as a serious interference with service and is subject to disconnection from the PacifiCorp system until the condition has been corrected. If the cause of the problem is traceable to the Facility Interconnection Customer 's facilities, all costs associated with determining and correcting problems shall be at the customer's expense.

Many methods may be used to restrict harmonics. The preferred method is to install a transformer with at least one delta connection between the interconnected facility and the PacifiCorp system. This method significantly limits the amount of voltage and current harmonics entering the PacifiCorp system. Generation system configuration with a star-grounded generator and a two-winding (both star-grounded) transformer shall not be allowed.

8.7.3 Voltage Flicker Limits

PacifiCorp's Engineering Handbook Section 1C.5.1, *Voltage Fluctuation and Light Flicker* will be utilized to evaluate any voltage flicker issue that may arise during the interconnection study process for transmission voltages. This subject typically arises on wind-turbine installations. It is usually rare that voltage flicker is an issue on transmission voltages. It could become problematic on the very rare 34.5 kV transmission lines and 46 kV transmission lines PacifiCorp owns and/or in single-turbine installations.

All generation interconnection projects must comply with this standard. The cost of corrective measures necessary for a project that does not comply with this standard will be borne solely by the Facility Interconnection Customer. It is necessary to acquire written review and approval from PacifiCorp before any corrective equipment is purchased and installed.

9 OPERATING REQUIREMENTS

1. The Facility Interconnection Customer shall not commence parallel operation of interconnected facility(s) until final written acceptance has been given by PacifiCorp. PacifiCorp reserves the right to inspect the Facility Interconnection Customer's facility and witness testing of any equipment or devices associated with the interconnection. The Facility Interconnection Customer shall submit a written, detailed procedure with specific requirements for initial commissioning of the Facility Interconnection Customer's generation and interconnecting facilities for PacifiCorp approval. PacifiCorp and the Facility Interconnection Customer shall each identify one representative to serve as a coordination contact to be the initial point of contact and coordinate communications between the parties for both normal and emergency conditions. PacifiCorp and the Facility Interconnection Customer shall notify each other in writing of the personnel that it has appointed as its coordination contact. PacifiCorp and the Facility Interconnection Customer shall abide by their respective switching and tagging rules for obtaining clearances for work or for switching operations on equipment. Such switching and tagging rules shall be developed in accordance with OSHA standards. PacifiCorp and the Facility Interconnection Customer shall develop mutually acceptable switching and tagging rules for PacifiCorp's and the Facility Interconnection Customer 's facilities that involve common clearance requirements. The Facility Interconnection Customer shall follow PacifiCorp directives with regard to emergencies on the PacifiCorp system.
2. The following are required before the Customer will be given permission for each operational milestone:
   a. Back feed requires that protection and metering to be complete and operational.
   b. First synchronization requires that all protection, metering, *and communications* be complete and operational. Power delivered to the system after first synchronization but prior to commercial operations is test energy.
   c. Commercial operations requires that the customer all testing be complete and the customer is ready to deliver commercial power.
3. The Facility Interconnection Customer shall not be permitted to energize a de-energized PacifiCorp circuit and will follow lockout/tagout procedures.
4. The operation of the Facility Interconnection Customer's on-site equipment shall not result in unacceptable service to other PacifiCorp customers, such as voltage and frequency fluctuations or harmonic currents on the PacifiCorp system. The Facility Interconnection Customer shall comply with the latest revision of PacifiCorp's allowable voltage flicker standards
5. The operation of the Facility Interconnection Customer's on-site generation shall not cause the service voltage for other PacifiCorp customers to go outside the requirements of ANSI C84.1, Range A.
6. The operation of the Facility Interconnection Customer's on-site generation shall not adversely affect the voltage regulation of the PacifiCorp system.
7. The operation of the Facility Interconnection Customer's on-site generation shall be conducted in a manner that minimizes reactive flow from the on-site generation to the PacifiCorp system, except when requested to assist in voltage control on the PacifiCorp system.
8. The Facility Interconnection Customer shall design the large generating facility to maintain a composite power delivery at continuous rated power output measured at the generator

terminals at a power factor within the range of 0.90 leading to 0.95 lagging, unless the transmission provider has established different requirements that apply to all generators in the control area on a comparable basis. This shall apply to all units unless specifically exempted by FERC, NERC, or PacifiCorp. The Facility Interconnection Customer's voltage regulation equipment will be designed and operated to limit VAr flow to a power factor between 0.90 leading and 0.95 lagging except for units connected to the PacifiCorp distribution system rated at 15 kV and less. These generators are to maintain unity power factor and shall not regulate the distribution system voltage unless requested or required to do so by PacifiCorp per IEEE 1547 Standards.

9. The operation of the Facility Interconnection Customer's on-site induction machines or other non-synchronous generation shall be required to provide the same VAr support as synchronous machines unless specifically exempted by FERC or other governmental authority.
10. Operation of the Facility Interconnection Customer 's equipment shall not adversely affect the voltage regulation of the PacifiCorp system. The Facility Interconnection Customer shall minimize the reactive flow, except when requested to assist in voltage control on the PacifiCorp system. The Facility Interconnection Customer shall provide adequate voltage control to minimize voltage regulation on the PacifiCorp system caused by generator loading conditions.
11. In cases where starting or load-changing on induction generators will have an adverse impact on PacifiCorp system voltage, step-switched capacitors or other techniques may be required to attenuate the voltage changes to acceptable levels.
12. For synchronous generators, sufficient generator reactive power capability shall be provided to withstand normal voltage changes on the PacifiCorp system. The generator voltage-VAr schedule, voltage regulator, and transformer ratio settings will be jointly determined by PacifiCorp and the Facility Interconnection Customer to ensure proper coordination of voltages and regulator action. The Facility Interconnection Customer is encouraged to genrate their own VAr requirements to minimize power factor adjustment charges and enhance generator stability.
13. Induction or other non-synchronous generating installations shall provide the same voltage and VAr support as synchronous installations referenced in Section 7.10, except where specifically exempted by FERC or other governmental authorities.
    a. Where the Facility Interconnection Customer's installation does not comply with this requirement, and the existing PacifiCorp system can reliably supply the VARs for voltage support without installations of reactive compensation, the Facility Interconnection Customer may either purchase the reactive requirements for voltage support from PacifiCorp or supply such requirements with its own compensation. The reactive supply obtained from PacifiCorp shall be billed on a tariff to be determined during contract discussions.
    b. Where the Facility Interconnection Customer's installation does not comply with this requirement and the existing PacifiCorp system cannot reliably supply the VArs for voltage support, PacifiCorp shall install apparatus on the PacifiCorp system to supply the required VArs. The cost of the apparatus, controls, installation, and operation shall be paid according to OATT requirements and procedures.
14. Reactive power supply requirements for inverter systems are similar to those for induction generators and the preceding comments apply except where specifically exempted by FERC or other governmental authorities.

15. To avoid self-excitation, care shall be exercised in applying power factor correction capacitors directly to or electrically near induction generator terminals.
16. The Facility Interconnection Customer shall discontinue parallel operation when requested by PacifiCorp for the following purposes:
    a. To facilitate maintenance, tests, or repairs of the PacifiCorp electric system.
    b. During emergencies on the PacifiCorp system.
    c. When the Facility Interconnection Customer generating equipment is interfering with customers on the PacifiCorp system.
    d. When an inspection of the Facility Interconnection Customer reveals a condition hazardous to the PacifiCorp system or a lack of scheduled maintenance records is found.
17. WECC requires all members to share in an operating reserve or Generation Reserve Sharing Pool. PacifiCorp shall require a specific agreement to supply operating reserve to cover the Facility Interconnection Customer 's generation to load at that site. The generator will provide or contract for adequate generation to meet WECC or power pool generation reserve, spinning reserve, and load-following requirements.
18. The Facility Interconnection Customer shall comply with all NERC, WECC, and PacifiCorp Underfrequency Load Shedding requirements. During any underfrequency situation, the Facility Interconnection Customer shall agree to immediately make available to PacifiCorp any spinning or operating reserves that exist on their generation.
19. The Facility Interconnection Customer shall adhere to WECC Operating Standards, any PacifiCorp Operating Guides, and any additional operating requirements either stated herein or mutually agreed to elsewhere. The latest revision of all applicable documents shall serve as the minimum requirements for system operation. These documents are available at the publishing organizations respective website. Contact the Transmission Account Manager for further details.
20. PacifiCorp and the Facility Interconnection Customer may, in accordance with good utility practice, remove from service facilities or network upgrades as necessary to perform maintenance, test, and install or replace equipment. PacifiCorp and the Facility Interconnection Customer will use reasonable efforts to coordinate outages for maintenance on dates and times mutually acceptable to both parties.
21. The Facility Interconnection Customer shall compensate PacifiCorp for any incremental energy or reactive losses and incremental demand charges resulting from changes in system power flow caused by the Facility Interconnection Customer 's system addition in accordance with OATT requirements and procedures.
22. The Facility Interconnection Customer shall operate the interconnection facilities in compliance with the latest revision of the National Electric Safety Code, applicable state codes, PacifiCorp safety rules, and IEEE Std 519. Failure to comply with said safety policies and power-quality standards will result in the interconnection being opened. The interconnection will not be re-established until compliance has been determined.
23. The Facility Interconnection Customer shall maintain its interconnection facilities and any generating equipment that could negatively impact the PacifiCorp system in good order. PacifiCorp reserves the right to inspect the Facility Interconnection Customer’s facilities on a periodic basis or whenever it appears that the Facility Interconnection Customer is operating in a manner hazardous to PacifiCorp’s system integrity.

9.1 Specific Generator Interconnection Requirements

The following requirements apply specifically to generation interconnections. The equipment associated with the Facility Interconnection Customer's generation equipment should be protected in accordance with the practices described in the latest revision of the following ANSI/IEEE standards or guides. There may be special requirements imposed by PacifiCorp due to the specific project or application.

ANSI C50.10-1990, *General Requirements for Synchronous Machines*

ANSI 50.12-1982, *Requirements for Salient Pole Synchronous Generators and Condensers*

ANSI C50.13-1989, *Requirements for Cylindrical-Rotor Synchronous Generators*

ANSI C50.14-1977, *Requirements for Combustion Gas Turbine Driven Cylindrical-Rotor Synchronous Generators*

ANSI/IEEE C37.101, *Guide for Generator Ground Protection*

ANSI/IEEE C37.102, *Guide for AC Generator Protection*

ANSI/IEEE C37.106, *Guide for Abnormal Frequency Protection for Power Generating Plants*

ANSI/IEEE Std 1001, *Guide for Interfacing Dispersed Storage and Generation Facilities with Electric Utility Systems*

IEEE 1547, *Standard for Interconnecting Distributed Resources with Electric Power Systems*

In addition to the above-listed requirements, the following standards apply:

1. Any generating unit or line/end user interconnection to the PacifiCorp electric system with its output purchased by PacifiCorp or another network customer shall be considered a "Network Resource" under the terms of Part III of the OATT.
2. Generator installations requesting WECC accreditation must meet all NERC, WECC, and PacifiCorp requirements, including WECC Generation Reserve Sharing Pool requirements, URGE testing, and any reactive testing requirements.
3. The generator step-up (GSU) transformer connection will be determined by the system impact study. In general, the GSU must be effectively grounded on the utility side providing an adequate ground reference and will isolate the generator's zero sequence current from the PacifiCorp system through the use of an ungrounded connection on the generator side. The transformer shall be equipped with a no-load tap changer covering the range of ± 5 percent in 2.5 percent steps from the nominal voltage of the interconnection.
4. PacifiCorp requires synch-check relays to be installed on all circuit breakers interconnecting a generating unit to the PacifiCorp electric system.
5. Induction generators may use a speed-matching relay (Device 15) as a means of synchronization and to limit the magnetizing inrush current/voltage drop. The speed matching must keep voltage flicker at the point of interconnection within PacifiCorp voltage flicker requirement and within IEEE 519 requirements.
6. Generation operated in parallel with the PacifiCorp electric system may supply additional fault current energy which shall be disconnected in case of a disturbance on PacifiCorp's system. The existence of parallel generation may alter the operation of protective devices normally used by PacifiCorp to protect the system.

7. Equipment shall be provided to detect system abnormalities in the Facility Interconnection Customer 's or PacifiCorp's system, and shall have the capability to isolate the sources of the disturbance. At a minimum, the Facility Interconnection Customer shall provide adequate protective devices to:
   a. Detect and clear the generator(s) from short circuits on PacifiCorp facilities serving the interconnecting facilities.
   b. Detect the voltage and frequency changes which can occur if PacifiCorp facilities serving the interconnecting facilities are disconnected from the main system, and clear any Facility Interconnection Customer generation/load from the isolated system if necessary.
   c. Prevent reclosing the Facility Interconnection Customer’s generation to PacifiCorp after an incident of trouble, until authorized to recluse by PacifiCorp’s Portland or Salt Lake City dispatch centers.
   d. Isolate Facility Interconnection Customer’s generation from the PacifiCorp electric system upon:
      - Receipt of a direct trip signal from an upstream PacifiCorp substation.
      - Failure of the communications channel used for direct tripping.
      - Receipt of a trip command from the Portland or Salt Lake City dispatch center via SCADA.
8. PacifiCorp, at its discretion, may require out-of-step protection and/or loss of excitation protection and/or overexcitation protection to trip or block-trip the Facility Interconnection Customer 's interconnection. The requirement for this protection will be determined during system studies.
9. The Facility Interconnection Customer should be aware that certain conditions on PacifiCorp’s system can cause negative sequence currents to flow in the generator. It is the sole responsibility of the Facility Interconnection Customer to protect the Facility Interconnection Customer’s equipment from excessive negative sequence currents.
10. The Facility Interconnection Customer shall design its facilities (generation or otherwise) to avoid causing dynamic voltage excursions above 1.2 and below 0.7 pu according to WECC performance design standards (see the WECC Reliability Handbook for NERC/WECC Planning Standards, Guidelines, and System Performance Table). The WECC Reliability Handbook may be accessed via the WECC website or may be obtained upon request from the Transmission Account Manager.
11. The Facility Interconnection Customer shall design its generation to remain online for faults and for any resulting low voltages to maintain system reliability. Generation must remain online for the duration of a normally-cleared (single- or three-phase) fault on the electric system up to a maximum of nine cycles, as well as for the recovery from such a normally-cleared fault even where the voltage drops to zero during the clearing of the fault.
12. Generators must be designed to remain online for normal clearing system faults within close proximity to the plant switchyard. Voltage may approach zero at the switchyard bus for nine cycles for some types of faults. Control systems, contactors, motors, and auxiliary loads which are critical to the operation of the plant must not drop out under these conditions. Critical 480 V supply contactors must be provided

with ride-through capability where required. Additionally, generator protection systems such as the Load Drop Anticipator, Early Valve Actuator, or Power Load Unbalance should not be designed to trip a generator for normal clearing external faults or stable swings.

13. The Facility Interconnection Customer shall design its generation to remain online for off-nominal frequency operation according to IEEE C.37.106 or the following time frames in accordance with PacifiCorp and WECC region over/underfrequency requirements:

Table 5–Over/Underfrequency Requirements

Underfrequency Range (Hz)	Overfrequency Range (Hz)	Time
60.0 - 59.7	60.0 - 60.3	Continuous
59.7 - 59.5	60.4 - 61.5	Continuous Governor action
59.4 - 58.7	61.6 - 61.8	10 minutes
58.6 - 58.5	61.9 - 62.0	30 seconds
58.5 - 57.4	–	7.5 seconds
57.3 - 56.9	–	45 cycles
56.8 - 56.5	–	7.2 cycles
< 56.4	> 62.0	Instantaneous trip

14. Only solid state microprocessor underfrequency relays shall be used on generators to provide off-nominal frequency protection.
15. Synchronous generators with a nameplate rating greater than 20.0 MVA shall have generator protection set such that it does not result in tripping of the generator for the following conditions:
    a. Generator terminal voltages that are within five percent of the rated nominal design voltage.
    b. Generator terminal voltage deviations that exceed five percent but are within 10 percent of the rated nominal design voltage and persist for less than 10 seconds.
    c. Generator volts per hertz conditions that are less than 116 percent (of generator nominal voltage) that last for less than 1.5 seconds.
    d. Generator overexcited stator currents (or generator apparent impedance) less than 150 percent of nameplate rating persisting for less than five seconds.
16. Documentation of the generator protection and controls that could respond to these conditions by tripping the generator shall be provided to PacifiCorp. In the event the generating equipment owner cannot correct or mitigate these potential generator trip conditions, a request for a waiver may be made to PacifiCorp. A waiver may be justified in certain special circumstances such as low adverse reliability consequences from generator tripping.
17. All synchronous generators connected to the PacifiCorp transmission system are to be equipped with automatic voltage regulators (AVR). Generators must operate with their excitation system in the automatic voltage control mode unless otherwise approved by the PacifiCorp system operator. Generating equipment owners shall

maintain a log which records the date, time, duration and reason for not being in the automatic voltage control mode when operating in parallel with the PacifiCorp system. Generating equipment owners shall make this log available to PacifiCorp on request.

18. All synchronous generators connected to the PacifiCorp transmission system must maintain a network voltage or reactive power output as specified by the PacifiCorp system operator within the reactive power capability of the generating equipment. Generating equipment owners shall maintain a log which records the date, time, duration, and reason for not meeting the network voltage schedule or desired reactive power output when operating in parallel with the PacifiCorp system. Generating equipment owners shall make this log available to PacifiCorp on request.

19. The generator step-up and auxiliary transformer tap settings shall be coordinated with PacifiCorp transmission systems voltage requirements. Generating equipment owners shall provide PacifiCorp with generator step-up and auxiliary transformer tap settings and available ranges.

20. The AVR's control and limiting functions must coordinate with the generator's short time capabilities and protective relay settings. The generating equipment owner shall provide PacifiCorp with the AVR's control and limiter settings as well as the protection settings which coordinate with AVR control and limiting functions.

21. All new synchronous generators connected to the PacifiCorp transmission system with a nameplate rating greater than 20 MVA shall be equipped with a speed/load governing control that has a speed droop characteristic in the three to six percent range. The preferred droop characteristic setting is five percent. Notification of changes in the status of the speed/load governing controls must be provided to the PacifiCorp System Operator.

22. Prior to commercial operation, the generating equipment owner shall provide PacifiCorp with open circuit, step-in voltage test results. Recording of generator terminal voltage and field voltages shall be clearly labeled so that initial and final values can be identified in physical units.

23. Generating equipment owners shall annually test the gross and net dependable summer and winter capability of their units. These test results shall be provided to PacifiCorp.

24. Generating equipment owners shall test the gross and net reactive capability of their units at least every five years. These test results shall be provided to PacifiCorp.

25. Generating equipment owners shall test the AVR control and limit functions of their units at least every five years. An initial test result shall be provided to PacifiCorp prior to commercial operation and every five years thereafter. The initial test results shall include documentation of the settings AVR control and limit functions. Typical AVR limit functions are maximum and minimum excitation limiters and volts per hertz limiters. Documentation of the generator protection that coordinates with these limit functions shall also be provided. Typical generator protection of this type includes overexcitition protection and loss of field protection.

26. The Facility Interconnection Customer generator shall meet all WECC requirements for providing an appropriate high-response excitation system and shall make provisions for a Power System Stabilizer (PSS) on all units rated at 70 MW and greater. The exciter shall meet the following requirements:

a. The response ratio less is less than 2.0 as demonstrated through calculations consistent with IEEE Standard 421.2-1990.

b. The response time is less than 0.1 second as demonstrated through the completion of a response ratio test.

c. The open circuit step-response test is satisfactory; where satisfactory means that the response is not oscillatory in nature.

27. The Facility Interconnection Customer shall demonstrate that they have the appropriate exciter model by providing P/SSE or other plots of generator response ratio tests and opencircuit step tests that demonstrate the unit meets the criteria in item 29 below.

28. The Facility Interconnection Customer generator shall meet all WECC requirements for the installation and tuning of PSS where appropriate long-term dynamic stability and eigen value studies show a positive contribution to the damping torque in the frequency range from 0.25 Hz to 2.0 Hz.

29. Where stabilizing equipment is installed on generating equipment for the purpose of maintaining generator or transmission system stability, the generating equipment owner is responsible for maintaining the stabilizing equipment in good working order and promptly reporting to the PacifiCorp system operator any problems interfering with its proper operation.

30. PacifiCorp will maintain a contact list of all Facility Interconnection Customers tied to PacifiCorp's transmission circuits for routine and emergency grid operation use. This list will compile the normal and emergency phone numbers for the Facility Interconnection Customer's facilities and an e-mail address if available. It will be the responsibility of the Facility Interconnection Customer to notify PacifiCorp in a timely fashion when any of this information is altered or changed for whatever reason. To keep the list current, the new updated information will be supplied to:

Transmission Interconnection Account Manager
PacifiCorp
825 N.E. Multnomah Blvd. Suite 1600
Portland, Oregon 97232
(503) 813-6102

10 COMMISSIONING FOR FACILITY INTERCONNECTIONS

The following outlines PacifiCorp's procedure for performing commissioning activities. All time requirements must be met for PacifiCorp to provide the Facility Interconnection Customer with timely service. Any inspections required by local government agencies must be completed and permits signed off prior to the pre-parallel date.

Since the meter installed for the facility interconnection is PacifiCorp-owned, a PacifiCorp meter/relay technician will be the only person authorized to test the meter. Coordination between the developer and PacifiCorp's project manager is recommended at least two months before the start-up date to assure that timelines for project completion are met. The owner/developer will provide unrestricted access for PacifiCorp's employees or vendor employees (whichever are utilized) to the equipment to be commissioned.

PacifiCorp will either utilize its own qualified employees or a contractor from its approved contractor list. Commissioning of any relays which tie with the PacifiCorp system and affect PacifiCorp's customer must be certified by a Professional Engineer licensed in the state in which the interconnection project is located.

It is the Facility Interconnection Customer's responsibility to provide adequate notification through the PacifiCorp project manager for commissioning activities.

It shall be the owner/developer's responsibility to pay for all commissioning costs

Commissioning testing, where required on either PacifiCorp-owned equipment or equipment that affects the operational integrity of the electrical circuit, will be performed on site to verify protective settings and functionality. Upon initial parallel operation of a generating facility, or any time interface hardware or software is changed which may affect the functions listed below, a commissioning test must be performed. Individual qualified in testing protective equipment (a Professional Engineer, factory-certified technician, or licensed electrician with verifiable experience in testing the protective equipment) must perform commissioning testing in accordance with the manufacturer's recommended test procedure to prove that the settings and requirements of PacifiCorp's interconnection study report are met. PacifiCorp reserves the right to witness commissioning tests listed below and requires written certification stamped by a Professional Engineer from the state in which the project resides describing which tests were performed and their accompanying results.

10.1 Test Results

All tests outlined below must be complete and two copies of the test reports submitted to a PacifiCorp representative a minimum of 15 working days before the requested energize date unless otherwise agreed to by PacifiCorp. All test reports require header information reflecting the equipment identification matching the one- or three-line diagrams. One-line and three-line diagrams of the facility are required to be submitted with the test reports. All requirements must be met and test reports approved at least three working days before the requested pre-parallel date.

10.1.1 Proving Insulation

For any of the megger tests referred to below a 2,500 V DC megger or a hi-pot is preferred, but a 1,000 V DC megger is acceptable.

1. All transformers connected to the primary bus and the main transformer must be meggered winding-to-winding and each winding to ground. For purposes of this document, "primary bus or PacifiCorp side of the bus or conductor" is defined as the source-side bus or conductor from the primary interrupting device to the generating plant.

2. All circuit breakers and circuit switchers connected to the primary bus and at the interconnection point must be meggered in the following manner: breaker open each pole to ground, pole 1 2, pole 3 4, pole 5 6; breaker closed pole 1 ground, pole 3 ground, pole 5 ground and if the poles are in common tank or cell, pole 1 3, pole 3 5, pole 5 1.
3. All buses and cables shall be meggered phase–to-phase and phase-to-ground.
4. The main transformer(s) and main breaker(s) shall have a dielectric test performed on the insulating medium (gas or oil). The unit shall pass this test by keeping within the acceptable levels for all gasses or other elements in the oil as certified by the laboratory chemist before energization. This will not apply to factory-sealed circuit switcher interrupters.
5. The generator(s) must be meggered or hi-pot-tested phase-to-phase and phase-to-ground.

10.1.2 Proving Ratios

All ratios of transformers connected to the primary bus must be proven using either a turns ratio tester or a voltage ratios test. The main transformer must be tested on the final operating tap. This tap shall be recommended by PacifiCorp to best match current transmission system operating voltages.

10.1.3 Circuit Breakers and Circuit Switchers

1. A minimum to trip at 70 percent or less of the nominal DC control voltage must be performed on all circuit breakers and/or circuit switchers which are operated by PacifiCorp required relays. All units must pass this test.
2. A micro ohm test must be performed on all circuit breakers and circuit switchers. The units tested must pass the micro ohm test.
3. A timing test showing the time from trip initiation to main poles opening is required. All units must pass this test.
4. A timing test showing the time from close initiation to main poles closing is required. All units must pass this test.

10.1.4 Current Transformers and Current Circuits

1. A saturation check should be made on all current transformers (CTs) associated with the required PacifiCorp relays. If this is not possible, a manufacturer's curve is acceptable.
2. The ratio of all CTs must be proven by either a current (primary-to-secondary) or voltage (secondary-to-primary) test.
3. CT circuits must be checked for proper connections and continuity by applying primary current and reading the results in the relays. Each test must be performed in all combinations to prove proper connections to all phase and ground relays. Current must be applied or injected to achieve a secondary reading of five amps in each relay to ensure that no loose wiring or parallel current paths exists.
4. A single-phase burden check must be made on each phase of each current circuit feeding PacifiCorp required relays.

5. A megger check of the total circuit with the ground wire lifted must be done to prove that only one ground exists.

10.1.5 Relays

All relays must be field tested on site to their specified settings to verify the following:

1. Minimum operating point at which relay picks up (minimum pickup).
2. Time delay at three different current test points, in integral multiples of minimum pickup that closely characterize the relay time current curve.
3. Phase-angle characteristic of the directional relay.
4. Pickup points at maximum torque angle (MTA) and ± 30 degrees of MTA on impedance relays using the approved settings.
5. Slip-frequency, voltage-matching, phase angle-acceptance, and breaker compensation time on synchronizing relays.
6. PacifiCorp tolerances are listed below:

Table 6–PacifiCorp Relay Tolerances

Relay Type	Tolerance
Current / Voltage / Time	± 10.0 percent
Impedance / Phase Angle	± 0.05 percent
Frequency	± 0.05 percent

If a pilot relay system is required by PacifiCorp, signal level checks must be performed to PacifiCorp standards.

10.1.6 Primary Disconnect Switch

The primary disconnect switch at the point of interconnection shall be assigned a number by PacifiCorp. The switch, platform, and switch number plate bracket must be constructed to PacifiCorp Engineering Standards, Section TS. A switch number plate bracket shall be furnished by PacifiCorp.

10.1.7 Checklists and Forms for Equipment Commissioning

The Transmission Account Manager will have available for both internal and external use checklists and forms for all relevant facility interconnection equipment to be commissioned for the Facility Interconnection Customer.

The commissioning process will be coordinated through the Project Manager with other PacifiCorp employees in the field.

10.2 Pre-Parallel Test for Generator Developers

Where generation has a rated output in excess of 100 kW, the entity shall reimburse PacifiCorp for the cost of performing the pre-parallel inspection.

The Facility Interconnection Customer is responsible for ensuring that all relays and other protective devices are adjusted and working properly prior to the pre-parallel inspection. If problems arise with equipment during testing, the PacifiCorp protection representative may elect to cancel the test and reschedule.

All pre-parallel tests should be scheduled to begin at 9 a.m., Monday through Friday only. Functional tests shall be performed by the Facility Interconnection Customer and all tests shall be observed by PacifiCorp as outlined below. The Facility Interconnection Customer shall provide all test equipment and qualified personnel to perform the required tests. PacifiCorp shall be there strictly as an observer. The appropriate commissioning form shall be completed by the PacifiCorp representative on site at the time of the pre-parallel inspection.

10.2.1 Functional Tests

The following functional tests shall be performed after the equipment has been energized, but before the generator is paralleled with PacifiCorp's system:

1. Check that each protective relay trips the appropriate generator breaker and/or main breaker. This may require injecting a signal. **Jumpering across contact on the back of the relay is not acceptable.**
2. When first energized, check that proper secondary potential is applied to all voltage and frequency relays.
3. Check the synchronizing meter, synchronizing equipment, and phasing panel (if used) with the paralleling breaker closed and the generator offline. This typically requires lifting the generator leads. The equipment should show an "in-phase" condition.
4. Check the generator phase rotation. (PacifiCorp's phase rotation is A B C counterclockwise).
5. All three phases must be checked using hot sticks with a phasing tool or a phasing panel provided by the Facility Interconnection Customer. The synchronizing equipment typically checks one phase only. Phase rotation varies by area within the PacifiCorp system. Facility interconnection customers shall consult PacifiCorp for the correct rotation.

10.2.2 Impedance and Directional Relay Tests

Direction check all impedance and directional relays by doing the following:

1. Bring up load on the plant and/or generator.
2. Verify direction of power flow.
3. Measure the phase angle between the current and potential applied to the relay.
4. Observe the current action of the directional contacts according to the direction of power flow. Reverse either the potentials or current to prove contact operation for reverse power flow.

10.2.3 Generator Load Tests

For generators, the following load tests shall be performed after the generator picks up load:

1. Load check all PacifiCorp-required differential relays. The load current must balance to zero in all differential relays.
2. Load check voltage restraint overcurrent relays to prove correct connection of currents and potentials.
3. The generator(s) may have to be paralleled temporarily with PacifiCorp's system to run the load tests. Permission to do this shall be given by the

PacifiCorp operations representative observing the test by PacifiCorp dispatch.

4. Verify operation of the generator at 90 percent lagging power factor and at 95 percent leading power factor at rated output.
5. Verify operation of the generator at 95 percent and 105 percent of per unit voltage while delivering rated output.
6. Typically, pre-parallel inspections can be performed within a normal working day. PacifiCorp shall dedicate one full work day to observe the tests. If a test cannot be completed by 6 p.m., the PacifiCorp representative may cancel the remainder of the test and reschedule it. In this case the Facility Interconnection Customer shall be charged another pre-parallel inspection fee.

10.3 Parallel Operation for Generator Developers

10.3.1 Clearance for Parallel Operation (For Testing Purposes Only)

The PacifiCorp representative shall contact the PacifiCorp Control Center at least 72 hours (3 days) before the pre-parallel test and obtain a clearance for parallel operation. The PacifiCorp representative shall provide the Control Center a drawing indicating which PacifiCorp circuit the generation facility will be connected to and which PacifiCorp operated disconnect will be identified with a PacifiCorp-designated number. When the pre-parallel test is passed, the generator may at PacifiCorp's discretion be allowed to operate in parallel with PacifiCorp for testing purposes only. This should not be mistaken as an official release for parallel operation. Once this testing only permission is granted, the generator may operate in accordance with a previously executed Generation Operating Agreement, or in the absence of such an agreement for a maximum of 14 days in accordance with good utility practice unless other arrangements are made with PacifiCorp.

10.3.2 Power System Stabilizer

During the 14-day testing period, the Power System Stabalizer (PSS) shall be calibrated and tested in accordance with the latest applicable WECC standard calibration and test procedures. The test report shall be submitted for approval to PacifiCorp's Transmission Account Manager. Adequate testing of the PSS can only occur on the generating unit(s) after pre-parallel inspection has been satisfactorily completed and the units are paralleled and supplying load. The generation facility shall not be considered officially operational until this PSS calibration and testing has been done to PacifiCorp's satisfaction.

10.3.3 Permission for Parallel Operation

At the end of this period, if the Facility Interconnection Customer has not received written permission from PacifiCorp to operate in parallel, the entity must isolate from PacifiCorp until written permission is received. Written permission to parallel shall be sent to the Facility Interconnection Customer via U.S. First Class mail. This shall be done after PacifiCorp has verified the following:

1. All proper contracts and documents have been executed and are in place.
2. The pre-parallel test has been passed.
3. PSS tests and calibration have been completed.

4. All other outstanding issues have been resolved, including rights-of-way, deeds of conveyance, insurance verification, and operating agreements.
5. PacifiCorp has received final copies of the one-line diagram and elementary diagrams that show as-built changes made during construction, as well as a completed finalized generator data sheet.
6. If applicable, firm capacity performance testing of new generators cannot begin until the Facility Interconnection Customer receives written permission from PacifiCorp to parallel.

10.4 General Notes

The PacifiCorp system has ABC counterclockwise rotation.

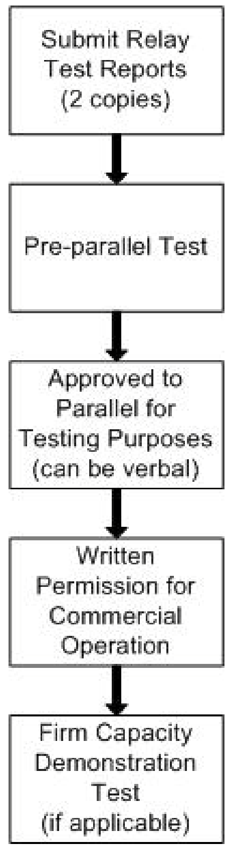
Any changes to PacifiCorp required protection equipment or major substation equipment (transformer, breaker, etc.) must be submitted to the PacifiCorp representative for review and approval by the appropriate PacifiCorp Engineer prior to the changes being made.

Routine maintenance on PacifiCorp-required protective relays and the breaker(s) must meet PacifiCorp's maintenance and test practices. After completion of these tests, test reports must be submitted to the PacifiCorp representative for review and approval by the appropriate PacifiCorp Engineer. A PacifiCorp technical representative shall then come to the customer's facilities and reseal the PacifiCorp required relays.

Questions should be directed to the PacifiCorp Transmission Account Manager.

10.5 Simplified Flow of Pre-Parallel/Parallel Test Procedure

Figure 2–Pre-Parallel/Parallel Test Procedure



11 GLOSSARY

A

Alternating Current (AC): That form of electric current that alternates or changes in magnitude and polarity (direction) in what is normally a regular pattern for a given time period called frequency.

Ampere: The unit of current flow of electricity. This is analogous to quantity per unit of time when referring to the flow of water. One ampere is equal to a flow of one coulomb per second.

Applicable Reliability Criteria: The reliability policies established by NERC, WECC, and local reliability criteria as amended from time to time, including any requirements of the NRC which are applicable to the particular type of generator and prime mover.

Automatic: Self-acting, operated by its own mechanism when actuated by some impersonal influence as, for example, a change in current strength; not manual; without personal intervention.

Automatic Control: An arrangement of electrical controls which provide for opening and/or closing in an automatic sequence and under predetermined conditions; the switches which then maintain the required character of service and provide adequate protection against all usual operating emergencies.

Automatic Generation Control (AGC): Generation equipment that automatically responds to signals from the EMS control in real time to control the power output of electric generators within a prescribed area in response to a change in system frequency, tie-line loading, or the relation of these to each other, so as to maintain the target system frequency and/or the established interchange with other areas within the predetermined limits.

Automatic Reclosing: A feature of some circuit breakers which allows them to reclose automatically after being tripped under abnormal conditions.

Automatic Tripping or Automatic Opening: The opening of a circuit breaker under predetermined conditions without the intervention of an operator.

B

Balanced Load: An equal distribution of load on all phases of an alternating current circuit.

Boost: To increase voltage.

Bundled Service or Bundled Utility Service: Traditional PacifiCorp service: transmission and distribution capacity for delivery, energy, and ancillary services.

Breaker: A switch which can open a circuit, usually designed for automatic operation.

C

Capacitance: Capacitance is developed when two charged or energized conductors are separated by a dielectric. An excess or deficiency of electrons is maintained on opposite plates of a charged capacitor. It may be said to be the property of an electrical circuit which opposes any change of voltage.

Capacity: The number of amperes of electric current a wire will carry without becoming unduly heated; the capacity of a machine, apparatus, or devices is the maximum of which it is capable under existing service conditions; the load for which a generator, turbine, transformer, transmission circuit, apparatus, station, or system is rated. Capacity is also used synonymously with capability.

Capacity Factor: The ratio of average load on a generating resource to its capacity rating during a specified period of time, expressed in percentages.

Circuit: A conducting part through which an electric current is intended to flow.

Circuit Breaker: A device for interrupting a circuit between separable contacts under normal or fault conditions.

Circuit Switcher: A device for interrupting a circuit between separable contacts under normal or fault conditions.

Class A Telephone Circuit: Service performance objective classification for a circuit which is non-interruptible before, during, and after a power fault condition.

Class B Telephone Circuit: Service performance objective classification for a circuit which is non-interruptible before and after a power fault condition exists.

Clearance: Permission to contact or to come in close proximity to wires, conductors, switches, or other equipment which normally might be energized at electrical, hydraulic, or pneumatic potential dangerous to human life. Conditions which must prevail before such permission can be granted are, in general, that the equipment or lines be completely isolated from all possible power sources and be tagged with properly filled out “man on line” tags.

Cogeneration: The sequential production of electricity and heat, steam, or useful work from the same fuel source.

Conductor: Material that can be used as a carrier of an electric current.

Control, Supervisory: A system for selecting control and automatic indication of remotely located units by electrical means, over a relatively small number of common transmission channels.

Control Switch: A switch controlling the circuit through circuit breakers or other switches which are magnetically operated.

Current: The part of a fluid (air, water, etc.) flowing in a certain direction. A flow of electric charge measured in amperes.

Current Transformer (CT): A transformer intended for metering, protective, or control purposes which is designed to have its primary winding connected in series with a circuit carrying the current to be measured or controlled. A current transformer normally steps down current values to safer levels. A CT secondary circuit must never be open-circuited while energized.

D

Dead-End Structure: The structure on which the last span of PacifiCorp-owned conductors terminates. Also called a landing structure. From the interconnection requester's point of view, it is sometimes called the take-off structure.

Delta-Connected Circuit: A three-phase circuit with three source windings connected in a closed delta (triangle). A closed delta is a connection in which each winding terminal is connected to the end (terminal) of another winding.

Demand: The rate at which electric energy is delivered to or by a system; normally expressed in kilowatts, megawatts, or kilovolt amperes.

Direct Access: Service election that allows customers to purchase electric power and additional related services from non-utility entities known as Energy Service Providers (ESPs).

Direct Current (DC): A unidirectional current in which the changes in value are either zero or so small that they may be neglected. (As ordinarily used, the term designates a practically non-pulsating current, such as the output of an electric battery.)

Disconnect: (noun) A device used to isolate a piece of equipment. A disconnect may be gang-operated (three operated together) or individually operated.

Dispatchability: Ability and availability of a generating facility to operate so that a utility can call upon it to increase or decrease deliveries of capacity to any level up to contract capacity.

Distribution Control Center: This center directs, coordinates, and implements routine and emergency switching activities on the PacifiCorp distribution system within its geographical jurisdiction.

Disturbance: Trouble (e.g., fault, sudden loss of load or generation, breaker operations, etc.) on the PacifiCorp power system resulting in abnormal performance of the system. See also System Emergency.

Droop: The slope of the prime mover's speed power characteristic curve. The speed droop, typically 5 percent, enables interconnected generators to operate in parallel with stable load division.

E

Electric Circuit: A path or group of interconnected paths capable of carrying electric current.

Electric Generator: See Generator.

Electric Substation: An assemblage of equipment for purposes other than generation or utilization, through which bulk electric energy is passed for the purpose of switching or modifying its characteristics. Service equipment, distribution transformer installations, and transmission equipment are not classified as substations.

End-Use Customer or End User: A purchaser of electric power who purchases such power to satisfy a load directly connected to the Electrical Power Grid and who does not resell the power.

Energize: To apply voltage to a circuit or piece of equipment; to connect a de-energized circuit or piece of equipment to a source of electric energy.

F

Fault Indicator: A device attached to lines which target when the current through the line exceeds the device setting.

Feeder: A circuit having as its primary purpose the distribution of electric energy.

FERC: Federal Energy Regulatory Commission.

Firm Capacity: Power committed to be available at all times during the period covered, except for forced outages and scheduled maintenance.

Forced Outage: Any unplanned outage resulting from a design defect, inadequate construction, operator error, or a breakdown of the mechanical or electrical equipment that fully or partially curtails the delivery of electricity between a load or Facility Interconnection Customer Facility Interconnection Customer 's facility and the PacifiCorp power system.

Frequency: The number of cycles occurring in a given interval of time (usually one second) in an electric current. Frequency is commonly expressed in Hertz (Hz).

Fuse: A short piece of conducting material of low melting point which is inserted in a circuit and will melt and open the circuit when the current reaches a certain value.

G

Generation Facility: A plant in which electric energy is produced from some other form of energy by means of suitable converting apparatus. The term includes the generation apparatus and all associated equipment owned, maintained, and operated by the Facility Interconnection Customer.

Generator: The physical electrical equipment that produces electric power. Sometimes used as a brief reference to a Facility Interconnection Customer.

Grid-Critical Protective Systems: Protective relay systems and Remedial Action Schemes that the may have a direct impact on the ability to maintain system security.

Ground: A term used to refer to the earth as a conductor or as the zero of potential. For safety purposes, circuits are grounded while any work is being done on or near a circuit or piece of equipment in the circuit; this is usually called protective grounding.

Ground Bank: A secondary transformer bank installed on delta-connected winding to provide a path to ground for relaying purposes.

Ground Fault: An unintentional electric current flow between one or more energized conductors and the ground.

Ground Potential Rise: A calculated value of the highest expected voltage due to a line-to-ground fault at or near the station (power switchyard). The value is calculated as follows:

GPR = 1.2 (DC Transient Factor) x 1.4. x Ground Fault Return Current (rms) x Ground Resistance

H

Hertz (Hz): The term denoting cycles per second or frequency; named after Heinrich Hertz, the pioneering German scientist who performed research on electrical power.

I

IEC: International Engineering Consortium.

IEEE: Institute of Electrical and Electronic Engineers.

Inductance: The property of an electric circuit which produces a voltage by electromagnetic induction when the current in the circuit changes or varies. It opposes any change of circuit current.

Induction Generator: Typically an induction motor that is being driven by a prime mover at a speed which is faster than the synchronous mechanical speed to generate electric power. It typically depends on the host system for its excitation and speed regulation.

Interconnection Agreement (IA): An agreement between the utility and the Facility Interconnection Customer specifying and outlining the terms and conditions of the interconnection of the generators to PacifiCorp's electrical system.

Facility interconnection customer: An entity interconnected to the PacifiCorp power system which has generation facilities (including back-up generation in parallel) on its side of the point of interconnection with the PacifiCorp power system.

Interconnection Facilities: All means required and apparatus installed to interconnect and deliver power from a load or Facility Interconnection Customer facility to the PacifiCorp power system including, but not limited to, connection, transformation, switching, metering, communications, and safety equipment, such as equipment required to protect: 1) the PacifiCorp power system and the load or Facility Interconnection Customer from faults occurring at the load or generation, and 2) the load or generation facility from faults occurring on the PacifiCorp power system or on the systems of others to which the PacifiCorp power system is directly or indirectly connected. Interconnected facilities also include any necessary additions and reinforcements by PacifiCorp to its system required as a result of the interconnection of a facility to the PacifiCorp power system.

Interconnection Study Agreement (ISA): An agreement between the Facility Interconnection Customer and PacifiCorp specifying what is to be done in the engineering interconnection study to interconnect the generator to PacifiCorp's system. This agreement specifies not only the items to be studied but the timeframe in which the study will be completed and the report results submitted to the applicant.

Interconnection Study: Those studies performed in conjunction with an interconnection request to determine the facilities needed to interconnect the load or Facility Interconnection Customer in accordance with applicable reliability requirements.

Interrupting Capacity: The amount of current a switch or circuit breaker can safely interrupt.

Interruption: A temporary discontinuance of the supply of electrical power.

K

Kilovolt (kV): 1,000 volts.

Kilovolt Ampere (kVa): The product of kilovolts times amperes. Used to refer to high voltage alternating current systems.

Kilovolt Ampere Reactive (kVAr): A measure of reactive power which is required to regulate system voltage.

Kilowatt (kW): An electrical unit of power which equals 1,000 watts.

Kilowatt-hour (kWh): 1,000 watts of energy supplied for I hour. A basic unit of electric energy equal to the use of I kilowatt for a period of I hour.

L

Lagging Power Factor: Occurs when reactive power flows in the same direction as real power. Stated with respect to the generator, lagging power factor occurs when the generator is producing VArs.

Leading Power Factor: Occurs when reactive power flows in the opposite direction to real power. Stated with respect to the generator, leading power factor occurs when the generator is absorbing VArs.

Line Losses: Electrical energy converted to heat in the resistance of all transmission and/or distribution lines and other electrical equipment (i.e., transformers) on the system.

Load-Only Entity or Customer Load: An entity interconnected to the PacifiCorp power system at a transmission or distribution voltage level which does not have generation of its own in parallel with the PacifiCorp power system and is not interconnected with any source of generation other than PacifiCorp's.

Log: A computer file, book, or loose leaf sheets for recording all station operations, clearances, readings, ratio reports, and other pertinent active daily data.

M

Maximum Torque Angle (MTA): The phase angle between the relay measured quantities at which the relay is the most sensitive.

Metering Services: Consists of removal, ensuring of meter design specifications, installation, calibration, and ongoing testing and maintenance of meters.

Meter Service Agreement (MSA): The agreement issued by PacifiCorp concerning meter services.

Megawatt (MW): 1 million watts.

Megger: An ohm meter device used to measure the ability of insulation to withstand voltage, as well as measuring the insulation resistance. A poor megger test would mean that the insulation is breaking down.

N

Nameplate Rating, Facility: Output rating information appearing on a generator nameplate or other electrical device, in accordance with applicable industry policies.

NEMA: National Electrical Manufacturers Association.

NERC: North American Electric Reliability Council or its successor.

Net Energy Output: The generation facility's gross output in kilowatt hours, less station use, to the point of delivery into the PacifiCorp power system.

Net Sale: The generation facility's gross output, in kW and kWh, less station use, to the point of delivery into the PacifiCorp power system.

Neutral: The common point of a star-connected transformer bank, a point which normally is at zero potential with reference to the earth.

No-Sale: The Facility Interconnection Customer desires to operate in parallel and not sell power to PacifiCorp.

O

Ohm: The unit of resistance of an electric circuit.

One-Line Diagram: A diagram in which several conductors are represented by a single line and various devices or pieces of equipment are denoted by simplified symbols. The purpose of such a diagram is to present an electrical circuit in a simple way so that its function and configuration can be readily grasped.

Operating Procedures: Policies and procedures governing the operation of the transmission grid as PacifiCorp, the WECC, or the NERC may from time to time develop as applicable to the particular type of generator and prime mover.

Operational Control: The rights of PacifiCorp to operate their transmission lines, facilities, and other electric plant equipment affecting the reliability of those lines and facilities for the purpose of affording comparable non-discriminatory transmission access and meeting applicable reliability criteria and policies.

Outage: A condition existing when a line or a substation is de-energized.

Output: The energy delivered by a generation facility during its operation.

Overload: A load in amperes greater than an electric device or circuit is designed to carry.

Overvoltage: Voltage higher than that desired or higher than that for which the equipment in question is designed.

P

PacifiCorp Control Center: The PacifiCorp location, manned 24 hours a day, which has been assigned operational jurisdiction over a load or Facility Interconnection Customer 's substation.

Parallel: (verb) To connect electrically a generator or energized source, operating at an acceptable frequency and voltage, with an adjacent generator or energized system, after matching frequency, voltage, and phase angle.

Parallel Operation: As used in this manual, the operation of a non-utility owned generator while connected to the utility's grid. Parallel operation may be required solely for the Facility Interconnection Customer's operating convenience or for the purpose of delivering power to the utility's grid.

Peaking: Operation of generating facilities to meet maximum instantaneous electrical demands.

Permissive Overreach Transfer Trip Scheme (POTTS): A very secure line protection scheme for insuring that a fault is within the protected line section. It requires the presence of both a trip signal from a remote terminal and a trip signal from the local relay before tripping the local breaker.

PacifiCorp Power System: The electric transmission and distribution wires, and their related facilities owned by PacifiCorp.

Point of Interconnection (POI): The point where the load or Facility Interconnection Customer 's conductors or those of their respective agents meet the PacifiCorp power system (point-of-ownership change).

Potential Transformer (PT): A transformer intended to reproduce in its secondary circuit, in a known proportion, the voltage of the primary circuit; also known as a voltage transformer.

Power: The time rate of transferring or transforming energy.

Power Factor (PF): The ratio of real (MW) power to apparent power (MVA). Power factor is the cosine of the phase angle difference between the current and voltage of a given phase.

Power Purchase Agreement (PPA): An agreement/contract between the utility and Facility Interconnection Customer whereby the amount for the purchase of power has been determined and is contractually binding on both parties.

Primary: Normally considered as the high-voltage winding of a substation or distribution transformer; any voltage used for transmission of electric power in reasonably good-sized blocks and for some distance, as contrasted with low voltage for the immediate supply of power and light locally, such as the distribution within a building. The lowest voltage considered as a primary voltage is 2.4 kV although this is also used for some heavy-power requirements over short distances.

Primary System: A system of alternating current distribution for supplying the primaries of transformers from the generating station or distribution substation.

Protection: All of the relays and other equipment used to open the necessary circuit breakers to clear lines or equipment when trouble develops.

Protective Relay: A device whose function is to detect defective lines or apparatus, or other power system conditions of an abnormal or dangerous nature, and to initiate appropriate control circuit action.

R

Reactance: In an alternating current circuit, the opposition to the flow of current attributable to the inductance and capacitance of the circuit.

Reactive Component of Current: That part of a current that does no useful work because its phase is 90 degrees leading or lagging the voltage.

Reactive Load: In alternating current work, a load whose current is not in phase with the voltage across the load.

Reactor: A coil with no secondary winding provided. The primary use is to introduce inductance into the circuit for purposes such as starting motors, paralleling transformers, and controlling current. A current limiting reactor is a reactor for limiting the current that can flow in a circuit under short circuit conditions.

Reclose: To again close a circuit breaker after it has opened by relay action.

Recloser: A protective device designed to: 1) sense overcurrent, 2) time and interrupt the overcurrent according to a preset characteristic, and 3) reclose to test and possibly reenergize the line after a specified time interval.

Remedial Action Scheme (RAS): Protective systems that typically utilize a combination of conventional protective relays, computer based processors, and telecommunications to accomplish rapid, automated response to unplanned power system events; also refers to details of RAS logic and any special requirements for arming of RAS schemes or changes in RAS programming that may be required.

Remote Station Alarms: Alarms received at an attended location from unattended stations or plants.

Remote Terminal Unit (RTU): Remotely located equipment used for collecting data and/or for supervisory control via communication channel.

Residual Current: The current which flows in the neutral or wye-connected current transformers when the current in the three phases of a line are unbalanced.

Resistance: Anything placed or already located in an electric circuit which opposes the flow of electric current.

Resistor: A device whose primary purpose is to introduce resistance into an electric circuit. An adjustable resistor is one so constructed that its amount of resistance can be readily changed.

Retail Service: Electric sales to PacifiCorp's end-use or retail customers. Such service is regulated by the jurisdictional state regulatory agencies.

S

Schematic: A diagram showing the essential features of a piece of equipment or a control system.

Secondary: The winding of a transformer which is normally operated at a lower voltage than the primary winding.

Secondary Distribution System: A low-voltage alternating current system which connects the secondaries of distribution transformers to the consumer's services.

Self-Excited: A term to describe an electric machine in which the field current is secured from its own armature current. In the case of induction generators, it refers to the condition in which the induction generator is separated from its normal excitation source and is unintentionally excited by the power factor correction capacitors in the vicinity.

Separately-Excited: Use of an exciter for sending current through the field windings of an electric machine in place of taking the field current from its own armature current.

Service Reliability: The time an entity or group of entities is served compared to the amount of time the entity or entities are without service over a given time period.

Service Restoration: The switching procedure a system operator directs or executes to restore services to entities following an outage.

Setting: The values of current, voltage, or time at which a relay is adjusted.

Single-Phase Circuit: A circuit in which all current can be represented by only one regular sine-wave pattern. Differs from a three-phase circuit, where when all circuit current is plotted, it produces three regular sine-wave patterns 120 electrical degrees apart.

Special Facilities: Those additions and reinforcements to the PacifiCorp power system which are needed to accommodate the receipt and/or delivery of energy and capacity from and/or to the entity's facility(ies), and those parts of the interconnection facilities which are owned and maintained by PacifiCorp at the entity's request, including metering and data processing equipment.

Standby Capacity: The lesser of: 1) net generation capacity, 2) connected loads to generator, or 3) 80 percent of main switch rating.

Star-Connected Circuit (Wye-Connected Circuit): A term applied to the manner in which a motor's windings or a transformer's windings are connected, (i.e., star-connected armature having one end of each of the coils connected to a common junction). A star-connected transformer is one in which the primaries and secondaries are connected in a star grouping.

Station Use: Energy used to operate the generating facility's auxiliary equipment. Auxiliary equipment includes, but is not limited to: forced and induced draft fans, cooling towers, boiler feed pumps, lubricating oil systems, power plant lighting, fuel handling systems, control systems, and sump pumps.

Step-Down Transformer: A transformer in which the secondary winding has fewer turns than the primary, so that the secondary delivers a lower voltage than is supplied to the primary.

Step-Up Transformer: A transformer in which the secondary winding has more turns than the primary, so that the secondary delivers a higher voltage than is applied to the primary.

Supervisory Control: A system by which equipment is operated by remote control at a distance using some type of code transmitted by wire or electronic means.

Surplus Sale: The generator's gross output, in kW and kWh, less any plant load and transformation and transmission losses, delivered to the PacifiCorp system.

Switch: A device for making, breaking, or changing the connections in an electric circuit.

Switch, Air: A switch in which the arc interruption of the circuit occurs in the air.

Switch, Alarm: A form of auxiliary switch which closes the circuit to a bell or other audible signaling device upon automatic opening of the circuit breaker or other apparatus with which it is associated.

Switch, Auxiliary: A switch actuated by some main device such as a circuit breaker for signaling, interlocking, or other purpose.

Synchronism: The condition across an open circuit wherein the voltage sine wave on one side matches the voltage sine wave on the other side in frequency and without phase angle difference.

System: The entire generating, transmitting, and distributing facilities of an electric utility.

System Emergency: Conditions beyond the normal control that affect the ability of the control area to function normally, including any abnormal system condition which requires immediate manual or automatic action to prevent loss of load, equipment damage, or tripping of system elements which might result in cascading outages or to restore system operation to meet the minimum operating reliability criteria.

System Protection Facilities: The equipment required by the utility to protect: 1) the PacifiCorp power system from faults occurring at a load or Facility Interconnection Customer ' facility, and 2) the load or Facility Interconnection Customer 's generating facility from faults occurring on the PacifiCorp power system or on the system of others to which it is directly or indirectly connected.

T

Telephone Working Limit: A voltage potential of 300 V or less, so personnel can work on the telephone cable without rubber gloves.

Telemetering: Measurement with the aid of a communication channel that permits power metering measurements to be interpreted at a distance from the primary detector.

Transfer Trip (TT): A form of remote trip in which a communication channel is used to transmit the trip signal from the relay location to a remote location.

Transformer: An electric device without continuously moving parts in which electromagnetic induction transforms electric energy from one or more other circuits at the same frequency, usually with changes in value of voltage and current.

Transformer Efficiency: Ratio of the electric power of the current going into a transformer to the power of the secondary circuit from the transformer.

Transformer Loss: The difference between the input power to a transformer and the output power of the transformer.

Transformer Ratio: The ratio of the voltage secured from a transformer to the voltage supplied to that transformer.

Transmission Line: A line used for electric power transmission. Distinguished from a distribution line by voltage. Lines rated 46 kV and higher are transmission lines.

Transmission Control Center: This center implements switching operations on the PacifiCorp transmission system within a specific geographical area.

U

UL: Underwriters Laboratories.

Undervoltage Protection: Upon failure or reduction of voltage, the protection device interrupts power to the main circuit and maintains the interruption.

Undervoltage Release: Upon failure or reduction of voltage, the protective device interrupts power to the main circuit but does not prevent again completing the main circuit upon return to voltage.

Unity Power Factor: A power factor of 1.000 which exists in a circuit wherein the voltage and current are in phase. There are no VArs in this condition, only watts.

V

VAr: A unit of measurement of reactive power. It is an expression of the difference between current and voltage sine waves in a given circuit; short for volt amps reactive.

VA2 = (Watts)2 + (VArs)2

Volt: The unit of electrical pressure similar to the pounds per square inch pressure on a steam gauge.

Volt Ampere: A unit of apparent power in an alternating current circuit. Equal to the product of volts and amperes without reference to the phase difference, if any. At unity power factor, a volt ampere equals a watt. Whenever there is any phase difference between voltage and current, the true power in watts is less than the apparent power in volt amperes.

Voltage Drop: The difference in voltage level between one point and another in a circuit (see line voltage drop).

Voltage Loss: The drop of potential in an electric circuit due to the resistance and reactance of the conductor. This loss exists in every circuit.

Voltage Ratio of Transformer: The ratio of the effective primary voltage to the effective secondary voltage of a transformer.

Voltage Transformer: See potential transformer.

W

Watt: A unit of electric power.

Watts AC = volts x amperes x power factor (single phase circuits).

Watt Hour: A measure of electric power. The power of one watt used for one hour.

Watt Hour Meter: An electrical measuring instrument which indicates power in watt hours.

WECC: Western Systems Coordinating Council or its successor.

Wholesale Customer: A person wishing to purchase energy and ancillary services at a bulk supply point or a scheduling point for resale.

Wholesale Sales: The sale of energy and ancillary services at a bulk supply point or a scheduling point for resale.

Wholesale Service: Electric sales to wholesale customers for resale. Such service is regulated by FERC.

"Wye"-Connected Circuit: A three-phase circuit which is star-connected, meaning the windings of all three phases have one common connection which may be connected to ground.

Appendix A Power System Stabilizer Operation and Performance Requirements

The Power System Stabilizer (PSS) aids overall electric system stability by providing additional machine damping. It will supplement the proportional voltage control used on the excitation system.

There are several types of PSS. Each type uses a different input signal, such as frequency, shaft slip, or accelerating power. The most common type of PSS uses frequency as its input signal; it consists of a source-signal transducer providing frequency deviation of the generator bus from 60 Hz and derivative and lead-lag networks to provide proper phase advance. Generator excitation is controlled by a composite of voltage and frequency.

Figure H1 provides a mathematical control block diagram of a conventional excitation system which includes a PSS that uses frequency as its input signal. The transducer provides translation of bus frequency deviation into an appropriately noise-free electrical signal to serve as input to the derivative network.

The associated filtering and wave-shaping shall be designed to emit the following signal requirements:

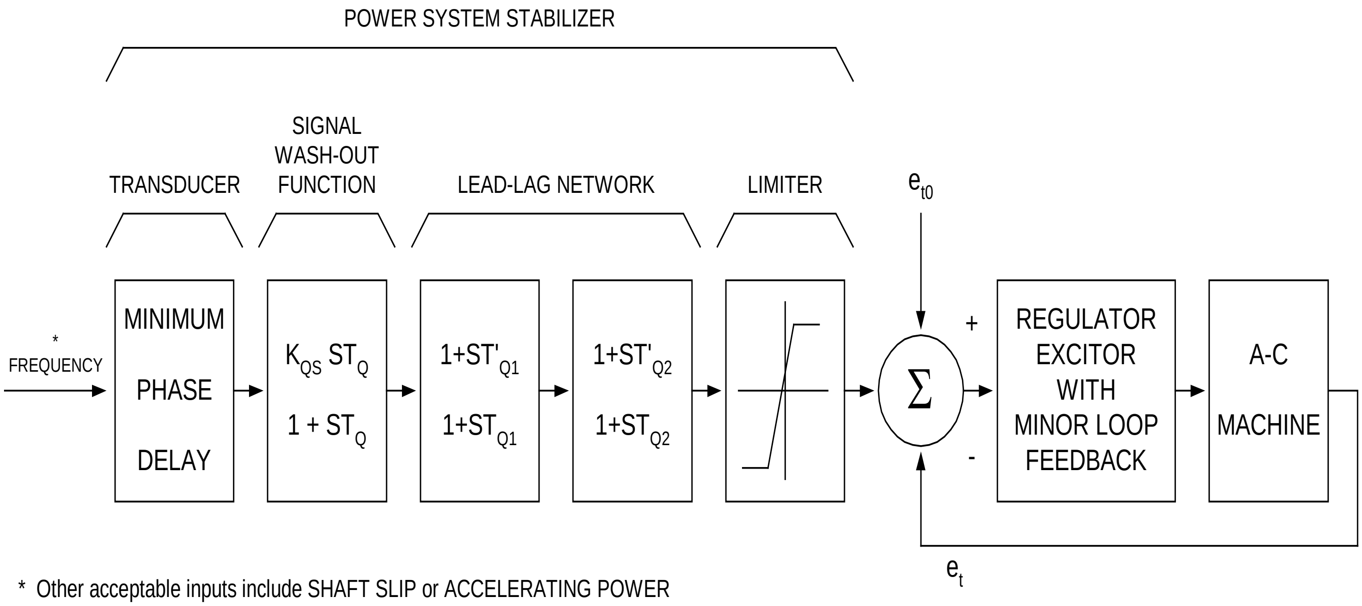
- Linearity between 59.5 and 60.5 Hz.
- Filtering and noise suppression to provide ripple shall not exceed one percent and a time constant less than 0.02 second.
- Large variations of power-supply voltage and frequency resulting from external or internal causes shall not affect performance of the PSS.

To provide the required phase lead, the PSS parameters shall be adjustable by calibrated dial settings. The parameter ranges shall be as follows:

KQs	0. 1 to 50 per unit
TQ	0. 1 to 60 seconds
T4QJ	0. 1 to 1. 5 seconds
TQi	0. 02 to 0. 1 second
T'Q2	0. 1 to 1. 5 seconds
TQ2	0.02 to 0. 1 second

FIGURE A-1

Block Diagram of Regulator-Exciter System with Power System Stabilizer



* Other acceptable inputs include SHAFT SLIP or ACCELERATING POWER

PACIFICORP
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Policy

Appendix B Site Documentation

PacifiCorp requires system drawings and relay instruction books from the dispersed generation facility. Sets of preliminary drawings are needed first. Sets of final drawings and equipment instruction books are required according to the timetable outlined below.

I. Provide one set of preliminary drawings one year prior to energizing the plant. The required drawings include:

   A. Station location plot plan.

   B. Station one-line.

II. Provide a set of final drawings and instruction books four months prior to energizing the plant.

   A. Provide three sets of the following:

      1. Station one-line.

      2. Tie breaker schematics, including:

         a. control schematics,

         b. current schematics, and

         c. potential schematics.

      3. Diagram of the relay panel arrangements.

One copy each of these drawings shall be routed to the Area Engineer, Relay and Protection Department, and the Transmission/Distribution Account Manager.

It is preferred that the copies be provided in paper format. Electronic files are acceptable if they are convertible to paper format in the size acceptable to the engineer assigned to the project. Please send all of these documents to the following address:

Pacificorp Transmission Account Manager
825 NE Multnomah Blvd., Suite 1600
Portland, Oregon 97272
503.813.6102

Appendix C Technical Data Sheet

TECHNICAL DATA SHEET

FOR

SYNCHRONOUS MACHINES

ON THE

PACIFICORP SYSTEM

FOR POWER FLOW, TRANSIENT STABILITY, AND FAULT ANALYSIS

Questions regarding this Technical Data Sheet should be directed to:

PacifiCorp Transmission Account Manager
PacifiCorp
825 N.E. Multnomah Blvd. Suite 1600
Portland, Oregon 97232
(503) 813-6102

NOTE 1: Please complete a separate data sheet for each generator that normally operates interconnected with PacifiCorp's Transmission System.

NOTE 2: This data sheet is for synchronous machines only, not induction machines

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Technical Data Sheet for Synchronous Machines on the PacifiCorp System

Project Name ________________Unit Number ____________Log Number ______________

Name of Person Completing Data Sheet ____

Telephone _________________ FAX ___________________ Email ___________________

GENERATOR DATA

1. Generator Manufacturer ___________________
2. Year Generator was Manufactured ___________________
3. Rated Generator MVA ___________________MVA
4. Rated Generator Terminal Voltage ___________________kV
5. Rated Generator Speed ___________________RPM
6. Number of Poles ___________________
7. Rated Generator Power Factor ___________________
8. Generator Efficiency at Rated Load ___________________%
9. Moment of Inertia (Turbine plus Generator) ωR^2: ___________________lb-ft^2
10. Inertia Time Constant (on machine base) H: ___________________sec. (MJ/MVA)
11. SCR (Short-Circuit Ratio - the ratio of the field current required for rated open-circuit voltage to the field current required for rated short-circuit current) ___________________
12. Typical Generator Auxiliary Load ___________________MW
13. Maximum Power Output ___________________MW
14. Please attach generator reactive capability curves. If these curves are not available give the maximum and minimum reactive limits. Q_{MAX} ___________________MVAR, lagging
Q_{MIN}: ___________________MVAR, leading
15. Rated Hydrogen Coating Pressure (Steam Units) ___________________psig
16. Please attach a simple one-line diagram that includes the generator step-up transformer bark plant load, meter, and transmission-level bus.

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

GENERATOR DATA (continued)

All impedance data should be based on MVA given in (3) and on kV given in (4) an previous page.

17. X_d direct-axis unsaturated synchronous reactance ____________pu
18. X_q quadrature-axis unsaturated synchronous reactance ____________pu
19. X'_d direct-axis unsaturated transient reactance ____________pu
20. X'_{ds} direct-aids saturated transient reactance ____________pu
21. X'_q quadrature-Axis unsaturated transient reactance ____________pu
22. X'_{qs} quadrature-axis saturated transient reactance ____________pu
23. X''_d direct-axis unsaturated subtransient reactance ____________pu
24. X''_{ds} direct-axis saturated subtransient reactance ____________pu
25. X''_q quadrature-axis unsaturated subtransient reactance ____________pu
26. X''_{qs} quadrature-axis saturated subtransient reactance ____________pu
27. X_L stator leakage reactance or Potier reactance ____________pu
28. R_a armature resistance ____________pu
29. T_{q0} direct-axis transient open-circuit tin,* constant ____________sec
30. T_{q0} quadrature-axis open-circuit time constant ____________sec
31. T'_{q0} direct-axis subtransient open-circuit time Constant ____________sec
32. T'_{q0} quadrature-axis subtransient open-circuit time constant ____________sec
33. TA_{GEN} armature short-circuit time constant ____________sec
34. T_D direct-axis transient short-circuit time constant ____________sec
35. T_Q quadrature-axis transient short-circuit time constant ____________sec
36. T'_D direct-axis subtransient short-circuit fine constant ____________sec
37. T'_Q quadrature-exis subtransient short-circuit time constant ____________sec
38. X_2 negative sequence reactance (sat./unsat.) ____________/____________pu
39. X_0 zero sequence reactance (sat/unsat) ____________/____________pu
40. Please attach a plot of generator terminal voltage versus field current that shows the air gap line, the open-circuit saturation curve, and the saturation curve at full load and rated power factor.

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

EXCITATION SYSTEM INFORMATION

Listed below are the most common excitation systems used for voltage regulation of large synchronous generators. Each type of excitation system has been specified according to its manufacturer and name. In addition, the different excitation systems have been grouped together according to common characteristics.

Please indicate, in the space provided on the left, the excitation system used for your generator. if your type of excitation system is not listed, please write the manufacturer and exciter type under the category that most accurately describes your excitation system.

A. Rotating DC commutator exciter with continuously acting regulator. The regulator power source is independent of the generator terminal voltage and current.

______1. Allis Chalmers, Regulex regulator
______2. General Electric, Amplidyne regulator - NA101
______3. General Electric, Amplidyne regulator - NA108
______4 General Electric, Amplidyne regulator - NA143
______5. General Electric, GDA regulator
______6. Westinghouse, Mag-A-Stat regulator
______7. Westinghouse, Rototrol regulator
______8. Westinghouse, Silverstat regulator
______9. Westinghouse, TRA regulator
______10. Brown Boveri, Type AB or Type ABC regulator
______11. Brown Boveri, Type DC regulator
______12. Other. Manufacturer/Type: ______________________/_______________________

B. Rotating DC commutator exciter with continuously acting regulator. The regulator power source is bus fed from the generator terminal voltage

______1. Westinghouse, PRX-400 regulator
______ 2. Other. Manufacturer/Type ______________________/_______________________

C Rotating DC commutator exciter with non-continuously acting regulator (i.e., regulator adjustments are made in discrete increments

______1. General Electric, GFA4 regulator
______2. Westinghouse, BJ30 regulator
______3. Other. Manufacturer/Type ______________________/_______________________

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

EXCITATION SYSTEM INFORMATION (Continued)

D. Rotating AC Altemator Exciter with non-controlled (diode) rectifiers. The regulator power source is independent of the generator terminal voltage and current (not bus-fed).
______1. Westinghouse Brushless
______2. Westinghouse High Initial Response Brushless
______3. Other: Manufacturer/Type______________________/_______________________

E. Rotating AC Alternator Exciter with controlled (thrysistor) rectifiers. The regulator power source is fed from the exciter output voltage.
______1. General Electric Alterrex
______2. Other: Manufacturer/Type______________________/_______________________

F. Rotating AC Alternator Exciter with controlled (thyristor) rectifiers.
______1. General Electric Alterrex
______2. Other: Manufacturer/Type______________________/_______________________

G. Static Exciter with controlled (thyristor) rectifiers. The regulator power source is bus-fed from the generator terminal voltage.
______1. Canadian General Electric Silcomatic
______2. Westinghouse Canada Solid State Thyristor System
______3. Westinghouse Type PS Static System, Type WTA, WHS, WTA-300 regulators
______4. ASEA Static System
______5. Brown Boveri Static System
______6. Rayrolle-Parsons Static System
______7. GEC-Eliott Static System
______8. Toshiba Static System
______9. Mitsubishi Static System
______10. General Electric Potential Source Static System
______11. Hitachi Static System
______12. Other: Manufacturer/Type______________________/_______________________

H. Static Exciter with controlled (thyristor) rectifiers. The regulator power source is bus-fed from a combination of generator terminal voltage and current (compound-source controlled rectifiers system).
______1. General Electric SCT-PPT or SCPT System
______2. Other: Manufacturer/Type______________________/_______________________

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

Other Excitation System Information

I. Please attach a *copy of* the instruction manual for your excitation system. Make sure that a block diagram or schematic of the excitation system is included in the manual. The diagram should show the input, output, and all feedback loops of the excitation system.

J. If the manufacturer's data *for* the excitation system (i.e., time constants, gains, and saturation curves) are available, please attach these also.

K. What is the excitation system response ratio (ASA) ?
(See *Power System Control and Stability* by Anderson and Fouad, 1st ed., 1977, pg 456, Fig E.1, for a precise definition of ASA.)

L. What is the rated exciter output voltage at *full* load? ______________Volts

M. What is the maximum exciter output voltage (ceiling voltage)? ______________Volts

N. Other comments regarding the excitation system?

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Technical Data Sheet for Synchronous Machines on the PacifiCorp System

POWER SYSTEM STANTLTZER INFORMATION (supplementary excitation system)

(Note: Complete this section only if your machine has PSS control.)

A. Manufacturer.

______1. General Electric
______2. Westinghouse
______3. Toshiba
______4. TTI
______5. Alsthom
______6. Other: Manufacturer ___________________________

B. Is your PSS digital or analog? ________________

C. What is the actuating signal (the input signal) for your PSS?

___ Bus frequency ___ Shaft slip ___Accelerating power ___Other

If "Other", indicate signal: __________________

D. Please attach the instruction manual for your PSS. The manual should include a block diagram or schematic of the PSS and the correspondence between dial settings and the time constants or PSS gain.

E. Please attach a copy of the test report for your PSS. This report should contain the dial settings or time constants and TISS gain. If this report is not available, write the dial settings below:

1. T_1 washout or reset time constant dial setting __________
2. T_2 first lead time constant dial setting __________
3. T_3 first lag time constant dial setting __________
4. T_4 second lead time constant dial setting __________
5. T5 second lag time constant dial setting __________
6. K MS gain dial setting __________
7. V_{max} maximum PSS output dial setting __________
8. V_{cut} dial setting for which PSS is set to zero when generator terminal voltage deviation is too large __________
9. Other ___________________________________ / __________
10. Other ___________________________________ / __________

F. Who installed your PSS?

Name: ____

Company: ____

City, State: ____

Phone/Fax: _____________________/_________________________

POWER SYSTEM STABILIZER INFORMATION (continued)

C. Other comments regarding the PSS?

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

TURBINE-GOVERNOR INFORMATION

Please complete part A for steam, gas or combined-cycle turbines, part B for hydro turbines, and part C for both.

A. Steam, gas or combined-cycle turbines

1. Steam turbine, Gas turbine, or Combined-cycle: ___________________

2. If steam or combined-cycle, does the turbine system have a reheat process (i.e., both high and low pressure turbines) ? ___________________

3. If steam with reheat process, or if combined-cycle, indicate, in the space provided, the percent of full load power produced by each turbine:

   by low pressure turbine or gas turbine ___________________%

   by high pressure turbine or steam turbine ___________________%

B. Hydro turbines

1 What is the turbine efficiency at rated load ___________________%

2. What is the length of the penstock? ___________________ft

3. What is the average cross-sectional area of the penstock ___________________ft^2

4. What is the typical maximum head (vertical distance from the bottom of penstock, at the gate, to the water level)? ___________________ft

5. Is the water supply run-of-the-river or reservoir? ___________________

6. What is the water flow rate at the typical maximum head? ____________________ft^3/sec

7. What is the average energy rate? ____________________kW-hrs/acre-ft

8. What is the estimated yearly energy production? ____________________kW-hrs

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Policy

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

C. Complete this section for each machine, independent of the turbine type.

1. Turbine manufacturer ______________________

2. Maximum turbine power output ___________________MW

3. Minimum turbine power-output (while on line) ___________________MW

4. Governor information:

   a. Droop setting (speed regulation) ______________________

   b. Is the governor mechanical-hydraulic or Electro-hydraulic? (Electrco-hydraulic governors have an electronic speed sensor and transducer.) ______________________

   c. Please provide below any time constants you have from the manufacturer describing the speed of response of the governor.
   Be sure to identify each time constant.

   ____ ________________sec

   ____ ________________sec

   ____ ________________sec

   ____ ________________sec

   d. Other comments regarding the turbine governor system?

   ____

   ____

   ____

   ____

   ____

   ____

   ____

   ____

   ____

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

STEP-UP TRANSFORMER DATA

1. Transformer Bank No.________________________________

2. Rated MVA ________________MVA

3. Available H.V. Taps __________ kV / __________ kV / __________ kV / __________ kV / __________ kV / __________ kV
   Available L.V. Taps ________ kV / ________ kV / ________ kV / ________ kV / ________ kV / ________ kV

4. Please indicate present tap settings: H.V. Tap: ___________kV
   L.V. Tap: ___________kV

5. Does transformer have tap changing under load? ___________

6. Is transformer a regulating-type transformer? ____________

   If yes, please indicate regulating voltage range and the number of steps.
   _______kV to _______kV Number of steps: ________

7. Please indicate how the transformer windings are connected.

   H.V. Side: ________ Wye
   ________ Gumnded Wye
   ________ Delta

   LV. Side: _________ Wye
   _________ Grounded Wye
   _________ Delta

8. Please attach a copy of the transformer test report, if available.

9. If the transformer test report is not available, please provide the "lowing impedances using the IAVA base given in (2) above:
   R_T per unit resistance _____________PU
   XT per unit reactance _____________PU
   BT per unit magnetizing susceptance _____________PU
   CT per unit core loss conductance _____________PU

10. Other comments regarding the transformer?

____

____

____

____

OF OPERATING PRACTICE QUESTIONNAIRE
SYNCHRONOUS GENERATORS

NOTE: The information on this survey is used to improve transmission models used in engineering studies.

A. Generation and Plant Load (served by own generation) Pattern:

1. Generator Size _________MVA

2. Please indicate typical peak generation level (in MW). If generator serves plant load on the same side of the PacifiCorp meter, also indicate typical load level. (Metered power equals peak generation level minus corresponding plant load).

   a. Peak Generation Level ________MW

   b. Corresponding Plant Load ________MW

3. Please indicate typical planned seasonal and time period variations as percentage of levels specified in (2) above. Approximate a percentages in Increments; of 25% (0%, 25%,50%,75%, 100%)

	Summer April thru October		Winter November thru March	
Time of Day (24-Hr format)	Generation	Load	Generation	Load
06:00 - 12:00				
12:00 -18:00				
18:00 - 22:00				
22:00 - 06:00.				

B. Type of Regulation (Complete either Section 1 or 2)

1. Maintain Voltage ____________________________
   Typical Voltage Range ____kV to ____________kV
   Generator Rated Terminal Voltage _______________kV

   Standard PacifiCorp operation bandwidth is 0.90 lagging (producing vars) to 0.95 leading (absorbing vars). If actual operation (not capability) is typically narrower than these limits, please indicate range.

   ______Lagging (producing vars) to ___________Leading (absorbing vars)

   Do you ever operate with manual voltage control (excitation system bypassed)? ______________________

   If yes, what percent of the time? ______________________

   Under what conditions?

   ____

   ____

   ____

   ____

2. Maintain Power Factor ______________

   Typical Machine Power Factor Range ____________________________
   To ________________________

   Is this automatically controlled? ____________

   If so, approximately how fast can the controller respond to a change in power factor?

   _________0 - 20 seconds
   _________20 seconds - 3 minutes
   _________greater than 3 minutes

   Standard Pacificorp bandwidth is 95 to 105% of rated voltage. If actual operation (not capability) is typically narrower than these limits please indicate range.

   ______________ to ________________ % of rated voltage

C. Governor Control

Do you operate with an automatic turbine speed controller (governor)? __________

If yes, do you operate with it blocked? _______

If yes, what percent of the time? _______%

Under what conditions?

____

____

____

D. Other comments regarding operation of your generator?

____

____

____

____

____

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____

____

Appendix D Requirements for Transmission Line Selector Switches and Associated Cost Responsibilities

Purpose

The purpose of this guideline is to: 1) ensure service availability can be maintained to single-tapped customers, 2) ensure system-wide consistency in the installation of selector switches on transmission lines, and 3) provide a clear understanding of the associated cost responsibilities wherever transmission lines are single-tapped.

Definition of Selector Switches

Line selector switches are installed on one or both sides of a single-tap in order to provide operational flexibility in service to customers on the tap line. Selector switches are operated to avoid customer outages for planned maintenance in the main line and to restore service in the case of an unplanned interruption of the main line (see Figure 1). Selector switches do not reduce the number of outages to the customer, but they do provide a relatively inexpensive way of reducing the duration of a sustained outage[1] by allowing the transmission line to be sectionalized. Selector switches cannot reduce the frequency of maintenance or unplanned outages on the single-tap line to the customer.

Applicability

Effective immediately, selector switches are a standard service requirement for all new single-tap interconnections to PacifiCorp's transmission system. This is applicable where a single-tap configuration is to be used to interconnect a new load or generation customer to a PacifiCorp-owned transmission line (46 kV and above) or when a change in service is requested by an existing load or generation customer. This guideline will also be incorporated into PacifiCorp's transmission interconnection requirements.

At PacifiCorp's discretion, a selector switch may not be required should the distance from the new single-tap interconnection to either end of the transmission line or to an existing selector switch on the line be approximately one mile or less, with minimal exposure to causes of outages (trees, traffic, etc.). Refer to Attachment 1 for a list of criteria in determining the need for selector switches.

[1] A sustained outage is an outage to a customer extending more than two minutes.

Single-Tap Configuration

For standard transmission tap interconnection to a customer-owned substation, a single-tap is provided from the most feasible transmission line to the customer's facility. With standard service, the customer will experience interruptions to their facility during a transmission line outage unless the customer has adequate on-site back-up generation.

The installation of selector switches reduces the duration of a sustained outage, but it does not eliminate momentary outages to a customer. For a sustained outage on the transmission line, service to the customer will be interrupted for the duration of time[2] it takes PacifiCorp to open the appropriate selector switch to isolate the faulted line section and close the breaker on the non-faulted line section. As an example, for a sustained outage between Station "B" and the tap point, selector switch "B" would be opened to isolate the problem and service to the customer would be restored by closing the circuit breaker at Station "A".

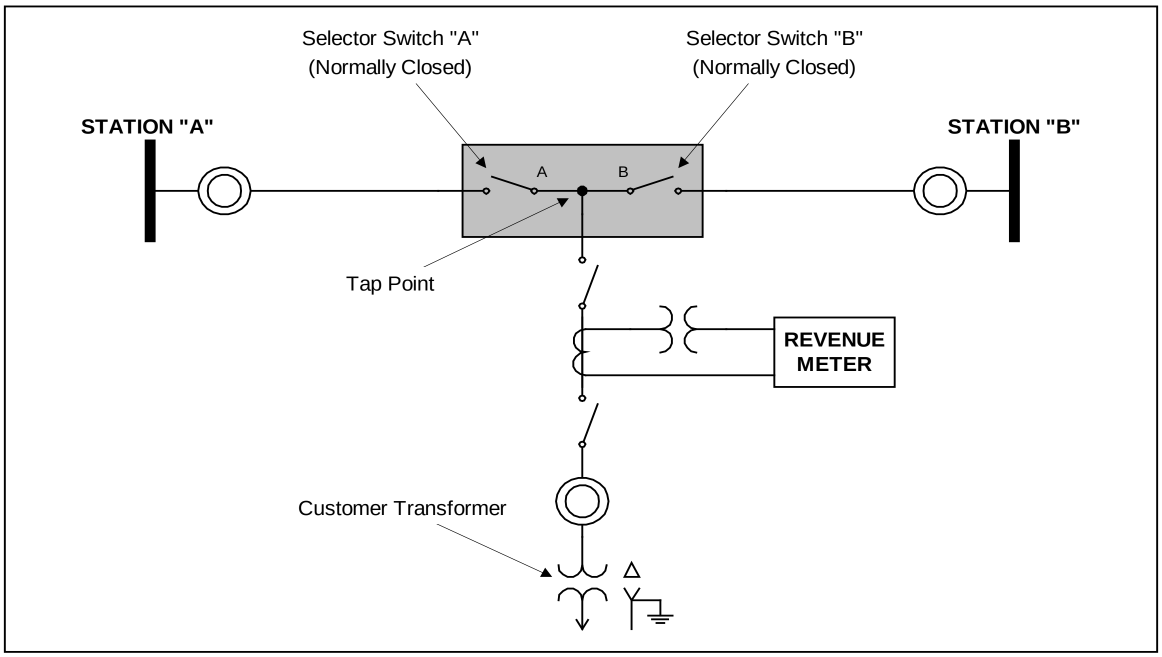


Figure 1–Typical Single-Tap Configuration with Selector Switches

Ownership and Accessibility

- Pacificorp shall own, operate, and maintain all selector switches in the system to serve customer-owned substations or customer load.
- PacifiCorp's personnel must be able to access all selector switches installation 24 hours a day.

[2] Duration of time refers to the time it takes a Pacificorp operator to manually operate the selector switches from the time Pacificorp was notified of an outage. This time could vary from about a half hour to several hours depending on the nature of the outage. Should the outage be such that the customer could be energized from one end of the transmission line, the appropriate selector switch would be opened.

Cost Responsibilities for New Single-Tap Interconnections[3]

Effective immediately, with the exception allowed in Attachment 1, line selector switches are a PacifiCorp requirement for all new single-tap interconnections to the transmission system as a means of providing adequate level of service availability. In accordance with PacifiCorp's electric tariff, if line selector switches are considered special facilities, the installation cost of the switches will be determined by the application of relevant jurisdictional state commision rules as appropriate[4].

For existing single-tap interconnections, refer to Attachment 2 for the need and installation cost responsibilities for line selector switches.

Selector Switches Capability

- PacifiCorp will determine on a case-by-case basis whether selector switches should be capable of line dropping and/or loop splitting and would specify the capabilities of the selector switches and any associated interrupting devices.
- PacifiCorp will identify locations with access difficulties, such as mountainous terrain, and may recommend that the selector switches be motor-operated and remotely controlled.

Selector Switches Installation

Selector switches must be located in close proximity (within one pole or tower structure) on either side of the single-tap on the transmission line. All structures used for mounting the selector switches will be determined and designed by PacifiCorp.

[3] New Single-Tap Interconnections: A customer requesting PacifiCorp's service who is not currently interconnected to PacifiCorp's transmission system.

[4] Unbundling of electric and transmission services may reqire the cost responsibilities be revised.

Appendix D, Attachment 1

Criteria for Determining When One or No Selector Switch Is Required

- Radial Transmission Line

  At PacifiCorp's discretion, only one selector switch may be required on the non-source side of the tapped transmission line.

- When One Selector Switch Is Sufficient

  At PacifiCorp's discretion, PacifiCorp may elect to install only one selector switch on one side of the single-tap provided that the line section without the selector switch is: 1) approximately one mile or less from the tap point to the end of the transmission line, with minimal exposure to causes of outages (trees, traffic, etc.), or 2) approximately one mile or less from the interconnection tap point of another customer with line selector switches, with minimal exposure to causes of outages.

- When No Selector Switches Are Required

  At PacifiCorp's discretion, selector switches may not be required on the transmission line if the distances on either side of the tap to the ends of the transmission line or other selector switches on the line are approximately one mile or less, with minimal exposure to causes of outages.

Criteria for Determining When Selector Switches Are Required

- Length of Transmission Line

  Long transmission lines have more exposure and have a greater frequency of being forced out of service for maintenance. Long lines are also at greater risk of experiencing sustained faults due to increased exposure to adverse elements.

- Location and Route of Transmission Line

  Geographic and environmental conditions affect the total exposure of the line to adverse elements. For example, transmission lines that traverse mountainous areas are subject to a greater number of outages due to exposure to trees and inclement weather.

- Multiple Customers on Transmission Line

  At PacifiCorp's discretion, PacifiCorp may require selector switches on a transmission line where multiple customers are tapped as a means of maintaining service availability.

Appendix D, Attachment 2
Need and Installation Cost Responsibilities for Existing Single-Tap Interconnections

This guideline is not intended for retroactive application to existing single-tap interconnections, however the installation of line selector switches on existing single-tap interconnections will be considered on a case-by-case basis based on the following:

Existing Single-Tap Customer's Request for Selector Switches

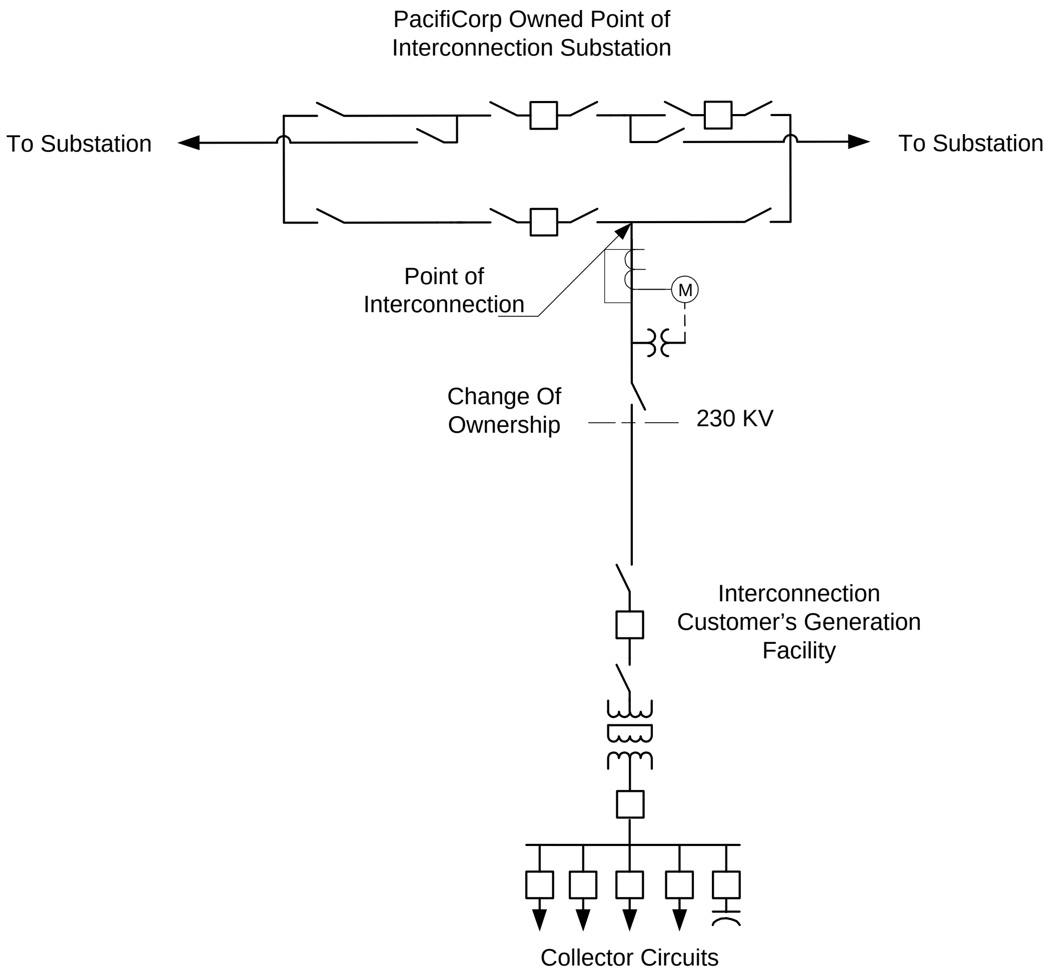
When an existing single-tap customer requests selector switches as a means of minimizing down time to his/her facility, the selector switches will be treated as Special Facilities and shall be paid for by the customer in accordance with applicable jurisdictional state utility commission rules.

PacifiCorp Determines When Selector Switches Are Necessary

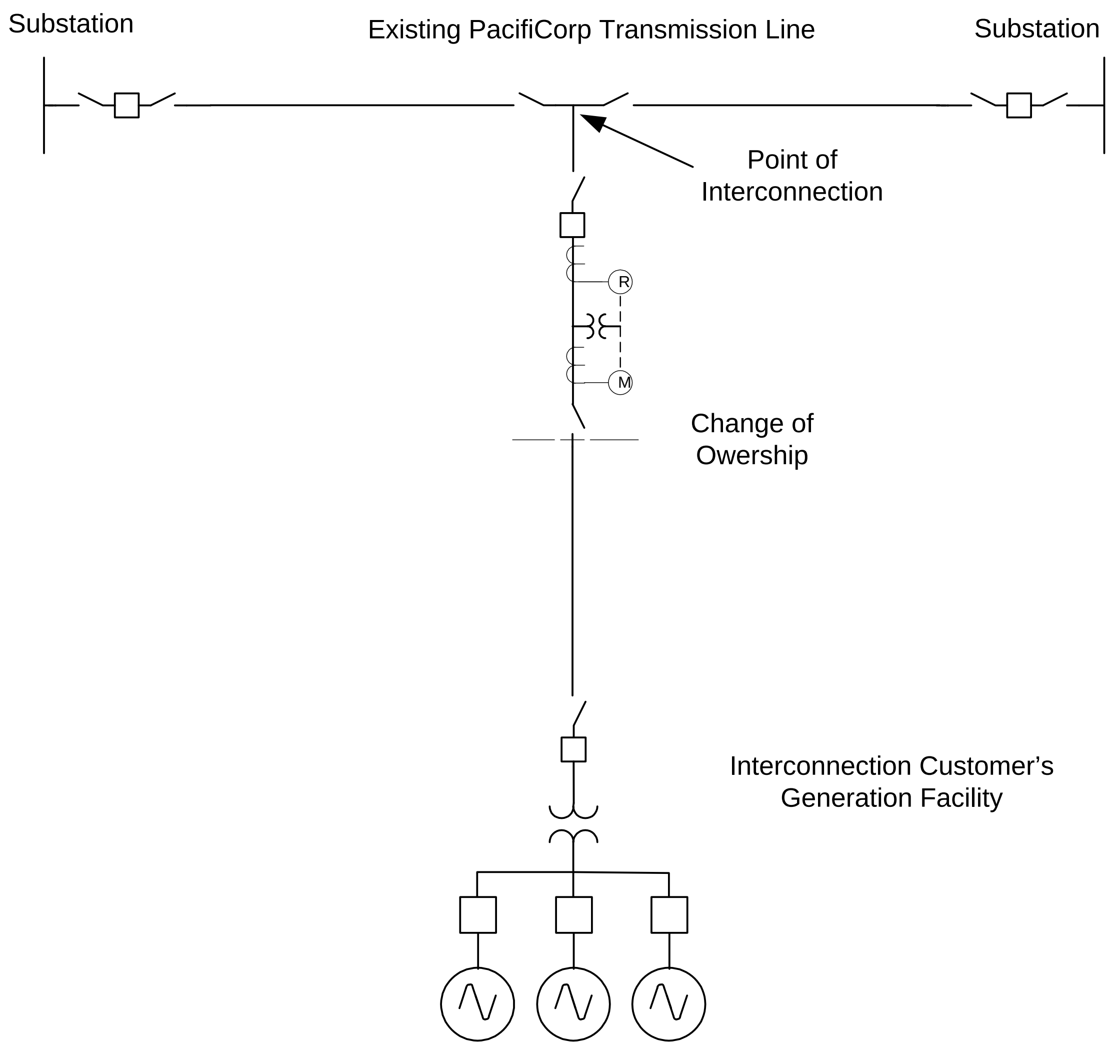
When line selector switches are determined by PacifiCorp to be needed for system benefits, the installed cost of the selector switches will be borne by PacifiCorp. System benefits include but are not limited to: 1) minimizing sustained outages to multiple customers on a single-tap line, and 2) avoiding difficult clearance coordination with multiple customers.

On existing single-tap interconnections, should the need for selector switches be identified, then the criteria outlined in Attachment I also applies.

Appendix E Typical One-Line Generator Interconnection ≥ 230 kV



Appendix F Typical One-Line Generator Interconnection < 230 kV



APPENDIX M

MECHANICAL COMPLETION, SUBSTANTIAL COMPLETION, FINAL COMPLETION, PERFORMANCE GUARANTEES AND PERFORMANCE TESTS

APPENDIX M

Mechanical Completion, Substantial Completion, Final Completion, Performance Guarantees and Performance Tests

Appendix M

Performance Tests and Minimum Standards

Section 1
Mechanical Completion Tests

1.0 Mechanical Completion Tests

Contractor shall perform and successfully complete the following tests (each, a "Mechanical Completion Test"). The Mechanical Completion Tests shall include all tests as are reasonably necessary, customary or required by Industry Standards to determine that all equipment and systems that comprise a portion of the Project function properly and within the parameters described in the Contract or in the Drawings and Specifications, as applicable.

Such tests shall include, but shall not be limited to, tests of the following items of equipment and systems:

- Low voltage switchgear and auxiliary transformers
- Auxiliary cooling water systems
- Compressed air system
- Air Cooled Condenser, including ACC fans and VFDs
- Condensate Pumps
- Chemical addition systems
- High voltage switchgear and electrical protection
- Main and auxiliary transformers
- Steam turbine
- Combustion turbines
- Heat recovery steam generators, duct firing systems, selective catalytic reduction and ammonia transfer systems and oxidation catalysts
- Main generators
- Service water system
- Water treatment systems
- Waste water discharge system
- Fire protection systems
- Auxiliary boiler and auxiliary steam system
- Natural gas preheating and gas pretreatment and filtration systems
- Emergency generator
- Uninterruptible Power Supply systems
- High pressure steam piping
- Reheat steam piping
- Safety valves
- Protective relays
- Instruments
- Controls

Such tests shall include the following types of tests:

- Radiograph selected piping
- Hydrostatic pressure tests per ASME, NFPA, AWWA, etc.
- Chemical cleaning
- Safety valve setting, if not factory set and sealed
- Balancing and vibration of all major rotating equipment
- Functional test of all safety devices (excluding safety valves and rupture discs)
- Functional tests of isolation and regulation valves
- Generator open circuit tests, if not performed at the factory
- Megger tests for power cables at voltages of 480V and higher
- Functional tests of controls and interlocks
- Settings of protective relays
- Bolt torque testing of field high voltage electrical connections
- Relay settings and amperage
- Electrical ground and/or insulation tests for all equipment
- Calibrate all instruments
- Check out of all instrument loops
- Operation of safety showers, eye wash stations and spill containment
- Automatic intervention of stand-by equipment where required (i.e. lube oil pumps)
- Load test of overhead cranes
- Operation of fire detection and alarm systems
- Operation of fire fighting equipment (NFPA requirements for systems operation)
- Successful operation of all system and subsystem components
- Other tests as specified in all applicable Codes and Industry Standards

1.1 Mechanical Completion Test Procedures

Contractor shall (i) provide for Owner's review and approval detailed Mechanical Completion Test Procedures and Mechanical Test checklist by system or major equipment not less than ninety (90) days prior to the start of Mechanical Completion Testing, which Mechanical Completion Test Procedures must be agreed upon by Contractor and Owner at least sixty (60) days prior to the commencement of testing and (ii) Contractor shall keep the Project Representative continuously apprised of the specified schedule and changes thereto for the commencement and performance of such testing activities.

The Mechanical Completion Tests will be deemed complete for a given piece of Equipment or system when such Equipment or system has been tested in accordance with Section 1.0 above and demonstrated to operate properly without endangering people, causing damage to Equipment and system and/or the Project.

Section 2
Substantial Completion Criteria

2. Substantial Completion Criteria

The Parties recognize that the terms "Capacity", "capacity", "Power" and "power" are utilized interchangeably in this Appendix M and agree that such terms are synonymous as used herein.

The Plant will be deemed ready for Substantial Completion when all of the following have occurred:

1. The Plant is substantially and materially complete and has been fully designed, constructed and equipped in accordance with the Contract (except as provided in the Final Punch List).

2. All Governmental Approvals obtained by Contractor can be assigned or transferred in accordance with this Contract.

3. All Equipment and systems are operational in accordance with this Contract.

4. All Mechanical Completion Tests have been successfully completed and documented evidence has been provided to confirm such actions have been provided; all in accordance with the Contractor's commissioning procedures.

5. All required air emissions source tests for each emissions source test identified in the Approval Order and required by the Title IV Acid Rain Program, including any compliance tests and CEMs certification tests (including RATA tests, cycle response time tests, linearity tests and seven day cal-error drift tests) shall be completed as required to meet the conditions of the Approval Order to operate the Plant. The Contractor shall, but not as a pre-requisite to achieve Substantial Completion, provide to the Owner, the draft test reports documenting the compliance test results and/or CEMS certification test results within 30 days after completing the required test(s). The Contractor shall provide a final test report for submittal by the Owner to the Utah Department of Air Quality within 45 days after completing the tests. All emissions source tests shall be conducted at the load conditions required by the Approval Order. An air stack emissions test will also be performed on the auxiliary boiler to demonstrate compliance with the Approval Order.

6. The following tests (the "Functional Tests") have been successfully completed:

(i) Plant Hot Start - Contractor will complete two (2) tests that demonstrate the ability of the Plant to start-up from a hot standby condition (overnight shutdown equivalent, 8 hours or less) to base load condition (each Gas Turbine at its normal firing temperature limit without duct firing) within XX (to be provided by Contractor) minutes.

(ii) Plant Full Load Capability Test - Contractor will complete one (1) test that demonstrates the ability of the Plant to star-up from a hot standby, "ready to run" condition within the duration defined below. The Plant shall be loaded to the full duct-fired Plant condition (each Gas Turbine at its normal full load firing temperature limit and the HRSG is duct firing at the maximum duct burner fuel flow for the ambient conditions of the test within XX (to be provided by Contractor). minutes.

(iii) Plant Partial Load Operational Test - Contractor shall demonstrate that the loading on the Plant can be successfully and smoothly transitioned from the base load condition to % load in 10% load increments. The Plant shall be operated with stable output at each load setting for a period of not less than XX (to be provided by Contractor) minutes at each load setting.

(iv)Plant Shutdown Test - Contractor will complete two (2) consecutive tests that demonstrate the ability of the Plant to safely shutdown from base load condition to a hot standby condition within XX (to be provided by Contractor) minutes.

(v) Minimum Load - The minimum electrical output for 1x1 and 2x1 operating modes is as follows, as measured at the Unit generator(s) terminals:

One Combustion Turbine Operating at Base Reference Conditions

XXX (To be provided by Contractor) MW   Minimum Load

Two Combustion Turbines Operating at Base Reference Conditions

XXX (To be provided by Contractor) MW   Minimum Load

Note: The values indicated above include the gross output from both the combustion turbine(s) and steam turbine exclusive of auxiliary loads.

For the purposes of conducting the Substantial Completion Functional Tests, a “Start” shall be deemed to be the period of time from the start command to initiate roll of the Gas Turbine to valves wide open (HP and IP) for the Steam Turbine at the specified Gas Turbine load/duct firing conditions.

All activities required for these startup and shutdown tests shall be performed through the Plant's Distributed Control System (“DCS”) with the exception of any normally expected and routine action taken by an operator. The Plant's DCS shall control, or shall cause to be controlled, all Equipment necessary for the safe and reliable operation of the Plant with the exception of Equipment normally controlled manually.

In addition, the following Functional Tests shall have met the following requirements:

Start-up After:	Duration (minutes)
Hot Start - 8 hr or less shutdown (788 F or greater ST HP Rotor Temp)	XX
Shutdown to Hot Standby	XX

Plant has been maintained in a “ready to run” condition for the duration of the shutdown.

- A purge credit (using a postpurge per NFPA 85) has been established.
- Condenser vacuum has been maintained for the duration of the shutdown, using the auxiliary steam system to maintain Steam Turbine seals.
- HRSG has been maintained in a “bottled-up” condition during the shutdown with drain valves in AUTO to allow removal of condensation.
- Stack damper has been closed as soon after shutdown as possible to maintain heat in the HRSG.
- Sparging steam is supplied to the HP, IP and LP drums to maintain heat in the HRSG per the capability of the auxiliary steam system (if required)
- Sparging steam is supplied to the Condenser to maintain low condensate oxygen levels per the capability of the auxiliary steam system.

- All vessels, including but not limited to the HP, IP, and LP drums and Condenser hotwell are maintained at prestart levels.
- All manual valves are maintained in the as-operating position.
- Control system is set to auto.
- All applicable electrical systems are energized.

Shutdown duration is defined as the time between plant at base load condition and all three generator breakers open.

Testing of the start-up and shutdown durations is contingent upon the grid accepting the required load ramp rates.

Steam Turbine HP rotor temperatures are predicted values based on average cool down rates and assume Steam Turbine was shutdown in a manner designed to preserve Steam Turbine temperature.

7. The Plant demonstrates the following as established by the thermal Performance Tests:

a) No less than (i) 95% of the Guaranteed Net Capacity and (ii) 95% of the Guaranteed Incremental Net Capacity pursuant to Section 3.1 herein; and

b) No more than (i) 105% of Guaranteed Net Heat Rate and (ii) 105% of the Guaranteed Incremental Net Heat Rate pursuant to Section 4.1 herein.

The Performance Tests for Substantial Completion shall be conducted in accordance with the procedures and conditions set forth in this Appendix M. The criteria above shall be demonstrated as measured with Plant instrumentation and special instruments as required by the Performance Test procedures when firing natural gas in accordance with the Fuel Gas Specification set forth in Section 10 herein. Performance will be adjusted to the Base Reference Conditions specified herein from the test conditions using the Site specific performance correction curves (to be provided after the execution of the Contract). Results shall be corrected for any of the Owner’s equipment auxiliary loads and corrected for degradation for operating hours in excess of the number of Equivalent

Degradation Hours as defined in Section 9 of this Appendix M. Plant performance tests will be performed with two plant operators; one operator will be in the main control room and the second in the plant to perform equipment operations.

Section 3
Final Completion Criteria

3. Final Completion Criteria

The Plant will be deemed ready for Final Acceptance when all of the following has occurred:

a. Substantial Completion has occurred and (i) Contractor has demonstrated Guaranteed Net Capacity Unfired or has paid the applicable liquidated damages per the calculations provided in Section 14 of this Appendix M, (ii) Contractor has demonstrated the Guaranteed Net Capacity Fired or has paid the applicable liquidated damages per the calculations provided in Section 14 of this Appendix M (iii) Contractor has demonstrated Guaranteed Net Heat Rate Unfired or has paid the applicable liquidated damages per the calculations provided in Section 14 of this Appendix M and (iv) Contractor has demonstrated Guaranteed Net Heat Rate Fired or has paid the applicable liquidated damages per the calculations provided in Section 14 of this Appendix M.

b. The following Functional Tests have been successfully completed:

(i) Plant Cold Start - one (1) test that demonstrates the ability of the Plant to start-up from a cold standby condition (shutdown for 72 hours or more) to base load condition (each Gas Turbine at its normal firing temperature limit without duct firing) within XX (to be provided by Contractor) minutes.

(ii) Plant Warm Start - two (2) consecutive tests that demonstrate the ability of the Plant to start-up from a warm standby condition (weekend shutdown equivalent, or 48 hours) to base load condition (each Gas Turbine at its normal firing temperature limit without duct firing) within XX (to be provided by Contractor) minutes.

(iii) Plant Hot Start - two (2) tests that demonstrate the ability of the Plant to start-up from a hot standby condition (overnight shutdown equivalent, 8 hours or less) to base load condition (each Gas Turbine at its normal firing temperature limit without duct firing) within XX(to be provided by Contractor) minutes.

(iv) Full Load Steam Bypass to Condenser - one (1) test that demonstrates the ability of the steam turbine to be tripped off line with the Plant at full load capacity so that the Gas Turbines continue to operate at full load with steam from the HRSGs bypassed to the condenser for a period of not less than four (4) hours.

(v) Auxiliary Boiler Capability Test (full load capability) - one (1) demonstration test of the ability of the auxiliary boiler to produce the design capacity of superheated steam at design conditions and the fuel use for its production. The demonstration may be by the input-output method of boiler testing and utilizing Plant instrumentation. Results shall be corrected to the boiler vendor's reference conditions and, for purposes of this demonstration; a tolerance equivalent to the test uncertainty shall be applied.

(vi) Diesel Generator Capability Test (full load capability) - one (1) demonstration test of the ability of the standby diesel generator to produce the design power capacity within the startup time criteria.

For the purposes of conducting the 2 x 1 Functional Tests, a "Start" shall be deemed the period of time from the ignition of the Gas Turbine to valves wide open (HP and IP) for the steam turbine. All activities required for these startup and shutdown tests shall be performed through the Plant's Distributed Control System ("DCS") with the exception of any normally expected and routine action taken by an operator. The Plant's DCS shall control, or shall cause to be controlled, all Equipment necessary for the safe and reliable operation of the Plant with the exception of equipment normally controlled manually. Plant performance tests will be performed with two plant operators; one operator will be in the main control room and the second in the plant to perform equipment operations. Plant performance tests will be performed with two plant operators; one operator will be in the main control room and the second in the plant to perform equipment operations.

In addition, the Functional Tests shall have met the following conditions/requirements:

Start-up After:	Duration (minutes)
Hot Start – less than 24 hour shutdown	XX
Warm Start – 24 to 72 hour shutdown	XX
Cold Start - 72 hour to 5 day shutdown	XX

Plant has been maintained in a "ready to run" condition for the duration of the shutdown.

- A purge credit (using a postpurge per NFPA 85) has been established.
- Condenser vacuum has been maintained for the duration of the shutdown, using the auxiliary steam system to maintain Steam Turbine seals.

- HRSG has been maintained in a “bottled-up” condition during the shutdown with drain valves in AUTO to allow removal of condensation.
- Stack damper has been closed as soon after shutdown as possible to maintain heat in the HRSG.
- Sparging steam is supplied to the HP, IP and LP drums to maintain heat in the HRSG per the capability of the auxiliary steam system (if required)
- Sparging steam is supplied to the Condenser to maintain low condensate oxygen levels per the capability of the auxiliary steam system.
- All vessels, including but not limited to the HP, IP, and LP drums and Condenser hotwell are maintained at prestart levels.
- All manual valves are maintained in the as-operating position.
- Control system is set to auto.
- All applicable electrical systems are energized.

Shutdown duration is defined as the time between plant at base load condition and all three generator breakers open.

Testing of the start-up and shutdown durations is contingent upon the grid accepting the required load ramp rates.

ST HP rotor temperatures are predicted values based on average cool down rates and assume ST was shutdown in a manner designed to preserve ST temperature.

c. The Plant demonstrates the Guaranteed Noise Emissions specified in Section 7 herein.

d. Record drawings have been delivered to the Owner in accordance with Appendix N of the Contract. Final training, spare parts lists, and operation and maintenance manuals have been submitted to the Owner.

e. Final Punch List items have been completed.

f. The Plant has demonstrated the Guaranteed Average Equivalent Availability of ninety five percent (95%) during the 168-hour test pursuant to Section 13 herein **or** the Plant has demonstrated an Average Equivalent Availability of at least ninety three percent

(93%) during the 168-hour test pursuant to Section 13 herein and the Contractor has paid the Liquidated Damages in accordance with the calculations per Section 13 of this Appendix.

g. The Owner shall conduct a series of HP superheater and reheater drains system acceptance tests during commissioning of the unit. Input data for these tests shall be provided by temporary tube temperature thermocouples and drain pot temporary thermocouples installed during fabrication and erection for this purpose and by normal plant instrumentation. Data from the temporary thermocouples shall be recorded at 2 second intervals during a period beginning 15 minutes prior to initiation of the CTG pre-start purge cycle until 15 minute after the unit has stabilized at full CTG load. Data shall be recorded for cold HRSG startup from initial conditions of zero HP drum pressure, warm HRSG startup from initial conditions of approximately 2 psig HP drum pressure, hot HRSG startup from initial conditions of approximately 75% of rated full HP drum operating pressure, and HRSG normal shutdown. If a temporary data acquisition system is utilized for recording temporary thermocouple data the DCS and temporary data acquisition system clocks shall be synchronized prior to each test. The acceptance criteria shall be no migration of condensate indicated during any test period by tube temperature thermocouples or attemperator inlet/outlet thermocouples, and no indication of steam exiting any drain pot during any test period as indicated by temporary drain pot thermocouples.

Section 4

Performance Guarantees

4. Performance Guarantees

4.1 Thermal Performance Guarantees

Performance consists of the Base Load Unfired Electrical Output (Net Capacity Unfired), the Base Load Unfired Heat Rate (Net Heat Rate Unfired), Peak Load Fired Electrical Output (Net Capacity Fired), Peak Load Fired Heat Rate (Net Heat Rate Fired), and Equivalent Availability.

2 x 1 Guaranteed Thermal Performance

Table 1 -Base Reference Conditions

	CASE 1	**CASE 2**
Load Level	BASE	BASE
Plant Equipment Condition	New & Clean	New & Clean
Ambient Temperature, ^{o}F	95	95
Ambient Relative Humidity , %	20	20
Barometric Pressure, psia	12.458	12.458
Fuel Type	Natural Gas	Natural Gas
Fuel Heating Value – Btu/lbm (LHV)	See note 4	See note 4
Fuel Composition	See note 4	See note 4
Fuel Temperature at Test Boundary, ^{o}F	60	60
Fuel Delivery Pressure to Site, psig	525 (minimum)	525 (minimum)
Generator Power Factor (lagging)	0.90	0.90
System Frequency, Hz	60	60
HRSG Blowdown, %	0	0
Evaporative Cooler Status, On/Off	On	On
Duct Burner Status, On/Off	Off	On

Table 2 - Guaranteed Performance Data

	Column 1	Column 2
Net Capacity Unfired and Fired, kW	_________ kW, Unfired (GNC-Guaranteed Net Capacity)	_________ kW, Fired
Net Incremental Capacity due to Duct Firing, kW (Net Capacity, Fired Column 2 minus Net Capacity Unfired Column 1)	Does not apply	_________ kW (GINC-Guaranteed Incremental Capacity)
Net Heat Rate Unfired and Fired, Btu/kWh (LHV)	_______ Btu/kWh (LHV) (GNHR, Guaranteed Net Heat Rate)	_______ Btu/kWh (LHV)
Net Incremental Heat Rate due to Duct Fired Capacity, Btu/kWh (LHV) (Difference in Heat Input at Fired Capacity and Unfired Capacity divided by Net Incremental Capacity in kW)	Does not Apply	_______ Btu/kWh (LHV) (GINHR, Guaranteed incremental Heat Rate)
Ramp Rate Guarantee	_____ MW/minute	

Ramp Rate Guarantee - Plant shall be capable of operation in automatic generation control while in compliance with the emissions requirements and noise limits. While each CTG unit is operating at the Guaranteed Minimum Output, at base load and each output level in between and in all operating conditions and while ramping of the CTGs from the Guaranteed Minimum Output to base load; the Guaranteed Ramp Rate of the complete combined cycle plant is XX (to be provided by Contractor) MW/min up and/or down repeatedly on a continuous basis with no hold points or settling times.

Table 3 – Performance Conditions

Performance is based on the following plant operating conditions and parameters, collectively known as the “Performance Conditions”. Any deviations from the Base Load Unfired and Base Load Fired Project Performance Conditions during the Performance Tests will require an appropriate correction of test data back to the Base Load Unfired and Base Load Fired Project Performance Conditions before comparison to the Estimated Performance.

Definition of Base Load Unfired and Peak Load Fired Electrical Output	Electrical output measured on the high side of the generator step-up transformers.
Definition of Base Load Unfired and Peak Load Fired Heat Rate	Total plant fuel heat consumption in Btu/h (LHV) divided by the net plant output in kilowatts.
Test Tolerance	A tolerance equal to 0.5% for capacity and 0.5% for heat rate. No other uncertainty, dead band, or test tolerance shall be applied.
Combustion Turbine Load	Base Load as defined by the manufacturer’s exhaust temperature control curve.
Auxiliary Equipment Operation	Only the equipment required to achieve Base Load Unfired/Fired operation of the Facility will be in operation.
Condition of Equipment	New and clean with less than XX (to be provided by Contractor) equivalent fired or base hours. A degradation correction will be applied according to CTG and STG OEM curves if Fired hours are greater than XX (to be provided by Contractor) at the time of the test.
Natural Gas Flow Measurement	The natural gas flow measurement used to calculate the as-tested plant heat rate shall be measured using the CTG OEMs flow section* with high precision temporary instruments installed by the contractor. Gas samples will be taken during the test for laboratory analysis of heating value. * A flow section with 1 percent measurement uncertainty, suitable for EPA emissions reporting, must be specified to the CTG OEM.

NOTES:

1. The Guaranteed Performance Data must be verified in general accordance with ASME PTC-46, “Performance Test Code on Overall Plant Performance”.
2. Division of responsibility for the performance of the test shall be as set forth in Article 12 of the Contract.
3. The Guaranteed Net Capacity is defined as set forth in Section 1.1 of Article 1.

4. The fuel gas composition (by vol.%) is included in Appendix J. Corrections to the performance test shall be provided for variations from this composition.

5. Performance guarantees for duct fired operation (Case 2) are defined on an incremental basis. Guarantee values represent the incremental heat input required for HRSG duct firing, divided by the incremental capacity obtained.

4.2 Guaranteed Air Emissions

REFERENCE CONDITIONS		
Fuel Type	Natural Gas	Natural Gas
Mode	Combined Cycle	Combined Cycle – Maximum Duct Firing
Ambient Temperature Range, °F	-16 to 105	-16 to 105
Gas Turbine Load (%)	___% Minimum load Contractor will guarantee emissions	Base
Duct Burner maximum heat input (MMBtu/hr, LHV) – Contractor to confirm during detailed design	Off	Not to Exceed ______Btu/hr (LHV)
EMISSIONS DATA (per HRSG Stack)		
NO_X (ppmvd @ 15% O_2)	Note 1	Note 1
CO (ppmvd @ 15% O_2)	Note 1	Note 1
VOC as CH_4 (ppmvd @ 15% O_2) * Note	Note 1	Note 1
Particulate (lbm/hr) (front and back half)	Note 1	Note 1
NH_3 Slip (ppmv @ 15% O_2)	Note 1	Note 1

**Note 1: Emissions shall be in accordance with Appendix U,*

Stack tests will be performed in accordance with the reference test methods set forth in the Approval Order (Air Permit). To the extent the specific test methods are not set forth in the Approval Order, then for the purposes of demonstrating the guaranteed air emissions, such air emissions shall be demonstrated by performing testing at the exhaust stack in accordance with the following United States Environmental Protection Agency (USEPA) Test Methods:

1. NO_X – USEPA Method 7E

   Demonstration of the NO_X guarantee is based on the average of three (3) one hour test runs at each test point. The test points will be the minimum CTG and maximum CTG loads plus duct firing contribution the guaranteed load range.

2. CO – USEPA Method 10

   Demonstration of the CO guarantee is based on the average of three (3) one hour test runs at each test point. The test points will be the minimum and maximum CTG loads in the guaranteed load range

3. VOC – USEPA Methods 25A and 18

   VOC are total hydrocarbons excluding methane and ethane and are expressed in terms of CH_4. Demonstration of the VOC guarantee is based on the average of three (3) one hour test runs at each test point. If Method 18 is required, at least three (3) samples will be analyzed and averaged for each test run. The test points will be the minimum and maximum CTG loads in the guaranteed load range.

3. Particulate – USEPA Methods 5/OTM-028

   Demonstration of the Particulate guarantee is based on the average of three (3) test runs at each test point. The gas turbine shall be operating at steady state conditions at the initial test load for at least two (2) hours prior to commencement of testing. Each test run shall be of sufficient length to collect a minimum sample volume of 150 cubic feet. A one-piece nozzle and probe assembly lined with borosilicate or quartz glass shall be utilized. The actual fuel flow rate during particulate testing shall be utilized to determine the exhaust gas flow rate per USEPA Method 19 when converting from units of concentration to the guaranteed emission rate. The test point will be at the maximum CTG load in the guaranteed load range.

4. Ammonia – USEPA Method 26/ISE

   Demonstration of the Ammonia Slip guarantee is based on the average of three (3) one hour test runs at each test point. Each test run shall be of sufficient length to collect a minimum sample volume of 15 cubic feet. The test points will be the minimum and maximum CTG loads in the guaranteed load range.

5. Sulfur – ASTM D5287 – per EPA recommendations

7. Emission guarantees apply during steady state operation and not during startup, shutdown, transient conditions and/or initial commissioning activities.

8. The base load condition is determined by operating on the exhaust temperature control curve with the Inlet Guide Vanes (IGV) in the nominal open position.

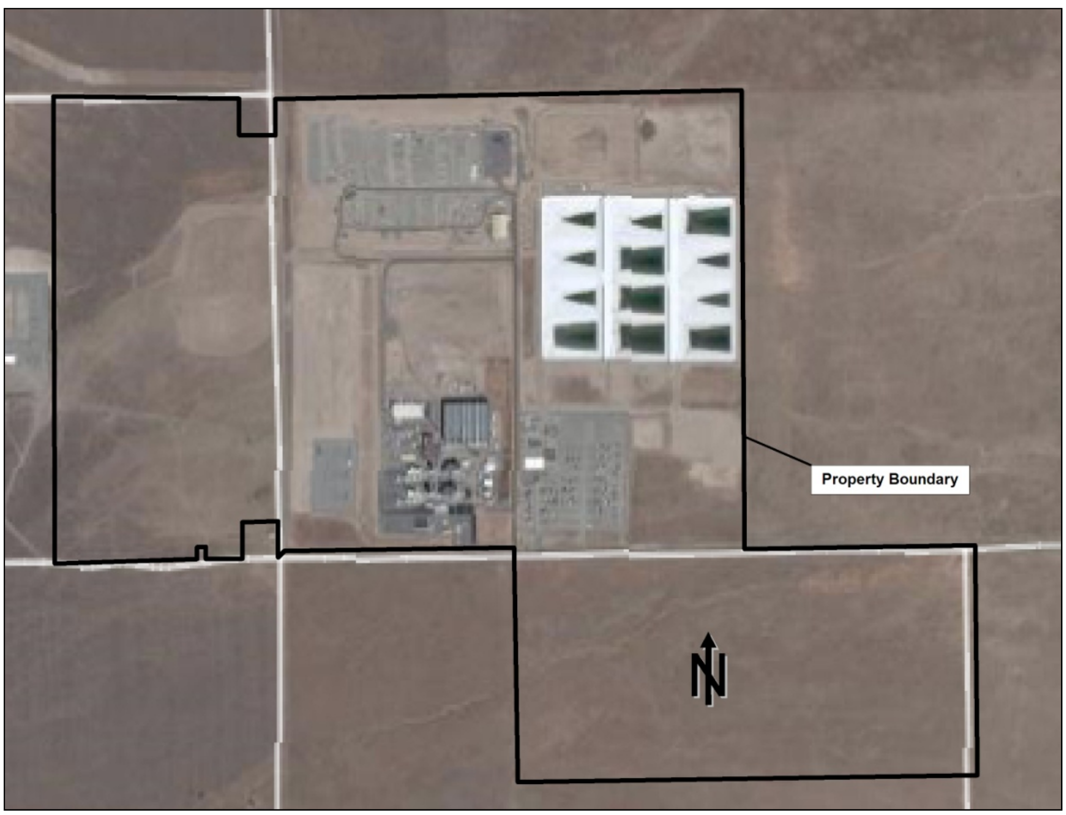
9. Emissions guarantees are on an individual stack basis and do not include ambient air contributions and are based on the design fuel composition and fuel temperatures as specified on in Section 4.1 above.

4.3 Guaranteed Noise Emissions

4.3.1 Environmental Noise Emissions

(a) The environmental noise emissions resulting from the normal operation of Currant Creek 1 and Currant Creek 2 at base load with 100% duct firing, steady-state conditions and during start-up, shutdown, and bypass operation, but exclusive of all emergency upset conditions, shall not exceed the following:

i. A maximum sound pressure level of 70 dBA, or less, in a free field environment, when measured at a distance of 400 feet (122 meters) from the plant fence line, as shown in the figure below.



(b) The environmental noise emissions resulting from the normal operation of Currant Creek 1 and Currant Creek 2 meets the noise limit requirements of the Juab County Land Use Code (July 2, 2007). These limits include an 85 dBA sound level limit at the facility property boundary, a 70 dBC sound level limit at the nearest occupied residence, and a 55 dBA day-night average sound level (Ldn). The Juab County land use code has been clarified that the 55 dBA limit applies at the nearest occupied residence.

(c) The Contractor shall conduct noise emissions performance testing in accordance with the procedure outlined herein to evaluate compliance with the environmental noise guarantee.

4.3.2 In-Plant Noise Emissions

(a) The A-weighted sound pressure level resulting from the base load, steady-state operation of individual equipment packages included in the Contractor's scope of supply shall not exceed a spatial average of 85 dBA along the equipment envelope at a height of 5 feet above the ground and personnel platforms. The equipment envelope is the perimeter line that completely encompasses the equipment package (including noise control devices) at a distance of 3 feet from the equipment face. This criterion is not a cumulative in-plant area sound level, but rather an individual equipment criterion when measured in a free-field in accordance with industry standard test methods. Contractor shall make all reasonable efforts to enforce this criterion. If it is not practical or reasonable to meet the 85-dBA equipment criterion, administrative controls shall be implemented with the Owner's approval. Administrative controls include posting warning signs prescribing hearing protection and limiting access to ensure worker noise exposure does not exceed OSHA noise exposure limits during normal operation of the facility.

(b) Silencers shall be provided for all vent valves including relief and safety valves. Each silencer shall be provided such that the A-weighted sound pressure level at 5 feet above the nearest platform or ground level in any direction from the silencer does not exceed 110 dBA.

(c) During intermittent operations such as, but not limited to, upset an emergency conditions, the sound levels within the plant shall not exceed a maximum A-weighted sound pressure level of 115 dBA in any area that is normally accessible by facility personnel and is not posted to require hearing protection.

(d) The Contractor shall conduct an in-plant noise survey to identify the in-plant areas that are exposed to A-weighted sound pressure levels exceeding 85 dBA during normal operation. These areas shall be identified with warning signs prescribing hearing protection in order to support compliance with OSHA permissible noise exposure levels. The in-plant noise survey shall be conducted in accordance with the procedures outlined herein.

4.3.3 Indoor Sound Levels

(a) The sound levels within normally occupied spaces including offices, conference rooms, and control rooms shall not exceed an A-weighted sound pressure level of 55 dBA at normally occupied locations during normal operation of the facility and exclusive of all noise sources unrelated to the normal operation of the facility including, but not limited to, people, computer equipment, phones, office equipment, warning alarms, etc. Normal facility operation excludes start-up, shut-down, and other intermittent operations as well as all emergency and upset conditions.

(b) The Contractor shall conduct a noise emissions performance test to verify compliance with the indoor sound level guarantees. The indoor sound level testing shall be conducted in accordance with the procedures outlined herein.

Section 5
Performance Tests

5. Thermal Performance Tests

In this Section 5 of Appendix M, Contractor shall perform Contractor's obligations herein.

The Performance Tests shall be conducted in general accordance with ASME PTC-46 unless mutually agreed upon by the parties.

Contractor shall plan, coordinate and conduct all of the Performance Tests. Assistance by the personnel of the Owner however shall be provided to the extent provided in the Contract.

The Contractor shall prepare and issue nine (9) months prior to the Guaranteed Substantial Completion Date, a detailed test procedure developed on the basis of using all applicable performance test codes set forth in this Appendix M and as otherwise agreed by Owner and Contractor. This procedure will be reviewed and approved by the Owner and all the tests will be witnessed by the Owner. Owner may utilize an independent third party to monitor, review and verify test procedures, performance tests and results. The test procedure shall include, but not be limited to the following:

- Administrative procedures.
- Test Procedures (including: duration, quantity, sampling requirements, test points, averaging methodology, instrumentation accuracy quality and calibration standards cycle isolation requirements).
- Correction curves and sample calculations, including all corrections to be applied, provided in algebraic format.
- The location of all test instrumentation.

Before the Performance Tests are conducted the Contractor must be given the opportunity to check all the main components in order to judge whether the Plant is in a suitable condition for the test. The Contractor shall be given opportunity to perform restorative measures within Contractor's scope of supply as Contractor sees fit. Prior to the Performance Tests, all Plant equipment directly associated with cycle performance shall be properly adjusted, calibrated, tuned, and washed to the satisfaction of the Contractor. The Equipment shall be in proper and clean working condition, and shall be functioning within its normal operating range as allowed by the equipment manufacturers.

Prior to the Performance Tests, the compressors of the Gas Turbines will be cleaned. This cleaning will be performed by the Contractor for all tests. The air intake filters must be clean or Owner and Contractor will mutually agree upon a correction factor. Should any major defects be detected they must either be rectified or a mutual Contract must be reached on how to account for them in the final results.

During the Performance Tests, the Contractor shall direct the Owner's operation and maintenance personnel in the operation of all the Equipment associated with the test and shall be responsible for the co-ordination of all on-site logistical activities in support of the tests.

All Performance Tests shall be run under normal operating conditions with essential equipment in automatic control (i.e., no control system jumpers for essential controls, forces, alarm bypasses or temporary hookups).

Contractor’s testing personnel, will also be present during the conduct of Performance Tests. Performance Tests should be performed at conditions as close as possible to the reference conditions. Correction curves will be used to convert the measured data at test conditions to the appropriate values at guarantee conditions. Other correction methods may be used if they are mutually agreed upon by the parties prior to the Performance Test. PTC 46 required corrections include inlet temperature, pressure and humidity, power factor, heat sink conditions, fuel analysis and all other base reference external or operating parameters. The degradation curve will be used to account for the effect of aging on capacity and heat rate.

All Performance Testing shall be subject to review and potential re-testing if performance-related control system settings are materially changed after Performance Tests have been run. Performance Test protocols shall incorporate a logical sequence of testing to reduce the potential of control system setting changes being required after related Performance Tests are run (i.e. Gas Turbine emissions and control settings should be completed prior to emissions testing, which in turn should be completed prior to Performance Testing).

All Performance Tests shall be conducted with the Continuous Emissions Monitoring systems, and associated data acquisition systems, in service.

Performance Test readings shall be taken at least once every five minutes except for any required manual data during each Performance Test run and average readings shall be calculated. The frequency of manual data (such as some electric metering) is dependent on the resolution of the metering. Fuel samples shall be taken at least once every 30 minutes.

General observations regarding current weather conditions, as well as significant changes in weather conditions shall be recorded on a regular basis during the applicable Performance Testing period.

In order to minimize the potential for misleading data measurements inherent with transient operation of the Plant, reasonable efforts shall be made to minimize the variation in independent test variables (those that can be controlled) during the conduct of the Performance Tests.

Prior to the Performance Test, the Contractor shall have the right to run preliminary tests in order to determine whether the Works are in a suitable test condition and to check the test instrumentation. The most recent available fuel analysis is to be used for the evaluation of the preliminary test. The Performance Test shall not be performed before the preliminary tests have been fully evaluated unless the Contractor chooses not to perform any preliminary tests.

Net Capacity Test (“NCT”) :

Three 1-hour Net Capacity Test runs will be performed to demonstrate the net electrical output. The Net Capacity Test shall be run concurrently with the Net Heat Rate Test, as set forth below. Start of each test run shall be identified prior to commencing. The Contractor and Owner shall verify the validity of the test data resulting from each test. If the test data from any test are determined to be invalid, the complete results of such test shall be disregarded. The results of at two valid runs shall be averaged to determine the net capacity.

Net Capacity (kW) is defined as gross capacity generated at the generator terminals less the Plant's auxiliary loads during normal operation, as corrected to base reference conditions. Plant auxiliary loads consist of electric loads associated with Contractor‘s equipment and the losses through the transformers. Capacity corrections shall include, but not be limited to:

- Barometric pressure
- Inlet temperature to plant equipment
- Relative humidity
- Evaporative Cooler Performance

- Generator power factor
- Fuel gas composition
- Duct Burners Heat Input

Net Heat Rate Test ("NHRT")

Three 1-hour Net Heat Rate Test runs will be conducted and performed concurrently with the respective Net Capacity Test. The Contractor and Owner shall verify the validity of the test data resulting from each NHRT. If the test data from any NHRT are determined to be invalid, the results of such NHRT shall be disregarded Net Heat Rate is defined as total fuel consumed (in MMBtu) in the Gas Turbines and the Heat Recovery Steam Generator duct burners divided by the Net Capacity (in kW) of the Plant, as corrected to base reference conditions. Heat Rate correction factors shall include, but not be limited to:

- Barometric pressure
- Inlet temperature to plant equipment
- Relative humidity
- Generator power factor
- Fuel gas composition
- Duct Burners Heat Input

Performance Test Procedures

General

The Performance Test Procedures for the NCT and the NHRT shall be written in accordance with the ASME Performance Test Code (PTC) for testing Overall Plant Performance (PTC 46). This includes methods to assure the quality of instrumentation requirements and locations, calibration requirements, fuel sampling, performance data collection and data reduction**.**

Data reduction and calculation methods will be mutually agreed-upon between Contractor and Owner.

Contractor will provide to the Owner the results in a written report of each completed Performance Test. The data is evaluated immediately after completion of the test, however, using an assumed fuel analysis based on earlier samples, and the necessary calculations are performed. The final results are presented shortly after obtaining the results of the fuel analyses from the actual test fuel samples. The Performance Test report contains the evaluations of the test recordings, the fuel analyses, the calculations, the Performance Test results and all other information needed to verify the Performance Guarantees of the Works. A preliminary report shall be provided to the Owner by the Contractor within three (3) Business Days of receipt of the fuel analyses, and shall include the final test results to which the Contract guarantees can be compared. The preliminary report shall include the data, including fuel analyses, calculations, and results. A final detailed report shall be provided to the Owner by the Contractor within fifteen (15) Business Days of completing the Performance Test.

After completion of each test, the Owner will receive copies of all the recorded observations, measurements and instrument readings necessary for the objective of the test. If required, these records shall be countersigned by the Owner and the Contractor.

Corrections for Deviations from Guarantee Conditions

The Performance Tests will be conducted as soon as practical in accordance with the Contract. The Performance Guarantees are based on equipment in new and clean condition. The Contractor will apply degradation adjustments to the Net Capacity and the Net Heat Rate per the correction factors as supplied by the Contractor as part of the correction**.**

Where applicable, other corrections will be based on mutually-agreed upon performance curves and otherwise in accordance with ASME PTC 46.

Natural gas conforming to the requirements of Section 10, herein, shall be provided by the Owner during all tests. Natural gas samples will be collected before, during, and at the end of the performance test runs. Both the Contractor and the Owner receive one set of fuel samples. A third set of fuel samples is set aside that can be used in the case of subsequent disputes. A mutually acceptable independent testing laboratory will be used for analysis of natural gas. Test results shall be corrected to the performance gas analysis used for the Performance Guarantees and based on the gas analyses performed on the gas samples taken during testing. The fuel heating value shall be determined by the average value of samples taken during each test run. The cost for sampling and analysis is by the Contractor. If an on-line gas chromatograph is available then these readings may be used as the basis for all evaluations if the Contractor approves. The gas chromatograph unit must, in this case, be properly calibrated prior to the Performance Test, and verification thereof must be made available to the Contractor. The Contractor shall always reserve the right to substitute the laboratory fuel analysis once received for the final test results.

Test Capacity Uncertainty and Test Heat Rate Uncertainty

The results shall be reported as measured and corrected per the accepted test procedure, without any adjustment for test uncertainty. There shall be a tolerance of 0.5% applied to the reported test results for power and heat rate for the purpose of, and as described in Section 14 and that wherever pursuant to this Contract there are computations to be made based on test results, then such computations shall be made using the Performance Test Values as follows: The Net Capacity Test Value is the value resulting from adjusting the Corrected Capacity Test Result upward by 0.5%. The Net Heat Rate Test Value is the result of adjusting the Corrected Heat Rate Test Result downward by the 0.5%.

Instrumentation and Measurements

The Performance Test Procedure will identify specific instrumentation, instrument accuracy level, instrumentation calibration requirements, and correction factors and correction curves to adjust the performance data from actual test conditions to Base Reference Conditions. In order to verify the Performance Guarantees, special instrumentation that is required must be in accordance with ASME PTC46. Where Plant instrumentation does not meet PTC 46 requirements, these instruments are to be provided and calibrated by the Contractor. Calibration protocols will be in accordance with ASME PTC 46.

Station instruments may be utilized as applicable for Performance Testing. Temporary instrumentation may be used as deemed necessary by the Contractor.

Inlet dry bulb and wet bulb temperature measurements will be made utilizing high accuracy instrumentation at the combustion turbine air filter, downstream of the evaporative cooler, and at the air cooled condenser. Alternatively, inlet dry bulb and humidity measurements may be made.

Auxiliary Loads

All auxiliary loads as required for normal service shall be operating, as applicable, consistent with normal operation conditions. The Performance Guarantees shall not be adjusted or corrected for any differences in the expected versus actual auxiliary power consumption.

Section 6
Air Emissions

Section 6 Air Emission Test

The Contractor shall prepare the air emissions source test procedures set forth in Section 4 of this Appendix M and shall perform all tests in compliance with the requirements of the applicable Governmental Authorities responsible for monitoring such testing.

Section 7
Noise Emissions Tests

7.0 Noise Emissions Test

(a) The Contractor shall conduct noise emissions performance testing to determine complaince with the Guaranteed Noise Emissions. The noise emissions test shall be conducted in accordance with the test protocol detailed herein as adapted from industry standards including ANSI B133.8, ANSI/ASME PTC 36, ANSI S1.13, ANSI S12.18, ANSI S12.56, ISO 10494, and ISO 3746. The Contractor shall conduct the survey with the facility operating at or near full load conditions. The Owner shall be notified prior to the survey and given the opportunity to witness the testing. The testing shall be conducted by personnel who are qualified through experience or training to conduct industrial facility noise surveys.

7.1 Measurement Instrumentation

(a) All sound level measurements shall be conducted using a sound level meter that meets the requirements of ANSI S1.4. The sound level meter shall be equipped with integrating capabilities to determine the average sound levels over a specified duration. For outdoor measurements, the microphone shall be equipped with a windscreen provided by or recommended by the sound level meter manufacturer. If necessary, the microphone shall be mounted on a tripod to maintain stability.

(b) The sound level meter shall be field calibrated immediately before and after each measurement series and after any change in equipment conditions such as a battery replacement. Field calibration shall be conducted using a precision calibrator or piston phone and each calibration level shall be recorded. A change in calibration level exceeding +/- 1.0 dB may require that the measurement series be repeated.

(c) The sound level meter equipment and calibrator shall have been laboratory calibrated within the 12 months prior to the testing. All equipment calibration certificates shall be available during the survey and copies shall be included with the final survey report.

7.2 Measurement Conditions

(a) During all operational sound level measurements, the Project should be operating under normal steady-state conditions. Normal conditions exclude start-up, shutdown, steam release, load transients, and all other abnormal or upset conditions. Any variation from the rated load shall be noted. Equipment that is not required for normal facility operation shall not be operating during the surveys. All equipment enclosures shall be fully installed and all doors and openings shall be closed. All on-site maintenance and construction activities that could potentially affect the Project sound levels shall be minimized.

(b) Outdoor sound level measurements shall not be conducted during adverse weather conditions or conditions which may damage the instrumentation. Measurements should be avoided during periods when the average wind speed exceeds 7 mph measured 5 feet above the ground or platform. Measurements during excessive wind speeds shall be noted on the data sheets. Measurements shall not be conducted during periods of precipitation or wet surface road conditions if such conditions increase the background noise. Weather conditions shall be noted on the measurement data sheets.

7.3 Property Boundary Sound Level Measurements

(a) Noise emissions testing shall be conducted along the plant property boundary. If local conditions such as background noise, accessibility, reflecting surfaces, screens, topographical conditions, or other restrictions preclude meaningful measurements at the measurement locations, alternate locations may be selected provided proper corrections are made in accordance with the referenced standards. The exact locations shall be determined prior to the testing and mutually agreed to by all parties involved. The background and operational measurements shall be taken at the same measurement locations. The microphone shall be positioned approximately 5 feet above the ground for all measurements.

(b) The noise emissions testing shall include operational sound level measurements along the property boundary during normal operation of the Project. All non-Project noise sources that are audible during the measurement period shall be noted on the data sheets. The sound level survey shall include background sound level measurements at each operational measurement location during a period when the Project is completely shut down. The background sound level measurements shall be conducted during a period that experiences ambient conditions (such as from Phase 1) similar to the background conditions experienced during the operational measurements.

(c) The sound level measurements shall include the A-weighted 90-percentile exceedance sound level, L90. The duration of the measurement period shall be a minimum of 5 minutes or longer as deemed necessary to capture a representative sound level at the measurement location. All sound level measurements shall be recorded during a period of minimal background influence, i.e. between vehicle passes, aircraft flyovers, train passes, and other discrete non-facility sources. The measurement may be paused during such discrete noise sources if necessary to achieve the minimum measurement period.

(d) Background sound level measurements shall be deemed unnecessary if the operational measurements, without any corrections for background noise, are equal to or less than the noise criteria defined in the Contract. Additionally, if representative background sound level measurements indicate that the background sound levels are at least 10 dB below the operational sound levels, the influence of the background noise shall be deemed negligible and further background sound level measurements shall not be necessary. If the measured background sound level is not at least 3 dB below the measured operational sound level, alternate measurements must be conducted. Alternate measurements shall include conducting measurements at locations closer to the Project (within the far-field) or during periods when the background noise is lower. The alternate measurements must provide background sound levels that are at least 3 dB lower than the operational sound levels. If the measured operational sound level does not exceed the measured background sound level by at least 3 dB and alternate measurements were not available as previously described, the operational sound level shall be deemed not to be contributing to the background. Thus, the Project sound pressure level shall be assumed to be 10 dB below the measured background level or equivalent to the noise criteria adjusted to the measurement location, whichever is lower.

(e) The Project sound level at each measurement location shall be determined by correcting the measured operational sound level in accordance with the referenced standards to account for background noise, if necessary. Following the background correction, the Project sound level at all measurement locations that are not property boundary or residential boundary locations shall be corrected in accordance with the referenced standards for the distance to the corresponding compliance location. The Project sound levels at the compliance locations, after appropriate corrections, shall be compared to the Guaranteed Noise Emissions. Measurement uncertainties shall be applied in accordance with the referenced standards.

7.4 In-Plant Sound Level Survey

(a) Survey locations shall be positioned along the equipment envelope of the major equipment packages. The microphone shall be positioned approximately 5 feet above the ground or personnel platform for all measurements. If the measured A-weighted sound pressure level exceeds 85 dBA, additional measurements shall be conducted at increasing distances from the equipment to identify the location of the 85 dBA sound pressure level contours/areas. Noise contributions and influences from non-Project related noise sources will be noted and qualified, as appropriate.

(b) The sound level measurements shall include the A-weighted equivalent-continuous sound level, Leq. The duration of the measurement period shall be a minimum of 5 seconds or longer to capture a representative sound level. All areas that experience sound levels exceeding 85 dBA during normal operation shall be delineated on appropriate arrangement drawings.

7.5 Indoor Sound Level Measurements

(a) Sound level measurements shall be taken at locations within the control room, offices, and conference rooms related to the Project. At a minimum, all positions where personnel are normally positioned will be included as measurement locations. The microphone shall be positioned 5 feet or 3.5 feet above the floor for locations where occupants are normally standing or sitting, respectively.

(b) Sound level measurements shall be conducted at each measurement location during normal operation of the facility. The sound level measurements shall include the A-weighted 90-percentile exceedance sound level, L90. The duration of the measurement period shall be a minimum of 15 seconds or longer as deemed necessary to capture a representative sound level at the measurement location. The measurement may be paused during discrete noise events if necessary to achieve the minimum measurement period.

(c) The operational measurements shall be recorded during a period of minimal background influence. Discrete noise events within the room such as people talking, people moving about, doors shutting, office equipment operating, phones ringing, radios playing, etc., shall be minimized. All doors and windows shall be closed and the ventilation system shall be operating under normal conditions. All noise sources that are audible during the measurement period shall be noted on the data sheet.

(d) If necessary, background sound level measurements shall be conducted at each measurement location during a period when the Project is completely shut down. The background measurements shall be made during a period that experiences ambient conditions similar to the background conditions experienced during the operational measurements. Background sound level corrections shall be applied as specified in the referenced standards.

(e) The average sound level within the space, after appropriate corrections, shall be compared to the guaranteed sound level to determine compliance. Measurement uncertainties shall be applied in accordance with the referenced standards.

7.6 Test Report

(a) A final noise emissions performance test report shall be submitted and shall include the following information. The final report shall include a list of all test equipment and the corresponding serial number(s) as well as copies of all laboratory calibration certificates. Additionally, the final report shall include the names of all personnel who conducted and witnessed the testing. Drawings shall be generated which show the location of each measurement and the measured sound level at that location. As appropriate, the drawings will delineate the extents of high noise areas where a sound level of 85 dBA is exceeded during normal operation.

Section 8
Factored Fired Hours & Factored Starts

8.0 DEFINITION OF FACTORED FIRED HOURS AND FACTORED STARTS

The value for Equivalent Base Hours and Equivalent Starts (or Factored Fired Hours and Factored Starts if General Electric equipment is utilized or Factored Operating Hours and Effective Starts if Mitsubishi equipment is utilized) shall be used for the calculation of Liquidated Damages as defined in the Liquidated Damages section of the Contract that may be incurred as a result of excessive Equivalent Base Hours and Equivalent Starts that occur during startup, commissioning and testing or as otherwise used in this Appendix.

Section 9

Definition of Equivalent Degradation Hours & Degradation Curve

9.0 Definition of Equivalent Degradation Hours:

1. Performance is based on new and clean conditions. The Performance Test for each CTG must be conducted prior to the achievement of ________ (By Contractor) Factored Fired Hours by the CTG (the “New and Clean Period”). However, preliminary test runs may be conducted prior to the Performance Tests to determine if the equipment is in condition to undergo the test, to check instruments and methods of measurement, to check adequacy of organization and procedures and to train personnel.

2. If required by the Performance Test procedure, during New and Clean Period, the CTG’s shall be started and taken to synchronous speed for a brief airflow test which will establish the CTG’s New and Clean compressor performance.

3. If the Performance Test is conducted after the New and Clean Period, degradation factors for all Equivalent Degradation Hours past this New and Clean Period will be applied based on the CTG engine tests or the degradation curves provided by the combustion turbine manufacturer to the Contractor. For the purpose of determining the elapsed time from the New and Clean Period reference point for performance degradation, the Equivalent Degradation Hours for the equipment shall be determined from certified station logs and other pertinent station data using the Contractor/Manufacturer’s calculation methodology.

4. The determination of Equivalent Degradation Hours shall match the CT Manufacturer’s methodology for determining Equivalent Base Hours or Factored Fired Hours that the CT Manufacturer’s would apply under its normal gas turbine maintenance program for the equipment being supplied.

Section 10
Fuel Specification

(See Fuel Gas Quality included in Appendix J)

Section 11

Water Specification

(Water Quality Recommendations for Evaporative Coolers for Gas Turbine Applications)

(To be supplied by Contractor)

Section 12
Correction Curves

(To be provided by Gas Turbine Supplier and Contractor as part of the Performance Test Procedure)

Section 13
Guaranteed Average Equivalent Availability

13.0 Guaranteed Average Equivalent Availability

A one-hundred sixty-eight (168) hours Average Equivalent Availability test will be performed with gas fuel in accordance with the Fuel Gas Specification set forth in Section 10 as a requirement of Final Acceptance. The test period will be a rolling window interval such that for successful completion of this test, the Average Equivalent Availability during the test run of one hundred sixty eight (168) consecutive hours must not be less than ninety-five percent (95%) ("Guaranteed Average Equivalent Availability").

The term "Average Equivalent Availability" is specifically defined as follows for the purposes of the test:

$$\text{Average Equivalent Availability (\%)} = \frac{A + B + C}{D} \quad X\ 100\%$$

Where:

A = Total number of hours that the Plant is available for dispatch or operated with the breakers closed to the station bus (including time required to start up and shut down the Plant) without a load restriction on the Plant imposed by Contractor or a failure of the Plant as covered in “C,” below. Actual Plant load will be as determined by Owner.

B = The product of the number of hours that the Plant is available for dispatch or operated with the breakers closed to the station bus (including time required to start up and shut down the Plant) during which Contractor has imposed in writing a load restriction on the Plant multiplied by the percentage of load then allowed.

C = The product of the number of hours that the Plant is operated with the breakers closed to the station bus but is incapable of operating at base load or a lower dispatched load due to failure of Plant equipment in the scope of the Contractor multiplied by the percentage of base load or dispatched load which is actually achievable.

D = Total number of hours of the test period.

The Average Equivalent Availability of the Plant shall be calculated at the end of the test period. If the Average Equivalent Availability of the Plant is equal to or greater than respective the Guaranteed Average Equivalent Availability, the test shall be conclusively deemed successful. If the Average Equivalent Availability of the Plant is less than ninety-five percent (95%) in the test but greater than or equal to ninety-three percent (93%), Contractor may either repeat the test of pay the liquidated damages in accordance with the Contract Terms & Conditions, Article 16 and this Appendix, In the event the Average Equivalent Availability Test is less than ninety-three percent (93%), Contractor shall take appropriate remedial action. Following such remedial action, the test shall be reinitiated and the Average Equivalent Availability will be re-calculated on a continuing basis.

13.1 Conditions Applicable to the Average Equivalent Availability Test

(a) Excluded are outage hours which are not under Contractor's control, including but not limited to those caused by low fuel gas supply pressure, grid frequency variations outside of the operating manuals and instruction manuals, operator error, equipment not supplied or installed under this Contract, acts of Owner or its agents or subcontractors, Force Majeure events, and Owner's failure to comply with its obligations under the conditions applicable to the tests and the general conditions of all warranties.

(b) Contractor shall not be liable for outage hours arising from Owner's failure to adhere to the operating manual, instruction manual and other written operational recommendations of Contractor.

(c) If the Plant is shut down or is derated due to any of the reasons listed above, the test will be interrupted for the duration of the shutdown or derating. When the test is restarted, the clock should be restarted at the number of hours achieved just before the shutdown or derating occurred. If such outages exceed 20 Days, the test will be deemed successfully complete.

(d) The achievement of the specified Average Equivalent Availability is based upon the anticipated operating parameters of the Plant (e.g. duty cycle, fuel specification, etc.) specified in the Contract.

(e) Owner shall maintain an operator log sheet, following a mutually agreeable format, indicating in detail performance parameters, cycles and maintenance actions. Owner shall report key performance parameters on a daily basis to Contractor. Contractor may inspect the operator log sheets. The Contractor, at its own expense, may provide a modem for the purpose of monitoring plant parameters during the tests. The Owner will provide a phone access line for this modem.

(f) Contractor shall be entitled to have a field representative present during performance of the Average Equivalent Availability tests.

To the extent forced outage hours are accumulating due to remedial actions for which Contractor is not responsible for performing, Owner shall perform such remedial actions diligently within such periods of time not in excess of times considered reasonable in the industry for such remedial actions.

Section 14
Performance Liquidated Damages

14.1 General

Liquidated damages will be calculated for performance which fails to achieve the Performance Guarantees (i.e. less than Guaranteed Net Capacity Unfired; less than Guaranteed Net Capacity Fired, greater than Guaranteed Net Heat Rate Unfired, greater than Guaranteed Net Heat Rate Fired). Liquidated Damage rates are provided in the Article 16 of the Contract.

14.2 Definitions

Final Test Value shall mean the measured Performance Test values which are corrected to the Base Reference Conditions set forth in Section 3.1 and adjusted for test tolerance all in accordance with the Performance Test procedures pursuant to Section 4 herein.

Test Tolerance ("TT") shall be 0.5% expressed as a decimal, applicable to the net capacity unfired, net capacity fired and 0.5% applicable to the net heat rate unfired and the net heat rate fired. The subscript letters "C", "IC", "HR" and "IHR", represent net capacity, incremental net capacity, net heat rate and incremental net heat rate respectively, in the following equations.

Ct = The Final Test Value of net capacity when the Plant is operating on Guarantee Fuel, in kilowatts.

ICt = The Final Test Value of incremental net capacity when the Plant is operating on Guarantee Fuel, in kilowatts.

HRt = The Final Test Value of net heat rate when the Plant is operating on Guarantee Fuel, in Btu/kWh, LHV.

IHRt = The Final Test Value of incremental net heat rate when the Plant is operating on Guarantee Fuel, in Btu/kWh, LHV

Cg= The Guaranteed Net Capacity when the Plant is operating on Guarantee Fuel (Note 1), in kilowatts.

ICg = The Guaranteed Incremental Net Capacity when the Plant is operating on Guarantee Fuel (Note 1), in kilowatts.

HRg= The Guaranteed Net Heat Rate when the Plant is operating on Guarantee Fuel (Note 1), in Btu/kWh, LHV.

IHRg = The Guaranteed Incremental Net Heat Rate when the Plant is operating on Guarantee Fuel (Note 1), in Btu/kWh, LHV.

Note 1: These values are the guaranteed values shown in Section 4.1 above.

14.3 Calculation of Liquidated Damages Relative to Net Capacity

(Cg – [Ct x (1+TTc)]) x GNCLD = A

The liquidated damage amount relative to net capacity shall equal the value of A if A is positive. If A is negative, no liquidated damages are applicable.

14.4 Calculation of Liquidated Damages Relative to the Incremental Net Capacity

(Cg – [ICt x (1+TTc)]) x GNCLD = B

The liquidated damage amount relative to net capacity shall equal the value of B if B is positive. If B is negative, no liquidated damages are applicable.

14.5 Calculation of Liquidated Damages Relative to Net Heat Rate

([HRt x (1 - TThr)] –HRg) x GNHRLD x 1.1091 = C

The liquidated damage amount relative to net heat rate shall equal the value of C if C is positive. If C is negative, no liquidated damages are applicable.

14.6 Calculation of Liquidated Damages Relative to the Incremental Net Heat Rate

([IHRt x (1 - TThr)] – IHRg) x GINHRLD x 1.1091 = D

The liquidated damage amount relative to net heat rate shall equal the value of D if D is positive. If D is negative, no liquidated damages are applicable.

APPENDIX N

PACIFICORP STANDARDS – ENGINEERING DOCUMENTS, DRAWINGS AND OTHER DELIVERABLES

APPENDIX N

PacifiCorp Standards – Engineering Documents, Drawings and Other Deliverables

General Owner Requirements for Document Preparation

Exhibit A – App. N – Specification DCAP 876

Appendix N

Engineering Documents, Drawings and Other Deliverables

1.0 General

To facilitate PacifiCorp Energy's (Company's) review in accordance with the terms of this Contract, the following submission requirements shall be met by the Contractor.

All transmittals are to clearly indicate the Company's name, Contractor's project number, Company's project number and name, how they are being sent, and the reason for the submittal. The transmittal should include a clear, concise description of all documents enclosed. Documentation by drawing number, revision number, and date should be indicated, if applicable. Distributions to other parties are to be shown on the face of the transmittal.

All documents prepared by Contractor or any of its Subcontractors shall be in English and shall bear the project number, name. Each document shall clearly indicate the applicable status, e.g. Preliminary, for Information, for Review, for Bid, for Construction, As Built.

All drawings, documents and manufacturer information shall indicate the Company as the owner, Contractor shall ensure that the Company is listed as the owner of record with all subcontractors and manufacturers providing any and all material or equipment for the project.

The measurement system shall be U.S. Customary System, and all drawings and dimensions shall be to scale. Non-scale dimensions (NTS) on drawings will not be permitted on scalable drawings. A scale bar shall be included to permit use following photo-reduction.

All drawings shall be prepared per PacifiCorp Energy's General AutoCAD/ Drafting Standards hereafter referenced as (Specification DCAP876). Drawings shall be prepared on PacifiCorp Thermal Group borders. If contractor is unable to provide drawings on said borders, a written itemized request for exemptions must be submitted for review and acceptance to the Company's Document Control Group. If exceptions are agreed to a complete drawing index must be provided using the drawing index template provided with Specification DCAP876 and associated documents.

2.0 Design Review By Company

Contractor shall provide to Company any and all information upon which the design is based, including, but not limited to the results of survey, geotechnical and materials investigations, design calculations, shop drawings, design drawings and manufacturers' data.

Contractor and Subcontractor generated drawings and documents shall be issued to Company for review. The final level of drawing and document review, including quantity required, shall be determined at the project kickoff meeting. Electronic AutoCAD files of drawings and other documents shall be submitted in addition to the hard copies as a part of the same transmittal and provided on Compact Disc (CD) or other electronic devise as may be directed by the Company. These electronic drawings will be checked by Company for compliance to documentation standards.

Except where expressly agreed otherwise by Company, the following will apply to document submittals by Contractor or Subcontractors:

a. Drawings: Full size prints of the size customary for the type of drawing and at least one copy in "B" size (11" x 17" format). In addition, one copy shall be submitted in electronic form (“PDF” or comparable for design and construction drawings only). Final drawings shall be AutoCAD and must not be a newer version than that which is currently being used by PacifiCorp Energy.

b. Documents: Letter size hardcopies and one electronic copy shall be provided for written text such as letters, specifications, procedures, calculations, manuals, lists, etc. in Microsoft Word and / or Excel format.

c. Drawings and Documents: Contractor shall make reasonable efforts to secure electronically formatted drawings and documents from all Subcontractors. When electronic formatting as noted in "a" and "b" above is not obtainable due to supplier policies or procedures then Contractor shall have such materials converted and submitted in ".tif “ or ".pdf” format.

d. Instruction, Operation, Equipment and all other Manuals: PDF manuals and other multi-page documents are file size limited to 100 MB and shall include a table of contents or index. Any PDF or multi-page document that is larger must be reduced or separated by chapter or tab. It is recommended that all chapters or tabs be bookmarked. Once the files or documents are placed on a Compact Disc (CD) they should be organized in the order of the hard copy binder or as one PDF (if less than 100 MB).

Subcontractor drawings and documentation shall also be submitted in hardcopy and electronic format to Company as described above. Company may make comments directed to Contractor on Subcontractor drawings and documents if items are found not to be in compliance with the requirements of this Contract. Contractor shall be obligated to resolve any such compliance issues with Subcontractor in a timely manner and resubmit Subcontractor drawings and documents.

3.0 Deliverables

The Contractor shall submit general specifications covering the type and design of all principal components of the equipment, when specifications have not been provided in the Contract.

All materials shall be fully identified by the Contractor.

The Contractor shall submit a complete bill of materials and list of all instruments and accessories supplied for each equipment category or specification. Contractor shall submit all bills of materials and equipment identification information electronically to the Company.

The Contractor shall be responsible for coordination with Company and / or Company's contractors for necessary interfaces. At the same time a copy of the interface information shall be submitted to the Company for review. The Contractor shall plan for the exchange of information in order to ensure the completion of the whole project meets the schedule requirement of the Contract.

The Contractor shall submit detailed procedures for testing, commissioning and putting into operation all equipment and / or systems as required.

The Company will not necessarily examine all details submitted by the Contractor and may, at Company option, require submittal to be subject to review or regard them as for information and record purposes.

The Contractor shall be responsible for any discrepancies, errors, or omissions on the drawings, or other documents, supplied by Contractor or Subcontractors.

The Contractor shall complete any and all noted changes to the drawings and data, which may be necessary to complete the Contract requirements.

Any work commenced prior to Company’s review of the drawings and /or data shall be at Contractor's risk and any necessary design changes to comply with the requirements and objectives of the Contract shall be made at no additional cost to the Company or cause delay to the project schedule.

Contractor deliverables supplied to Company shall include but are not limited to the following:

- A complete drawing index, in an Excel compatible file format per Specification DCAP876. Index shall include all Contractor and Sub-Contractor drawings.
- Diagrams - electrical one-line, electrical three-line, schematic, wiring including relay/control schematics, logic, SCADA and communication block diagrams.
- Physical arrangement and equipment drawings including site grading, equipment arrangement, building arrangement, civil, raceway and power, structure drawings, and underground utilities. The final list of drawings to be provided shall be determined by Company after consultation with Contractor.
- Drawings of all equipment foundations showing all structure and equipment outline requirements including anchor bolts and foundation loads that are to be used in the design of the foundations.
- Internal panel component arrangement drawings including terminal block size, location, spacing and types.
- Equipment, instrument, device, cable/conduit/raceway, and electrical load lists and schedules.
- Instrument manuals and data sheets (including protective and auxiliary relays, etc).
- Equipment manuals and data sheets
- Complete system operating manuals.
- All drawings used for construction.
- Design Statements - Overall design concept and detailed design criteria including design calculations.
- All Subcontractor's drawings, documentation, and manuals including outline drawings.
- Schedules, including engineering, procurement, construction and integrated Critical Path Schedule.
- Project procedures manual - Procedures for design, review and comment or approvals, procurement, construction, scheduling, progress reports, etc.
- Quality assurance and quality control program manuals.
- Environmental protection manual
- Construction safety assurance plan.
- Procurement specifications.
- Erection specifications and procedures.
- Material instruction bulletins and cut sheets.
- Contractor Acquired Permits.
- Progress Report, monthly, weekly, etc.
- Meeting minutes and reports.
- Instructions for handling, storage, and pre-operational and operational maintenance of equipment.
- Testing and commissioning plans and reports.
- Site and shop inspection and testing plans and requirements.
- Material safety data sheets for all hazardous materials and equipment.
- Test procedures including site and shop testing plans and requirements.

- Test reports or other required reports.
- Final commissioning and acceptance reports / documents.

4.0 Final Drawings

Contractor shall provide detailed "as built" drawings for the entire project consisting of, but not limited to, plan and profile sheets, foundation detail drawings, mechanical, electrical, civil, one-line, three-line, schematics, control logic, wiring, raceways, conduits and duct banks. Documents shall be re-drafted as necessary to incorporate final information. Mark-up sketches, referencing, and other field marking techniques are not acceptable as final as-built drawings. Contractor shall prepare "as-builts" of the original drawings or data sheets.

During construction, Contractor shall update and maintain on file in the field current mark-ups of all drawings and data sheets to represent actual work completed.

"As-builts" shall be issued as the next sequential revision from previous releases. The revision block shall state "As-Built". All clouds, revision diamonds, and other interim control markings shall be removed. All information listed as "later" or "hold" shall be completed. The "as-builts" shall be clear and readable in both full size and B size reduction. Contractor shall provide new versions of Subcontractor drawings if the Company judges originals to be too damaged, deteriorated, or illegible.

All Subcontractors' drawings shall be "as-built" to reflect actual installed configuration. These Subcontractor drawings shall be in sufficient detail to indicate the kind, size, arrangement, weight of each component, and operation of component materials and devices, the external connections, anchorages, and supports required; the dimensions needed for installation, and correlation with other materials and equipment. Final Subcontractor's drawings shall be bound in the equipment operation and maintenance manuals. One electronic copy for each drawing shall be supplied in AutoCAD format. (The AutoCAD version shall not be newer than current version being used by PacifiCorp Energy).

Drawing Information:

All AutoCAD and drawing requirements are per Specification DCAP876 and associated documents. This specification includes, but is not limited to, information on the following:

- PacifiCorp Title Block Information. /Borders are provided and required.
- Drawing numbers shall conform to the existing specific plant numbering guidelines. If there are no existing guidelines that apply, PacifiCorp will supply new numbers that can be used.
- Indexes, lists, data sheets, and schedules per Specification DCAP876, or other if approved.

- Drawing revisions.

5.0 Lists

All lists, including but not limited to drawing lists, instrument lists, equipment lists, circuit lists, raceway lists, conduit lists, piping and accessories lists, bills of materials, etc. shall be furnished in an Excel compatible file format per Specification DCAP876, or other as may be approved by Company.

Instrumentation Lists and Data Sheets:

- All instruments shall be given a "Tag Number" composed of two to four alpha characters and a three digit numeric reference per the Instrumentation Society of American standards and existing specific plant procedures.
- The "Tag Number" will be used to reference all instruments on drawings, instrument indexes and data sheets.
- Data sheets for each instrument shall reference vendor, model numbers, conditions of service, construction material, specifications, etc.

Equipment Lists:

- All equipment shall be given a "Tag Number" identifying the type of equipment, the media that it services and a numeric reference per existing specific plant procedures.
- The "Tag Number" will be used to reference all equipment on drawings, instrument indexes and data sheets.
- Equipment indexes shall reference service location, drawing references, rating, manufactures, data sheet locations, etc.

Electrical Circuit Schedule:

- All electrical cables shall be given a "Circuit Number" that meets specific plant requirements. Information on the existing system will be provided upon contractor selection.

    - Cable Numbering
      Cable numbering shall sequentially follow the existing specific plant numbering system.
    - Multi-Conductor Signal Wire:
      Multi-conductor signal wire color scheme shall match the existing specific plant system.

- The "Circuit Numbers" will be used to reference all equipment on drawings, instrument indexes and data sheets.
- Circuit indexes shall reference service location, drawing references, rating, manufactures, data sheet locations, etc.

Piping Line List:

- All piping shall be given a “Line Number” that shall match the existing specific plant system.
- The “Line Number” will be used to reference all pipes on area/routing drawings, indexes and line lists.
- The line list shall contain line sizes, description of starting and ending location, operating and design location, insulation, drawing references, etc.

6.0 Software Requirements

All Contractor Deliverables including final drawings, lists, and manuals shall be provided to the Company in the appropriate file format listed below. This requirement pertains to both Contractor and / or original equipment manufacture (OEM) developed deliverables.

All Contractor deliverable lists, provided in database format, shall be designed to be integrated into Company's existing applications. Company will provide Contractor with formatting information as required.

Contractor shall provide electronic submittals in the following software formats:

Software Function	**Software Name**
Word processing	Microsoft Word
Spreadsheets	Microsoft Excel
Database	Microsoft Access
Design/Construction & Original OEM Drawings	AutoCAD version no newer than that currently being used by PacifiCorp Energy. Drawings in PDF format are only acceptable for design and construction phases of the project. (See specification DCAP876.)
Project Schedules	*Primavera/Microsoft schedule or as directed by Company.
Scannable Material	Adobe Acrobat ".pdf' or ".tif'
***Revision**	

7.0 Submission of Drawings and Data

The documents and drawings for review, comment, or approval, shall be submitted to the Company at the following address.

PacifiCorp Energy
Attn: Contact person
Specific plant information

Additional copy (or copies) may be directed for submittal to other Company Representative(s) as requested.

Drawings / documents shall be updated as the engineering and design progresses to reflect current design(s). Revisions shall be identified per specification DCAP876.

Company shall only receive drawings and other documentation for review upon prior approval for submittal by Contractor's Representative.

The Company shall review the all documents for conformance with the contract and mark or stamp said documents to indicate whether changes or corrections are required. Any and all necessary changes or corrections will be noted on the documents and returned to the Contractor. The Contractor shall resubmit the corrected or changed documents, with changes and corrections clearly indicated.

When no further corrections or changes to the drawings submitted by the Contractor are required, they shall be marked "Approved for Construction." The Contractor shall supply one (1) hard copy and one (1) electronic copy for each of the "Approved for Construction" drawings to Company for record. The Company will inform the Contractor when the final drawings have been received.

Design information may later be included on the certified drawings. The fact that such design information may later be included in the instruction and/or operating manuals does not relieve the Contractor from compliance with this requirement.

APPENDIX O

PACIFICORP STANDARD – HAZCOM COMPLIANCE

DOCUMENT 1037

HAZCOM
Document #1037

	Name	Job Title	Signature	Date
Prepared By	**David L. Verdi**	**Safety Administrator**		
Reviewed By	**Kerry Powell**	**Environmental Analyst**		
Reviewed By	**Bob Archibald**	**Production Manager**		
Reviewed By	**Jared Kissell**	**Production Manager**		
Approved By	**John Bowater**	**Managing Director**		
Revised By	**John Kasanicky**	**Safety Administrator**	**Signature in File**	**5/14/2010**
Revised By	**John Kasanicky**	**Safety Administrator**	**Signature in File**	**05/14/2010**

PacifiCorp Currant Creek Plant			
DOCUMENT AMENDMENT RECORD			
Version	**Date Issued**	**Date Effective**	**Purpose of Issue and Description of Amendment**
Draft	8/11/2008		Initial HazCom program for Currant Creek Plant
1.01.0	5/13/20105/14/2010	5/13/20105/14/2010	Reviewed and posted. Reviewed and Posted

Table of Contents

1 INTRODUCTION

1.1 Purpose

The purpose of this policy is to comply with the Occupational Safety and Health Act and to protect employees and contractors by establishing a means to communicate potential chemical hazards.

1.2 Related Regulations and Company Policies

PacifiCorp Generation Safety & Operating Rules Handbook section 19
29 CFR 1910.1200

1.3 Reporting Errors and Requesting Changes

This document will be reviewed at least annually by the Currant Creek Safety Administrator and will be revised and reissued when appropriate. Anyone who wishes to comment on it or identify any errors, needed changes, or possible improvements is encouraged to contact the local management of Currant Creek Plant.

1.4 Distribution

This document will be available to all company employees throughout the Currant Creek Plant via P8. It is the employees' responsibility to obtain and review any and all policies pertaining to this subject. If the employee has questions they should contact their local plant management.

2 POLICY

Currant Creek will meet the requirements of 29 CFR 1910.1200 as follows:

A. <u>Container Labeling</u>

1. The employee working with a chemical will verify that all chemical containers received for use will:
   a. be clearly labeled as to the contents,
   b. note the appropriate hazard warnings,
   c. list the name and address of the manufacturer.

It is the policy of this company that no containers will be released for use until the above data is verified.

2. <u>Material Safety Data Sheets (MSDS)</u>
   a. A MSDS of all chemicals located at Currant Creek Plant is available on line through the MSDS Online Company.

b. MSDS are also available to individual employees through the MSDS Online Company by calling **1-800-362-2007** and requesting a fax of the MSDS.

c. Information required by MSDS Online to supply the MSDS through fax: Product name, manufacturer name, any other codes or numbers located on the labels, and a valid fax number.

d. New products that are not listed in the MSDS database will be added via the Change Management procedure. Once a new product is approved for use, it will be entered into the MSDS Online system by the Safety Administrator.

3. Employee Training and Information.

a. Training on chemicals used at these locations, their hazards, appropriate protective measures, and use of material safety data sheets (MSDS) will be conducted during regularly scheduled monthly safety meeting.

b. Employees will annually view the audiovisual program “Chemical Safety”, receive a Chemical awareness handbook, and complete a Material Safety Data Sheet exercise.

B. List of Hazardous Chemicals

1. A list of all known chemicals used by employees of Currant Creek Plant is located on line at the MSDS Online website. Any employee of the Currant Creek plant should be able to provide a list of chemicals if required. Further information on each noted chemical can be obtained by reviewing the appropriate Material Safety Data Sheet.

C. Hazardous Non-routine Tasks

1. Periodically, employees are required to perform non-routine hazardous tasks. Prior to starting work on such tasks, the manager will obtain the MSDS of the chemicals to be used and review it with the employees.

2. The information discussed will include:

a. The specific chemical hazards.

b. The personal protective equipment required and any other protective/safety measures required to protect the employee.

c. The measures that have been taken to reduce the chemical hazards.

D. **Materials in Unlabeled Pipes**

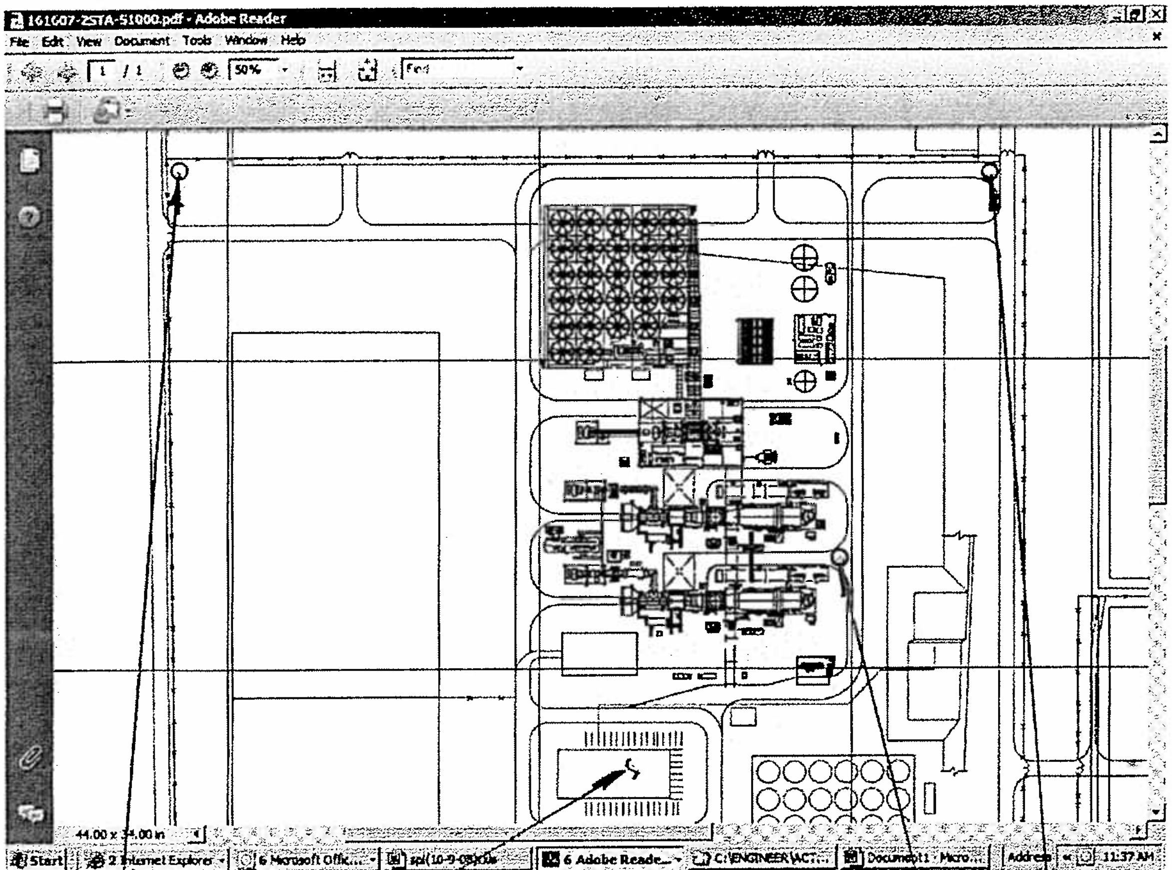
1. Work is infrequently done in areas where materials run through unlabeled pipes.
2. Prior to starting work in these areas, the employee shall contact the Production Manager or Maintenance Manager for information regarding:
   a. The identity of materials in the pipes.
   b. The potential hazards of the materials including temperature and pressure they may be operating.
   c. Safety precautions which should be taken to protect employees and equipment.

E. **Informing Contractors**

1. It is the responsibility of the PacifiCorp representative or Production Manager to provide contractors and their employees the following information:
   a. The identity of chemicals to which they may be exposed while on the job site.
   b. Protective measures the employees may take to lessen the possibility of exposure.
   c. Copies of PacifiCorp MSDS's that contractors may request.
   d. Contractors will provide MSDS to PacifiCorp when they request any chemicals to be brought on to PacifiCorp sites. This must receive approval prior to bringing the chemical on plant site.

APPENDIX P

SECURITY CONDUIT TERMINATION LOCATIONS



Security head-end equipment—conduit termination

Conduit termination for CEMs, etc. (12/24 strand fiber)

Conduit termination (6 strand fiber)—two locations

<u>"F" series plot--shown</u>
<u>"G" series plot--similar</u>

<u>Currant Creek Unit #2—Drawing No. 1</u>

JWW 10-9-08

APPENDIX Q

SCHEDULE OF PERMITS AND GOVERNMENTAL APPROVALS

SCHEDULE OF PERMITS AND GOVERNMENTAL APPROVALS: APPROVALS, CERTIFICATES, PERMITS AND LICENSES

Currant Creek 2 Plant

AGENCY	PERMIT/CITATION/APPROVAL	REASON REQUIRED	PERMIT IN NAME OF	PREPARE	OBTAIN	FEE PAYMENT
Federal						
US Army Corps of Engineers (USACE)	404 Wetlands Fill Permits as required	Filling of > .5 Acres of Wetlands	N/A	N/A	N/A	N/A
US Army Corps of Engineers (USACE)	Streambed Alteration Permit	Altering of stream beds associated with waters of the US. Joint permit with State for installation of a discharge pipe in Currant Creek	EPC[1]	EPC	EPC	EPC
US Environmental Protection Agency-USEPA	PSD and Title V Permit review and approval delegated to State of Utah Dept of Air Quality	Federal and State regulatory requirement for emissions sources	Owner	Owner	Owner	Owner
US Environmental Protection Agency-USEPA (Construction)	Hazardous Waste Generator ID number	CC #2 hazardous waste during construction	EPC	EPC	EPC	N/A
US Environmental Protection Agency-USEPA (Operations)	Hazardous Waste Generator ID number	CC #2 hazardous waste after Owner takes title.	Owner	Owner	Owner	N/A
US Environmental Protection Agency-USEPA (Construction)	SPCC Plan	Spill Prevention Control and Countermeasure Plan	EPC	EPC	EPC	EPC
US Environmental Protection Agency-USEPA (Operations)	SPCC Plan	Spill Prevention Control and Countermeasure Plan	Owner	Owner	Owner	Owner
FERC	Permit to connect to certain NG pipelines	Only if NG pipeline is FERC regulated	N/A	N/A	N/A	N/A
Federal Aviation Administration (FAA)	Notice of Proposed Construction or Alteration	Stack height which may affect navigable air Owner. (If Required)	EPC	EPC	EPC	EPC
National Park Service	Class I/II NAAQS Visibility Analysis	Demonstrate no impact to the air quality	Owner	Owner	Owner	Owner
US Fish and Wildlife Services (USFWS)	Threatened & Endangered Species Act Compliance Acknowledgment	Demonstrate no impact – Update to 2004 Endangered Species Review	Complete	Complete	Complete	Complete
Federal Emergency Management Agency (FEMA)	Flood Plain Re-designation	Wastewater discharge may encroach on an area FEMA designated as a 100 year Flood Plain	Complete	Complete	Complete	N/A

[1] EPC Contractor to change the name on the streambed alteration permit as a condition of substantial completion.

EPC = Contractor
Owner/EPC = Owner has primary responsibility and EPC Contractor to provide reasonable efforts to support Developer.
O = Others

SCHEDULE OF PERMITS AND GOVERNMENTAL APPROVALS: APPROVALS, CERTIFICATES, PERMITS AND LICENSES

Currant Creek 2 Plant

AGENCY	PERMIT/CITATION/APPROVAL	REASON REQUIRED	PERMIT IN NAME OF	PREPARE	OBTAIN	FEE PAYMENT
Federal						
EIA	Power Plant Registration ORIS Code with DOE	Registration of facility	Owner	Owner	Owner	Owner
DOT (Construction)	Equipment and Materials Handling, Including Materials Disposal	Highway transportation for materials and equipment (Equipment Delivery – EPC Contractor and their Suppliers).	EPC	EPC	EPC	EPC
DOT (Operation)	Equipment and Materials Handling, Including Materials Disposal	Highway transportation for materials and equipment.	Owner	Owner	Owner	Owner

SCHEDULE OF PERMITS AND GOVERNMENTAL APPROVALS: APPROVALS, CERTIFICATES, PERMITS AND LICENSES

Currant Creek 2 Plant

AGENCY	PERMIT/CITATION/APPROVAL	REASON REQUIRED	PERMIT IN NAME OF	PREPARE	OBTAIN	FEE PAYMENT
State						
Utah Public Utilities Commission	PUC Certificate of Convenience and Necessity/ Resource Approval	PUC Approval for the Resource	Owner	Owner	Owner	Owner
Utah PSC	Upgrade or additional new transmission facilities	Transmission Network Service Upgrades & Direct Assigned Interconnection Facilities as required by the LGIA	Owner	Owner	Owner	Owner
UDWQ	Stream Bed Alteration Permit	Permit to disturb Currant Creek in order to install outfall for the UPDES waste water discharge.	EPC[2]	EPC	EPC	EPC
UDWQ	State Pollutant Discharge Elimination System Permit (UPDES)	Wastewater discharge approval to a water body and for facility and Operational storm water discharges associated with industrial activity.	Owner	Owner/EPC	Owner	Owner
UDWQ	Construction Dewatering & Hydrostatic Water Discharge Permit	Permit to discharge water from Construction dewatering activities and for discharge of hydrostatic tests water. Will cover ground improvement activities	Owner	EPC	EPC	EPC
UDWR (division of water rights)	Well Drilling Permit	Required for any well or boring including monitoring wells.	Owner	EPC	EPC	EPC
UDWR (division of water rights)	Permit to pump ground water	Concurrence by State regarding the transfer of water rights from a Seller to Owner and the assignment of these rights to deep well pumping using existing or new wells.	Owner	EPC	EPC	EPC
UDWR	Water rights Transfer Approval for private purchase of water supply rights	Needed if purchase existing water rights from an owner.	Owner	Owner	Owner	Owner
Utah Division of Air Quality (UDAQ)	Prevention of Significant Deterioration (PSD) Approval Order	Utah is a designated state to grant these permits	Owner	Owner	Owner	Owner
UDAQ, Federal Land Managers	Class I/II NAAQS Visibility Analysis	Utah is a designated state to grant these permits	Owner	Owner	Owner	Owner
UDAQ	Federal Clean Air Act Title V Operating Permit	Utah is a designated state to grant these permits	Owner	Owner	Owner	Owner

[2] EPC Contractor to change the name on the streambed alteration permit as a condition of substantial completion.

SCHEDULE OF PERMITS AND GOVERNMENTAL APPROVALS: APPROVALS, CERTIFICATES, PERMITS AND LICENSES

Currant Creek 2 Plant

AGENCY	PERMIT/CITATION/APPROVAL	REASON REQUIRED	PERMIT IN NAME OF	PREPARE	OBTAIN	FEE PAYMENT
State						
UDAQ	Designated Representative Declaration [submit Alternate Designated Representative when Plant Manager is named]	Utah is a designated state to grant these permits	Owner	Owner	Owner	Owner
UDAQ	Clean Air Act Acid Rain Permit	Utah is a designated state to grant these permits.	Owner	Owner	Owner	Owner
UDAQ	AIRS ID Number	If not included in CC#1	Owner	Owner	Owner	Owner
DAQ, DEQ	Utah Hazardous Waste Disposal	Obtain an ID number for Site – Use CC #1 Existing ID # for CC #2	N/A	N/A	N/A	N/A
UDEQ	Tier II Emergency & Hazardous Chemical Inventory	Submittal of Hazardous Chemical Inventory within 90 days after initial delivery of hazardous chemicals	Owner	Owner /EPC	Owner	Owner
UDWQ	Construction Storm Water Permit NOI	Needed if more than 1 acre (includes construction staging/parking areas) will be disturbed	EPC	EPC	EPC	EPC
UDWQ	Utah DWQ Construction SWPP	Storm water plan to support construction. Include with Site Procedures – BMP's and must be available on site for DWQ audit	EPC	EPC	EPC	EPC
UDWQ	Utah DWQ Operational SWPP	Storm Water Plan to support operations	Owner	Owner /EPC	Owner	Owner
DWQ	Utah DWQ Groundwater Monitoring Plan	During Construction (EPC Contractor prepare, Owner provide input)	EPC	EPC	EPC	EPC
UDOT/OTHER (Construction)	Equipment and Materials Handling, Including Materials Disposal	Highway/road transportation, oversize loads UDOT has jurisdiction over state highways only	EPC	EPC	EPC	EPC
DEP, DER	Variance for Noise During Construction	Construction noise not in compliance with code.	EPC	EPC	EPC	EPC
DEP, DER	Excavation Materials Disposal	Permit to dispose of excavated materials.	EPC	EPC	EPC	EPC
Utah Labor Commission, Division of Safety	Certificate of Inspection	Need State signoff on completed HRSG & Auxiliary Boiler	Owner	EPC	EPC	EPC
Utah Labor Commission, Division of Safety	Permit to Operate Boilers	Need State signoff on completed HRSG & Auxiliary Boiler	Owner	EPC	EPC	EPC
Utah Division of Occupational and Professional Licensing	Contractor License	Required to per State Regulations	EPC	EPC	EPC	EPC

EPC = Contractor
Owner/EPC = Owner has primary responsibility and EPC Contractor to provide reasonable efforts to support Developer.
O = Others

Currant Creek 2 Plant

AGENCY	PERMIT/CITATION/APPROVAL	REASON REQUIRED	PERMIT IN NAME OF	PREPARE	OBTAIN	FEE PAYMENT
State						
EPA/Utah Dept. of Public Safety/DEQ/Division of Environmental Response and Remediation/SERC/LERC	During Construction - Emergency Planning and Community Right to Know (MSDS, Emergency chemicals Inventory Form/Facility Emergency Response Plan and filing necessary government reports)	Required for On-Site storage of chemicals, fuels, lubricants, etc. used during construction if present above threshold amounts. EPC Contractor covers in Site Procedures & Policies.	EPC	EPC	EPC	EPC
State Emergency Response Commission (SERC)	EPCRA Notice of Facility Subject to EPCRA 40 CFR 355.30(b)	Only if have extremely hazardous materials above threshold quantities.	Owner	Owner /EPC	Owner	Owner
SERC	Hazardous Materials Inventory	EPC Contractor to provide input, Owner to prepare if store more than TQ provided in 40 CFR 370.20	Owner	Owner /EPC	Owner	Owner
Historical Society (USHPO)	Confirmation of no Artifacts or Sites of Archaeological, Cultural or Historic Significance	Confirmation of no interference for construction. – Completed for Currant Creek #1	Owner	EPC	EPC	EPC
UDOT	Construction of utility across a state highway or along the state highway ROW		N/A	N/A	N/A	N/A
Utah Division of State Lands	Easements across state-owned lands.	May be required for new Transmission facilities	N/A	N/A	N/A	N/A

SCHEDULE OF PERMITS AND GOVERNMENTAL APPROVALS: APPROVALS, CERTIFICATES, PERMITS AND LICENSES

Currant Creek 2 Plant

AGENCY	PERMIT/CITATION/APPROVAL	REASON REQUIRED	PERMIT IN NAME OF	PREPARE	OBTAIN	FEE PAYMENT
Local/County						
Local/County	Planning Board Site Plan Approval	Review of Site Plan, Architectual Plans, Landscaping, access, Fire Protection, etc.	Owner	Owner	Owner	Owner
City of Mona	Potable Water Extension Permit or tie into existing line (If Required)	Build, modify or extend potable water line (None Required).	N/A	N/A	N/A	N/A
City of Mona	Potable Water for Temporary Construction Facilities	Water connection for Construction Offices	EPC	EPC	EPC	EPC
City of Mona	Variance for Noise During Construction	Construction noise not in compliance with Local Ordinances (if required).	EPC	EPC	EPC	EPC
Juab County Engineer	Road Cutting Permit	Cutting/disturbing road for installing process water supply line.	EPC	EPC	EPC	EPC
Building Department Juab County	Construction/Building Permit	Authorization to construct.	Owner	EPC	EPC	EPC
Fire & Local Police Agencies (Construction)	Construction Security and Safety Procedures and Equipment	Approval of site procedures.	EPC	EPC	EPC	EPC
Local Police Agencies & Traffic Department	Construction Equipment and Materials Handling, Including Materials Disposal	Street transportation and delivery for Contractor supplied equipment. – Heavy Hauls	EPC	EPC	EPC	EPC
Local Police Agencies Chief & Traffic Department	Construction Personnel Parking and Transportation	Traffic management.	EPC	EPC	EPC	EPC
Fire Chief and Emergency Management Coordinator	Approval for On-site Storage of Chemicals, Fuels, Lubricants, etc. used during construction	Approval to allow storage and usage.	EPC	EPC	EPC	EPC
Local Fire Department Juab County Community Emergency Response Team (CERT) Juab County Local Emergency Planning Committee (LEPC)	SARA TIER II Form Reports	Needed if stored more than threshold amounts. Filed every March 1.	Owner	Owner/EPC	EPC	Owner

EPC = Contractor
Owner/EPC = Owner has primary responsibility and EPC Contractor to provide reasonable efforts to support Developer.
O = Others

Currant Creek 2 Plant

AGENCY	PERMIT/CITATION/APPROVAL	REASON REQUIRED	PERMIT IN NAME OF	PREPARE	OBTAIN	FEE PAYMENT
Local/County						
Juab County Commission	Conditional Use Permit	Construction along or across the ROW of a county/town highway.	Owner	EPC	EPC	EPC
Building Department (Construction Offices)	Certificate of Occupancy	Occupancy of structures.	EPC	EPC	EPC	EPC
Building Department (Operating Offices)	Certificate of Occupancy	Occupancy of structures (if needed)	Owner	EPC	EPC	EPC
Building Department	Soil Erosion & Sedimentation Control Plan (for construction only activities)	Soil Erosion and Sedimentation Control Plan during construction.	EPC Contractor	EPC	EPC	EPC
Police & Fire Chiefs	Permits for Signs and Fencing – Construction	Authorization to erect.	EPC Contractor	EPC	EPC	EPC

EPC = Contractor
Owner/EPC = Owner has primary responsibility and EPC Contractor to provide reasonable efforts to support Developer.
O = Others

AGENCY	PERMIT/CITATION/APPROVAL	REASON REQUIRED	PERMIT IN NAME OF	PREPARE	OBTAIN	FEE PAYMENT
Miscellaneous						
Kern/Questar	Interconnection Agreement for gas Transportation Services	Interconnection with Kern or Questar	Owner	Owner	Owner	Owner
PacifiCorp Transmission	Interconnection Study & Facilities Agreement	Interconnection of the Project to the transmission system.	Owner	Owner	Owner	Owner
PacifiCorp Transmission	Network Service Agreement	Buyer enters into Network Agreement with PacifiCorp Transmission to interconnect the generation into the PacifiCorp System	Owner	Owner	Owner	Owner
Land Owners including private owners, local governments and rail roads	Easements and Rights of Way	If required for construction of permanent facilities.	Owner	Owner	Owner	Owner
Land Owners including private owners, local governments and rail roads	Easements, Rights of Way, leases, rental and purchases	If required for construction of temporary facilities, construction parking, or laydown.	EPC	EPC	EPC	EPC

APPENDIX R

SUBSTATION GENERAL INFORMATION AND SCOPE OF WORK

Appendix R

Currant Creek 2 Substation

General Information
And
Scope of Work

Section 1

General Information

Table of Contents

Section 1
General Information

1.0 Preamble

For purposes of this document, the Owner is defined as PacifiCorp.

For purposes of this document, the Switchyard Contractor is defined as the party contracted by Owner to Engineer, Procure, and Construct (EPC) the requirements of this switchyard project.

For purposes of this document, the Plant Contractor is defined as the party contracted by Owner to Engineer, Procure, and Construction (EPC) the new Currant Creek generating plant (Unit 2).

Exhibit A, including the attached information, outlines the requirements of the work to be performed by the Contractor. Exhibit A includes the requirements associated with the design, procurement, construction, testing, and commissioning of the new Currant Creek 2 345 kV switchyard and transmission line facilities. The contractor awarded EPC contract is expected to follow Owner engineering design specifications, material specifications, drafting standards, communication specifications, construction, startup, testing and commissioning specifications, for the substation and transmission line, and communication components of the project. Testing and commissioning requirements for the project are outlined in Exhibit X.

2.0 Statement of Work

2.1 General Specifications

These general specifications contain requirements that apply to all the work to be completed by the Switchyard Contractor, or where stated, refer to coordination issues interrelating the various components of work.

2.2 Project and Site Information

The site is located in Juab County, approximately 80 miles south of Salt Lake City and 1 mile west of Mona, Utah, at an elevation of 5051ft. The new substation will be built right next to the existing substation. The transmission line will be built from the existing Mona Substation to the new Currant Creek 2 substation.

2.3 Industry Codes and Standards

The latest edition and addenda of the following codes or standards published by the following industry organizations, associations, or groups are part of the project requirements and when referred to by title or basic designation only are applicable to the extent indicated by the specific reference.

Reference to the standards of any technical society, organization, association, laws, ordinances, or codes of governmental authorities shall mean the latest standard code or specification adopted and published as of the effective date unless specifically stated otherwise.

The codes and standards referenced (including addenda, amendments, and errata) shall govern in all cases where references thereto are made except where they conflict with the requirements of the project, in which case the more stringent codes and/or standards will govern.

If the Switchyard Contractor becomes aware after the effective date of a change in a code or standard affecting the design or work to be performed, the Switchyard Contractor shall promptly advise Owner of such change.

Reference Abbreviation	Name
AA	Aluminum Association
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AISC	American Institute of Steel Construction
AISE	Association of Iron and Steel Engineers
ANSI	American National Standards Institute
API	American Petroleum Institute
AREMA	American Railway Engineering and Maintenance Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
ASTM	American Society for Testing and Materials
AWS	American Welding Society
CMAA	Crane Manufacturer Association of America
CRSI	Concrete Reinforce Steel Institute
EIA	Electronic Industries Alliance
EPA	Environmental Protection Agency
HMI	Hoist Manufacturer’s Institute
IBC	International Building Code

Reference Abbreviation	Name
ICEA	Insulated Cable Engineers Association
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISA	Instrument Society of America
ISO	The International Organization for Standardization
NACE	National Association of Corrosion Engineers
NBS	National Bureau of Standards
NEBB	Nation Environmental Balancing Bureau
NEMA	National Electrical Manufacturers Association
NERC	North American Electric Reliability Council
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
SAE	Society of Automotive Engineers
SDI	Steel Deck Institute
SSPC	Structural Steel Painting Council
TIA	Telecommunications Industry Association
UBC	Uniform Building Code
UL	Underwriters Laboratories, Inc

2.4 Hazardous Materials

2.4.1 *General*

As required under Federal Hazardous Communications Standards and certain other applicable laws, the Switchyard Contractor shall provide Material Safety Data Sheets (MSDS) covering all hazardous materials furnished under or otherwise associated with the work for this project. The Switchyard Contractor shall provide Owner with either copies of the applicable MSDSs or copies of a document certifying no MSDSs are required under any applicable laws in effect at the jobsite.

Hazardous Materials are defined in the applicable laws, which may use the terminology "toxic substances" instead of "hazardous materials". The Switchyard Contractor is responsible for determining if any substance or material furnished, used, applied, or stored as part of this project is within the provisions of any applicable laws.

In addition, before any chemicals are brought on site the Switchyard Contractor shall furnish MSDSs for each chemical. MSDSs shall be provided to Owner at least 30 days prior to the materials arrival on site.

The Switchyard Contractor shall provide labeling of "Hazardous Materials" and training of employees in the safe usage of such materials as required under any applicable law(s).

Switchyard Contractor agrees to dispose of and/or recycle such hazardous materials that the Switchyard Contractor is responsible for hereunder in a facility approved by the proper governmental authority and notified to Owner, and transport such hazardous materials to a facility approved by the proper governmental authority and notified to Owner, provided that, the Switchyard Contractor shall make reasonable commercial efforts to comply with Owner's request with regard to the choice of such facilities. At Owner's request, Switchyard Contractor shall provide the Owner with the name, address, and phone number of the storage, treatment, and disposal facility(s) where the hazardous materials for which the Switchyard Contractor is responsible hereunder will be sent. Owner shall have the right to inspect and obtain copies of all written licenses, permits, or approvals, issued by any governmental authority to Switchyard Contractor or a Subcontractor relating to the receipt, handling, storage, treatment, disposal/recycling, and transportation of hazardous materials in connection with the requirements of this project; and Switchyard Contractor agrees to provide (and cause its Subcontractors to provide) such other documents and information relating to the transportation and disposal of hazardous materials as Owner may reasonably request.

2.4.2 *Asbestos*

The supply or furnishing of materials and/or products containing asbestos is prohibited. This prohibition includes such items as packing, gaskets, wiring insulation; roofing material, floor coverings and insulation, even though the item is encapsulated or asbestos fibers are impregnated with a binder material.

2.4.3 *Mercury*

The supply or furnishing of materials and/or products containing mercury is prohibited. This prohibition includes such items as mercury filled instruments, even though the mercury is encased or encapsulated.

2.4.4 *Lead Based Paint*

Supply or furnishing of lead based paint is prohibited.

2.4.5 *PCBs*

The supply or furnishing of materials and/or products containing PCBs is prohibited.

2.5 Contractor's Safety Assurance Program

The Switchyard Contractor's Safety Assurance Program shall be provided to Owner for review as the work is to be completed near and within energized facilities.

2.6 Contractor's Quality Assurance Program

The Switchyard Contractor's Quality Assurance Program shall be provided to Owner for review.

2.7 Critical Path Schedule Requirements

Switchyard Contractor shall submit to the Owner the "Construction Schedule" with a detailed network schedule that is developed using the critical path method of scheduling and planning the Work. In the proposal, the Switchyard Contractor shall identify the critical path. Through construction, the Switchyard Contractor shall provide regular updates to the Construction Schedule, including highlighting any changes to the critical path.

2.8 Progress Reporting

Progress reporting to the Owner's project manager is required. The frequency and format of this reporting shall be outlined by the Owner's project manager during the initial meeting with the Switchyard Contractor.

2.9 Design Meetings

Within two (2) weeks after the Initial Notice to Proceed, the Switchyard Contractor shall conduct a design conference with Owner to review at a minimum the conceptual design of the project, drawing format, contract deliverables format, and project procedures. This design meeting shall be held at a mutually agreed upon location.

The Switchyard Contractor shall also conduct monthly design conferences with Owner to discuss among other items the conceptual design of the project including equipment and the electric system operating constraints. These design conferences are in addition to the formal design reviews outlined in the Specification of Performance documents and shall be held at a mutually agreed upon location or via phone. The Switchyard Contractor's Project Manager, Project Engineer, and appropriate design personnel shall be in attendance at these meetings.

Site Meetings, Weekly Progress Meetings, and Monthly Progress Meetings shall occur when required to support the project or as requested by Owner's project manager.

2.10 Transmission Line Work Constraints

All switchyard work must be completed by May 1, 2015.

The Switchyard Contractor understands and agrees the construction associated with the substation and the transmission line must be scheduled and completed within certain Transmission Grid reliability, outage requirements, and constraints. The general requirements and constraints are set forth in this section (1.11); provided, however, the exact dates, times and restrictions shall be determined by the Owner's transmission control center in accordance with Applicable Laws and Prudent Utility Practices.

In addition to the constraints identified in this section (1.11) the Switchyard Contractor shall make a reasonable attempt to schedule construction activities to minimize scheduled outages of the Transmission Grid.

The Owner shall make a reasonable attempt to provide the Switchyard Contractor with a schedule showing anticipated Transmission Grid outages which could directly impact construction activities.

The Switchyard Contractor must follow procedures and guidelines for requesting outages to support construction activities as outlined in Owner's Switching Order Processing Policy (Policy SOPPOL001, Rev. 5). This policy shall be discussed at the initial project design kickoff meeting.

Depending on the Switchyard Contractor's proposed construction plan, the constraint requirements for each transmission project may or may not overlap with other active projects. When using the information contained in this section (1.11), the Contractor shall consider the information in its entirety.

2.11 Fiber Optic Communication Work Constraints

The Switchyard Contractor shall coordinate fiber optic communication work with the Owner to ensure that continuity of service at the existing Block I Switchyard and Mona Substation are maintained.

2.12 Substation Work Constraints

All switchyard work must be completed by May 1, 2015.

2.13 SCADA Communication Work Constraints

No SCADA communication work restraints are anticipated for this project.

2.14 Power Line Carrier (PLC) Work Constraints

No power line carrier work restraints are anticipated for this project.

2.15 Microwave Work Constraints

No microwave communication work restraints are anticipated for this project.

2.16 Other Communication Work Constraints

Any additional communication work identified outside the sections above shall be coordinated with Owner's Communications Engineering, including the fiber optic communication work associated with Currant Creek 1 – Mona transmission line and the interconnection of the Currant Creek 1 switchyard communication system with the Currant Creek 2 switchyard communication system.

2.17 Engineering Design

The Switchyard Contractor is responsible for providing all engineering and design services required to support the work identified within Exhibit A. The detailed engineering shall include all calculations, drawings, studies, and evaluation and documentation of vendor information as specified in the Engineering Design Specification of Performance for the Electrical Design, Civil Design, Transmission Design, and Communication Design (see attachments).

The Switchyard Contractor shall keep one (1) copy of the most current design drawings, Operations and Maintenance Manuals, and other vendor and/or construction documentation required for construction at the jobsite. The documentation shall be kept in good order and available for use by Owner. Documentation shall include current redlines.

The requirements identified in the Engineering Design Specification of Performance documents, Engineering Handbook, completed and standard Material Specifications, Construction Specifications, requirements contained in all section attachments are to be considered as minimum requirements. The Switchyard Contractor shall meet or exceed all specifications and requirements as outlined in the Engineering Design Specification of Performance documents, Engineering Handbook, completed and standard Material Specifications, Construction Specifications, and requirements contained in all section attachments. Construction specifications are to be used as a guideline and shall be modified by the appropriate design engineer for the identified project as necessary. A copy of the construction specifications shall be provided to Owner for review prior to the start of construction.

In the event there are any conflicts between the specifications provided by Owner and industry standards the Switchyard Contractor shall notify Owner to obtain direction on how to proceed.

. The following Owner personnel shall be responsible to support this project.

Project Manager
Insert name and contact details

RMP Major Projects and EPC Technical Services
Insert name and contact details

Protection and Control Engineer

Insert name and contact details

Project Engineer
Insert name and contact details

Substation Engineer
Insert name and contact details

Communications Engineer
Insert name and contact details

SCADA Engineer
Insert name and contact details

Transmission Line Engineer
Insert name and contact details

2.18 Engineering Design Standards

2.18.1 *Distribution*

The Switchyard Contractor shall be required to design and construct all distribution modifications and/or additions to Owner standards. Any deviation from the standards must be reviewed and approved in writing by Owner.

2.18.2 *Substation*

The Switchyard Contractor shall be required to design and construct all substation modifications and/or additions to Owner standards. Any deviation from the standards must be reviewed and approved in writing by Owner.

2.18.2.1 Civil/Foundation/Structural

The Switchyard Contractor shall be required to use standard Owner foundations and steel structures in the design of all substation modifications and/or additions. It is understood by Owner that foundations may need to be modified due to soil conditions and steel structure heights may need to be adjusted for specific applications. Refer to the Civil Design Specification of Performance and Civil/Structural Design Criteria for additional information regarding deviation guidelines.

2.18.2.2 Electrical

The Switchyard Contractor shall be required to use standard Owner bus configurations, grounding, conduit, and electrical applications (details) in the design of all substation modifications and/or additions. It is understood by Owner that specific application standards may not exist for certain installations.

Nonstandard bus configurations or details developed by the Switchyard Contractor must be reviewed and approved in writing by Owner. The Switchyard Contractor shall refer to the Electrical Design Specification of Performance for additional information.

2.18.2.3 Protection and Control

The Switchyard Contractor shall be required to use standard Owner Protection and Control schematics, wiring, and panel layouts. It is understood by Owner that some modifications may be required for special applications. Any deviation from the Protection and Control standards shall be reviewed and approved in writing by Owner. Should a nonstandard panel be required the Switchyard Contractor shall work with Owner standards and design personnel to develop an acceptable panel design. The wiring design shall be completed by the Switchyard Contractor's design team and not by the panel manufacturer. Refer to the Electrical Design Specification of Performance and Protection and Control Standards for additional information.

2.18.2.4 Material Specifications

The Switchyard Contractor shall be responsible for completing all material specifications not already completed and included as attachments within Exhibit A or already provided by others. Copies of all material specifications shall be included with the final documentation provided to Owner at the conclusion of the project. If the Switchyard Contractor determines the need for an equipment or material specification not provided by Owner it is the Switchyard Contractors responsibility to prepare the specification. A copy of the specification prepared by the Contractor shall be forwarded to Owner for review and written approval prior to purchase of the equipment or material. A copy of the approved specification shall be included with the final documentation provided to Owner at the conclusion of the project. Refer to the Electrical Design Specification of Performance for additional information.

2.18.3 *Transmission*

The Switchyard Contractor shall use Owner transmission design standards for any transmission work that must be completed to support this project. It is understood by Owner that transmission design modifications, upgrades, and/or additions may differ from design standards and need to be adjusted for specific applications. Owner must review and agree to in writing any deviation from current transmission design standards. Refer to the Transmission Design Specification of Performance, Civil Design Specification of Performance, and Substation Civil/Structural Design Criteria for additional information regarding deviation guidelines.

All transmission design and/or drawings completed by the Switchyard Contractor shall comply with the appropriate Owner communications design and/or drawing standards.

2.18.4 *Fiber Communications*

The Switchyard Contractor shall use and install OPGW and ADSS according to transmission standards for installing fiber optic cable which is in the process of development and a copy of this standard will be provided to Switchyard Contractor when it becomes available.

2.18.5 *SCADA Communications*

All SCADA design shall be completed by the Owner. The Switchyard Contractor shall coordinate all external connections to the RTU with the Owner SCADA Engineer. Any SCADA design and/or drawings completed by the Switchyard Contractor shall comply with the appropriate Owner communications design and/or drawing standards.

2.18.6 *Power Line Carrier (PLC) Communications*

Not required for this project.

2.18.7 *Microwave Communications*

Not required for this project.

2.18.8 *Other Communications*

Any miscellaneous communications design and/or drawings completed by the Switchyard Contractor shall comply with the appropriate Owner communications and/or substation design and/or drawing standards.

2.19 Engineering Design Drawing Standards

Design drawings developed by the Switchyard Contractor shall comply with the Owner drafting standards. Owner will review the drawings for drafting compliance with each review submittal and provide feedback in writing. The Switchyard Contractor shall be required to correct any drafting that does not comply with Owner drafting standards.

For additional drafting requirements refer to the attached Civil Design, Electrical Design, Transmission Design, and Communication Design Specification of Performance documents.

The documents referenced below are located in Appendix S.

S1.10 Specification of Performance Documents

S1.10.1 Electrical Design Specification of Performance (10-27-06)
S1.10.2 Civil & Structural Design Specification of Performance (10-17-06)

S1.32 Transmission Design Specification of Performance (5-22-06)

S1.60 Communication Design Specification of Performance, (10-17-07)

End of Appendix R, Section 1

Section 2

Scope of Work

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Section 2
Scope of Work

2.1 Overview

For purposes of this document the Owner is defined as PacifiCorp.

For purposes of this document, the Switchyard Contractor is defined as the party contracted by Owner to Engineer, Procure, and Construct (EPC) the requirements of this project.

The Contractor shall design, procure, install, and commission all switchyard and transmission line equipment and materials required to energize and operate the new 345kV Currant Creed 2 switchyard. The interconnection work associated with this new switchyard to the Owner's existing transmission system at its existing Mona Substation will be performed by the Owner.

For purposes of this document, the Plant Contractor is defined as the party contracted by Owner to Engineer, Procure, and Construct the new Currant Creek 2 generating plants (Unit II).

2.2 General

The Switchyard Contractor shall be responsible to complete all tasks necessary to provide the Owner with a new 345 kV switchyard, including its interconnected transmission line, located in Juab County, approximately 80 miles south of Salt Lake City and 1 mile west of Mona, Utah, at an elevation of 5,051 feet. The switchyard shall be completed and ready to interface with Currant Creek 2 by May 15, 2015.

The Switchyard Contractor shall be responsible for verifying the switchyard and transmission line site conditions, for determining the transmission structure locations, and if applicable, distribution structure locations, as Owner cannot guarantee the accuracy of existing documentation associated with the Currant Creek 1 plant, the Currant Creek 1 switchyard, the Mona substation, and Currant Creek 1 – Mona transmission line.

All work, drawings, documentations, and calculations associated with this new 345kV switchyard and transmission line shall conform to standards, specifications, drawings, and other requirements outlined/provided in this document.

Major components of the work under these specifications shall include, but not necessarily be limited to, the following items associated with new 345kV switchyard:

A. Switchyard engineering and design, including electrical, civil, structural, protection, and communication elements
B. Transmission line engineering and design, including electrical, civil, and structural elements
C. All required construction permitting
D. Soil boring tests, soil resistivity tests, and geotechnical survey
E. Site and structure surveying
F. Site development and grading
G. Equipment and material procurement
H. Equipment and material storage
I. Equipment removal, salvage, and disposal, if any
J. Equipment and material installation
K. Site Security
L. Construction
M. Equipment, functional and system testing
N. Support during commissioning
O. Decommissioning
P. Documentation and Submittals as outlined in Appendix S, Engineering Documents, Drawings, and Other Deliverables.

The above explanation and listing are intended to give a general definition of the scope of the work under these specifications, and shall not be construed to be an itemized listing of each element of work required. The Switchyard Contractor shall be responsible for determining work required based on the drawings and the construction of complete facilities, conforming in all respects to the details and requirements of the specifications, drawings, and other contract documents.

Planned transmission line outages will be mutually established by the Owner and the Switchyard Contractor; however, once established the Switchyard Contractor shall perform all outage related work during these planned outage timeframes.

In the event of technical conflicts, errors, or discrepancies, the detailed technical specifications, including this Appendix R, Section 1 and Section 2, Appendix S, and all other Owner's standards, policies, and specifications of performance take precedence.

2.3 Description

The new Block II 345kV switchyard shall be designed in radial scheme with three generator positions connecting to a common bus, and one transmission line position exiting the switchyard as indicated on the drawings and in the documents. Each generator position shall contain revenue metering. System protections schemes shall include circuit breaker failure protection, bus protection, and transmission line protection schemes. System control schemes shall include circuit breaker control, disconnect switch control, grounding switch control, and synchronization control. Metering shall include bus, generator, and line voltages, currents, and power.

The new Currant Creek 2 345kV transmission line shall be constructed on tubular steel structures and shall include OPGW for communications, as indicated on the drawings and in the documents. The anticipated transmission line length is approximately 0.4 miles.

This work also includes the relocation of up to two structures (three spans) of the existing Currant Creek 1 – Mona Substation line to align with a new line position within the Mona Substation. This new line position will be west of the existing Currant Creek 1 – Mona Substation line position. The new Currant Creek 2 line will be installed at the original (existing) Currant Creek 1 line position.

The actual interconnection from the western most transmission line structures to the respective deadend structure within the Mona Substation shall be completed by the Owner, for both of the Currant Creek 1 and Currant Creek 2 transmission lines.

The Switchyard Contractor shall provide adequate OPGW slack and a fiber optic termination cabinet at the Mona Substation end of the each transmission line. The Owner will terminate a fiber optic cable from the Mona Substation at the respective termination cabinets. The Owner will also terminate the Switchyard Contractor provided OPGW at the termination cabinets.

This scope of work also includes the interconnection of the new plant and switchyard for protection, control, metering, and communications system. The interconnection point shall be at a designated marshalling cabinet location within the Currant Creek 2 plant complex.

This scope of work includes the connection of the Plant Contractor provided generator step-up transformers and the new switchyard, from the transformer high side bushings. This work includes connecting to the Plant Contractor provided transformer mounted lightning arresters. The Switchyard Contractor shall provide the wire and fittings necessary to perform this work.

The Switchyard Contractor shall be responsible for the design and installation of fiber optic communication facilities between the existing Currant Creek 1 switchyard and the new Currant Creek 2 switchyard.

The Switchyard Contractor shall be responsible for procurement of all required equipment and materials necessary to complete the construction of new 345kV Block II switchyard.

The Switchyard Contractor shall be responsible for procurement of all required equipment and materials necessary to complete the construction of new 345kV Currant Creek 2 –Mona transmission line and relocation of the existing 345kV Currant Creek 1 – Mona transmission line.
The Switchyard Contractor shall be responsible for all required site development including, but not limited to, overall site grading, overall site drainage, access roads, switchyard roads, surfacing inside and outside the switchyard, and fencing.

The Owner has legal possession of all land associated with this project. No additional right of way or access permits are required. Juab County requires that a *Utility and Road Trenching Permit Agreement* be obtained for specific activities in the County. The Switchyard Contractor shall ensure that the permit requirements for Juab County are met for the switchyard and transmission line work.

The Switchyard Contractor shall obtain all necessary state, county, and local permits necessary to perform this Currant Creek 2 switchyard and transmission line construction work.

The Switchyard Contractor shall coordinate with the Plant Contractor to ensure the interconnection requirements set forth in the Owner's standards and these documents are achieved. These requirements include, but are not limited to, protection, control, synchronization, metering, and communication requirements.

The Switchyard Contractor shall coordinate with the Owner to ensure the Currant Creek 2 interconnection requirements as defined in the Owner's standards and these documents are achieved. These requirements include, but are not limited to, power, protection, control, metering, and communication requirements.

2.4 Engineering and Design

The Owner has prepared preliminary one-line design drawings for this project. The Switchyard Contractor shall use these drawings as a starting point. The Switchyard Contractor shall be required to complete the detailed design necessary to procure, construct, test, and operate the new switchyard. The Switchyard Contractor shall assume the bid issue drawings are preliminary and shall be required to verify the accuracy of these and any further drawings provided. Should the Switchyard Contractor wish to deviate from the design as shown on the preliminary design drawings the proposed deviation shall be submitted for review and consideration by Owner. Any deviations in the design will be accepted or rejected in writing by Owner.

The Switchyard Contractor shall be responsible for using existing drawings to create new drawings and drawing series according to existing Owner standards. The following types of drawings are expected to be created by the Switchyard Contractor:

A. Plan and layout drawings
B. Section and elevation drawings
C. Conduit and raceway drawings
D. Control building drawing, both plan and elevations
E. Control panel drawings
F. Grounding drawings
G. Single line drawings
H. AC and DC schematic drawings
I. Wiring drawings
J. Circuit list drawings
K. Foundation drawings
L. Structure loading diagrams
M. Structure drawings
N. Transmission line plan and profile drawings
O. Construction permit drawings

Switchyard Contractor is responsible for all other drawings as necessary for completion of the design, procure, construction, and testing. The use of the term drawings here also refers to documentation generated to establish the design basis and for calculations.

Any existing drawing series affected by this project shall be updated to the latest drafting standards.

All plan drawings shall start with a "KEY" sheet. The plan shall then be divided up into larger scale sections on the following sheets. The match lines on all plan (general plan, foundation, grounding, conduit, and lighting) sheets shall occur at the same locations. New elevation numbers shall be assigned. The elevation number shall match the sheet number of the drawing series.

The Switchyard Contractor shall follow the Owner's Engineering Handbook Volume 9, Computer Aided Design to create the drawings and documents associated with the switchyard project work.

The Switchyard Contractor shall be responsible, if any, to "VOID" or "SUPERCEDE" appropriate drawings. This requirement is essential to ensure outdated documentation is removed from the system.

Refer to Appendix R, Section 1 concerning the standard engineering and design requirements for this project. The Switchyard Contractor shall be required to complete all engineering and design as it relates to the scope of work contained in this document.

The Switchyard Contractor shall be required to supply all documentation and submittals as outlined in Appendix S.

Owner has not obtained a survey, soil boring test, geotechnical engineering report, or soil resistivity measurements. The Switchyard Contractor shall be responsible for obtaining the necessary survey, soil boring test, geotechnical engineering report, and soil resistivity measurements to support analysis of the switchyard ground grid, civil, and structure design. After reviewing these reports, if the Switchyard Contractor determines additional information is required to complete the design, the Switchyard Contractor shall coordinate with Owner to obtain the additional information.

The Switchyard Contractor shall be responsible for verifying existing facilities/drawings are accurate in areas that are impacted by any additions/modifications/upgrades required at Mona Substation, Currant Creek 1 Switchyard and at the proposed location of the Currant Creek 2 Switchyard as Owner cannot guarantee the accuracy of the existing documentation. This verification shall be completed before starting any site improvements, foundation installation, or wiring modifications.

2.5 Procurement and Material Management

The Switchyard Contractor shall be responsible to procure and expedite the following equipment and materials in accordance with the Owner's Engineering Standards and Material Specifications.

A. High voltage circuit breaker, including bushing current transformers
B. High voltage disconnect switches and ground switch
C. CCVTs and CT/PT units
D. Modular control building with AC systems, DC systems, HVAC systems, and fire detection systems
E. Control, power, metering, and communication cables.
F. Grounding material
G. Lightning protection material including surge arrestors, shield wire, etc.
H. Station service transformer
I. Switchyard lighting fixtures
J. Anchor bolts and reinforcement bar
K. Steel structures including generators step-up deadend structures and transmission line structures
L. Insulators, rigid bus, and strain bus, including fittings
M. Revenue metering units
N. Control and relay panels
O. Raceway and conduit materials
P. Control, protection, synchronization, metering, and communication equipment and materials
Q. Insulators
R. Erection hardware
S. SCADA equipment and material, including digital remote terminal unit (RTU)

The Switchyard Contractor shall be responsible to procure and expedite the following equipment and materials in accordance with the Owner's Engineering Standards and Material Specifications.

A. Anchor bolts and reinforcement bar
B. Structures and support arms
C. Insulators and fittings
D. Conductor and fittings
E. OPGW, fittings, and termination cabinets
F. Grounding material

The Switchyard Contractor is responsible for all equipment and material damaged during shipping and storage. The Switchyard Contractor shall notify Owner immediately concerning damaged material or equipment.

2.6 Construction and Commissioning

2.6.1 *General*

2.6.1.1 All Switchyard Contractor personnel who will be entering Block II Switchyard facilities shall be required to complete a Safe Entry Course provided by Owner. Upon completion of this course, Switchyard Contractor personnel shall be allowed access to the switchyard facility to complete any work as it relates to this project. During the initial design meeting, a training schedule and logistics shall be developed between Owner and the Switchyard Contractor to provide Substation Safe Entry Training.

2.6.1.2 The Switchyard Contractor shall be responsible to crib and/or protect all equipment and material that could be damaged by weather after arrival at the construction site.

2.6.1.3 The Switchyard Contractor is responsible for securing the construction and storage site(s). Any material or equipment that must be replaced due to theft or vandalism shall be at the Switchyard Contractor's cost.

2.6.2 *Equipment and Material Installation*

2.6.2.1 The Switchyard Contractor shall be responsible for the procurement and installation of all equipment necessary to construct new 345kV switchyard. In addition to the switchyard, the following clarifications are provided.

2.6.2.2 The Switchyard Contractor is responsible for the installation of all switchyard cables inside and outside the control building including all the interface cables with Currant Creek 1 and Currant Creek 2 plants. The Switchyard Contractor shall terminate, test, and lay down all cables, outlined in Exhibit X to a designated marshalling cabinet.

2.6.2.3 The Switchyard Contractor shall be responsible for the panel installation and panel-to-panel wiring of all the panels. Refer to Exhibit X for the testing and commissioning responsibility matrix.

2.6.2.4 The Switchyard Contractor shall install and wire all AC and DC load centers, transformers, and safety switches located within the existing control building or located within the switchyard. The Switchyard Contractor shall also install and wire cables connecting to the Currant Creek 2 marshalling cabinet and to an Owner-provided utility transformer. The Plant Contractor will pull the 480V AC source cable from the plant 480V system. The Switchyard Contractor will terminate this cable in the switchyard control building.

2.6.2.5 The Owner shall be responsible for completing the RTU software check after receipt of equipment and/or prior to wiring.

2.6.2.5 The Switchyard Contractor shall install the generator step-up transformers' deadend structures and facilities. These facilities include, but are not limited to, foundations, insulators, conductor, shield wire, fittings, foundations, and grounding. All work shall be coordinated with Plant Contractor. Owner shall approve the final design and arrangement of dead-end structures and facilities.

2.6.3 *Security Systems*

The Switchyard Contractor shall at all times conduct all of its operations under this Contract in a manner to avoid the risk of loss, theft, or damage by vandalism, sabotage, or other means, of and to any property. The Switchyard Contractor shall cooperate with Owner on all security matters and shall promptly comply with any Project security requirements established by Owner. The Switchyard Contractor shall promptly take all reasonable precautions which are necessary and adequate against any conditions which involve a risk of loss, theft, or damage to its property. The Switchyard Contractor shall be solely responsible for discovery, determination, and correction of any such conditions.

The Switchyard Contractor shall provide security sufficient for the protection of its own property, equipment, and personnel. Owner will not be responsible for any loss of, theft of, damage to, or injury to the Switchyard Contractor's property or personnel from any cause.

The Switchyard Contractor and its Subcontractors and their employees shall observe all procedures for admission to the Jobsite required by Owner and Plant Contractor, including the establishment of a badging system for the employees of the Switchyard Contractor and its subcontractors. Unauthorized personnel will not be permitted on the Jobsite.

2.6.4 *Equipment and/or Material Removal and/or Relocation*

The Switchyard Contractor shall be responsible for removing, disposing off-site and/or salvaging, if any, existing equipment and material.

2.6.5 *Testing and Commissioning*

Testing and Commissioning requirements and responsibilities are outlined in Exhibit X.

2.6.6 *Work at Mona Substation*

Owner will construct a new line position in the Mona Substation. The existing Currant Creek 1 transmission line will connect to this new line position, west of its existing location. The new Cuirrant Creek 2 transmission line will connect to the existing line position. Owner will furnish and install the deadend structure and insulators in the Mona Substation and the span to the first transmission structures outside the substation fence, for each transmission line. Unless otherwise specified, Contractor's interface point shall be the insulators on the deadend structure outside the Mona Substation. Switchyard Contractor shall provide the transmission line structures, including support arms and insulators.

2.6.7 *Protection, Control, Synchronization, and Metering, Interface Work*

The Switchyard Contractor shall install all facilities required for protection, control, synchronization, and metering interface with the Currant Creek 2, including facilities required between Currant Creek 2 and the switchyard, inside the switchyard and between the switchyard and the first transmission structure outside of the Mona

Substation. Facilities shall include, but not be limited to, trench systems, conduit, cable, wiring, programming, controls, relaying equipment, synchronization equipment, and metering equipment. The Switchyard Contractor shall make terminations on the switchyard side of the termination point.

2.6.8 *Communication Work*

The Switchyard Contractor shall provide fiber optic connection from the switchyard control building and a termination cabinet on the first transmission structure outside the Mona Substation. The Switchyard Contractor shall provide all facilities required for control, relaying, metering and data communications. Facilities shall include, but not be limited to, trench system, fiber, wiring, programming, and interface equipment.

The Switchyard Contractor shall provide fiber optic communication between the Currant Creek 1 switchyard and the Currant Creek 2 switchyard.

2.7 Technical Requirements - Switchyard

2.7.1 *Land*

Owner has obtained the property required to build a new 345kV Currant Creek 2 Switchyard and the right of way for the new 345kV transmission line.

2.7.2 *Site Development*

The Switchyard Contractor shall be responsible for all site development associated with the construction of the new 345 kV switchyard. This work shall include, but is not limited to, the surveying, site grading, yard surfacing, road surfacing, fencing, and drainage.

The site development design shall at a minimum meet the requirements outlined in the Civil Design Specification of Performance, Civil Design Criteria, and Construction Specifications 02010, 02020, 02030, 02110, 02120, 02122, 02130, 02132, 02134, 02136, 02910 and 02950.

2.7.3 *Fence, Walls, and Gates*

The Switchyard Contractor shall install fence, walls, and gates as shown in the drawings and shall at a minimum meet the requirements outlined in the Owner's Standard 6B.5- Fence Application and Construction and substation construction specifications 02010 and 02853. The Contractor shall obtain permits as needed.

2.7.4 *Foundations*

As discussed in earlier Sections, Owner has not provided a geotechnical engineering report for the switchyard site. The Switchyard Contractor shall conduct a geotechnical survey to complete the foundation design and provide a copy to Owner. This investigation shall be within the switchyard and as close as possible to the new foundations. Test pits may be used, as new foundations are not expected to be drilled piers.

Owner has not provided a survey for the switchyard site. The Switchyard Contractor is to create survey drawings including the general plan. The Switchyard Contractor is to complete an as-built survey of the yard and surrounding area to the street curb, but this survey must not delay construction with its creation. If needed, a temporary survey referencing the existing foundations may be used. The final as-built survey shall be tied to property corners and may need research to reveal their location.

Steel structure foundations can be either drilled pier or pad and pedestal construction. If the Contractor elects to use a pad and pedestal foundation design, the pads shall be placed deep enough as to not interfere with conduit and grounding installation.

Transformer foundations shall be reinforced concrete slab construction. Foundation design and construction shall consider any expansive soil and frozen soil conditions. Foundations design shall at a minimum meet the requirements outlined in substation construction specifications, 02360, 02364, 03100, 03500 and 03732.

The Switchyard Contractor shall remove any unused slab foundation in its entirety. Pier foundations shall be removed a minimum of 3'-0" below sub grade. Pad and pedestal foundations shall be removed a minimum of 3'-0" below sub grade or in their entirety.

2.7.5 *Liquefaction and Seismic Issues*

Liquefaction is a condition that may occur during a seismic event where loose saturated clean sandy soils lose shear strength due to sudden increase in pore water pressure. A physical change occurs to the soil transforming it "from solid ground capable of supporting a structure, to quicksand-like liquid with a greatly reduced ability to bear the weight of a structure." Liquefaction can induce ground surface settlement, which may result in damage to structures.

Foundations shall resist liquefaction-induced element; therefore for the final foundation design, Switchyard Contractor shall analyze, evaluate, and address any applicable seismic requirements and liquefaction concerns at the switchyard site and along the transmission line route. If liquefaction were to be occurred at the site and the liquefaction-induced settlement were to be greater than 1 inch, all foundations shall be designed to resist the excessive liquefaction settlement.

Seismic design of the foundation shall be conducted in accordance with the design spectral accelerations factors (short and long period), seismic site class, and other seismic factors information provided in the Geotechnical Engineering Report.

2.7.6 *Oil Containment*

Oil containment shall be required for any oil filled transformer and any other equipment containing 55 gallons or more of oil.

The containment area shall extend a minimum of 2 feet beyond any radiator, conservator, and/or mechanism containing oil. Squirt distance shall not be addressed. The requirement shall be to minimize the horizontal area and increase the vertical area (deeper) to support the containment requirement.

Refer to the Civil Design Specification of Performance and the Civil Design Criteria for additional information and requirements.

2.7.7 *Steel Structures*

Switchyard steel structures shall be designed per the Civil Design Specification of Performance and the Civil Design Criteria. Steel structures shall be procured, fabricated, and installed per Owner's substation structure design criteria "SL.13" and Construction Specifications 05100, 05101, 5110, 5200, and 5310. Owner shall provide standard 345kV steel structure drawings. The standard 345 kV steel structures shall be used unless a unique situation arises.

The Switchyard Contractor shall attempt to use standard steel structures for this installation. Height or phase spacing adjustments to standard structures is acceptable, but appropriate calculations shall be completed and provided as outlined in the Civil Design Specification of Performance. Should a standard steel structure not exist for a particular application the Switchyard Contractor shall attempt to use a standard steel structure as a starting point during the development of the new steel structure.

The Switchyard Contractor shall be required to use the deflection and seismic criteria outlined in the Civil Design Specification of Performance and Civil Design Criteria. The Switchyard Contractor has the responsibility to verify standard steel structures meet or exceed the latest deflection and seismic criteria as Owner does not guarantee the standard steel structures provided meet the current criteria.

2.7.8 *Control Building*

The Switchyard Contractor shall be responsible for the detailed design, procurement, and erection of the new control building to support this switchyard project. The control building shall be specified to be of either a modular type or one that is fully factory built. However, non-control items, such as the battery system, battery charge and/or any other electrical equipment, can be installed at the factory by the building manufacturer. If so specified, then all materials supplied or installed by the building manufacturer must meet Owner Power's current standard and specifications.

The building cable tray and its support system shall be specified as; to be furnished and installed by the building vendor or to be designed for field installation.

All building vendors must be approved by Owner. The Switchyard Contractor shall submit to Owner all building architectural drawings and color samples for review and approval.

The Switchyard Contractor shall coordinate all testing and checkout work within the control building as outlined Exhibit X with Owner.

2.7.9 *Cable Trench, Conduit, and Bollards*

Raceways shall be furnished in quantities sufficient for a complete installation as indicated on the drawings and in these specifications. The raceway system is defined to include rigid conduit, flexible conduit, cable tray, underground duct, cable trench wire way, cabinets and boxes, and all materials and devices required to install, support, secure, and provide a complete system for support and protection of electrical conductors.

All new cable trenches and conduits shall be sized and installed to accommodate any identified future development of the switchyard. Trenwa cable trench with ProGlass lids (pedestrian and road crossing) shall be used.

The Switchyard Contractor shall consider site drainage, equipment maintenance access, and minimizing road crossings when developing the cable trench design. 4/0 or 500 KCMIL copper ground wires shall be installed in the cable trench. The cable trench ground shall be installed along the top of the trench wall with cable trench ground clips provided by Trenwa.

Cable trenches shall not extend into or near transformer oil containment areas. Cable trench installed to a transformer shall stop short of the oil containment area at which point conduit shall be installed between the cable trench and the oil containment basin wall.

Bollards shall be installed at the edge of each road crossing.

Bollards shall also be installed in areas where there is a high probability of vehicles driving over the trench. Bollards shall be painted (yellow) galvanized steel with two rows of reflective yellow tape installed near the top of the bollard. The bollards shall have a two-hole ground pad approximately 6 inches above finished grade and connected to the grounding grid.

Conduits exiting the cable trench shall be Schedule 40 PVC. A 90-degree elbow installed at a 45-degree angle (in the direction of the control and/or cable run) shall be used for conduits side exiting perpendicular to the cable trench. A 45degree elbow shall be used for conduits exiting the end of a cable trench. End bells shall be installed on all conduits exiting the cable trench to protect control and/or cables.

Below grade conduit shall be Schedule 40 PVC. Conduit risers, including 90degree elbow, shall be galvanized rigid steel (GRS).

All conduit termination points at equipment and any conduit penetration of the control building shall be sealed with duct seal. Prior to installing the duct seal, stainless steel wool shall be installed in the conduit to control the access of the rodents and insects.

The Switchyard Contractor shall work with Plant Contract to identify the number of ducts to be installed in the ductbank between plant and the manhole for plant interface cables. The Plant Contractor will provide the plant manhole near the exterior of the switchyard. The Switchyard Contractor shall provide the interface from this plant manhole to the switchyard trench system and conduits for all protection, control, power, synchronization, metering, and communications conductors.

AC and DC station service source cables shall be run is separate conduits, not in the trench system, from the plant manhole to the control building.

Spare conduits shall be provided for each source cable, both from the plant sources and from the local utility source.

Conduit and Cable Trench shall be designed and installed per the Electrical Design Specification of Performance, Civil Design Specification of Performance and Construction Specifications 03400 and 16380.

2.7.10 *Grounding*

The switchyard grounding design shall provide a continuous ground system consisting of a buried main ground grid with ground rods. All equipment, stand-alone cabinets, structures, fencing, gates cable trench, rigid conduit, structures, and buildings shall be connected to the main ground grid. All ground grid conductors below the surface shall be bonded at each joint and at teach ground rod using an exothermic welding technique (CadWeld). Only 4/0 and 500 KCMIL Copper shall be used for any ground grid or tail (stinger) installation.

The Plant Contractor will provide the grounding calculation and design. The Switchyard Contractor however, shall analyze the entire switchyard ground grid design and mitigate grounding problems, if any, identified in the grounding report.

Soil resistivity measurements were not obtained by Owner. The Switchyard Contractor shall be responsible for obtaining the necessary soil resistivity measurements per specifications to support analysis of the switchyard ground grid design provided by the Plant Contractor.

The Switchyard Contractor is also responsible for extending and connecting the switchyard grounding grid with plant grounding grid system as per drawings and documentations provided by Plant Contractor.

The following fault duties are provided by Owner- and shall be used to complete analysis of the ground grid design.

345 kV Fault Duties:

- 345 kV bus 3-phase fault, Ia = xxxx amps
- 345 kV bus 1L-gnd fault, 3Io = xxxx amps

Approved grounding materials, design requirements, and installation methods are identified in the Electrical Design Specification of Performance, Engineering Handbook Section 6B.6- Substation Grounding, and Construction Specification 16520.

The Switchyard Contractor shall be responsible for repairing any existing ground grid damaged and/or cut during construction. The ground grid shall be tested for continuity after repair as outlined in Exhibit X.

The Switchyard Contractor shall be responsible for testing of the ground grid after installation. Both continuity and ground resistance testing shall be required. See Testing and Commissioning, Exhibit X, for the requirements. For the continuity test, the test locations shall be indicated on the Grounding Plan. The Switchyard Contractor must document this test and be given the option to witness the ground grid testing. Once the ground resistance test value is known, the Switchyard Contractor shall use the CDEGS ground grid model needs to ensure that the grid design is adequate. In addition to placing the results of the ground grid resistance tests on the drawing the Switchyard Contractor shall be responsible for formally documenting the results of all ground grid testing and providing the data to Owner as outlined in Exhibit X. Testing as outlined in Exhibit X shall be completed within 100 feet anywhere the ground grid has been disturbed, replaced, or modified.

2.7.11 *Bus and Conductor*

Ampacity rating of the rigid bus and wire conductors shall comply with the "Conductor Ampacity Rating" design criteria contained in Owner Engineering Handbook, section 6B.7. Rigid bus and Jumper conductors, fittings, connections, and jumper conductor material installation shall be in accordance with the Electrical Design Specification of Performance and Construction Specification 16220.

End closure plugs shall be furnished for all bus tubing including plugs required to close bus ends in expansion fittings.

The sizes of the bus tubing are indicated on the drawings.

The Switchyard Contractor shall be responsible for the procurement and installation of animal/raptor protection on any bus (rigid or wire) with less than 5'-0" centerline to centerline phase spacing and 3'-3" phase to ground spacing. This requirement shall also apply to all equipment and transformer bushings.

2.7.12 *Mobile Transformer*

Not required for this project.

2.7.13 *Shielding*

The Switchyard Contractor shall design and install switchyard shielding system in accordance with the Electrical Design Specification of Performance and Owner's Engineering Manual Section 1.B.7 and Construction Specification 16220.

Lightning protection system shall provide protection for new equipment within the switchyard fence such that the probability of failures of insulation is less than once in 100 years. Shielding wire around switchyards shall be according to Owner's current shield wire standard. Shielding masts and wires, and structure lighting finials shall be included in the shielding analysis.

Shielding plan drawing shall be developed indicating the zone of coverage of the shield wire and/or static masts.

Line structures will be protected according to a 30-degree shield angle from the shield wire outward to the phase position.

2.7.14 *Yard Lighting and Receptacles*

Lighting and yard receptacles are to be installed per Substation Construction Specification 16600.

2.7.15 *AC Station Service*

The Switchyard Contractor shall engineer, design, and procure AC station service system required for this project. The AC station service system will be located in the new control building and will consist of automatic transfer switch, dry type pad mount transformer, fused disconnect switches and AC distribution panel (s) as required. The new load center shall be sized such that at least five spare breakers on each panel remain for future expansion.

Switchyard transformer will have two 480 V AC sources fed through the automatic transfer switch. The Switchyard Contractor shall coordinate with the Currant Creek 2 plant project for a primary AC source and with the local utility for a secondary AC source. The 480V AC source from the plant shall not be located in the switchyard cable trench system. This source should be installed in a separate conduit starting at the Currant Creek 2 provided manhole located for interface with the switchyard cables towards the control building. For both sources, a spare conduit shall also be installed, with both ends capped, and with its purpose labeled on the cap. The cable for this source shall be provided and pulled by the plant contractor. The switchyard termination shall be completed by the Switchyard Contractor.

All secondary feeders and circuits will be sized and protected in accordance with NEC standards and voltage drop shall be considered when sizing cables as specified in the Electrical Design Specification of Performance.

2.7.16 *Switchyard DC System*

The Switchyard Contractor shall engineer, design, and procure DC station service system required for this project. The DC station service system will be located in the new control building to supply switchyard control and protection systems. A second DC station service supply will also be provided by the Plant Contractor.

The DC station service system will consist of the battery, two tier battery rack, battery spill containment tray, fused disconnect switches, charger, transfer switch, and dc distribution panel(s), as required. The new load center shall be sized such that at least five spare breakers per panel remain for future expansion.

The Battery system and battery charge shall be provided in according with the electrical design specification of performance and material specifications 25018 and 25019.

All dc feeders and circuits will be sized and protected in accordance with NEC standards and voltage drop shall be considered when sizing cables as specified in the Electrical Design Specification of Performance.

2.7.17 *600V Cable*

The 600V control and power cables installed within the switchyard shall be in accordance with the Electrical Design Specification of Performance and Material Specifications ZS-071 and ZS-072. The 600V control and power cables shall be installed and terminated per Construction Specifications 16300, 13620 and 16350.

All control cables installed outside the control house shall be shielded with the shields grounded at one end inside the control house, unless specified otherwise by Owner. Yard lighting and receptacle cables installed outside the control house do not need to be shielded cables. All cables installed and energized at 480VAC shall have a red jacket or red striped jacket.

Voltage drop and burden shall be considered when sizing all AC and DC cables. Electrical Design Specification of Performance outlines Owner control cable application.

2.7.18 *Power Transformers*

Not required for this project.

2.7.19 *Phase Shifting Transformers*

Not required for this project.

2.7.20 *Shunt Reactors*

Not required for this project.

2.7.21 *Series Reactors*

Not required for this project.

2.7.22 *Shunt Capacitors*

Not required for this project.

2.7.23 *Series Capacitors*

Not required for this project.

2.7.24 *Static VAR Compensation (SVC)*

Not required for this project.

2.7.25 *Dynamic VAR Compensation (D-VAR)*

Not required for this project.

2.7.26 *Circuit Breakers*

Breakers shall be provided in accordance with the drawings and Owner's Engineering Handbook Volume 6 Part C and Substation Material Specification ZS-013.

2.7.27 *Switches*

Group operated disconnect switches and ground switches shall be provided in accordance with the electrical design specification of performance and switchyard material specification ZS-050

2.7.28 *Capacitive Coupled Voltage Transformers (CCVTs)*

Capacitive Coupled Voltage Transformers (CCVTs) shall be provided in accordance with the electrical design specification of performance and substation material specification ZS-026.

2.7.29 *Voltage Transformers (VT)*

Not required for this project.

2.7.30 *Current Transformers (CT)*

Bushing mounted current transformers are required for this project for protection, control, and general metering purposes.

2.7.31 *Metering Instrument Transformers (combined VT/CT)*

Metering Instrument Transformers (VT/CT) with technical details as given below shall be provided for revenue metering purposes.

The manufacturer:	Areva T&D
Type:	KOTEF 362ER
Cat number:	253620000.0002 (KOTEF 362ER)
CT Ratio:	1000/5
VT Ratio:	1800/3000:1
PacifiCorp Stock number:	3090297

2.7.32 *Surge Arresters*

Surge arresting shall be provided in accordance with the electrical design specification of performance and drawings.

2.7.33 *Line Traps and Line Tuners*

Not required for this project.

2.7.34 *Insulators*

Station post insulators shall be provided in accordance with the electrical design specification of performance and drawings.

2.7.35 *Generator*

Not required for this project.

2.7.36 *Transrupter*

Not required for this project.

2.7.37 *Protection, Control, and Synchronization*

Protection, control, and synchronization design and drawings shall be completed as outlined in the Engineering Design Specification of Performance and Engineering Handbook Volume 5 “Protection and Control.”

Specific relaying requirements and design criteria for line, bus, and device protection will be provided by Owner and documented in the Project Plan.

2.7.38 *SCADA*

The Switchyard Contractor shall be responsible for the design, procurement, and installation of the SCADA system for the switchyard. The Switchyard Contractor shall provide SCADA status, analog, accumulator, and control to support the equipment being installed for this project. Any SCADA devices and equipment purchased and installed must meet the requirements provided in Owner Engineering Handbook Volume 8 “Electrical Communication and SCADA.”

The Switchyard Contractor shall coordinate with Owner’s SCADA Engineering to support design of the RTU and interposition panels. Switchyard Contractor shall work closely with the Owner to create the list of the analog, digital and control signals that need to be acquired to SCADA system from the switchyard. With this list, the Switchyard Contractor shall ensure that the identified RTU points list matches control schematics.

Switchyard Contractor shall prepare the RTU specific drawings, internal RTU wiring and be responsible for ordering and programming the RTU. The Switchyard Contractor shall provide wiring external to the RTU based on input from Owner.

The Switchyard Contractor shall be responsible for terminating all field and panel-to-panel cables on the SCADA TSN blocks.

2.7.39 *Power Line Carrier (PLC)*

Not required for this project.

2.7.40 *Fiber Optic Communications*

Optical Ground Wire, OPGW is required between this switchyard and Mona Substation for communication and line protection. The OPGW will be terminated on the transmission tower/dead-end structure located just west of the switchyard fence. If the transmission tower/dead-end structure is located within the switchyard yard, then the OPGW shall be terminated on the first tower/structure located outside the switchyard. At some point the OPGW will need to be spliced to an All Dielectric Self Supporting Cable (ADSS). The method used to get the fiber optic cable into the switchyard will depend on the location of the tower that the OPGW is terminated on. The preferred method is to locate the ADSS in the electrical space between the energized conductors and the shield wire. The Switchyard Contractor's shall insure that all applicable codes are adhered to and an equipotential plot is submitted to Owner per the schedule given the Project plan. Project specific requirements and the preferred method used to install the OPGW and ADSS cables will be specified in the Project plan.

In general, Owner will be using a 0.471" diameter, 48 fibers, OPGW for new projects.

2.7.41 *Fiber Optic Communications (Nodes)*

Not required for this project.

2.7.42 *Microwave Communications*

Not required for this project.

2.7.43 *Other Communications*

Not required for this project.

2.7.44 *Revenue Metering*

The Switchyard Contractor shall provide the revenue meters at each individual generator line. High accuracy .15 % extended range revenue class metering instrument transformers shall be installed on the high side of the transformer for per unit net generation. The generator metering will include SCADA EMS and bidirectional KWH data. The primary meter will provide data to SCADA and the secondary meter will provide backup data to Telemetry. An analog phone line is required for retail sales and generation accounting via the MV-90 translation system. This telephone line will be provided by the Owner.

2.7.45 *Equipment Removal*

No equipment removal is anticipated by the Switchyard Contractor for the switchyard project; however, if the Currant Creek 1 – Mona transmission line realignment requires new foundations, the existing foundations shall be removed per Section 2.7.4.

2.7.46 *Environmental*

No special environmental concerns have been identified for this site.

2.7.47 *Landscaping*

The Switchyard Contractor shall restore any landscaping disturbed during this project back to original or better.

2.7.48 *Deadend Structures*

Dead end structure shall have a conductor height of 45 feet, a shield wire height of 65 feet, mast height of 20 feet, phase spacing of 20 feet and a line angle from 0 to 20 degrees. Design conditions shall be NESC heavy loading. The structure shall be designed using the ultimate stress method. The following are the maximum loads:

Conductor Loading – 3000 lb per conductor
Shield Wire Loading – 2500 lb per wire

2.8 Technical Requirements – Transmission Line

2.8.1 *General*

The 345kV transmission line shall consist of steel structures using davit arm or suspension insulator construction. The line design conditions shall meet NESC heavy loading. The conductor height shall be a minimum of 45 feet above the ground at any point along the route.

The design shall meet the requirements of the Civil Design Specification of Performance and Substation Civil/Structural Design Criteria, including any deviations. In addition, the transmission line design and construction shall meet the requirements of the following Transmission Construction Standards, including other standards referenced within:

Standard	Description
TA 041	General – Line Design
TD 001	Poles – General Information
TD 100	Conductor– General Information,
TD 200	Shield and Guy Wire – General Information
TD 300	Grounding – General Information
TD 400	Suspension Hardware – General Information
TD 500	Tension Hardware – General Information
TD 700	Crossarms and Braces – General Information
TD-800	Insulators – General Information
TD-900	Bolts, Nuts, and Washers – General Information

2.8.2 *Structures*

The transmission structures for this project shall be standard structures:

Structure	Description
TJ 202	345kV Structure, Shielded, Single Circuit, Tangent, Davit Arm (0 - 3 deg)
TJ 251	345kV Structure, Shielded, Single Circuit, Deadend, (5 – 65 deg)
TJ 252	345kV Structure, Shielded, Single Circuit, Deadend, (65 – 90 deg)
TJ 276	345kV Structure, Shielded, Single Circuit, Angle, Davit Arm, (5 – 15 deg)

2.8.3 *Foundations*

As discussed in earlier sections, Owner has not provided a geotechnical engineering report for the transmission line. The Switchyard Contractor shall conduct a geotechnical survey to complete the foundation design and provide a copy to the Owner.

Owner has not provided a survey for the transmission line, neither the existing Currant Creek 1 line nor the new Currant Creek 2 line. The Switchyard Contractor is to create survey drawings including the plan and profile. The Switchyard Contractor shall also complete an as-built survey of the transmission lines and the surrounding area. The survey, initial and final, shall be tied to property corners.

Foundation design shall follow best practice designs.

2.8.4 *Conductors*

The conductor shall be selected based on Construction Standard TD 121. The preliminary design was based on 2-954kcmil ACSR, Cardinal.

The sag, tension, and loading of the conductors shall be designed using Construction Standard TD 109. The conductor shall be installed using the sagging methods as defined in Construction Standard TD 109.

Hold for OPGW Requirements. In general, Owner will be using a 0.471" diameter, 48 fibers, OPGW for new projects.

2.8.5 *Access Roads*

The Switchyard Contractor shall construct an access road from the Currant Creek 2 switchyard along the Currant Creek 2 transmission line either to the Mona Substation or to a location intersecting the Currant Creek 1 transmission line access road. The design for the access road shall be based on the following drawings:

Drawing	Description
PL-40690	Transmission Line Access Road Typical Cross Sections
PL-40691	Transmission Line Access Road Typical Grading Cross Sections
PL-40685	Transmission Line Access Road Culver Installation
PA-40687	Transmission Line Access Road Typical Ditch Section
PL-40687	Transmission Line Access Road Water Bar or Dip Installation

2.8.6 *Transmission Line Crossings*

Switchyard Contractor shall identify any potential line crossings through engineering analysis and field surveys; however, no line crossings are anticipated. If a line crossing is identified, the Switchyard Contractor shall notify Owner to determine if any further work is required.

The documents referenced below are located in Appendix C Conceptual Site Arrangements and Reference Drawings.

A2.1.1	162628-2PPA-E8500	Block II One Line Diagram
A2.1.2	162628-2PPA-E8100	Block II Electrical Plan
A2.1.3		Exh 5.1- Site Location-USGG-7.5 Minute Map-Currant Creek
A2.1.4	70456R01	Mona Substation One Line Diagram Key Sheet Sketch
A2.1.5	120334.002	Mona Substation General Plan Future Development Sketch
A2.16	113910.001	Plan & Profile – Currant Creek Transmission (Existing)

End of Appendix R, Section 2

APPENDIX S

SUBSTATION ENGINEERING DOCUMENTS, DRAWINGS AND OTHER DELIVERABLES

Appendix S

Currant Creek 2 Switchyard Engineering Documents, Drawings, and Other Deliverables

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Engineering Documents, Drawings, and Other Deliverables

1.0 <u>General Information</u>

To facilitate Owner's technical review and submittal of final technical documentation the Contractor shall meet the following submission requirements. All transmittals are to clearly indicate the following:

- Company's name (Owner Power)
- Project Name (i.e. Currant Creek 2)
- Facility name (i.e. Lake Currant Creek New 345kV Switchyard)
- Contractor's project number
- How submittal is being transmitted.
- Reason for submittal
- Date of transmittal.

The transmittal should include a clear, concise description of all documents enclosed. Documentation by drawing number, revision number, and date should be indicated, if applicable. Distributions to other parties are to be shown on the face of the transmittal.

All documents prepared by the Contractor or any of its Subcontractors shall be in English and shall include Owner's project name and number, and a full title block containing a unique identification number, revision number, source and type of document and descriptive title. Each document shall clearly indicate the applicable status (i.e. Preliminary, For Information, For Review, For Bid, For Construction, As-Built). Applicable drawings shall be placed on Owner drawing borders that contain unique Owner drawing numbers and appropriate Owner drafting standards.

All drawings, documents, and manufacturer information shall indicate Owner as the final owner. The Contractor shall ensure Owner is listed as the owner of record with all Subcontractors and Manufacturers providing material or equipment for the project.

All engineering work and applicable deliverables are to be certified and sealed by a Professional Engineer (PE).

The measurement system used for this project shall be the U.S. Customary System. All drawings and dimensions shall be to scale. Nonscale dimensions (NTS) on drawings shall not be permitted on scalable drawings. A scale bar shall be included on scaled drawings to permit use following photo-reduction.

Standard ANSI sizes shall be used for all drawings as required by the Drawing requirements outlined in Section 1 of Appendix R. Drawings shall be prepared such that photo-reduction to B-size shall result in a legible and useable drawing. When submitting drawings larger than B-size a B-size print shall also be submitted.

During construction, at the construction site, the Contractor shall be required to update and maintain on file a set of current markups of all documents, drawings, and data sheets to agree with actual work undertaken. These documents should be used to create the "As-built" drawings at the conclusion of the project.

Testing and commissioning related submittals are addressed in the Testing and Commissioning Section located in Exhibit X.

2.0 Software Requirements

All Contractor Deliverables including final drawings, lists, and manuals shall be provided to Owner in electronic format. This requirement pertains to both Contractor developed deliverables as well as Original Equipment Manufacturer's (OEM) developed deliverables.

Contractor shall provide electronic submittals in the following software formats:

Software Function	Software Name
Word Processing	Microsoft Word
Spreadsheets	Microsoft Excel
Database	Microsoft Access
Switchyard Drawing List	Microsoft Excel
Switchyard Bill of Material	Microsoft Excel
Switchyard Conduit & Cable List	Microsoft Excel
RTU Points List	Microsoft Excel

Software Function	Software Name
Switchyard Design Drawings	AutoCAD 2007
Manufacturer's Drawings	AutoCAD 2002 or 2004, or ".dxf"
Grading Design	AutoCAD 2007 (with contours at elevation)
Foundation Design	LPILE for pier foundations and Excel or other for pad and pedestal
Steel Structure Design	STAAD
Grounding Design	SES CDEGS 2007
Transmission Line Design/Drawings	PLS-CADD – AutoCAD 2007
Communications Design Drawings	AutoCAD 2007 saved as 2000
OTDR Test Data (Raw Data)	TraceView or NetTest
OTDR Summaries	Microsoft Excel
Scannable Material	Adobe Acrobat ".pdf"
Scannable Drawings	Adobe Acrobat ".tif"
Transformer Testing	Doble DTAF, SFRA

Owner must approve in writing the use of any software outside what has been identified above prior to its use.

3.0 Design Review by Owner

Contractor shall provide documentation for Owner engineering and drafting review as outlined in the various engineering Specification of Performance documents. Specification of Performance documents are included in Appendix R, Section 1 for Switchyard, Civil, Transmission, and Communications Engineering.

Should the review submittals agreed upon within the Contract be different than that identified in the Specification of Performance documents the Contractor shall still be required to make a final submittal for review prior to issuing the design documents or drawings for construction. The intent of the final review (Review #3) submission requirements outlined in the Specification of

Performance documents are to verify all comments and concerns identified during the review process have been addressed by the Contractor and Subcontractors.

The Contractor shall provide for review at Owner request or as identified in the Specification of Performance documents any and all information upon which the design is based. This could include but is not limited to results of survey, additional geotechnical exploration, material investigations, design calculations, shop drawings, design drawings, Subcontractor's information and drawings, and Manufacturer's information and drawings.

Review submittals to Owner shall include six (6) copies of all drawings and/or documents. Electronic files of all drawings and documents shall be submitted in addition to the six (6) hard copies. The electronic files shall be provided on a Compact Disk (CD). A separate CD shall be supplied with drawings and/or documents for each Section within an Appendix. Discipline specific drawings and/or documents within a specific Section shall be supplied on separate CD's as follows:

- Switchyard Civil
- Switchyard Foundation
- Switchyard Structural
- Switchyard Protection & Control
- Switchyard Revenue Metering
- Switchyard Electrical
- Transmission Line
- Distribution
- SCADA Communications
- Power Line Carrier (PLC) Communications
- Fiber Communications
- Microwave Communications
- Other Communications.

Each CD submitted shall clearly indicate the reason for the submittal (i.e. Review 1, Review 2, Review 3, For Construction, As-Built) and labeled with Appendix, Section, and Discipline.

Except where expressly agreed otherwise by Owner, the following shall apply to review submittals generated by the Contractor:

a. Documents: Six (6) hard copies of Letter and Tabloid size documents shall be provided with each review submittal. In addition, one (1) electronic copy shall be provided in Microsoft Word or Excel. Documents in ".pdf" format shall only be accepted with written approval from Owner.

b. Drawings: Six (6) hard copies of design, shop, manufacturer, and other related design and material drawings shall be provided with each review submittal. The six (6) hard copies shall include three (3) full size prints of the size customary for the type of drawing and three (3) "B" size (11" x 17") prints for full size drawings submitted that are larger than "B" size. In addition, one (1) electronic copy shall be provided in AutoCAD or Microsoft Excel. Documents in ".dxf" and ".tif" format shall only be accepted with written approval from Owner.

The Contractor shall make reasonable efforts to secure electronically formatted drawings and documents from all Subcontractors and Manufacturers. Owner shall be notified in writing when the Contractor is unable to obtain electronically formatted drawings from a Manufacturer and Owner shall work with the Contractor to obtain the electronically formatted drawings. When electronic formatting as noted in "a" and "b" above is not obtainable due to supplier policies and/or procedures then the Contractor shall have such material scanned and submitted in ".tif" or ".pdf" format as identified in "a" and "b" above. Manufacturer drawings in ".dxf" format shall be accepted but must first be approved by the Owner and the Contractor must verify it is compatible with AutoCAD.

Owner shall review the documentation and/or drawings for adherence to the Scope of Work as identified in Exhibit A, Owner standards and practices, and Owner documentation and drawing standards.

Contractor and Subcontractor drawings and documentation shall also be submitted in hard copy and electronically to Owner as described above. Owner may make comments to the Contractor on Contractor, Subcontractor, and Manufacturer drawings and documents if items are found not to be in compliance with the requirements or obligations of this Contract. The Contractor shall be obligated to resolve any such compliance issues internally or with the Subcontractor or Manufacturer in a timely manner and resubmit the drawings and documents for Owner review.

The Contractor shall notify Owner in writing ten (10) working days prior to submission of a review package. This notification shall include a complete description of what shall be included in the review package being submitted. For each review submittal Owner shall require at a minimum ten (10) working days to review and provide comments. Owner shall review the documents and drawings for conformance with the Scope of Work as identified in Exhibit A and shall mark or stamp to indicate whether changes or corrections are required. If changes or corrections are necessary, such changes or corrections shall be noted on the documents and/or drawings. Documents and/or drawings with comments and/or corrections shall be scanned in color and returned to the Contractor on CD or via a prearranged ftp site. The Contractor shall resubmit the corrected or changed drawings with changes and corrections clearly identified with the next review or prior to issuing for construction. Owner shall retain one (1) hard copy of all documents and drawings with comments and/or corrections.

Owner shall not necessarily examine or review all documents, drawings, or details submitted by the Contractor and may at Owner's discretion require the submittal to be subject to review or regard them as for information and record purposes.

The Contractor shall be responsible for any discrepancies, errors, or omissions on the documentation and/or drawings supplied by the Contractor, Subcontractors, and Manufacturers. Owner shall require the Contractor to make any changes to the documents and drawings, which may be necessary to make the work conform to the Scope of Work as identified in Exhibit A. Work completed before review of the documents and drawings shall be at the Switchyard's Contractor's risk. Any necessary design changes required to meet the requirements and objectives of the project shall be made at no additional cost to Owner or delay to the project.

All documents and drawings shall be updated as the design progresses so they continuously reflect the current design(s). Revisions shall be identified and alphanumerically indicated in the document/drawing revision block(s).

4.0 Documents and Drawings Issued for Permitting

The Contractor shall be responsible for supporting identified project permitting requirements. This shall include but is not limited to the permits outlined in Exhibit C. Any drawings developed to support permitting shall be completed in accordance with Owner drafting standards. Owner personnel shall review all permit drawings prior to submission to any municipal, state, or federal agency. If required the permit drawings shall be provided to Owner personnel for submission to municipal, state, or federal agencies.

A Professional Engineer (PE) as described in Section 4.5 of the Contract shall stamp all final drawings created by the Contractor to support permitting.

Owner shall require review of the permitting documentation prior to submission to the municipal, state, or federal agency. Except where expressly agreed otherwise by Owner, the following shall apply to permit review submittals generated by the Contractor:

a. Documents: Four (4) hard copies of Letter and Tabloid size documents shall be provided with each review submittal. In addition, one (1) electronic copy shall be provided in Microsoft Word or Excel. Documents in ".pdf" format shall only be accepted with written approval from Owner.

b. Drawings: Four (4) hard copies of design, shop, manufacturer, and other related design and material drawings shall be provided with each review submittal. The four (4) hard copies shall include two (2) full size prints of the size customary for the type of drawing and two (2) "B" size (11" x 17") prints for full size drawings submitted that are larger than "B" size. In addition, one (1) electronic copy shall be provided in AutoCAD or Microsoft Excel. Documents in ".dxf" and ".tif" format shall only be accepted with written approval from Owner

Except where expressly agreed otherwise by Owner or required by the municipal, state, or federal agency, the following shall apply to permit submittals generated by the Contractor:

a. Documents: Five (5) hard copies of Letter and Tabloid size documents shall be provided with each final permit submittal. In addition, one (1) electronic copy shall be provided in Microsoft Word or Excel. Documents in ".pdf" format shall only be accepted with written approval from Owner.

b. Drawings: Five (5) hard copies of design, shop, manufacturer, and other related design and material drawings shall be provided with each final permit submittal. The five (5) hard copies shall include two (2) full size prints of the size customary for the type of drawing and three (3) "B" size (11" x 17") prints for full size drawings submitted that are larger than "B" size. In addition, one (1) electronic copy shall be provided in AutoCAD or Microsoft Excel. Documents in ".dxf" and ".tif" format shall only be accepted with written approval from Owner

The Contractor shall notify Owner in writing ten (10) working days prior to submission of a review package. This notification shall include a complete description of what shall be included in the permit review package being submitted. For each permit review submittal Owner shall require at a minimum twenty (20) working days to review and provide comments. Owner shall review the documents and drawings for conformance with the Scope of Work as identified in Exhibit A and shall mark or stamp to indicate whether changes or corrections are required. If changes or corrections are necessary, such changes or corrections shall be noted on the documents and/or drawings. Documents and/or drawings with comments and/or corrections shall be scanned in color and returned to the Contractor on CD or via a prearranged ftp site. Owner shall retain one (1) hard copy of all documents and drawings with comments and/or corrections.

As Owner has no control of the municipal, state, or federal agencies review period the Contractor must allow at a minimum 30 (thirty) working days for permitting review.

5.0 Documents and Drawings Issued for Construction

After final review of documents and drawings required for construction by Owner the Contractor shall issue the documents and/or drawings for construction. The documents and drawings issued for construction shall be revision zero (Rev. 0). Drawing submittal procedures shall conform to those outlined in the Design Review section of this document with one exception as outlined below.

A Professional Engineer (PE) licensed in the state of record shall stamp all documents and drawings submitted for construction by the Contractor. These drawings shall be marked "FOR CONSTRUCTION" and shall include the appropriate Contractor signatures (Checked, Discipline, Project, and Approval Engineer). Two sets of full size original PE wet stamped drawings shall be issued with the six (6) hard copies. The other four (4) copies shall be stamped by a PE and can be copies of the original PE stamped drawings. A PE stamp is not required on electronic documents and drawings unless drawings are .pdf or .tif documents or drawings submitted to support the design (i.e. design calculations, analysis, field test reports, equipment specifications created by Contractor or Subcontractor, etc.).

Construction shall not start until after the Owner Project Manager and/or Project Engineer have received the original PE wet stamped documents and drawings. Owner shall notify the Contractor in writing when the construction drawings have been received. This requirement applies to revision zero (Rev. 0) and any revision created to support construction. This requirement cannot be waived for revision zero (Rev. 0) but can be waived for a single identified revision created to support construction upon written confirmation from Owner's Project Engineer and Project Manager.
Electronic files associated with revision zero (Rev. 0) and any revision created to support construction shall be provided to Owner on CD as outlined in Section 3 of this document. The files shall be checked into Owner's drawing/document database. Once the drawings/documents have been placed in the database the drawings shall be checked back out to the Contractor to support additional construction revisions and/or as-builts as outlined in Section 7.0 of this document.

Required and/or requested design information may later be included on the design drawings. The fact such design information may later be included in the instruction and/or operating manuals does not relieve the Contractor from compliance with this requirement.

6.0 Revisions to Documents and Drawings after Construction Issue

As discussed in Section 5.0 of this document the revision zero (Rev. 0) construction drawings and documents shall be supplied to Owner. The revision zero (Rev. 0) drawings and/or documents shall be placed in the drawing/document database. After the construction drawings and/or documents are placed in the database they shall be checked out to the Contractor to support additional construction revisions (if necessary) and/or As-Builts as outlined in Section 8.0 of this document.

Any revisions created after revision zero (Rev. 0) to support construction activities shall follow the same process outlined in Section 5.0 of this document.

7.0 Deliverables other than Construction, Revision, and Final Documentation

Deliverables supplied by the Contractor to Owner shall include but are not necessarily limited to:

- Final Foundation Calculations (Electronic file and PE stamped hard copy of LPILE documentation).
- Steel Structure Calculations (Electronic file and PE stamped hard copy of STAAD model).
- Rigid Bus Calculations (file and PE stamped hard copy Electronic).
- AC Station Service Calculations (Electronic file and PE stamped hard copy).
- DC Battery Calculations (Electronic file and PE stamped hard copy).
- Communications (Fiber) test data (Electronic file).
- Line Data Form.
- RCMS units for Transmission and Distribution.
- Stringing Charts.
- Steel & Concrete Pole manufacturer drawings (Electronic file).
- Ground Resistance Test Report.
- CDEGS grounding analysis (Electronic file of CDEGS input/output and PE stamped hard copy of output).
- Final Construction Specifications.

- Gradation of imported aggregate or structural fill materials.
- Soil compaction test documentation.
- Concrete mix designs.
- Concrete slump, air, and compression results.
- Special inspectors' reports.
- Cable trench and cover vendor approval drawings.
- Geotechnical Information/Reports obtained by Contractor after award of the contract.
- Survey Information obtained by Contractor after award of the contract. Electronic files compatible with AutoCAD shall be supplied.
- All PLS-CADD electronic design files in final form.
- Final major equipment specifications.
- Equipment specifications developed by Contractor or Subcontractor.
- Equipment and material cut sheets as outlined below.
- Final major equipment manufacturer drawings and test reports as outlined below.

The Contractor shall be required to submit Major Equipment Manufacturer's documentation (test reports, instruction manuals, installation manuals, cut sheets, drawings, etc.), written in English, to Owner's Major Equipment Documentation Coordinator prior to the completion of construction. All documentation and drawings shall have the SAP equipment number on them. Documentation shall be supplied for at least but is not limited to the following equipment:

- Group operated switches
- Motor operators
- Circuit switchers
- Transrupters
- Line Rupters
- Voltage transformers (potential devices)
- Capacitive coupled voltage transformers (CCVT)
- Current transformers
- Metering units (CT/VT combination units)
- Power circuit breakers
- Power transformers
- Station Service Transformers (oil filled, padmount, and dry type)
- Shunt reactors
- Series reactors

- Shunt capacitor banks
- Series capacitor banks
- Generators and related equipment (i.e. automatic transfer switch)
- Control House.

Except where expressly agreed to otherwise by Owner, the following shall apply to Major Equipment Manufacturer drawings listed above supplied by the Contractor:

a. Documents: Five (5) hard copies of Letter and Tabloid size documents shall be provided. In addition, one (1) electronic copy shall be provided in Microsoft Word or Excel. Documents in ".pdf" format shall only be accepted with written approval from Owner

b. Drawings: Five (5) hard copies of drawings shall be provided. The five (5) hard copies shall be full size prints of the size customary for the type of drawing. In addition, one (1) electronic copy shall be provided in AutoCAD (version 2004). Documents in ".dxf" and ".tif" format shall only be accepted with written approval from Owner

One of the five hard copies shall be supplied and kept with the equipment. The hard copy supplied with the equipment shall be stored in a filing cabinet located in the control house. The hard copies shall be placed in a file folder labeled with a description (i.e. 230kV breaker – CB 1H230 – SAP #, 230kV switch 1H231 – SAP #, 230kV switch w/ground switch 1H232 – SAP #, etc.).

Electronic files for Major Equipment shall be supplied on compact disk (CD). A separate CD shall be supplied for each manufacturer and model. The CD shall be labeled with manufacturer, model, and associated SAP equipment numbers.

Major equipment documents and drawings shall be required to support Owner's development of the relay settings. The Contractor should factor into their overall project schedule the delivery of these drawings to support development of the relay settings prior to energization.

The Contractor shall be required to submit Manufacturer's documentation (instruction manuals, installation manuals, cut sheets, drawings, etc.) to Owner's Project Engineer prior to the completion of construction. Documentation shall be supplied for at least but is not limited to the following material:

- Cable trench
- Cable trench lids
- Pull boxes (hand holes)
- Steel structures
- Insulators
- Rigid bus and fittings
- Wire bus and fittings
- Transmission fittings
- Fuse and fuse holders
- Hook operated switches
- Station service related equipment (circuit breakers, disconnect switches, etc.)
- Line (wave) traps
- Line tuners
- Control house
- Junction boxes
- Conduit and conduit fittings
- Grounding material (i.e. fittings, bars, etc.)
- Yard lighting and related equipment
- Yard receptacles and related equipment
- Protection and control related equipment (i.e. relays)
- Communication related equipment.
- Control and Power cable.
- Oil containment related equipment.

Except where expressly agreed otherwise by Owner, the following shall apply to Manufacturer material cut sheets, documentation, and drawings listed above supplied by the Contractor:

c. Documents: Two (2) hard copies of Letter and Tabloid size documents shall be provided. In addition, one (1) electronic copy shall be provided in Microsoft Word or Excel. Documents in ".pdf" format shall only be accepted with written approval from Owner

d. Drawings: Two (2) hard copies of drawings shall be provided. The two (2) hard copies shall be full size prints of the size customary for the type of drawing. In addition, one (1) electronic copy shall be provided in AutoCAD (version 2004). Documents in ".dxf" and ".tif" format shall only be accepted with written approval from Owner.

The material documents and drawings shall be organized logically and placed in three- ring binders (D-ring). As two (2) hard copies are required the hard copies shall be separated to create two (2) complete sets of binders.

Electronic files for Manufacturer material shall be supplied on compact disk (CD). The electronic material information shall be organized logically in folders on the CD.

8.0 Final Documentation

The Contractor shall be required to provide Owner with "As-Built" drawings and documentation for the entire project outlined in Exhibit A. The final documentation shall consist of but is not limited to the following:

- Any outstanding items identified in Section 6.0.
- All equipment and material warranties.
- All final "As-Built" design drawings.
- All final "As-Built" Subcontractor drawings.
- All completed SAP Equipment forms.

Documents and/or drawings shall be updated and/or re-drafted by the Contractor or Subcontractor as necessary to reflect the final installation and conditions. All relevant field marks shall be incorporated into updated and/or re-drafted documents. Mark-up sketch, referencing, and other field marking techniques are not acceptable as final as-built documents and/or drawings.

All Contractor and Subcontractor (not manufacturer) drawings shall be "As-Built" to reflect the final installation, condition, and configuration. The Subcontractor drawings shall be in sufficient detail to indicate the kind, size, arrangement, and weight of each component, operation of component materials and devices, the external connections, anchorages, and supports required; the dimensions needed for installation, and correlation with other materials and equipment.

"As-Built" documents and/or drawings shall be issued as the next sequential revision from previous releases. The revision block shall state, "AS-BUILT" or "REVISED PER FIELD

CONDITIONS". All clouds, revision diamonds, and other interim control marking shall be removed. All information listed as "LATER" or "HOLD" shall be completed. The "As-Builts" shall be clear and readable in both full size and B-size reduction. The Contractor shall provide new versions of the Subcontractor documents and/or drawings if Owner judges originals to be damaged, deteriorated, or illegible.

The Contractor shall supply all field marked drawings and/or documents with the final documentation. This shall include hard copies and scanned electronic copies of the field marked drawings. The scanned electronic copies shall be supplied on CD.

Except where expressly agreed otherwise by Owner, the following shall apply to final "As-built" document and drawing submittals generated by the Contractor:

a. Documents: Six (6) hard copies of Letter and Tabloid size documents shall be provided with the submittal. In addition, one (1) electronic copy shall be provided in Microsoft Word or Excel. Documents in ".pdf" format shall only be accepted with written approval from Owner.

b. Drawings: Six (6) hard copies of design, shop, manufacturer, and other related design and material drawings shall be provided with the submittal. The six (6) hard copies shall include three (3) full size prints of the size customary for the type of drawing and three (3) "B" size (11" x 17") prints for full size drawings submitted that are larger than "B" size. In addition, one (1) electronic copy shall be provided in AutoCAD or Microsoft Excel. Documents in ".dxf" and ".tif" format shall only be accepted with written approval from Owner.

9.0 Submission of Deliverables and Review, Construction, Revision, and Final Submittals

Documents, drawings, and other deliverables identified in this document shall be submitted to Owner and Owner's Representative.

End of Exhibit S

APPENDIX T

PROPOSED UTAH POLLUTANT DISCHARGE ELIMINATION SYSTEM

PERMIT APPLICATION

Please print or type in the unshaded areas only
(fill-in areas are spaced for elite type, i.e., 12 characters/inch).

For Approved. OMB No. 2040-0086. Approval expires 5-31-92

FORM 1 GENERAL

U.S. ENVIRONMENTAL PROTECTION AGENCY

GENERAL INFORMATION

Consolidated Permits Program

(Read the "General Instructions" before starting.)

I. EPA I.D. NUMBER

S		T/A	C
F	UTR000008359		D
1	2 13	14	15

LABEL ITEMS	
I. EPA I.D. NUMBER	PLEASE PLACE LABEL IN THIS SPACE
III. FACILITY NAME	
V. FACILITY MAILING LIST	
VI. FACILITY LOCATION	

GENERAL INSTRUCTIONS

If a preprinted label has been provided, affix it in the designated space. Review the information carefully; if any of it is incorrect, cross through it and enter the correct data in the appropriate fill-in area below. Also, if any of the preprinted data is absent *(the area to the left of the label space lists the information that should appear)*, please provide it in the proper fill-in area*(s)* below. If the label is complete and correct, you need not complete Items I, III, V, and VI*(except VI-B which must be completed regardless)*. Complete all items if no label has been proved. Refer to the instructions for detailed item descriptions and for the legal authorization under which this data is collected.

II. POLLUTANT CHARACTERISTICS

INSTRUCTIONS: Complete A through J to determine whether you need to submit any permit application forms to the EPA. If you answer "yes" to any questions, you must submit this form and the supplemental from listed in the parenthesis following the question. Mark "X" in the box in the third column if the supplemental form is attached. If you answer "no" to each question, you need not submit any of these forms. You may answer "no" if your activity is excluded from permit requirements; see Section C of the instructions. See also, Section D of the instructions for definitions of **bold-faced terms**.

SPECIFIC QUESTIONS	MARK "X" YES	NO	FORM ATTACHED	SPECIFIC QUESTIONS	MARK "X" YES	NO	FORM ATTACHED
A. Is this facility a **publicly owned treatment works** which results in a **discharge** to **waters of the U.S.?** (FORM 2A)	☐ 16	☒ 17	☐ 18	B. Does or will this facility *(either existing or proposed)* include a **concentrated animal feeding operation** or **aquatic animal production facility** which results in a **discharge** to **waters of the U.S.?** (FORM 2B)	☐ 19	☒ 20	☐ 21
C. Is this facility which currently results in **discharges** to **waters of the U.S.** other than those described in A or B above? (FORM 2C)	☐ 22	☒ 23	☐ 24	D. Is this proposal facility *(other than those described in A or B above)* which will result in a **discharge** to **waters of the U.S.?** (FORM 2D)	☒ 25	☐ 26	☒ 27
E. Does or will this facility treat, store, or dispose of **hazardous wastes?** (FORM 3)	☐ 28	☒ 29	☐ 30	F. Do you or will you inject at this facility industrial or municipal effluent below the lowermost stratum containing, within one quarter mile of the well bore, underground sources of drinking water? (FORM 4)	☐ 31	☒ 32	☐ 33
G. Do you or will you inject at this facility any produced water other fluids which are brought to the surface in connection with conventional oil or natural gas production, inject fluids used for enhanced recovery of oil or natural gas, or inject fluids for storage of liquid hydrocarbons? (FORM 4)	☐ 34	☒ 35	☐ 36	H. Do you or will you inject at this facility fluids for special processes such as mining of sulfer by the Frasch process, solution mining of minerals, in situ combustion of fossil fuel, or recovery of geothermal energy? (FORM 4)	☐ 37	☒ 38	☐ 39
I. Is this facility a proposed **stationary source** which is one of the 28 industrial categories listed in the instructions and which will potentially emit 100 tons per year of any air pollutant regulated under the Clean Air Act and may affect or be located in an **attainment area?** (FORM 5)	☒ 40	☐ 41	☐ 42	J. Is this facility a proposed **stationary source** which is NOT one of the 28 industrial categories listed in the instructions and which will potentially emit 250 tons per year of any air pollutant regulated under the Clean Air Act and may affect or be located in an **attainment are?** (FORM 5)	☐ 43	☒ 44	☐ 45

III. NAME OF FACILITY

C	SKIP	
1		CURRANT CREEK GENERATING STATION
15	16-29	30 69

IV. FACILITY CONTACT

C	A. NAME & TITLE *(last, first, & title)*	B. PHONE *(area code & no.)*		
2	Powell, Kerry; Environmental Engineer	435	623	3816
15	16 45	46 48	49 51	52 55

V. FACILITY MAILING ADDRESS

C	A. STREET OR P.O. BOX
3	P.O. Box 523
15	16 45

C	B. CITY OR TOWN	C. STATE	D. ZIP CODE
4	Mona	UT	84645
15	16 40	41 42	47 51

VI. FACILITY LOCATION

C	A. STREET, ROUTE NO. OR OTHER SPECIFIC IDENTIFIER
5	2096 West 300 North
15	16 45

B. COUNTY NAME
Juab County
46 70

C	C. CITY OR TOWN	D. STATE	E. ZIP CODE	F. COUNTY CODE
6	Mona	UT	84645	023
15	16 40	41 42	47 51	52 54

CONTINUED FROM THE FRONT

VII. SIC CODES *(4-digit, in order of priority)*

A. FIRST		B. SECOND	
C 7 4911	*(specify)* Electric Services	7	*(specify)*
C. THIRD		**D. FOURTH**	
C 7	*(specify)*	7	*(specify)*

VIII. OPERATOR INFORMATION

A. NAME: C 8 PacifiCorp Energy

B. Is the name listed in Item VIII-A also the owner? ☒ YES ☐ NO

C. STATUS OF OPERATOR *(Enter the appropriate letter into the answer box; if "Other," specify.)*

F = FEDERAL
S = STATE
P = PRIVATE
M = PUBLIC *(other than federal or state)*
O = OTHER *(specify)*

P *(specify)*

D. PHONE *(area code & no.)*: C A 801 220 2989

E. STREET OR PO BOX: 1407 W. North Temple

F. CITY OR TOWN	G. STATE	H. ZIP CODE
C B Salt Lake City	UT	84116

IX. INDIAN LAND

Is the facility located on Indian lands? ☐ YES ☒ NO

X. EXISTING ENVIRONMENTAL PERMITS

	C	T	I	Permit		C	T	I	Permit	(Specify)
A. NPDES *(Discharges to Surface Water)*	9	N		N/A	D. PSD *(Air Emissions from Proposed Sources)*	9	P		DAQE - AN2524002-04	
B. UIC *(Underground Injection of Fluids*	9	U		N/A	E. OTHER *(specify)*	9			UGW230003	Groundwater Discharge Permit
C. RCRA *(Hazardous Wastes)*	9	R		UTR000008359	E. OTHER *(specify)*	9			Permit #12024	Water Treatment Operating Permit

XI. MAP

Attach to this application a topographic map of the area extending to at least one mile beyond property boundaries. The map must show the outline of the facility, the location of each of its existing and proposed intake and discharge structures, each of its hazardous waste treatment, storage, or disposal facilities, and each well where it injects fluids underground. Include all springs, rivers and other surface water bodies in the map area. See instructions for precise requirements.

XII. NATURE OF BUSINESS *(provide a brief description)*

PacifiCorp Energy (PacifiCorp) operates a 550 Megawatt (MW), natural gas-fired, combined cycle power plant on a 251-acre site near Mona, Utah. This Currant Creek facility is somewhat unique because it employs dry cooling technology for steam condensing. The plant uses a huge air-cooled condenser to recover turbine exhaust steam whereas most combined cycle plants used a less costly wet cooling system. This translates to the plant using only about 10 percent of the amount of water that a similar sized power plant with wet cooling would require. This dry cooling system was selected because water is a scarce commodity in the area.

PacifiCorp plans to construct a second 550 MW combined cycle block at the same facility. Unit 2 will also utilize a dry cooling system and be essentially the same as Unit 1. A new wastewater discharge outfall structure will need to be constructed in order to accommodate wastewater flows of up to 300 gallons per minute (gpm) from the existing Unit 1 and the proposed Unit 2 operations. When Unit 2 is operational, the facility will utilize four natural gas-fired combustion turbines and four heat recovery steam generators with two steam turbines to generate approximately 1100 megawatts of electric power for commercial and residential use.

XIII. CERTIFICATION *(see instructions)*

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this application and all attachments and that, based on my inquiry of those persons immediately responsible for obtaining the information contained in the application, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME & OFFICIAL TITLE *(type or print)*	B. SIGNATURE	C. DATE SIGNED
Dana Ralston, Vice President, Generation		

COMMENTS FOR OFFICIAL USE ONLY

C C

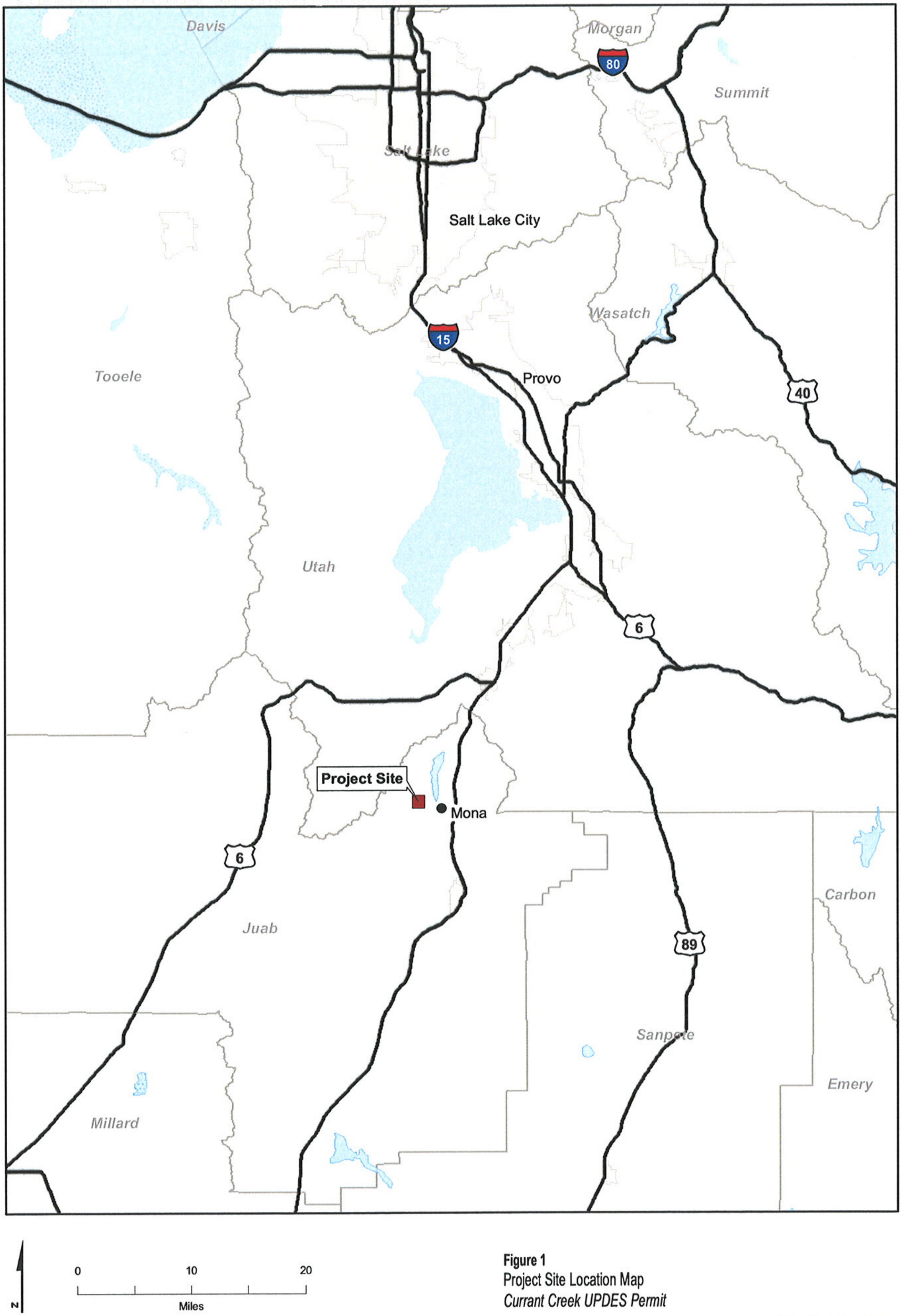


Figure 1
Project Site Location Map
Currant Creek UPDES Permit

CH2MHILL

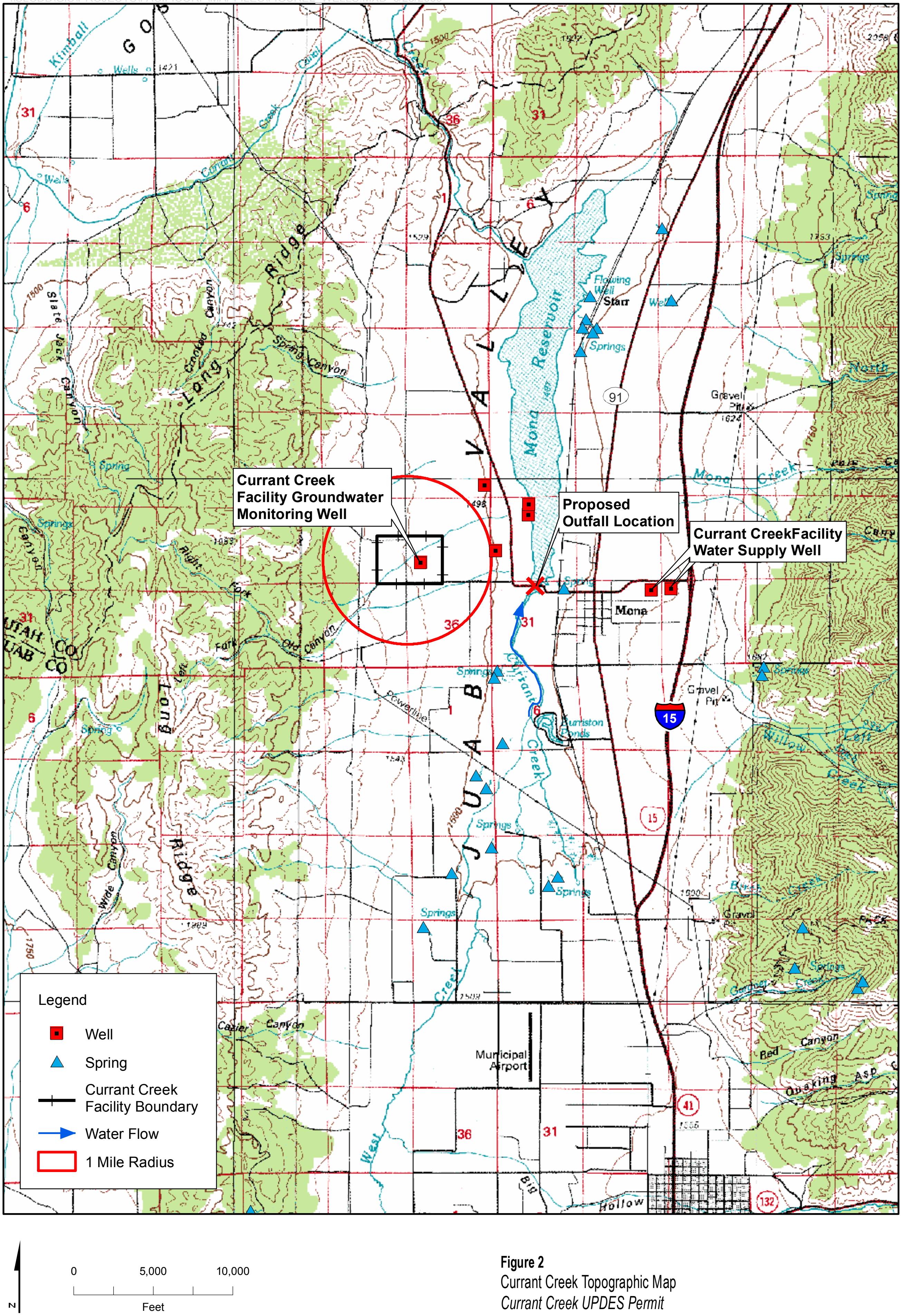


Figure 2
Currant Creek Topographic Map
Currant Creek UPDES Permit

CH2MHILL

Please type or print in the unshaded areas only	EPA ID Number *(Copy from Item 1 of Form 1)* UTR000008359	*Form Approved OMB No. 2040-0086 Approval expires 7-31-88*

Form **2D** NPDES

New Sources and New Dischargers
Application for Permit to Discharge Process Wastewater

I. Outfall Location

For this outfall, list the latitude and longitude, and name of the receiving water(s)

Outfall Number *(list)*	Latitude			Longitude			Receiving Water *(name)*
	Deg	Min	Sec	Deg	Min	Sec	
01	39	49	12.23	111	52	03.47	Mona Reservoir

II. Discharge Date *(When do you expect to begin discharging?))*

III. Flows, Sources of Pollution, and Treatment Technologies

A. For each outfall, provide a description of (1) all operations contributing wastewater to the effluent, including process wastewater, sanitary wastewater, cooling water, and stormwater runoff; (2) the average flow contributed by each operation; and (3) the treatment received by the wastewater. Continue on additional sheets if necessary.

Outfall Number	1. Operations Contributing Flow *(list)*	2. Average Flow *(include units)*	3. Treatment *(Description of list Codes from Table 2D-1)*
01	Heat recovery steam	gpm	None
	Generator blowdown	300	
	Sump (includes wastewater		
	From RO concentrate sump		
	and oil/water separator		
	sump, excess condensate		
	from condensate system,		
	auxiliary boiler blowdown,		
	HRSG blowdown)		
01	Evaporative cooler blowdown	20 gpm	None
01	RO CIP & combustion turbine	52,000 gal/yr	None
	washwater (discharge		
	occurs twice a year)		

B. Attach a line drawing showing the water flow through the facility. Indicate sources of intake water, operations contributing wastewater to the effluent, and treatment units labeled to correspond to the more detailed descriptions in Item III-A. Construct a water balance on the line drawing by showing average flows between intakes, operations, treatment units, and outfalls. If a water balance cannot be determined (e.g., for certain mining activities), provide a pictorial description of the nature and amount of any sources of water and any collection or treatment measures.

C. Except for storm runoff, leaks, or spills, will any of the discharges described in Item III-A be intermittent or seasonal?

☒ Yes *(complete the following table)* ☐ No *(go to Item IV)*

Outfall Number	1. Frequency		2. Flow		
	a. Days Per Week *(specify average)*	b. Months Per Year *(specify) average)*	a. Maximum Daily Flow Rate *(in mgd)*	b. Maximum Total Volume *(specify with units)*	c. Duration *(in days)*
Outfall 01 (combustion turbine washwater; seasonal discharge of up to 24,000 gal/yr	conducted twice per year, less than 12 hours per duration		0.006 (per event)	6,000 gallons (per event)	<1 day per year
Outfall 01 (reverse osmosis clean-in-place wastewater; seasonal discharge of up to 40,000 gallons per year)	Conducted twice per year less than 12 hrs per duration		0.02 (per event)	20,000 gallons (per event)	<1 day per year

*Turbine washwater and reverse osmosis (RO) clean-in-place (CIP)wastewater will be sampled and submitted for laboratory analysis at the conclusion of each event.
Discharges from the above listed waste streams would only occur at Outfall 01 if analytical results indicate the discharges would not violate permit effluent conditions. The discharge at Outfall 01 from the heat recovery steam generator blowdown sump will likely occur on a regular (daily) basis.

IV. Production

If there is an applicable production-based effluent guideline or NSPS, for each outfall list the estimated level of production (projection of actual production level, not designed), expressed in the terms and units used in the applicable effluent guideline or NSPS, for each of the first 3 years of operation. If production is likely to vary, you may also submit alternative estimates (attach a separate sheet).

Year	a. Quantity Per Day	b. Units of Measure	c. Operation, Product, Material, etc *(specify)*

CONTINUED FROM THE FRONT	EPA ID Number *(cop from Item 1 of Form 1)*	Outfall Number

V. Effluent Characteristics

A and B: These items require you to report estimated amounts *(both concentration and mass)* of the pollutants to be discharged from each of your outfalls. Each part of this item addresses a different set of pollutants and should be completed in accordance with the specific instruction for that part. Data for each outfall should be on a separate page. Attach additional sheets of paper if necessary.

General Instructions *(See Table 2D-2 for Pollutants)*

Each part of this item requests you to provide an estimated daily maximum and average for certain pollutants and the source of information. Data for all pollutants in Group A, for all outfalls, must be submitted unless waived by the permitting authority. For all outfalls, data for pollutants in Group B should be reported only for pollutants which you believe will be present or are limited directly by an effluent limitations guideline or NSPS or indirectly through limitations on an indicator pollutant.

1. Pollutant	2. Maximum Daily Value *(include units)*	3. Average Daily Value *(include units)*	4. Source *(see instructions)*
See Attachment 2 for effluent characteristics			

CONTINUED FROM THE FRONT	EPA ID Number *(cop from Item 1 of Form 1)*	

C. Use the space below to list any of the pollutants listed in Table 2D-3 of the instructions which you know or have reason to believe will be discharged from any outfall. For every pollutant you list, briefly describe the reasons you believe it will be present.

1. Pollutant	2. Reason for Discharge
PacifiCorp has no reason to believe that any pollutants listed in Table 2D-3 will be discharged at the proposed outfall location.	

VI. Engineering Report on Wastewater Treatment

A. If there is any technical evaluation concerning your wastewater treatment, including engineering reports or pilot plant studies, check the appropriate box below.

☐ Report Available ☐ No Report

B. Provide the name and location of any existing plant(s) which, to the best of your knowledge, resembles this production facility with respect to production processes, wastewater constituents, or wastewater treatments.

Name	Location
Lake Side Power Plant UPDES Permit #UT0025623	1900 North Pioneer Lane Vineyard, UT 84057

EPA ID Number *(cop from Item 1 of Form 1)*
UTR 000008359

VII. Other Information *(Optional)*

Use the space below to expand upon any of the above questions or to bring to the attention of the reviewer any other information you feel should be considered in establishing permit limitations for the proposed facility. Attach additional sheets if necessary.

Note 1. Sanitary waste discharged at the facility is discharged to an onsite septic tank system and leach field. No sanitary wastewater will be discharged at Outfall 01.
Note 2. The temperatures of the discharge effluent product in Attachment 2 are estimates based on average soil temperature provided by USGS soil temperature data for Utah. It is assumed that the temperature of the discharge at Outfall 1 will be similar to surrounding soil temperature since the discharge pipe will be buried below ground surface for a length of approximately 6,500 feet to 7,000 feet, allowing the effluent to acclimate to surrounding soil temperatures before reaching the outfall location.

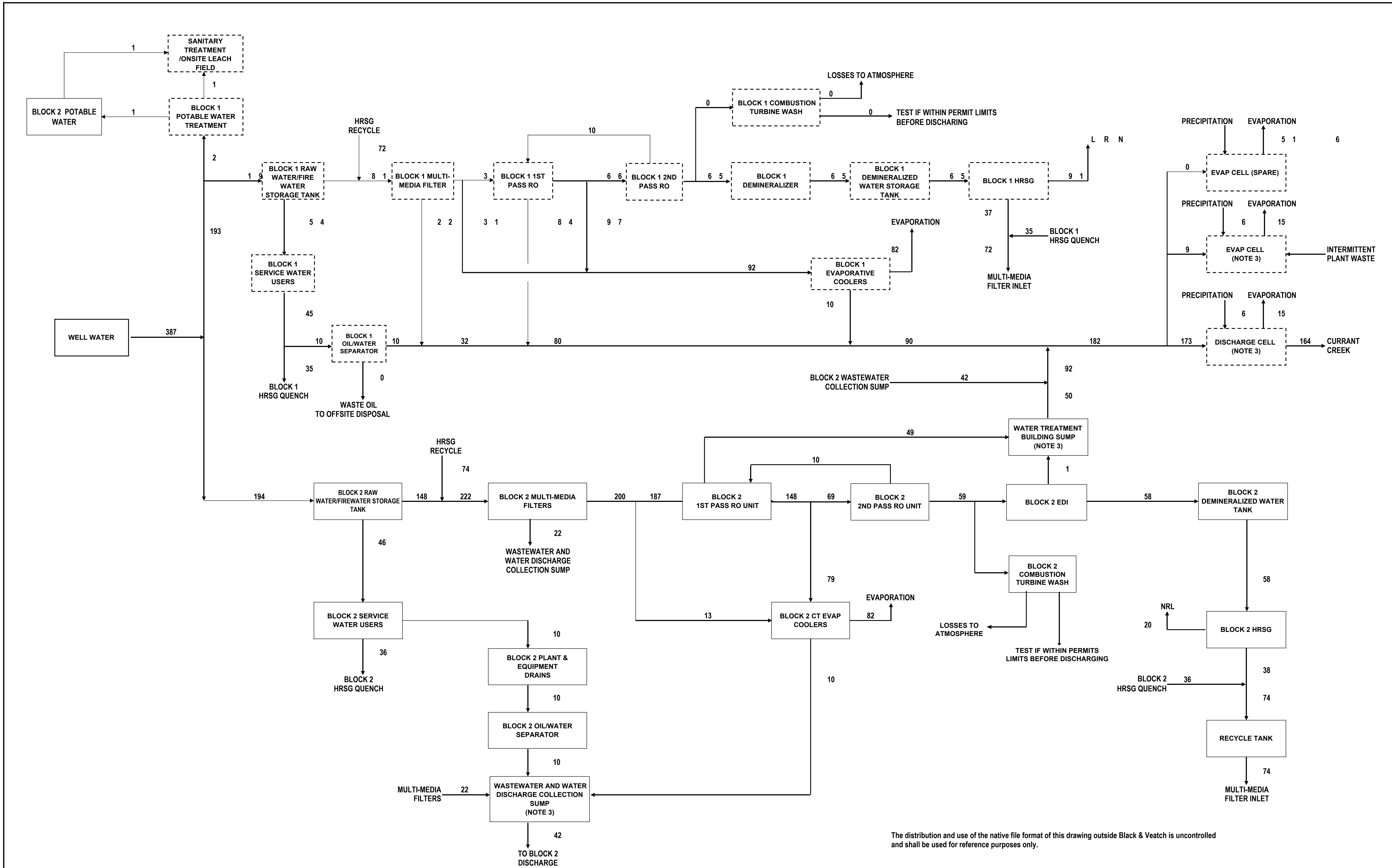
VIII. Certification

I Certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

A. Name and Official Title *(type or print)*	B. Phone No.
Dana Ralston, Vice President, Generation	(801) 220-4017
C. Signature	D. Date Signed

ATTACHMENT 1

Currant Creek Water Balance and Process Flow Diagram



The distribution and use of the native file format of this drawing outside Black & Veatch is uncontrolled and shall be used for reference purposes only.

NOTES:
1. FLOWS ARE IN GPM.
2. DASHED BOXES ARE BLOCK 1 SYSTEMS.
3. THE EVAPORATION POND HAS 3 CELLS INCLUDING DISCHARGE, EVAPORATION, & SPARE CELLS

BLOCK 2			
CONDITION	Annual Average	CYCLE MAKEUP	2%
COMBUSTION TURBINE FUEL	Natural Gas	1ST PASS RO RECOVERY	75%
TURBINE CONFIGURATION	1 x 2 Combined Cycle	2ND PASS RO RECOVERY	85%
CONDENSER COOLING SYSTEM	Dry	MULTI-MEDIA RECOVERY	90.0%
COMBUSTION TURBINE	GE 7 FA	EVAP COOLER CYCLES	9

CH2MHILL

Eng:	HLL	Dwg:	HLL
Check:	VAC	Date:	1 /13/2009

PacifciCorp
Currant Creek

Project 162628
Rev A

COMBINE CYCLE
WATER MASS BALANCE

WMB-1

APPENDIX U

OWNER PREPARED DATA FOR AIR PERMIT

Appendix U

Owner Prepared Data for Air Permit

Owner Prepared Data

The following Tables have been developed by the Owner for filing of the Air Permit for the Currant Creek 2 facility. The data has been developed from equipment manufacturers information and the Owners experience with similar projects. Contractor shall be responsible for providing the design, procurement and installation of the Currant Creek 2 Facility which is in conformance with the data in these tables and the location of critical emission points shown on the conceptual drawings included in Appendix C of these documents.

Building & Equipment Sizes

The following tables include sizes for the major equipment and buildings which will be a part of the Current Creek 2 facility. It is assumed that there may be some variance from this criteria, however, any variances shall be reported to the Owner for review and approval.

TABLE	TITLE
Table U – 1, September 23, 2011	Building & Equipment Sizes GE 7 FA.05 Series CT's
Table U – 2, September 23, 2011	Building & Equipment Sizes Siemens SGT6-5000F Series CT's
Table U – 3, September 23, 2011	Building & Equipment Sizes MHI M501GAC Series CT's

Emissions Data for Diesel Fire Pump, Auxiliary Boiler and Emergency Diesel Generator

The following table includes, not to exceed emissions data for the Diesel Driven Fire Pump, Auxiliary Boiler and Emergency Diesel Generator which will be a part of the Currant Creek 2 Facility. It is assumed that there may be some variance from this criteria, however, any variances shall be reported to the Owner for review and approval.

TABLE	TITLE
Table U - 4	Emissions Data for Diesel Fire Pump, Auxiliary Boiler & Emergency Diesel Generator

Emissions Data for Combustion Turbines

The following table includes, not to exceed emissions data for the three (3) Combustion Turbine Generator Configuration options which will be a part of the Currant Creek 2 Facility. It is assumed that there may be some variance from this criteria, however, any variances shall be reported to the Owner for review and approval.

<u>TABLE</u>	<u>TITLE</u>
Table U - 5	Steady State Emissions – Not to Exceed Startup and Shutdown Emissions – Not to Exceed Siemens SGT6-5000F(5) Configuration
Table U – 6	Steady State Emissions – Not to Exceed Startup and Shutdown Emissions – Not to Exceed GE 7FA.05 Configuration
Table U – 7	Steady State Emissions – Not to Exceed Startup and Shutdown Emissions – Not to Exceed MHI 501 GACFAST Configuration

TABLE U - 1

PACIFICORP CURRANT CREEK BLOCK 2
Building/Equipment Sizes for "GE 7 FA.05" Series CT's

Building/Equipment	E-W Length (ft)	N-S Width (ft)	Height (ft)
HRSG No. 1	100'	45'	93'
HRSG No. 2	100'	45'	93'
Combustion Turbine No. 1			
Transition Duct	14'	14' (E) - 20' (W)	22' (E) - 28' (W)
Exhaust Transition	18'	20' (E) - 28' (W)	28' (E) - 73.5' (W)
Enclosure (CT & Generator)	92'	22'	25.5'
Air Inlet Filter(*)	30'	52'	87'
Combustion Turbine No. 2			
Transition Duct	14'	14' (E) - 20' (W)	22' (E) - 28' (W)
Exhaust Transition	18'	20' (E) - 28' (W)	28' (E) - 73.5' (W)
Enclosure (CT & Generator)	92'	22'	25.5'
Air Inlet Filter (*)	30'	52'	87'
Steam Turbine/Generator	164'	106'	85'
Air Cooled Condenser	212'	244'	120'(**)
Administration/Control	existing		
Office/Warehouse	existing		
Auxilary Boiler	40'	60'	25'
Air Cooled Heat Exchanger	75'	55'	32'
Emergency Diesel Gen.	40'	14'	16'
Amonia Storage Tank	40'	Horizontal	10' Diam.
Water treatment Building	64'	78'	20'
Demin Water Storage Tank	34' Diam.		35'
Fire Water Tanks (2)	40' Diam.		35'
Fire Water Pumps Building	14'	30'	15'
C.T. GSU Transformer (2)	12'	10'	18'
S.T. GSU Transformer	14'	12'	18'

Stack Data

Source	Stack Height (ft) (***)	Exit Temp (F)	Stack Diameter (ft)
HRSG (2)	165'		18.5' ID
Emergency Diesel Gen.	20'	763.5	8" ID
Air Cooled Condenser	Approx. 112'		Approx. 210' X 240'
Air Cooled Heat Exchanger	Approx. 32'		Approx. 75' X 55'
Diesel Fire Pump	20'	853	6" ID
Auxilary Boiler	50'	300	42" ID

NOTES:
(*) CT Air Inlet Filter is elevated above the top of CTGenerator Enclosure. Bottom of Filter is approximately 47 feet above grade and top of filter is approximately 87 feet above grade.
(**) Height is to top of duct headers
(***) Minumum Height

30-Sep-11

TABLE U - 2

PACIFICORP CURRANT CREEK 2
Building/Equipment Sizes for "Siemens SGT6-5000F" Series CT's

Building/Equipment	E-W Length (ft)	N-S Width (ft)	Height (ft)
HRSG No. 1	100'	45'	95'
HRSG No. 2	100'	45'	95'
Combustion Turbine No. 1			
Transition Duct	52'	22' (E) - 26' (W)	30' (E) - 90' (W)
Exhaust Transition	28'	14' (E) - 22' (W)	22' (E) - 30' (W)
Enclosure (CT & Generator)	108'	35'	39'
Air Inlet Filter(*)	24'	52'	87'
Combustion Turbine No. 2			
Transition Duct	52-	22' (E) - 26' (W)	30' (E) - 90' (W)
Exhaust Transition	28'	14' (E) - 22' (W)'	22' (E) - 30' (W)'
Enclosure (CT & Generator)	108'	35'	39'
Air Inlet Filter(*)	24'	52'	87'
Steam Turbine/Generator Bldg.	164'	140'	85'
Air Cooled Condenser	212'	250'	129'(**)
Administration/Control	existing		
Office/Warehouse	existing		
Auxilary Boiler	40'	60'	25'
Air Cooled Heat Exchanger	75'	55'	32'
Emergency Diesel Gen.	40'	14'	16'
Amonia Storage Tank	40'	Horizontal	10' Diam.
Water treatment Building	64'	78'	20'
Demin Water Storage Tank	34' Diam.		35'
Fire Water Tanks (2)	40' Diam.		35'
Fire Water Pumps Building	14'	30'	15'
C.T. GSU Transformer (2)	12'	10'	18'
S.T. GSU Transformer	14'	12'	18'

Stack Data

Source	Stack Height (ft) (**)	Exit Temp (F)	Stack Diameter (ft)
HRSG (2)	165'		22' ID
Emergency Diesel Gen.	20'	763.5	8" ID
Air Cooled Condenser	Approx. 110'		Approx. 212' X 250'
Air Cooled Heat Exchanger	Approx. 32'		Approx. 75' X 55'
Diesel Fire Pump	20'	853	6" ID
Auxilary Boiler	50'	300	42" ID

NOTES:

(*) CT Air Inlet Filter is elevated above the top of the CT Generator Enclosure. Bottom of Filter is approximately 47 feet above grade and top of filter is approximately 87 feet above grade.

(**) Height is to top of duct headers.

(***) Minimum Height

30-Sep-11

TABLE U - 3

PACIFICORP CURRANT CREEK 2
Building/Equipment Sizes for "MHI M501GAC" Series CT's

Building/Equipment	E-W Length (ft)	N-S Width (ft)	Height (ft)
HRSG No. 1	91'	45'	110'
HRSG No. 2	91'	45'	110'
Combustion Turbine No. 1			
Transition Duct	32'	18' (E) - 32' (W)	26' (E) - 75' (W)
Exhaust Transition	20'	18'	26'
Enclosure (CT & Generator)	108'	30'	30'
Air Inlet Filter(*)	30'	52'	87'
Combustion Turbine No. 2			
Transition Duct	32'	18' (E) - 32' (W)	26' (E) - 75' (W)
Exhaust Transition	20'	18'	26'
Enclosure (CT & Generator)	108'	30'	30'
Air Inlet Filter (*)	30'	52'	87'
Steam Turbine/Generator	180'	120'	85'
Air Cooled Condenser	212'	257'	120'(**)
Administration/Control	existing		
Office/Warehouse	existing		
Auxilary Boiler	40'	60'	25'
Air Cooled Heat Exchanger	55'	230'	32'
Emergency Diesel Gen.	40'	14'	16'
Amonia Storage Tank	40'	Horizontal	10' Diam.
Water treatment Building	64'	78'	20'
Demin Water Storage Tank	34' Diam.		35'
Fire Water Tanks (2)	40' Diam.		35'
Fire Water Pumps Building	14'	30'	15'
C.T. GSU Transformer (2)	12'	10'	18'
S.T. GSU Transformer	14'	12'	18'

Stack Data

Source	Stack Height (ft) (***)	Exit Temp (F)	Stack Diameter (ft)
HRSG (2)	165'		21' ID
Emergency Diesel Gen.	20'	763.5	8" ID
Air Cooled Condenser	Approx. 112'		Approx. 210' X 253'
Air Cooled Heat Exchanger	Approx. 32'		Approx. 55' X 230"
Diesel Fire Pump	20'	853	6" ID
Auxilary Boiler	50'	300	42" ID

NOTES:
(*) CT Air Inlet Filter is elevated above the top of the CT Generator Enclosure. Bottom of Filter is approximately 47 feet above grade and top of filter is approximately 87 feet above grade.
(**) Height is to top of duct headers
(***) Minimum Height

30-Sep-11

TABLE - U4

PACIFICORP CURRANT CREEK 2
Emissions Data for Diesel Fire Pump, Auxiliary Boiler & Emergency Diesel Generator

Parameter	Fire Pump	Aux. Boiler	Emergency Generator
Engine Rating	375HP	NA	600kW
Heat Input for Boiler	NA	109.41(MMBtu/hr)	NA
Annual Hours of Operation	300	4000	300
NO_X	4.3 (g/HP-hr)	0.011(lbm/MMBtu)	4.97 (g/hp-hr)
CO	0.24 (g/HP-hr)	0.036 (lbm/MMBtu)	0.45 (g/HP-hr)
SO_2	0.0021(lb/HP-hr)	-	-
SO_X	-	0.006 (lbm/MMBtu)	-
PM	0.19 (g/HP-hr)	-	.03 (g/HP-hr)
PM_{10}	-	0.007(lbm/Mmbtu)	-
HC	-	-	0.11 (g/HP-hr)
NMHC	0.34 (g/HP-hr)	-	-
VOC	-	0.0042 (lbm/MMBtu)	-

9/30/2011

TABLE U - 5

PacifiCorp – Currant Creek 2

Steady State Emissions Not to Exceed
Siemens SGT6-5000F(5) Configuration

CTG Model	SGT6-5000F(5)
CTG Manufacturer	Siemens
Emissions Limit at Stack (Per HRSG)	
NO_X Emission Rate (ppmvd @ 15% O2)	2.0
NO_X Emission Rate (lb/hr at site elevation)	19.0
SO_2 Emission Rate (ppmvd@15%O2)	0.22
SO_2 Emission Rate (lb/hr at site elevation)	2.9
CO Emission Rate (ppmvd @ 15% O2)	2.0
CO Emission Rate (lb/hr at site elevation)	12.0
VOC Emission Rate (ppmvd @ 15% O2)	2.3
VOC Emission Rate as CH4 (lb/hr at site elevation)	7.3
Total PM_{10} Emission Rate (lb/hr at site elevation)	14.0
Total $PM_{2.5}$ Emission Rate (lb/hr at site elevation)	14.0
NH3 Slip, (ppmvd @15%O2)	5

Note
1. The above SO2 emission estimates are based on 0.4 gr/100 SCF sulfur content.

PacifiCorp – Currant Creek 2

Startup and Shutdown Emissions Not to Exceed at 59°F

Siemens SGT6-5000F(5) Configuration

CTG Model	SGT6-5000F(5)	SGT6-5000F(5)	SGT6-5000F(5)	SGT6-5000F(5)
CTG Manufacturer	Siemens	Siemens	Siemens	Siemens
Estimated Emissions at Stack				
Condition	Cold Start	Warm Start	Hot Start	Shutdown
CO Emissions				
Total Emissions Per Event, CTG/Stack 1 (lb.)	251	123	123	70
Total Emissions Per Event, CTG/Stack 2 (lb.)	251	123	123	70
NO_X Emissions				
Total Emissions Per Event, CTG/Stack 1 (lb.)	80	91	91	31
Total Emissions Per Event, CTG/Stack 2 (lb.)	80	91	91	31
VOC Emissions				
Total Emissions Per Event, CTG/Stack 1 (lb.)	59	49	49	28
Total Emissions Per Event, CTG/Stack 2 (lb.)	59	49	49	28
PM_{10} Emissions				
Total Emissions Per Event, CTG/Stack 1 (lb.)	6.3	6.6	6.6	2.5
Total Emissions Per Event, CTG/Stack 2 (lb.)	6.3	6.6	6.6	2.5
$PM_{2.5}$ Emissions				
Total Emissions Per Event, CTG/Stack 1 (lb.)	6.3	6.6	6.6	2.5
Total Emissions Per Event, CTG/Stack 2 (lb.)	6.3	6.6	6.6	2.5
Duration of Startup Events.				
CTG/Stack 1 (min)	32	32	32	11
CTG/Stack 2 (min)	32	32	32	11

Note

1. Startup duration is defined from Gas turbine ignition to emission compliance load. Shutdown duration is defined from 70% GT load to fuel shutoff.

TABLE U - 6

PacifiCorp – Currant Creek 2

Steady State Emissions Not to Exceed
GE 7FA.05 Configuration

CTG Model	7FA.05
CTG Manufacturer	GE
Emissions Limit at Stack (Per HRSG)	
NO_X Emission Rate (ppmvd @ 15% O2)	2.0
NO_X Emission Rate (lb/hr)	17.1
SO_2 Emission Rate (ppmvw)	0.14
SO_2 Emission Rate (lb/hr)	1.20
CO Emission Rate (ppmvd @ 15% O2)	2.0
CO Emission Rate (lb/hr)	10.4
VOC Emission Rate (ppmvd @ 15% O2)	2.4
VOC Emission Rate as CH4 (lb/hr)	6.7
Total PM_{10} Emission Rate (lb/hr)	11.8
Total $PM_{2.5}$ Emission Rate (lb/hr)	11.8
NH3 Slip, (ppmvd @15%O2)	5

Note
1. The SO2 emissions are based on 0.4 gr/100 SCF sulfur content.

PacifiCorp – Currant Creek 2

Startup and Shutdown Emissions Not to Exceed at 59°F

GE 7FA.05 Configuration

CTG Model	7FA.05	7FA.05	7FA.05	7FA.05
CTG Manufacturer	GE	GE	GE	GE
Estimated Emissions at Stack				
Condition	Cold Start	Warm Start	Hot Start	Shutdown
CO Emissions				
Total Emissions Per Event, CTG/Stack 1 (lb.)	268	150	150	510
Total Emissions Per Event, CTG/Stack 2 (lb.)	268	150	150	510
NO_X Emissions				
Total Emissions Per Event, CTG/Stack 1 (lb.)	37	11	11	50
Total Emissions Per Event, CTG/Stack 2 (lb.)	37	11	11	50
VOC Emissions				
Total Emissions Per Event, CTG/Stack 1 (lb.)	12	3.3	3.3	21
Total Emissions Per Event, CTG/Stack 2 (lb.)	12	3.3	3.3	21
PM_{10} Emissions				
Total Emissions Per Event, CTG/Stack 1 (lb.)	3.7	1.9	1.9	5.3
Total Emissions Per Event, CTG/Stack 2 (lb.)	3.7	1.9	1.9	5.3
$PM_{2.5}$ Emissions				
Total Emissions Per Event, CTG/Stack 1 (lb.)	3.7	1.9	1.9	5.3
Total Emissions Per Event, CTG/Stack 2 (lb.)	3.7	1.9	1.9	5.3
Duration of Startup Events.				
CTG/Stack 1 (min)	24	12	12	34
CTG/Stack 2 (min)	24	12	12	34

Note

1. Startup duration is defined from Gas turbine ignition to emission compliance load. Shutdown duration is defined from gas turbine emission compliance load to fuel shutoff.

TABLE U - 7

PacifiCorp – Currant Creek 2

Steady State Emissions Not to Exceed
MHI 501GACFAST Configuration

CTG Model	501GAC FAST
CTG Manufacturer	MHI
Emissions Limit at Stack (Per HRSG)	
NO_X Emission Rate (ppmvd @ 15% O2)	2.0
NO_X Emission Rate (lb/hr at site elevation)	19.3
SO_2 Emission Rate (ppmvw)	0.23
SO_2 Emission Rate (lb/hr at site elevation)	2.3
CO Emission Rate (ppmvd @ 15% O2)	2.0
CO Emission Rate (lb/hr at site elevation)	11.7
VOC Emission Rate (ppmvd @ 15% O2)	3.0
VOC Emission Rate (lb/hr at site elevation)	10.1
Total PM_{10} Emission Rate (lb/hr at site elevation)	9.7
Total $PM_{2.5}$ Emission Rate (lb/hr at site elevation)	9.7
NH3 Slip, (ppmvd @15%O2)	5

Note
1. The above SO_2 emission estimates are based on 0.4 gr/100 SCF sulfur content.

PacifiCorp – Currant Creek 2

Startup and Shutdown Emission Estimates Not to Exceed at 59°F
MHI 501GAC Configuration

CTG Model	501GAC FAST	501GAC FAST	501GAC FAST	501GAC FAST
CTG Manufacturer	MHI	MHI	MHI	MHI
Estimated Emissions at Stack				
Condition	Cold Start	Warm Start	Hot Start	Shutdown
CO Emissions				
Total Emissions Per Event, CTG/Stack 1 (lb.)	255.9	255.9	255.9	114
Total Emissions Per Event, CTG/Stack 2 (lb.)	255.9	255.9	255.9	114
NO_X Emissions				
Total Emissions Per Event, CTG/Stack 1 (lb.)	12	12	12	3
Total Emissions Per Event, CTG/Stack 2 (lb.)	12	12	12	3
VOC Emissions				
Total Emissions Per Event, CTG/Stack 1 (lb.)	49.6	49.6	49.6	102.9
Total Emissions Per Event, CTG/Stack 2 (lb.)	49.6	49.6	49.6	102.9
PM_{10} Emissions				
Total Emissions Per Event, CTG/Stack 1 (lb.)	7.4	7.4	7.4	36
Total Emissions Per Event, CTG/Stack 2 (lb.)	7.4	7.4	7.4	36
$PM_{2.5}$ Emissions				
Total Emissions Per Event, CTG/Stack 1 (lb.)	7.4	7.4	7.4	36
Total Emissions Per Event, CTG/Stack 2 (lb.)	7.4	7.4	7.4	36
Duration of Startup Events.				
CTG/Stack 1 (min)	9	9	9	12
CTG/Stack 2 (min)	9	9	9	12

Note

1. Startup duration is defined from Gas turbine ignition to emission compliance load. Shutdown duration is defined from gas turbine emission compliance load to fuel shutoff.

APPENDIX V

CONTRACTOR PROVIDED ON-SITE TRAINING PROGRAM

Appendix V
Contractor Provided On-site Training Program

On Site Training Program Overview

Contractor shall provider Owner's operation and maintenance personnel training necessary for the safe, reliable and efficient operation of the Currant Creek 2 power plant. Training shall include:

1. Training plan
2. Lesson plans
3. Training and instruction manuals
4. System documents
5. Classroom training
6. Hands-on training
    a. Systems walk downs
    b. Support of start up
    c. Operation during startup

The training program will be scheduled to coordinate with PacifiCorp's needs, hiring schedules, vendor training, and commissioning activities. Training shall be completed on or before Substantial Completion.

Notwithstanding the minimum requirements described herein, training shall be complete when learning evaluations demonstrate that the operation and maintenance personnel demonstrate that they have mastered the learning objectives of all of the training.

Training Plan

Contractor shall prepare and submit a written training plan. The training plan shall describe the training program. The training program shall include as a minimum:

1. Training plan overview
2. Specific training goals
3. Learning objectives
4. Learning methods and activities
5. Safety and environmental precautions
6. Student and instructor manuals and documentation
7. Learning evaluations
8. Instructor and lesson plan preparer minimum qualifications
9. Training schedule
10. Training program evaluation

The training plan shall be submitted to Owner within 360 days of contract award.

Lesson Plans

Contractor shall prepare lesson plans for classroom training and system walkdowns prior to presenting the lesson or conducting the system walkdown. Lesson plans shall include as a minimum:

1. Specific Training goals
2. Learning objectives
3. Safety and environmental precautions (for all field activities)
4. Student manuals and documentation
5. Learning evaluations

Plant Specific, Training and Instruction Manuals

Contractor shall develop a set of plant specific training manuals for the plant systems and equipment. Each section shall consist of technical detail and depth, written at a level that is easy to understand and effectively conveys the specific operation and preventive maintenance of the newly installed equipment. The manuals shall address fundamental power plant principles where appropriate. The manuals shall be prepared for an audience that has some experience and knowledge in equipment operation and maintenance.

Contractor shall submit plant specific, training and instruction manuals for Owner review and comment.

Contractor shall provide all training and instruction manuals needed to perform the training. Manuals shall include both student manuals and instructor manuals. By completion of training each student shall have been provided the student training and instruction manuals appropriate for their work.

Contractor shall provide a minimum of one set of instructor manuals.

System Documents

A specific training document shall be developed for each Balance of Plant system. All of the training document and manuals shall be combined into a complete, multi-volume training manual, suitable for training or as a plant reference.

Contractor shall submit system documents for Owner review and comment.

The system documents shall be broken down as follows:

System Overview**—**Shall describe the purpose of the system and how it accomplishes its function in relation to the entire Power Plant. A description of the system flowpath shall be included to identify system boundaries and major components.

Major Components**—**This section shall provide a description of the major components. It shall identify the function of each component in the system and a description of the mechanical and electrical features of the equipment. When necessary sub-components or sub-systems shall are identified and broken down subsequently. In this section, cutaway diagrams and photos are used. When adequate pictures are not available and a picture is appropriate ‘typical’ figures may be used.

Controls/Operations**—**A complete identification of all equipment controls and indications shall be covered under a section titled “Controls and Operations.” Local and remote (DCS based) instrumentation shall be identified and setpoints and reasonable parameter ranges shall be provided, as available. Equipment protective and permissive devices such as electrical, pressure, temperature, vibration shall be identified and ranges will be provided.

Pre-Operational Checks—This section shall cover all of the personnel and equipment safety precautions and limitations that need to be followed. A complete valve lineup and power lineup checklist for the operator to use for aligning the system for operation shall be provided. Any necessary prerequisite system operation (electrical, air or water systems, for example) shall be identified to identify the priority in which systems are placed into operation.

Operating Procedures**—**This section shall be developed to include operating procedures needed to Startup, walkdown, normally operate, and shutdown a system during normal operation. Procedures for abnormal operating conditions and emergency shutdowns shall be included as appropriate. Integrated startup and shutdown procedures for 1x1 and 2x1 modes shall be provided prior to conclusion of commissioning.

Alarm Responses**—**This section shall provide the operator with the possible causes and immediate operator responses for the most common alarms associated with the systems. This is intended to cover primarily the most prominent alarms (Tank Level LOW, etc.).

Preventive Maintenance—This section shall provide a tabular listing of the preventive maintenance tasks to be performed by the operators and maintenance technicians. This section shall break down the tasks on a frequency based order. Applicable portions of the Maintenance Manuals shall be used to support this section; however, the entire Maintenance Manual is not required to be included here.

Classroom Training

Contractor shall provide a minimum of 80 hours of onsite classroom instruction to train plant personnel on plant specific operations and maintenance.

The training shall include an outline similar to the following:

1. Combined Cycle Fundamentals
2. Currant Creek 2 Plant Overview
3. Heat Recovery Steam Generator (HRSG) and associated systems (To be co-conducted by Contractor and HRSG Manufacturers Representatives)
    a. HRSG Proper
    b. Duct Burner and Burner Management System
    c. Steam Systems (including Steam Dump)
    d. SCR / Ammonia System
    e. Blowdown System
    f. Condensate System
    g. Feedwater system
    h. Water and Steam Sampling
    i. Boiler Chemical Feed System
4. Air Cooled Condenser
5. Electrical Distribution System
    a. Electrical High Voltage Systems
    b. Electrical Medium Voltage Systems

c. Electrical Low Voltage Systems
d. UPS and DC Power Systems
e. Emergency Diesel Generator

6. Distributed Control System
7. Continuous Emissions Monitors
8. Balance-of-Plant Systems
    a. Auxiliary Cooling Water
    b. Closed Cooling Water
    c. Plant Instrument and Service Air
    d. Plant Raw water
    e. Service water
    f. Fire Protection
    g. Ammonia Feed System
    h. Fuel Gas System
    i. On-Site Water Treatment
    j. Condensate/Air Cooled Condenser
    k. Plant equipment & storm drains
    l. Plant waste water
    m. Auxiliary Boiler
9. Integrated Plant Operations

Classroom training may consist of a combination of classroom instruction and plant walk downs. Training material shall be presented by qualified instructors, experienced in combined cycle power plant, gas turbines, and BOP systems and equipment. The Instructors may use various training aids; including slide-show presentations, overhead projectors, DVDs, and digital photographs of plant equipment. The plant specific, training and instruction manuals and the system documents shall be used during the classroom training.

Contractor shall provide student testing both prior to the course instruction and at the completion of training blocks and sessions. The testing shall be based on the learning objectives in the training plan and lesson plans. Test results shall be made available to PacifiCorp upon the completion of each lesson and the training program.

Upon completion of the project, Contractor shall forward all developed material to PacifiCorp in electronic format on a compact disc (CD). All developed text will be developed using Microsoft® Office Software. Contractor shall update the manuals and documents to Rev. 0 after training to incorporate any changes to the manual that were identified during the actual training process. All training aids (transparencies, drawings, handouts, etc.) used in the class shall also be supplied to the Owner.

Hands-On Training

Contractor shall provide hands-on training consisting of system walkdowns, support of startup and operations during commissioning and startup.

System Walkdowns - System walkdowns shall consist of an instructor lead or self-paced field review of each system. A safety tailgate shall be performed prior to each system walkdown. System walkdowns may be conducted in conjunction with classroom training or vendor representative field training. Lesson plans shall be prepared prior to system walkdowns. Learning evaluations shall be performed after each system walkdown. System walkdowns shall include system documents and may include plant specific, training or instruction manuals.

Support of Pre-commissioning and Commissioning – Electrical, mechanical and instrument pre-commissioning and commissioning shall be performed by the Contractor Startup Engineers. Plant operations and maintenance personnel will be available to support pre-commissioning and commissioning. Contractor may involve operations and maintenance personnel in pre-commissioning and commissioning activities that improve or enhance the personnel's knowledge and understanding of the operation of the Project.

Contractor shall take reasonable steps to allow vendor installation/commissioning representatives to provide hands on field training to select operation and maintenance personnel provided the training does not impact Contractors schedule.

Operation During Startup – Plant operations and maintenance personnel will operate the Project under direction of the Contractor during startup. Contractor shall provide operation and maintenance personnel with hands on training to familiarize operations and maintenance personnel with the proper methods of startup, normal operations, shutdown and alarm response.

While supporting startup as requested, operations and maintenance personnel will continue to report to their respective supervisory personnel.

APPENDIX W

NERC CIPS WORK SCOPE

APPENDIX W

NERC/CIPS Work Scope

<u>Document Title</u>

NERC-CIPS Scope of Work
Patch Management, Intrusion Management and Raceways

CIP Work Specification

Cyber Asset Security Controls Checklist v2.1

Critical Infrastructure Information (CII) Procedure,
Revision 1.04 (External Vendors/Contractors)

NERC/CIPS Compliance Plan for Clean Air Initiative and
Generation Engineering Projects

Corporate Security Policy Handbook, June 5, 2009

NERC-CIPS SCOPE OF WORK

PATCH MANAGEMENT, INTRUSION MANAGEMENT AND RACEWAYS

1. Contractor shall provide and implement an automated controls systems patch management system and provide all documentation for NERC/CIPS.

2. Contractor shall provide and implement an automated firewall and intrusion management system and provide all documentation for NERC/CIPS.

3. Contractor shall provide raceways and termination boxes for badge readers, and include in their raceway schedule and drawings location of future fiber optic or copper cable, as appropriate, for badge readers from the security system to each and every room that contains critical infrastructure. The badge readers, installation of badge readers, fiber optic cable, copper cable, installation of cable and programming the security system are to be provided by Others.

CIP Standard Number - CIP Standard Title
Requirement Number - Requirement Title
Performance/Design Requirement

CIP-002 - Critical Cyber Assets Identification
R3 - Critical Cyber Assets Identification
Contractor shall document cyber asset information for systems installed within the electronic security perimeter.

CIP-003 - Security Management Controls
R3 - Exceptions
Contractor shall complete Owner's Cyber Asset Checklists for each and every individual cyber asset installed that resides within the electronic security perimeter. This will be the basis by which Owner files technical feasibility exceptions.

CIP-005 - Electronic Security Perimeters
R1 - Electronic Security Perimeter
The Owner's IT network team wholly manages the Currant Creek electronic security perimiter (perimeter only - not inside the perimeter). Contractor shall not implement additional entry points into the electronic security perimeter. Should remote access into the electronic security perimeter be necessary, access shall be through Owner's IT network team managed equipment.

R2 - Electronic Access Controls
The Owner's IT network team manages electronic access controls into the electronic security perimeter through the use of firewalls where routable protocol is used, or through the use of Gauntlet gateway devices where dial-up access is required. Dial-up access should be used as a last resort.

For networking equipment inside of the electronic security perimeter, Contractor shall ensure that unused physical ports are disabled through switch/router configuration, and ensure the use of appropriate use banners.

R3 - Monitoring Electronic Access
The Owner's IT network and security teams wholly manage monitoring of the electronic security perimeter. Should it be determined that a shared solution be required (such as for remote monitoring and tuning), said solution should be capable of integrating into the plant IDS and logging infrastructure.

For networking equipment inside of the electronic security perimeter, Contractor shall ensure that network equipment is capable and configured for monitoring and logging access. Logging shall be forwarded to a Owner managed log server.

R5 – Documentation
Contractor shall document network and computing infrastructure inside of the electronic security perimeter following Owner's practices. Documentation shall be for both physical and logical network design, and depicts computer classifications and relations.

CIP-007 - Systems Security Management

R1 - Test Procedures

Contractor shall provide documented procedures for the testing of installed systems for when security patches, service packs, Contractor software releases, and operating system version upgrades are performed. Procedures shall indicate how the testing of security features enabled as part of the hardening effort (see CIP-007 R2) are conducted to confirm that security settings are not reversed.

R2 - Ports and Services

Contractor shall provide document outlining the required ports and services each computer system requires in order to operate. Contractor shall provide procedural documentation for the disabling of ports and services in the event they are re-enabled as part of a security update or service pack installation.

Contractor shall disable any unnecessary ports and services prior to go-live.

Contractor shall remove any unnecessary software prior to go-live.

R3 - Security Patch Management

Contractor shall evaluate any operating system manufacturer issued patches and services packs within 30 days for applicability and compatibility, publishing results to Owner.

Contractor shall evaluate any third-party Contractor issued patches and service packs within 30 days for applicability and compatibility, publishing results to Owner.

Where Microsoft Windows is used as the operating system, Contractor shall ensure such systems are capable of integrating into PacifiCorp's patch management infrastructure, Microsoft Windows System Update Services, for Windows-specific updates.

Contractor shall provide a mechanism, manual or automated, for the distribution of non-Microsoft Windows security updates.

Contractor shall verify and submit documentation demonstrating that installed computer systems are fully patched to supported levels at the time of go-live.

R4 - Malicious Software Prevention

Contractor shall use Symantec Antivirus software (Corporate Edition) for malicious software prevention. Where Symantec is not supported Contractor shall obtain Owner approval for alternatives.

Contractor shall ensure that antivirus definition files are current at the time of go-live.

R5 - Account Management

Contractor shall adhere to the Owner’s security policy for account management where technically feasible.

Contractor shall minimize the use of shared accounts, including administrator and operator users.

Contractor shall implement log setting and audit policies on computer and network systems to ensure security logging requirements are met. Cisco is the preferred network equipment supplier for PacifiCorp. Network equipment shall meet CIP security and logging requirements.

PacifiCorp must be capable of changing shared account passwords prior to go-live.

Contractor shall install computer and network equipment capable of meeting password selection requirements (Page 103, Section 9.6.1.1 of the PacifiCorp Corporate Security Policy Handbook) where technically feasible.

Contractor shall integrate with Active Directory for any Microsoft Windows devices, for account management where reasonably possible..

R6 - Security Status Monitoring

Owner's security wholly owns the intrusion detection system for, at and inside the electronic security perimeter. Contractor shall establish a protocol, jointly with Owner's security, for how intrusion detection shall be performed.

PacifiCorp security wholly owns the logging of security events at and inside the electronic security perimeter. Contractor shall provide necessary supporting infrastructure for any cyber assets residing inside the electronic security perimeter for the automatic forwarding of security logs.

CIP-009 - Recovery Plans for Critical Cyber Assets

R1 - Recovery Plans

Contractor shall submit documentation of procedures used in the backup and restoration of critical cyber assets installed.

R4 - Backup and Restore

Contractor shall regularly backup Contractor installed critical cyber assets. Critical data shall be backed up based on the frequency of data changes. A full-system backup for a full-system recovery should be implemented as well. Where only minimum, critical data may be backed up, restoration procedures shall include the system rebuild procedures in conjunction with the data restoration procedures.

R5 - Testing Backup Media

Contractor shall provide documented procedures for the testing of all backup media.

Cyber Asset Security Controls Checklist v2.1

Asset Name / Hostname, IP Address, CCA or ACA	Site, Location in Facility	Device Type (Select from List)
		Choose…

Platform/OS (Select from List)
Choose…

Platform columns: Windows – Microsoft Windows NT4, 2000, XP, 2008, Vista etc.; Unix / Linux – System V Unix, Solarix, Tru64, Linux, AIX, HP-UX, OpenVMS; Network – Firewall, Switch, Router, Cisco IOS, Cisco PIX, Cisco ASA; Industrial proprietary – RTU, Relay, PLC, Controller, Windows CE/Embedded, etc.; Other – All Others

Reference to "Cyber Asset Security Baseline" section number and description	Windows	Unix / Linux	Network	Industrial proprietary	Other	Implemented (Y/N)	Exception Requested (Y/N)	Primary Reason code 1-6	Reason sub-category A-G	Notes (Exception Reference, Implementation Notes, Technical Issues, Schedule for Completion, etc.)
Mandatory Controls: NERC CIP-002 through CIP-009										
[2.1] Critical Cyber Asset within an ESP	✓	✓	✓	✓	✓		n/a			
[2.2] Restrict Access Point Access	n/a	n/a	✓	n/a	✓		n/a			
[2.3] Control Dial-up Access (Where Exists)	✓	✓	✓	✓	✓		n/a			
[2.3] Dial-Up Modem Security Logging (Where Exists)	✓	✓	✓	✓	✓		n/a			
[2.4] Set Appropriate-Use Banner	✓	✓	✓	✓	✓					
[2.5] Test Security Controls	✓	✓	✓	✓	✓					
[2.6] Harden Ports and Services	✓	✓	✓	✓	✓					
[2.7] Apply Latest Patches and Updates	✓	✓	✓	✓	✓					
[2.7] Integrate with Patch Management Server	✓	n/a	n/a	n/a	✓					
[2.8] Install Antivirus or Malicious Software Prevention	✓	✓	✓	✓	✓					
[2.8] Integrate with Antivirus Mgmt Server	✓	n/a	n/a	n/a	✓					
[2.9] Change Default Usernames	✓	✓	✓	✓	✓					
[2.9] Disable Temporary or Unnecessary Accounts	✓	✓	✓	✓	✓					
[2.10] Set Passwords for All Accounts	✓	✓	✓	✓	✓					
[2.11] Enable Password Aging	✓	✓	✓	✓	✓					
[2.11] Enable Password Minimum Length, 6-Char or More	✓	✓	✓	✓	✓					
[2.11] Enable Password Complexity	✓	✓	✓	✓	✓					
[2.12] Enable Security Event Logging	✓	✓	✓	✓	✓					
[2.12] Security Log Retention 90 Days or Greater	✓	✓	✓	✓	✓					
[2.13] Backup Procedure	✓	✓	✓	✓	✓					
[2.13] Restoration Procedure	✓	✓	✓	✓	✓					
Mandatory Controls: Corporate Security Policy Handbook										
[3.1] Uninstall Unnecessary Software	✓	✓	n/a	n/a	✓					
[3.1] Disable Non-Essential Software Features	✓	✓	✓	✓	✓					
[3.2] Conform to Existing Architecture	✓	✓	✓	✓	✓					
[3.3] Avoid New Access Points	✓	✓	✓	✓	✓					
[3.4] Disable Default/Legacy User Accounts	✓	✓	✓	✓	✓					
[3.5] Enable Screen Saver Locking	✓	✓	✓	✓	✓					

Cyber Asset Security Controls Checklist v2.1

Asset Name / Hostname, IP Address, CCA or ACA	Site, Location in Facility	Device Type (Select from List)
		Choose…

Platform/OS (Select from List)
Choose…

Windows: Microsoft Windows NT4, 2000, XP, 2008, Vista etc.
Unix / Linux: System V Unix, Solarix, Tru64, Linux, AIX, HP-UX, OpenVMS
Network: Firewall, Switch, Router, Cisco IOS, Cisco PIX, Cisco ASA
Industrial proprietary: RTU, Relay, PLC, Controller, Windows CE/Embedded, etc.
Other: All Others

Reference to "Cyber Asset Security Baseline" section number and description	Windows	Unix / Linux	Network	Industrial proprietary	Other	Implemented (Y/N)	Exception Requested (Y/N)	Primary Reason code 1-6	Reason sub-category A-G	Notes (Exception Reference, Implementation Notes, Technical Issues, Schedule for Completion, etc.)
[3.6] Harden Remote Control Software (RDP, SSH…)	✓	✓	✓	n/a	✓					
[3.7] Install Symantec Antivirus	✓	n/a	n/a	n/a	✓					
[3.8] Install Snare Security Log Forwarding Agent	✓	n/a	n/a	n/a	✓					
[3.8] Configure Syslog Event Forwarding	✓	✓	✓	✓	✓					
[3.9] Enable and Configure SNMP Agents	✓	✓	✓	✓	✓					
[3.10] Configure File and Print Share Permissions	✓	✓	n/a	n/a	✓					
[3.11] Backup Strategy (Spare, Automated, Config Doc)	✓	✓	✓	✓	✓					
Conditional Controls										
[4.1] Join Active Directory Domain	C	n/a	n/a	n/a	C					
[4.3] Configure Devices to Use Cisco ACE server	C	n/a	n/a	n/a	C					
[4.4] Enable Portable Device Restrictions	C	C	n/a	n/a	C					
[4.5] Configure File Permissions	C	C	n/a	n/a	C					
[4.6] Enable Change Detection	C	C	C	C	C					
[4.7] Send Alerts and Notifications	C	C	C	C	C					
[4.8] Prevent Log Tampering	C	C	C	C	C					

Legend:
- ✓ Mandatory
- n/a Not Applicable, or Exception Not Permitted.
- C Conditional

Date: ____________________

Performed By (Print & Signature): ____________________ ____________________

PacifiCorp Approval (Print & Signature): ____________________ ____________________

Cyber Asset Security Controls Checklist v2.1

Asset Name / Hostname, IP Address, CCA or ACA	Site, Location in Facility	Device Type (Select from List)
		Choose…

Platform/OS (Select from List)
Choose…

Microsoft Windows NT4, 2000, XP, 2008, Vista etc.
System V Unix, Solarix, Tru64, Linux, AIX, HP-UX, OpenVMS
Firewall, Switch, Router, Cisco IOS, Cisco PIX, Cisco ASA
RTU, Relay, PLC, Controller, Windows CE/Embedded, etc.
All Others

Reference to "Cyber Asset Security Baseline" section number and description	Windows	Unix / Linux	Network	Industrial proprietary	Other	Implemented (Y/N)	Exception Requested (Y/N)	Primary Reason code 1-6	Reason sub-category A-G	Notes (Exception Reference, Implementation Notes, Technical Issues, Schedule for Completion, etc.)

Instructions

1. Type or choose entries for: **Asset Name...**, **CCA or ACA**, **Site...** , **Device Type** and **Platform/OS**.
2. Fill out the remainder of form according to the highlighted Platform column.
3. Where the security control has been implemented, mark column "Implemented Y/N" as Yes. Record a comment in the Notes column, and attach to this Checklist records of the actual changes performed.
4. Where security controls cannot be implemented, or have not been verified in place yet, mark column "Implemented Y/N" as No. Fill in the Primary Reason code, Reason Sub-Category and detailed Notes in the checklist, and attached notes as to why the security control is not implemented. If a security control will be implemented in the future, please include this statement.
5. Where security controls are not implemented, an Exception must be requested. Once the Exception has been recorded in the Exception Record Sheet or Requested using the Exception Request form, only then can column "Exception Requested Y/N" be marked as Yes. This column is an action item, and indicator that an Exception has been filed/requested.
6. There will be many cases where the security control is assumed impossible, such as Antivirus software on Network equipment or Industrial Proprietary hardware. NERC CIP understands this is not possible, but it is still necessary to mark it as "Not Implemented". It is also necessary to following the Exception Request process for all security controls that cannot be implemented.
7. Print and sign (**Performed By** and **Pacificorp Approval**) completed forms.
8. Scan the signed forms, along with all attached notes and evidence of change. A checklist shall be considered non-compliant if there is insufficient supporting evidence.
9. Give the saved scan file the same name as the Excel form (include Site Acronym and Cyber Asset name as part of filename) "CIP-003-R1 Checklist <SiteAcronym>.<Hostname>.xls".
10. Store the scan file and all attachments in the same location as the Excel file.

Primary reason codes (for exceptions)

1 Not technically possible or precluded by technical limitations.
2 Operationally infeasible or could adversely affect reliability of Bulk Electric System, that far outweighs the reliability benefits of strict compliance.
3 Cannot achieve by compliance date, due to scarce technical resources, limitations on availability of equipment and components, or equipment outage availability.
4 Unacceptable safety risks or issues outweigh the reliability benefits of strict compliance.
5 Conflicts with other statutory or regulatory requirement.
6 Costs exceed benefits. Equipment is far from end of life and costs to replace far outweigh the incremental benefits achieved through strict compliance.

Reason Sub-categories (for exceptions)

A High risk, requires testing.
B Requires reboot and/or unit outage.
C No vendor information, requires testing.
D Application not supported/compatible.
E Security control/feature not supported/compatible.
F Patch not supported/compatible.
G Insufficient site staff/vendor expertise or availability.

Critical Infrastructure Information (CII) Procedure

Revision 1.04 (External Vendors/Contractors)
July 27, 2009

Revision History

Version	Status	Author	Reason for Issue	Date
0.00	Draft	Paul Golden	Document Outline	09/11/08
0.01	Draft	Paul Golden	Include comments from Information Security and IT	09/30/08
0.02	Draft	Paul Golden	Include comments from IT Repository Project	10/13/08
1.00	Final	Paul Golden	Document revised to include comments from group review.	10/27/08
1.01	Revision	Paul Golden	Added P8 Decision Process Addendum	10/30/08
1.02	Revision	Paul Golden	Modified decision flowchart and corrected random drug screening text	12/01/08
1.03	Revision	Paul Golden	Added comments from Corporate Information Security	01/09/09
1.04	Revision	Paul Golden	Corrected file/folder marking	07/27/09

Revision Control

This document is maintained by the PacifiCorp Compliance Office. The latest revision of this document can be obtained at: the PacifiCorp NERC Compliance portal:
http://idoc.pacificorp.us/Article/Article82849.html

Standards of Conduct

This document has been reviewed by PacifiCorp's legal and compliance departments. This document fully complies with the "Standards of Conduct Compliance Procedures" and **can be shared** with all PacifiCorp employees including marketing function employees.

Applicable Standards

This document satisfies the various North American Electric Reliability Corporation standards listed below:

CIP-003-1 Cyber Security - Security Management Controls

R4. Information Protection — The Responsible Entity shall implement and document a program to identify, classify, and protect information associated with Critical Cyber Assets.

> **R4.1.** The Critical Cyber Asset information to be protected shall include, at a minimum and regardless of media type, operational procedures, lists as required in Standard CIP-002, network topology or similar diagrams, floor plans of computing centers that contain Critical Cyber Assets, equipment layouts of Critical Cyber Assets, disaster recovery plans, incident response plans, and security configuration information.

R4.2. The Responsible Entity shall classify information to be protected under this program based on the sensitivity of the Critical Cyber Asset information.

R4.3. The Responsible Entity shall, at least annually, assess adherence to its Critical Cyber Asset information protection program, document the assessment results, and implement an action plan to remediate deficiencies identified during the assessment.

R5. Access Control — The Responsible Entity shall document and implement a program for managing access to protected Critical Cyber Asset information.

R5.1. The Responsible Entity shall maintain a list of designated personnel who are responsible for authorizing logical or physical access to protected information.

R5.1.1. Personnel shall be identified by name, title, business phone and the information for which they are responsible for authorizing access.

R5.1.2. The list of personnel responsible for authorizing access to protected information shall be verified at least annually.

R5.2. The Responsible Entity shall review at least annually the access privileges to protected information to confirm that access privileges are correct and that they correspond with the Responsible Entity's needs and appropriate personnel roles and responsibilities.

R5.3. The Responsible Entity shall assess and document at least annually the processes for controlling access privileges to protected information.

Table of Contents

1. Scope

The North American Electric Reliability Corporation has issued a catalog of Reliability Standards in response to the Federal Energy Regulatory Commission's mandate that federal regulations be enacted and enforced for electric utilities. The Critical Infrastructure Protection Standards are a subset of those Reliability Standards that seek to ensure that electric utilities, as part of the nation's critical infrastructure, are able to sustain and secure against vulnerabilities that may threaten the electric system and the utilities operating it. These CIP standards were passed into law effective January 17, 2008. This document will address the requirements of CIP-003-1 Cyber Security – Security Management Controls relative to PacifiCorp's protection of information associated with critical cyber assets.

The provisions of this document apply to all PacifiCorp operational areas affecting critical assets (facilities and systems which, if destroyed, degraded or otherwise rendered unavailable, would affect the reliability or operability of the bulk electric system) and those critical cyber assets utilized within those facilities to operate the bulk electric system.

2. Objective

This procedure is intended to provide an outline of the steps necessary to appropriately identify, document and handle all information associated with PacifiCorp critical cyber assets. The data classification assigned by corporate security to this type of information is called - Critical Infrastructure Information.

3. Definitions

3.1 Critical Asset (CA)

Critical assets are those key facilities, systems and equipment ***owned by the responsible entity*** which, if destroyed, damaged, degraded or otherwise rendered unavailable, would have a significant impact on the ability to serve large quantities of customers for an extended period of time, would have a detrimental impact on the reliability or operability of the bulk electric system, or would cause significant risk to public health and safety.

3.2 Critical Cyber Asset (CCA)

Critical cyber assets are programmable electronic devices and communication networks, including hardware, software and data essential to the reliable operation of critical assets and the reliability of the bulk electric system.

3.3 Critical Infrastructure (CI)

Critical Infrastructure means systems and assets, whether physical or virtual, so vital to the United States that the incapacity or destruction of such systems and assets would have a debilitating impact on security, national economic security, national public health or safety or any combination of those matters.

3.4 Critical Infrastructure Information (CII)

Critical Infrastructure Information, or CII is information not customarily in the public domain and related to the security of critical infrastructure or protected systems. Specifically at PacifiCorp, CII is considered information concerning proposed or existing critical assets and the associated critical cyber assets that:

1. Relate to the production, generation or transmission of energy;
2. Could be useful to a person planning an attack on critical infrastructure; and
3. Provide strategic information beyond the physical/geographic location of the critical infrastructure.

3.5 Business *Need-to-Know*

A business *need-to-know* is defined as any PacifiCorp personnel (FTE and contractor/vendor) and business partners (other utilities and regional authorities) that have a legitimate need to have access to PacifiCorp CII. Access to CII must correspond to the individual's needs and is dependent upon their assigned role and responsibilities.

Requirements for access to CII

All PacifiCorp employees and contractors are subject to the PacifiCorp Personnel Risk Assessment Program which includes recurring background checks (every seven years), initial and "*for cause*" drug screening, and required annual security training. Access to CII does not require that an employee satisfy the requirements of the Personnel Risk Assessment Program, rather it is a condition of employment at PacifiCorp.

Business partners, contracting firms and vendors are required to sign a Non-Disclosure Agreement with PacifiCorp acknowledging their responsibilities to securely treat this sensitive information (see section 6 for more information about the NDA requirement). They are not required to submit to PacifiCorp background checks or drug screening as required in the PacifiCorp Personnel Risk Assessment Program.

3.6 Electronic Security Perimeter

An Electronic Security Perimeter is defined by a logical boundary that encompasses critical cyber assets isolated from other cyber assets. The logical boundary consists of firewalls, routers and access control systems.

4. Identification of CII

As each PacifiCorp facility/system, identified as a critical asset, is brought into CIP compliance, the information associated with its critical cyber assets (CII) must be reviewed, assigned a sensitivity classification and appropriately protected.

This procedure provides guidance in locating, identifying, labeling and securing electronic and physical media/information for critical cyber assets, including access control devices for electronic security perimeters and physical security monitoring.

Each PacifiCorp business unit originating the CII document/data is responsible for establishing local methods to label, protect and store the information in alignment with this procedure.

The following guidance is provided to assist PacifiCorp personnel in identifying CII information.

4.1 CII Attributes

Critical Infrastructure Information (CII) is now another PacifiCorp data classification with strict security requirements. Identification of which documents or data qualify as CII can be a difficult task. The primary consideration to keep in mind is whether the data or document describes a cyber asset(s) within a critical facility in enough detail that someone could use that information to compromise the security of that facility or asset resulting in a negative impact to the bulk electric system.

Note: *Remember, in its simplest form, CII is only data or documents referring to critical cyber assets within a critical asset or facility.*

CII attributes include the following:

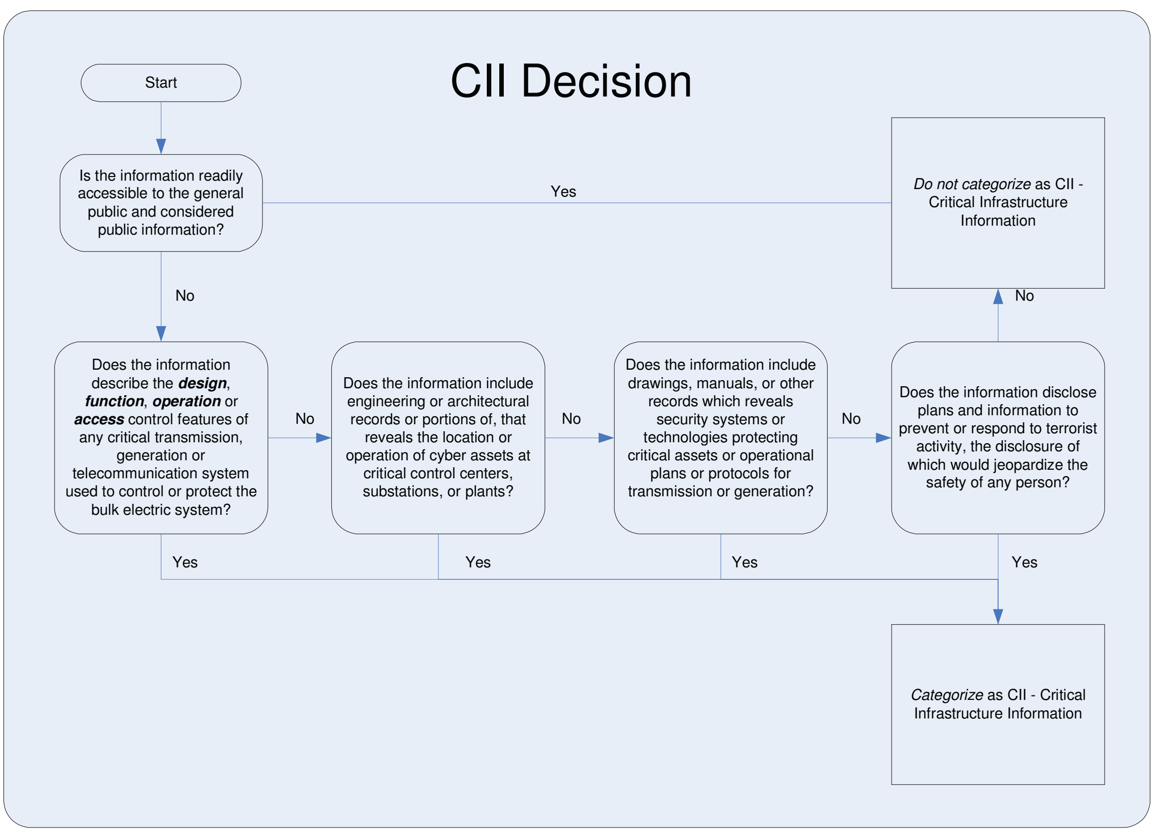
- ***Documentation or other information that describes the design, function, operation or access*** *control features of any transmission, generation or telecommunication system, manual or automated, used to control or protect the bulk electric system.*
  - Operational plans or protocols for transmission or generation
  - Operational procedures or guides for critical assets that contain information about covered cyber assets
  - Passwords of critical cyber assets that allow configuration settings to be changed or control/manipulation of input/output devices
  - Security configuration information of critical cyber assets
  - Network topology or similar diagrams:
    - Communication block diagram for covered cyber asset
    - Substation single line or three line diagram (only if showing critical cyber assets)
    - Schematic diagram showing critical cyber asset that includes software addressing logical configuration information
    - Schematics for access control and monitoring devices
  - Wiring diagrams for critical cyber assets or access control devices and monitoring devices
  - Configuration information for critical cyber assets or access control devices and monitoring devices

- ***Engineering or architectural records*** *or portions of, that reveal the location or operation of control centers, substations or plants:*
  - Control system designs
  - Electrical equipment and systems
  - Security equipment and systems
  - Emergency equipment and systems
  - Fire protection equipment and systems
  - Telecommunications equipment and systems

- Floor plan of computing center showing covered cyber asset
- Floor plan of substation control house showing covered cyber assets
- Equipment layouts of critical cyber assets (control panel layout 'bill of materials' drawings only if showing critical cyber assets or access control and monitoring devices)
- Remote Terminal Unit Layout spreadsheet for critical substations
- Energy Management System Database spreadsheet for critical substations
- Lists of critical assets and critical cyber assets identified in CIP-002
- Protective relay and communication processor configuration/settings for critical cyber assets (if no advanced level passwords included)

- ***Information*** *(including drawings, manuals or other records)* ***which reveals security systems*** *or technologies protecting critical assets:*
  - Alarm or security systems or technologies protecting critical assets

- ***Plans and information to prevent or respond*** *to terrorist activity, the disclosure of which would jeopardize the safety of any person, including:*
  - Operational, procedural and tactical planning or training manuals
  - Vulnerability assessments
  - Disaster recovery and incident response operational plans/procedures that contain information about covered cyber assets
  - Staff meeting minutes or other records related to the above



Points to consider when determining what constitutes CII

- What impact could the information have if it was inadvertently transferred to an unintended audience?
- Does the information provide details concerning security procedures and capabilities?
- Could someone use the information to target personnel, facilities or operations?
- How could someone intent on causing harm use the information?
- Could the use of this information be dangerous if combined with other publicly available information?
- Look at the material from an adversary's point of view.

5. Marking CII Documents

Once information has been designated as CII, it should be marked according to the following:

It is the responsibility of the owner of the information to make sure that CII contained within the document is identified and marked, whether it has been previously marked or not.

If a person is handling a document which contains CII and the document has not been properly marked; the handler should refer the document back to the owner of the information for proper marking.

Documents stored in an electronic format:
The marking shown below (frame and format optional) should be placed appropriately on all pages or sections containing CII material. It should be located either at the top or bottom of the page consistently throughout the document. The format and arrangement of the words may be modified to accommodate different situations but the wording should remain consistent. A document watermark can be used if the format allows.

CII - CRITICAL INFRASTRUCTURE INFORMATION

Documents only available in hardcopy:
The hand stamp shown below should be placed appropriately on all pages or sections containing CII material. It should be located on every page consistently throughout the document. Hand stamps can be obtained from the compliance office. Bound hardcopies of vendor documentation should be stamped on the cover, if possible, and on the first page of the publication.

6. Releasing CII Documents

Prior to releasing CII information to business partners (other utilities or regulatory agencies) or contractors/vendors in connection with work being performed under the terms of a PacifiCorp contract, the sender (PacifiCorp) must determine if there is a legitimate need-to-know. If there is a ***legitimate business need-to-know***, the sender (PacifiCorp) must require the recipient of the CII to complete a *Non-Disclosure Agreement (NDA)* and retain a copy on file for 36 months. NDA's are available on the NERC Compliance portal. If the contract firm or vendor is included in the master vendor list an NDA should be available. Contact your procurement resources to confirm that a valid NDA is on file. If there is not a legitimate business need-to-know, the information should never be released.

7. Handling CII Documents

All PacifiCorp's staff (FTE and contractor/vendor) are responsible for safeguarding CII in their custody or under their control. The extent of protection afforded CII shall be sufficient to reasonably prevent the possibility of its loss or compromise.
Note: *PacifiCorp staff (FTE and contractor/vendor) shall follow the appropriate handling procedures for CII whether they are within the confines of a secured PacifiCorp facility or working in unsecured corporate/public facilities. CII must be protected at all times!!*

The following precautions should be taken when handling all CII in any document, in whole or in part, that contains CII:

- ***Protection*** - CII shall be protected at all times, either by appropriate secure storage or having it under the personal observation and control of a person authorized to receive it. Each person who works with protected CII is personally responsible for taking proper precautions to ensure that ***unauthorized persons do not gain access*** to it.
    - While on corporate travel be sure to physically secure laptops/personal electronic devices containing CII
        - Lock up laptops/personal electronic devices in room safes
        - Use locked leashes when leaving a laptop unattended
        - Ensure your desktops and laptops conform to the required desktop timeouts and password security
    - While working on drafts or revisions of CII documents be sure to secure working copies
        - Don't leave CII documents laying unattended on your desk

  - When transporting CII be sure not to leave CII information in unlocked vehicles
    - Store laptops and documents out of plain sight in locked compartments

- ***Use and Storage*** - During working hours, reasonable steps shall be taken to minimize the risks of access to CII by unauthorized personnel.
  - *Physical Storage*
    - After working hours, CII shall be protected in a secure container, such as a locked desk, file cabinet or facility where security is provided.
  - *Electronic Storage*
    - Document management systems and network folders
      - PacifiCorp provides two methods of storing electronic copies of CII: secured network folders and EDMS/FileNet (P8).
      - CII data owners will make the decision on which secured storage mechanism their information will reside.
      - Initial migration of CII data from public network folders to secured folders is the responsibility of the business unit data owner.
      - Secured folders are those that have been assigned a data owner and one that the data owner has requested restricted access.
      - Initial migration is completed by reviewing what folders will contain CII and renaming the folder as CII.
      - Once the folder is defined, a data owner/folder owner must be identified.
      - All CII folders must have an assigned CII data owner.
    - CII and non-CII information can be co-mingled in the folders/file structures and directories or database. Understanding that the access security of the non-CII data inherits that of the CII data.
    - Secured folders must have CII in the name of the folder as in 'CII-folder name'.

- ***Reproduction*** - Documents or material containing CII may be reproduced to the minimum extent necessary consistent with the need to carry out official duties provided that the reproduced material is marked and protected in the same manner as the original material.
  - Copying, scanning or printing (local/remote) a document:
    - CII items must be retrieved from the office equipment immediately.
    - When a CII document is copied, scanned or printed, the document may be electronically stored on the local device and the recipient device. All local and recipient copies shall be deleted upon completion of task where technically feasible. Note: CII should not be faxed.

- ***Disposal*** - Material containing CII information should be disposed through secured shredding receptacles or other secured document destruction methods.

- ***Transmission (Sending Externally)*** – When sending *externally*, CII shall be transmitted only by US first class, express, certified or registered mail, bonded courier or through secure electronic means such as:
  - E-mail with encrypted file (such as, WinZip with password). ***Caution!*** The password should not be included in e-mail. Deliver password by phone or in an unrelated e-mail not mentioning the document name. Note: Password-protected Microsoft Office documents do not meet the encryption requirements. A guide to encryption is also available on the compliance portal.
  - Secured file transfers (SFTP) to external (Internet) sites or internal (intranet) sites must be sent to a specific IP address and have a password.

- ***Transmission (Sending Internally)*** – When sending *internally* within PacifiCorp, CII shall be transmitted only by interoffice mail or corporate email.
  - E-mail subject line shall note that CII is contained within and the following disclaimer is included in the body of the e-mail.
    Disclaimer:
    The sensitivity of the information contained in this email has been classified under the PacifiCorp Data Classification Program as CII. The recipient of this information is required to follow the procedures outlined in the PacifiCorp Critical Infrastructure Information Procedure.
  - Interoffice mail envelope should be labeled as containing CII.

8. Controlling Access to CII

PacifiCorp's program to manage access to CII utilizes the current policies and procedures in place to control logical and physical access to critical assets and critical cyber assets. An annual review of user access to CII is required by the compliance office.

8.1 Access to hardcopy CII

Controlling access to hardcopy CII stored ***within*** PacifiCorp facilities is described within the ***"PacifiCorp Physical Access Control Program (Critical Assets)"***. The document defines the administrators of those facilities where CII is stored, the quarterly review processes and the removal of access for transfer, termination, and termination for cause.

8.2 Access to electronically stored CII

Controlling access to electronically stored CII ***within*** PacifiCorp is described within the ***"PacifiCorp Logical Access Management Policy-DS5-1"*** and *its associated procedures*. The documents define administrator/access steward and data owner roles and responsibilities for applications, databases or folders where CII is stored, the quarterly review processes and the removal of access for transfer, termination and termination for cause. Annual reviews and reports of the controlled access to CII contained in P8 and secured folders are required by the compliance office. IT will facilitate the user access review for electronic storage of CII in P8 and in secure network folders. This review will utilize the list of folders and P8 document classes provided to the Data Owner mailbox as described in section 7 'Use and Storage' above. P8 document class access will be reviewed by the data owner in the quarterly data owner review. For review of users with access to CII folders, data owners will receive a list of users with access to the designated CII folders annually. Data owners will be required to review both the quarterly P8 and annual folder review and provide confirmation of completion of this review to the Access Report Review mailbox as is completed today for the quarterly supervisor review.

PACIFICORP ENERGY
A DIVISION OF PACIFICORP

NERC/CIPS
COMPLIANCE PLAN
FOR
CLEAN AIR INITIATIVE
AND
GENERATION ENGINEERING
PROJECTS

1. Introduction

Background

The North American Electric Reliability Corporation (NERC) has issued the Critical Infrastructure Protection Standards (CIPS) to ensure that electric utilities, as part of the nation's critical infrastructure, are able to be secured against threats to the electric system and the utilities operating it. These CIP Standards were passed into law effective Jan. 18, 2008. Congress has authorized the Federal Energy Regulatory Commission to impose penalties of up to $1 million per day for each violation of the requirements of the NERC Reliability Standards.

Many questions were asked by the Contractors during the past year concerning PacifiCorp NERC/CIPS requirements on the Clean Air Projects at various PacifiCorp generating facilities. Typical questions, along with the answers provided to those questions, are found in the appropriate sections of this document.

Purpose

The purpose of this plan is to provide a basic description of the CIPS program in place at PacifiCorp Energy. Additional, detailed information can be found in the documents referenced in bold. These documents can be found on PacifiCorp's intranet site under e-resources/NERC Compliance/CIPS.

This plan also provides a checklist to ensure all applicable NERC/CIPS requirements are met in CAI projects.

Definition of Terms

Critical Assets (CA) - Facilities, systems and equipment owned by PacifiCorp which, if destroyed, damaged, degraded or otherwise rendered unavailable, would affect the reliability or operation of the bulk electric system. Critical Assets are generally categorized as:

1. Control centers;
2. Substation/switchyard facilities;
3. Generation plants, or
4. Systems.

Cyber Assets (CA) - programmable electronic devices and communication networks, including hardware, software and data.

Critical Cyber Assets (CCA) – Cyber Assets which are essential to the reliable operation of Critical Assets.

Critical Infrastructure means systems and assets, whether physical or virtual, so vital to the United States that the incapacity or destruction of such systems and assets would interrupt commerce and trade, endanger life, impede public services and have a debilitating impact on security, national economic security, national public health or safety or any combination of those matters.

Critical Infrastructure Information, or CII is information not customarily in the public domain and related to the security of critical infrastructure or protected systems. Specifically at PacifiCorp, CII is considered information concerning proposed or existing Critical Assets and the associated Critical Cyber Assets that:

1. Relate to the production, generation or transmission of energy;

2. Could be useful to a person planning an attack on critical infrastructure; and

3. Provide strategic information beyond the physical/geographic location of the critical infrastructure.

A business need-to-know is defined as any PacifiCorp personnel (full time employees(FTE) and contractor/vendor) and business partners (other utilities and regional authorities) that have a legitimate need to have access to PacifiCorp CII. Access to CII must correspond to the individual's needs and is appropriate based upon their assigned role and responsibilities.

An Electronic Security Perimeter is defined by a logical boundary that encompasses critical cyber assets that are isolated from other cyber assets. The logical boundary consists of firewalls, routers and access control systems.

Sensitive Personnel shall include all Personnel with authorized unescorted physical access or authorized cyber access to PacifiCorp's CIPS Covered Assets.

Question: Does the Contract definition of Sensitive Personnel extend to the contractor's engineering off-site staff that has access to CII and they therefore will require background checks or is it limited as you note below to those "who have been granted unescorted access to any PacifiCorp facility that requires authorization to receive access OR logical access to Critical Cyber Assets?

Answer: Background checks, etc. are limited to those who have been granted authorized cyber or authorized unescorted physical access to Owner's CIP covered assets. The contractors working off-site who have access to CII do not require background checks. That is covered under the Confidentiality Agreement.

Question: Regarding background checks: Any guidelines on this requirement? I'd like to limit this to the people working on a specific project so I'd like to discuss what would be required to restrict access to the CII.

Answer: Paragraphs 38.1 (a) and 38.1. (c) of Attachment B of the NERC/CIPS Compliance Plan for CAI Projects give the guidelines for background checks. This is only applicable to those participating in work at a plant under the contract who have been granted unescorted access to any PacifiCorp facility that requires authorization to receive access OR logical access to Critical Cyber Assets, i.e., limited to people working on the specific project).

2. Roles and Responsibilities

The PacifiCorp project manager has overall responsibility for implementing and enforcing company NERC/CIPS polices on each project.

3. Physical Security Plan

- A physical security plan for protection of Cyber Assets has been developed and has been implemented at all PacifiCorp power plants. Details of the program are contained in **PacifiCorp's Physical Access Control Program (Critical Assets).** The plan contains requirements and procedures for such items as: Ensuring and documenting that all Cyber Assets within an Electronic Security Perimeter also reside within an identified Physical Security Perimeter.
- Identification of access points and measures to control entry at those points.
- Monitoring physical access to the perimeter.
- The appropriate use of physical access controls.

4. Requirements for Access to CII

a. PacifiCorp Employees

All PacifiCorp employees (full time and contract) requiring unescorted physical or cyber access to PacifiCorp's CIPS covered assets are subject to the PacifiCorp Personnel Risk Assessment Program which includes reoccurring background checks (every seven years), initial, for cause and random drug screening, and required annual security training.

Question: Regarding drug testing: Are there any specific requirements for this testing? Which drugs? How often?

Answer: Paragraph 38.1(b) of Attachment B of the NERC/CIPS Compliance Plan for CAI Projects gives the specific requirements for this testing. The designation SamHSA5 panel at 50NG – THC cut-off gives drugs and levels. The abbreviation SAMHSA is Substance Abuse and Mental Health Services Administration and it sets the guidelines for the federal government in drug testing programs. The 5-Panel drugs are Marijuana (THC), Cocaine, Amphetamines/Methamphetamines, Opiates2, and Phencyclidine (PCP). 50NG is the cutoff level for the test – 50 ng/ml.

According to the PacifiCorp legal department the NERC CIPS area regarding how often drug tests are required, "there is no requirement which requires an updated drug test with any specified frequency -- the simple answer is that currently there is no frequency requirement for drug testing. Workers are subject to "for cause" and random screening after the initial test."

Note: NERC CIPS does not require drug testing. It is a PacifiCorp requirement rolled into the NERC CIPS program.

All PacifiCorp contract employees are assigned a P-number for identification purposes. Contract employees with a computer will take the training at their work station. Contract employees with a P-number but no computer may take the required training by logging on to a computer approved by their hiring manager. Completion of the training requirements is tracked by the human resources department within SAP.

Hiring managers must have contractors complete the training as soon as possible. Failure to complete the required security training within 90 days will result in revocation of all physical and electronic access privileges.

b. Contractors

CAI projects will invariably require PacifiCorp and the Contractor to exchange confidential, highly confidential, restricted or critical infrastructure information (CII).

To ensure that all CAI projects comply with NERC-CIPS requirements, the following must be performed:

1) A NERC-CIPS Compliance section and supporting Exhibit Y, such as that shown in Attachment B, will be included in the Contract,
2) Business partners, contracting firms and vendors will be presented with a copy of PacifiCorp's CII procedure and will be required to sign a Confidentiality Agreement (CA). There is a version of PacifiCorp's CII procedure which we can share with vendors. The version which we can give to vendors is now found on the S: drive at: S:/Resource Development/CAI Projects/NERC_CIPS_CII/External CII procedure

for vendors.

3) The Confidentiality Agreement must be executed by both Company and Contractor. (The Confidentiality Agreement further defines "Confidential Information" and provides requirements for protection of CII after it is received from PacifiCorp),
4) Upon request by Owner, Personnel Screening requirements of the NERC-CIPS Compliance section of the Contract (background checks and drug and alcohol exams) will be performed by the Contractor,
5) In the event that the project requires authorized cyber or authorized unescorted physical access to CIP covered assets, contractor will fulfill the requirements of the NERC-CIPS Compliance section of the Contract.
6) Before being granted unescorted cyber or physical access to PacifiCorp's NERC CIPS covered assets, all contractors will be required to complete the following two Owner provided mandatory training courses—PL086 – NERC CIPS overview and PL119 – Electronic and Physical Security. There are two training options for contractor personnel. Those are, a PDF copy of the training material or giving them the training on the intranet. The training is good for a year.

Question: Are the people required to submit to the drug testing the same people who would be required to submit to a background check?
Answer: Yes. See Article 38.2 of the NERC-CIPS Contract Compliance Section of the Contract.

Question: Which of the contractor's construction personnel would need this check? Only electricians working in the electrical enclosures?
Answer: No, not only electricians--anyone requiring authorized, unescorted, physical access or authorized cyber access to Critical Cyber Assets. If a construction person's Job requires authorized cyber or authorized unescorted physical access to Owner's CIP Covered Asset (not the plant) the Contractor would have to meet the requirements of section 38.2, NERC CIPS Compliance, of the Contract. Section 38.2 does not apply to construction people not requiring access to critical assets to perform their job. Examples of personnel not requiring background checks would be mechanics or other craft who enter or pass through a CIPS covered area without having work to perform in the area. Those who have a function to perform in the CIPS area which can be performed with a PacifiCorp escort (preferably quickly--this would have to be prearranged with plant people to ensure they have someone available for escort), or someone working outside the area on terminations for wiring which would leads to a CIP asset.

Question: Regarding the background checking, does this apply to contractor's engineering personnel who are not on-site?
Answer: It depends upon their job function. If they have logical access to Critical Cyber Assets to perform a job such as, for example, perform programming of the DCS, it would apply. If they perform functions such as preparation or review of

drawings, procurement documents, etc. containing Critical Infrastructure Information (CII), off-site, it does not apply to them. This is covered by the **Confidentiality Agreement** signed by the contractor and PacifiCorp).

Question: Do individuals working for a company on the project need to execute the confidentiality agreement (CA).

Answer: Individuals do not sign the CA. This is for companies (contractor and PacifiCorp) to sign.

Question: How about the contractor's start-up staff who will be working with the DCS?
Answer: Yes, since this work meets the above access requirement criteria.

5. Identification of CII

As each PacifiCorp facility/system identified as a critical asset is brought into CIP compliance, the information associated with its critical cyber assets (CII) must be reviewed, assigned a sensitivity classification and appropriately protected in accordance with the procedure found in section **4 of PacifiCorp's CII Procedure.**

Due to the importance of Section 4 and the frequency it will be used, the procedure is included below. This procedure provides guidance in locating, identifying, labeling and securing electronic and physical media/information for critical cyber assets, including access control devices for electronic security perimeters and physical security monitoring. Each PacifiCorp business unit originating the CII document/data is responsible for establishing local methods to label, protect and store the information in alignment with this procedure.

The following guidance is provided to assist PacifiCorp personnel in identifying CII information.

CII Attributes
Critical Infrastructure Information (CII) is now another PacifiCorp data classification with strict security requirements. Identification of which documents or data qualify as CII can be a difficult task. The primary consideration to keep in mind is whether the data or document describes a cyber asset(s) within a critical facility in enough detail that someone could use that information to compromise the security of that facility or asset resulting in a negative impact to the bulk electric system.

Note: *Remember, in its simplest form, CII is only data or documents referring to critical cyber assets within a critical asset or facility.*

CII attributes include the following:

Documentation or other information that describes the design, function, operation or access control features of any transmission, generation or telecommunication system, manual or automated, used to control or protect the bulk electric system.

o Operational plans or protocols for transmission or generation

o Operational procedures or guides for critical assets that contain information about covered cyber assets

o Passwords of critical cyber assets that allow configuration settings to be changed or control/manipulation of input/output devices

o Security configuration information of critical cyber assets

o Network topology or similar diagrams:

- Communication block diagram for covered cyber asset
- Substation single line or three line diagram (only if showing critical cyber assets)
- Schematic diagram showing critical cyber asset that includes software addressing logical configuration information
- Schematics for access control and monitoring devices

o Wiring diagrams for critical cyber assets or access control devices and monitoring devices

o Configuration information for critical cyber assets or access control devices and monitoring devices

Engineering or architectural records *or portions of, that reveal the location or operation of control centers, substations or plants:*

o Control system designs

o Electrical equipment and systems

o Security equipment and systems

o Emergency equipment and systems

o Fire protection equipment and systems

o Telecommunications equipment and systems

o Floor plan of computing center showing covered cyber asset

o Floor plan of substation control house showing covered cyber assets

o Equipment layouts of critical cyber assets (control panel layout 'bill of materials' drawings only if showing critical cyber assets or access control and monitoring devices)

o Remote Terminal Unit Layout spreadsheet for critical substations

o Energy Management System Database spreadsheet for critical substations

o Lists of critical assets and critical cyber assets identified in CIP-002

o Protective relay and communication processor configuration/settings for critical cyber assets (if no advanced level passwords included)

Information *(including drawings, manuals or other records)* ***which reveals security systems*** *or technologies protecting critical assets:*

o Alarm or security systems or technologies protecting critical assets

Plans and information to prevent or respond *to terrorist activity, the disclosure of which would jeopardize the safety of any person, including:*

o Operational, procedural and tactical planning or training manuals

o Vulnerability assessments
o Disaster recovery and incident response operational plans/procedures
that contain information about covered cyber assets
o Staff meeting minutes or other records related to the above

Note: At this point, PacifiCorp's CII Procedure contains a decision tree. It is not included herein.

Points to consider when determining what constitutes CII

o What impact could the information have if it was inadvertently transferred to an unintended audience?
o Does the information provide details concerning security procedures and capabilities?
o Could someone use the information to target personnel, facilities or operations?
o How could someone intent on causing harm use the information?
o Could the use of this information be dangerous if combined with other publicly available information?
o Look at the material from an adversary's point of view.

Question: Does PacifiCorp have a definition of CIP covered assets at each plant?

Answer: Each plant has a person assigned as the NERC CIPS coordinator. That person has a definition of what is consider to be CIPS covered assets.

6. Marking CII documents

Once information has been identified as CII, it must be marked in accordance with the requirements of **Section 5 of PacifiCorp's CII Procedure**.

Question: When do project drawings become CII?

Answer: If PacifiCorp personnel reviewing contractor drawings determine they contain critical infrastructure information, PacifiCorp will notify the Contractor of this fact. Contractor will mark the drawings as CII and handle all future issues of the drawing as CII. The applicable drawing index will be marked to reflect the drawing as CII at this time.

Before giving CII documents to a Contractor, they must be marked as CII in accordance with **Section 5 of PacifiCorp's CII Procedure** using the appropriate method for either electronic or hardcopy documents. As a general rule, documents must be marked as CII if they meet the requirements of Paragraph 5 above.

It is the responsibility of the owner of the information to make sure that CII contained within the document is identified and marked, whether it has been previously marked or not.

If a person is handling a document which contains CII and the document has not been properly marked; the handler must refer the document back to the owner of the information for proper marking.

Question: Should drawings identified as CII on the drawing index be identified by category or as specific drawings?

Answer: They should be identified as specific drawings. That means marking individual drawings instead of marking all in a category, such as General Arrangement drawings. All GAs should not be marked as CII. Only those which contain CII should be marked as such.

Question: Does everyone involved with the development of CII documents need to have a background check?

Answer: People who prepare CII documents are covered by the Confidentiality Agreement and don't need background checks. Background checks, drug testing, and training are only required for those people whose job requires them to have unescorted physical or unescorted cyber access to PacifiCorp's CIP covered assets.

7. Releasing CII Documents

Prior to releasing CII information to business partners (other utilities or regulatory agencies) or contractors/vendors in connection with work being performed under the terms of a PacifiCorp contract, the sender (PacifiCorp) must determine if there is a legitimate need-to-know.

If there is a legitimate business need-to-know, the sender (PacifiCorp) must require the recipient of the CII to complete a Non-Disclosure Agreement (NDA) and retain a copy on file for 36 months. If there is not a legitimate business need-to-know, the information must never be released. See **Section 6 of PacifiCorp's CII Procedure**.

8. Handling CII Documents

All PacifiCorp staff (full time employees and contractor/vendor) is responsible for safeguarding CII in their custody or under their control. See **Section 7 of PacifiCorp's CII Procedure** for detailed requirements.

<u>Protection</u> – CII must be protected at all times, either by appropriate secure storage or having it under the personal observation and control of a person authorized to receive it. Each person who works with protected CII is personally responsible for taking proper precautions to ensure that unauthorized persons do not gain access to it.

While on corporate travel laptops/personal electronic devices containing CII must be physically secured by locking them up in room safes, using locked leashes when leaving a laptop unattended and ensuring desktops and laptops conform to the required desktop timeouts and password security.

While working on drafts or revisions of CII documents, they must be secured and not left lying unattended on your desk.

When transporting CII your vehicle must be locked and laptops and documents must be stored out of plain sight in locked compartments.

Reproduction – Reproduce documents or material containing CII only to the minimum extent necessary consistent with the need to carry out official duties provided that the reproduced material is marked and protected in the same manner as the original material.

After copying, scanning or printing CII items must be retrieved from the office equipment immediately.

When a CII document is copied, scanned or printed, the document may be electronically stored on the local device and the recipient device. All local and recipient copies shall be deleted upon completion of task where technically feasible. Note: CII must not be faxed.

Disposal – Dispose of material containing CII information only through secured shredding receptacles or other secured document destruction methods.

Transmission (Sending Externally) – When sending *externally*, transmit CII only by US first class, express, certified or registered mail, bonded courier; or through secure electronic means such as E-mail with encrypted file (such as WinZip with password).

Do not include the password the in e-mail. Deliver password by phone or in an unrelated e-mail not mentioning the document name. Note: Password-protected Microsoft Office documents do not meet the encryption requirements. Assistance can be obtained for encrypting documents by contacting the Enterprise Service Desk via email or 503-813-5555 or 801-220-5555.

Secured file transfers (SFTP) to external (Internet) sites or internal (intranet) sites must be sent to a specific IP address and have a password. Contact the Enterprise Service Desk via email or 503-813-5555 or 801-220-5555 for assistance.

Transmission (Sending Internally) – When sending *internally* within PacifiCorp, transmit CII only by interoffice mail or corporate email. E-mail subject line shall note that CII is contained within and the following disclaimer is included in the body of the e-mail:

> Disclaimer: The sensitivity of the information contained in this email has been classified under the PacifiCorp Data Classification Program as CII. The recipient of this information is required to follow the procedures outlined in the PacifiCorp Critical Infrastructure Information Procedure.

Label interoffice mail envelopes as containing CII.

Use and Storage - During working hours, take reasonable steps to minimize the risks of access to CII by unauthorized personnel.

Physical Storage - After working hours, protect CII in a secure container, such as a locked desk, file cabinet or facility where security is provided.

Electronic Storage - PacifiCorp provides two methods of storing electronic copies of CII: secured network folders and EDMS/FileNet (P8). CII data owners will make the decision on which secured storage mechanism their information will reside.

9. P8 Decision Process

P8 Decision Making - **Addendum 1 to PacifiCorp's CII procedure** provides guidance for classification of documents and for determining when P8 is the appropriate storage alternative. Use this addendum for classifying documents and determining if the class would benefit from being stored in P8.

Addendum 1 to PacifiCorp's CII procedure also provides instructions for requesting enterprise content services review of the P8 targeted CII and initial migration of CII data from public network folders to secured folders.

10. Controlling Access to CII

Specific requirements and procedures for logical access to systems and applications that house business related data are found in **PacifiCorp's Access Management Program.** This includes new access for new hires, rehires, setup of outside contractor, consultant or vendor; new access for existing personnel; changes to access, and removal of access.

Specific requirements and procedures for physical access to critical assets or facilities that house critical cyber assets are found in **PacifiCorp's Physical Access Control Program (Critical Assets).**

Controlling access to hardcopy CII stored within PacifiCorp facilities is also described within the ***"PacifiCorp Physical Access Control Program (Critical Assets)"***.

ATTACHMENT A

CAI/Generation Engineering Projects

NERC-CIPS

Compliance Checklist

NERC-CIPS COMPLIANCE CHECKLIST				
	ACTIVITY	**VERIFIED**	**N/A**	**COMMENTS**
1	All PacifiCorp CAI project employees (full-time and contract) requiring access to CII have satisfied the requirements of the PAC's Personnel Risk Assessment Program (background checks, drug screening and security training). (4.a)			
2	There is a NERC-CIPS COMPLIANCE section in the Project Contract. (4.b.1)			
3	Confidentiality Agreement has been executed by both Company and Contractor. (4.b.3)			
4	Contractor has been given a copy of the version of PacifiCorp's Critical Infrastructure Information (CII) Procedure which we can share with vendors. (4.b.2)			
5	Contractor has designated one person to be responsible for compliance with NERC-CIPS COMPLIANCE section of the Contract. (contract article 38)			

6	Will work require any authorized cyber or authorized unescorted physical access to Owner's CIP Covered Assets? If answer is yes, respond to 6a through 6d below. (4.b.5)	Yes_____ No______		
6a	Contractor has provided Owner with a list of Sensitive Personnel authorized to access CIPS covered assets. (4.b.5 and contract)			
6b	Sensitive Personnel have completed mandatory training classes prior to gaining access to CCA. (4.b.6)			
6c	Background checks completed with certification for Sensitive Personnel. (Contract)			
6d	Drug tests have been completed for Sensitive Personnel. (4.b.4)	Yes_____ No______		
7	Contractor has and complies with a substance abuse/drug and alcohol policy. (Contract)			
8	Contractor has supplied owner with certification for all of the Sensitive Personnel assigned to the work. (Contract)			
9	Information associated with the Project's cyber assets is reviewed and identified as CII in accordance with the requirements of section 4 of PacifiCorp's CII Procedure. (Paragraph 5 of this manual)			

10	Information designated as CII is marked in accordance with Section 5 of PacifiCorp's CII (Section 4 of this manual) Procedure.			
11	CII information is never released to business partners or contractors/vendors without a legitimate business need to know. (Section 7 of this manual)			
12	If there is a legitimate need to know, the recipient is required to fill out a Non-Disclosure Agreement(NDA)			
13	CII is protected at all times in accordance with the requirements of Section 7 of PacifiCorp's CII Procedure—either by appropriate secure storage or having it under the personal observation and control of a person authorized to receive it. (13 through 22 are from Section 8 of this manual)			
14	Documents or material containing CII are reproduced to the minimum extent necessary.			
15	Reproduced material is marked and protected in the same manner as the original material.			
16	Material containing CII material is disposed of through secured shredding receptacles or other secured document destruction methods.			
17	CII is sent externally only by US first class, express, certified or registered mail, bonded courier; or through secure electronic means			

	such as E-mail with encrypted file.			
18	CII is transmitted internally only by interoffice mail or corporate email. Email subject line contains appropriate disclaimer.			
19	Interoffice mail envelopes containing CII are labeled as containing CII.			
20	During working hours, reasonable steps are taken to minimize risk of access to CII by unauthorized personnel.			
21	After hours, CII is protected in a secure container or a facility where security is provided.			
22	Electronic copies of CII are stored in secured network folders or EDMS/fileNet (P8)			
23	Addendum No. 1 to PacifiCorp's CII procedure is used to determine when P-8 is the appropriate storage alternative. (Section 9 of this manual)			

Corporate Security Policy Handbook

June 5, 2009

Revision History

Revision history

Version No.	**:**	**Number** – v 1.8	**Date** – 05/29/09
Author(s)	**:**	Corporate Information Security Office	
Reviewed by	**:**	Corporate Information Security Office, Physical Security Department	
Authorized by	**:**	Compliance Office	
Framework reference	**:**	NIST 800 Series	

Version*	**Status**	**Author**	**Reason for Issue**	**Date**
1.0	Draft	Daniel Marvin	Initiate Policy Development	7/12/02
1.1	Final	Corporate Security	Reviewed and Ratified	2/21/03
1.2	Format	Dave Banegas	Alignment with MEHC Security Policies & Re-branding	4/07/06
1.3	Format	Dave Banegas	New Corporate Information Security document format	4/30/08
1.4	Updated	Stacy Bresler	Revised terms and content to better match NIST 800 series	6/9/08
1.5	Updated	Corp. Sec.	Annual Review and Ratification	04/15/09
1.6	Updated	Corp Sec	Needed changes	05/07/09
1.7	Updated	Group	Needed Changes	05/13/09
1.8	Upgrade	Group	Final Upgrades	05/19/09

** e.g., Draft, Authorized, etc.*

This document supersedes all previous PPW Holding corproate security policies (paper and electronic)

PACIFICORP

Required Signatures:

Title: President, Pacific Power		Name: Pat Reiten	
Signature		Date:	6/25/09

Title: Vice President and General Counsel		Name: Natalie Hocken	
Signature	Natalie Hocken	Date:	6/23/2009

Title: Managing Director, Applications and Corporate Security		Name: Nancy Kent	
Signature	Nancy Kent	Date:	6/23/09

Title: Director, Construction and Support Services		Name: Stuart Kelly	
Signature		Date:	

Title: Director, Corporate Information Security Office		Name: Michael Ball	
Signature	Michael Ball	Date:	6/23/09

Title: Director, Corporate Physical Security Office		Name: Gary Berndt	
Signature	Gary Berndt	Date:	6/23/2009

June 5, 2009
Authority
Letter

For several years, PacifiCorp has taken a proactive approach to assuring our businesses were implementing the proper security controls necessary to help maintain a safe and reliable working environment. The importance of security to our personal lives, our businesses and our nation continue to grow with ever year that passes. Physical security controls such as intrusion detection, improved access controls and monitored cameras are making our facilities safer. Information and IT security controls such as system log analysis, strong authentication solutions and vulnerability management continue to help make our computing environments more reliable.

The fact remains, that all these technology solutions only get us so far. It takes each and every one of us to be vigilant and disciplined to ensure that all aspects of security related to our respective areas of responsibility are appropriately designed, effectively implemented and consistently practiced. No one should assume that security is someone else's responsibility. It is essential that everyone bear this responsibility.

Be certain to familiarize yourself with the Corporate Security Policy Handbook. Links to the handbook can be found on the Security portal at: http://newweb.pacificorp.com/Article/Article64755.html. This document presents the most current set of requirements that PacifiCorp must follow to assure an acceptable level of security and compliance to various security regulations. It is mandatory that everyone in the organization follow these policies.

I have enormous confidence in your ability to identify and change any practice or attitude that is not fully consistent with these policies.

Sincerely,

Pat Reiten
President, Pacific Power

Table of Contents

1 Introduction

1.1 Policy

The *Corporate Security Policy Handbook* establishes the PPW Holding, Inc security policies required for appropriately identifying information resources, physical resources and business requirements necessary to apply proportionate controls and protective measures. PPW Holding, Inc. is committed to creating and maintaining an environment that protects PPW Holding, Inc. information resources from accidental or intentional unauthorized use, modification, disclosure, or destruction and safeguarding our physical assets from theft, sabotage, potential terrorist actions and other harmful acts that could put our human resources at risk.

Adherence to corporate security policies will safeguard the integrity, confidentiality, and availability of PPW Holding, Inc. information and will protect the interests of PPW Holding, Inc., its personnel, its business partners, and the general public.

This policy must be published so that it is readily available to all personnel. Furthermore the policy must be reviewed annually and approved by the senior manager assigned to this task.

1.2 Purpose

The intent of this handbook and corporate security policies is to ensure the creation and implementation of an environment that:

- Protects information and physical resources critical to PPW Holding, Inc.
- Protects information, cyber assets and physical assets as mandated by Federal laws.
- Protects the personal information and privacy of employees, contractors and customers.
- Reinforce the reputation of PPW Holding, Inc. as an institution deserving of public trust.
- Complies with due diligence standard for the protection of information, cyber assets and physical assets.
- Assigns responsibilities to relevant PPW Holding, Inc. officers, executives, managers, employees, contractors, partners and vendors.

The Corporation Security policies and procedures (referred to as “security policy” hereafter) set out in this document are designed to ensure that security requirements at PPW Holding, Inc. are consistent with industry "Common Practice" and conform to the principles of NIST 800 series of security guidelines.

Successful implementation of security can only be achieved if it is led and practiced by management. This set of policies addresses management, organizational, personnel, business continuity, legislative and third party issues as well as physical protection and IT solutions. In order to be fully effective, security must:

- Reflect business objectives;
- Be appropriate, pragmatic, and support business growth;
- Be cost effective and add business value where possible;
- Comply with all legal and regulatory requirements;
- Be monitored, measured and continually approve.

1.3 Scope of Security Policies

1.3.1 Information Resources

These policies apply to all information, in any form, related to PPW Holding Inc. business activities, employees, or customers, which have been created, acquired, or disseminated using PPW Holding, Inc. resources, brand, or funding. These policies also apply to all technologies associated with the creation, collection, processing, storage, transmission, analysis, and disposal of information. These policies also apply to all information systems, infrastructure, applications, products, services, telecommunications networks, process control equipment, and related resources, which are sponsored by, operated on behalf of, or developed for the benefit of PPW Holding Inc.

For the purpose of these policies, information technologies and the information they contain are collectively known as **information resources** (see Exhibit 1.3.1, *Examples of Information Resources*).

Exhibit 1.3.1 – Examples of Information Resources

Category	Descriptions	Examples	
Systems and Equipment	All multi-user computers and computer-controlled systems and their components	Data Processing Equipment Process Control Computers Embedded Computer Systems Mainframe Computers Minicomputers Microcomputers	Microprocessors Office Automation Systems Stand-Lone, Shared Logic, or Shared Resource Systems Firmware Servers Kiosks
Process Control Equipment and Decision Support	All computer-controlled equipment, networks, industry control systems, process control systems	Remote Terminal (telemetry) Units (RTUs) Intelligent Electronic Devices (IEDs) Programmable Logic Controllers (PLCs) Human-Machine Interface (HMI)	Data Historians Input/Output (IO) Servers SCADA Server or Master Terminal Unit (MTU) Control Server
Single-user Computer Equipment	All computers and their components used by individuals	Personal Computers (PCs) Workstations Laptop Computers Notebook Computers	Personal Digital Assistants (PDAs) Palm Tops Handheld Computers
Hardware	All major items of equipment or their components associated with a computer system	Central Processing Units (CPUs) Terminals Monitors	Video Display Terminals Projection Equipment Modems Printers
Software	All programs, scripts, applications, operating systems, HTML, and related resources	Operating Systems Programs Applications Applets	Database Management Systems Custom Code Associated Documentation
Data and Information	All information or data stored in digital format or as a printed product or data stored in digital format.	Text Files Documents Spreadsheets Digital Images	Electronic Mail Tables Databases Biometrics Information
Products and Services	All objects, processes, functions, and information delivered by, for, or under the brand of the PPW Holding, Inc.	Information Delivery Services \E-commerce Applications	Digital Certificate Services Web Site Content
Network Facilities	All communications lines and associated	Transmission Lines Terminal Equipment	Internet Intranet

	interconnected communications equipment	Routers Firewalls Hubs Switches Local Area Networks (LANs) Wide Area Networks (WANs) Virtual Public Networks (VPNs) Infrastructure	Extranet Telephone and Telephone Systems Voice-messaging Systems Fax Machines Videoconferencing Equipment Wireless Communications
Media	All electronic and non-electronic media used for information exchange	Magnetic Tapes Magnetic or Optical Disks	Diskettes Hard Copy Printouts

1.3.2 Physical Resources

These policies apply to all company facilities, resources and assets owned, leased and operated by PPW Holding Inc. The policies also apply to personnel behavior with regard to reporting suspicious activity, compliance with corporate physical security procedures and local security practices.

1.3.3 Organizations and Personnel

These policies apply to all PPW Holding Inc. functional organizations and personnel, including PPW Holding, Inc. employees, contractors, vendors, business partners, and any other authorized users of PPW Holding, Inc. information systems, applications, telecommunication networks, data, and related resources.

For the purposes of these policies, the above entities are collectively known as **personnel**. This definition of "personnel" excludes customers whose only access is through publicly available services, such as public web sites of PPW Holding Inc.

Note: For specific guidance regarding practices or actions not explicitly covered by these policies, contact the manager, Corporate Information Security, prior to engaging in such activities.

1.4 Objectives and Guiding Principles

The following objectives and principles guide the development and implementation of PPW Holding, Inc. security policies and practices:

1.4.1 Information Security Objectives

Ensure that only the people who are authorized to have access to information and information systems have such access.

Maintain the integrity by ensuring the accuracy and reliability of information by preventing or detecting unauthorized modifications.

Ensure that information and information systems are available and operational when such are needed.

Respond appropriately to cyber attack incidents, misuse of information systems and data, and mis-configured system that would jeopardize PacifiCorp's ability to maintain confidentiality, integrity, availability and reliability.

1.4.2 Physical Security Objectives

Support the safety of personnel

Reduce risks of human error, theft, fraud or misuse of facilities, resources and assets

Ensure that users are aware of security threats and concerns

Minimize the damage from security incidents and malfunctions

Ensure proper reporting of security incidents or suspicious activity

Respond quickly to threats and vulnerabilities against company facilities and personnel.

Ensure compliance with industry regulations regarding physical security.

1.4.3 Guiding Principles

1.4.3.1 Support the Mission of the Organization

The purpose of security is to protect an organization's valuable resources, such as physical assets, information and software. Through the selection and application of appropriate safeguards; security helps the organization's mission by protecting its physical and financial resources, reputation, legal position, employees and other tangible and intangible assets.

1.4.3.2 Protect and Manage Our Assets Responsibly

Responsible management of assets must consider contractual agreements, legislation, privacy concerns and ethical considerations.

1.4.3.3 Balance Business Needs with security Objectives

Security should be appropriate and proportionate to the business value and business dependence upon the asset(s) being protected and to the severity, probability and extent of potential harm. Requirements for security vary, depending upon the particular environment or system.

1.4.3.4 Defend in Depth

The idea behind defense-in-depth is to manage risk with diverse and layered defenses. If one layer is penetrated, another will prevent a full breach. Effective security requires a comprehensive approach.

1.4.3.5 Promote Responsibility and Accountability

The responsibility and accountability of owners, providers, users of PPW Holding Inc.'s assets, and other parties concerned with the security of corporate assets must be explicitly defined. The assignment of the responsibilities may be internal to an organization or may extend across organizational boundaries.

1.4.3.6 Embrace Simplicity

A system is only as secure as its weakest link, so a system with fewer links is easier to secure. As far as security is concerned, preference should be given to simplicity. To quote Albert Einstein, “Everything should be as simple as possible, but no simpler.”

1.4.3.7 Active Diligence

Proactive security requires five (5) major disciplines to be followed:

- Risk Management
- Compliance Management
- Threat Analysis
- Incident Response
- Security Awareness and Training

These disciplines are essential to the deliverance of adequate security.

1.5 Importance of Compliance

1.5.1 Maintaining Public Trust

The public entrusts vast amounts of information to PPW Holding, Inc. every day - information that PPW Holding, Inc. is required by law and good business practice to protect. Compliance with corporate security policies will help protect information resources and enhance the reputation of PPW Holding, Inc. as deserving of public trust.

1.5.2 Continuing Business Operations

PPW Holding, Inc. is committed to delivering superior customer service in an increasingly competitive marketplace through the effective use of technology, information, and automation. Compliance with corporate security policies will help ensure the continuous availability and integrity of the technological infrastructure that is critical to PPW Holding, Inc.’s ability to perform its mission.

1.5.3 Protecting PPW Holding, Inc. Investment

PPW Holding, Inc. information resources represent a sizable financial investment in technologies, facilities and in information that can never be replicated. These information rand physical resources are of paramount importance to the mission of PPW Holding, Inc. and must be protected.

1.5.4 Abiding by Federal Regulations

PPW Holding, Inc. corporate security policies are designed to respond to the intent and spirit of government regulations and directives.

1.5.4.1 Critical Infrastructure Protection Standard

The critical infrastructure protection standards (CIPS) were developed by the North American Energy Company (NERC) and have the full authority from the Federal Energy Reliability Commission (FERC) to be followed as any other reliability standard. These standards can be found at this Internet address: http://www.nerc.com/page.php?cid=2|20

The corporate security policy provides significant direction to assure compliance to this important law. However, the corporate security policies are not the only document that supports the policies, procedures and practices required to meet compliance requirements. The corporate security policies do address the standards at various levels; however, some requirements that are necessary to follow are maintained outside this document. In order to assure completeness, exhibit 1.5.4.1 provides a matrix of those separate supporting documents and the elements within the corporate security policy that address the policies, standards and guidelines that must be followed to meet PPW Holding, Inc. CIPS compliance obligations.

The governance for CIPS will follow the frameworks described in the ***The Standards Compliance Resource Manual*** maintained by the compliance office.

1.5.4.2 Corporate Security Policy Exception Process

In the event that any information or physical resource can not comply with a security policy, standard or other documentation of authority which has been deemed an official declaration of security expectations (including, but not limited to, the corporate security policy handbook, the boundary control standard and the CIPS reference architecture) then a formal exception request must be processed.

The ***corporate security policy – exception/alternative authorization*** form and process (Appendix A) must be utilized. The president of Pacific Power or delgate (s) must authorize the exception/alternative by signature on this form. All exceptions/alternatives must be documented within thirty (30) days of being approved.

	Title	Supporting Documentation	
CIP-002-1	Cyber Security – Critical Cyber Asset Identification	Corporate Security Policy Handbook	Other Documentation
R1	Critical Asset Identification Method	-	-
R1.1	The Responsible Entity shall maintain documentation describing its risk-based assessment methodology that includes procedures and evaluation criteria.	4.7.1	Control Center Critical Asset Identification Methodology.doc Generation Critical Asset Identification Methodology.doc Transmission Substation Critical Asset Identification Methodology.doc]
R1.2	The risk-based assessment shall consider the following assets:	4.7.1	-
R2	Critical Asset Identification	4.7.2	
R3	Critical Cyber Asset Identification	4.7.3	Corporate Critical Cyber Asset Identification Methodology.doc
R3.1	The Cyber Asset uses a routable protocol to communicate outside the Electronic Security Perimeter	4.7.3	-
R3.2	The Cyber Asset uses a routable protocol within a control center	4.7.3	-
R3.3	The Cyber Asset is dial-up accessible.	4.7.3	-
R4	Annual Approval	4.7.4	-
CIP-003-1	Cyber Security – Security Management Controls	Corporate Security Policy Handbook	Other Documentation
R1	Cyber Security Policy	-	-
R1.1	The cyber security policy addresses the requirements in Standards CIP-002 through CIP-009, including provision for emergency situations.	1.5.4.1	-
R1.2	The cyber security policy is readily available to all personnel who have access to, or are responsible for, Critical Cyber Assets.	1.1	-
R1.3	Annual review and approval of the cyber security policy by the senior manager assigned pursuant to R2.	1.1	-
R2	Leadership	2.1.1.1	2009 Leadership Assignments.PDF

R2.1	The senior manager shall be identified by name, title, business phone, business address, and date of designation.		-	
R2.2	Changes to the senior manager must be documented within thirty calendar days of the effective date.		-	
R2.3	The senior manager or delegate(s), shall authorize and document any exception from the requirements of the cyber security policy		1.5.4.2 Appendix A	2009 Leadership Assignments.PDF
R3	Exceptions		1.5.4.2 Appendix A	Security Policy Exception-Aurhorization_Form.doc
R3.1	Exceptions to the Responsible Entity's cyber security policy must be documented within thirty days of being approved by the senior manager or delegate(s).		1.5.4.2 Appendix A	-
R3.2	Documented exceptions to the cyber security policy must include an explanation as to why the exception is necessary and any compensating measures, or a statement		Appendix A	-
R3.3	Authorized exceptions to the cyber security policy must be reviewed and approved annually by the senior manager or delegate(s) to ensure the exceptions are still required and valid. Such review and approval shall be documented.		Appendix A	-
R4	Information Protection		3.4.1.2.3	CII Protection Procedures.pdf
R4.1	The Critical Cyber Asset information to be protected shall include, at a minimum and regardless of media type, operational procedures, lists as required in Standard CIP-002, network topology or similar diagrams, floor plans of computing centers that contain Critical Cyber Assets, equipment layouts of Critical Cyber Assets, disaster recovery plans, incident response plans, and security configuration information.		3.4.1.2.3	
R4.2	The Responsible Entity shall classify information to be protected under this program based on the sensitivity of the		3.4.1.2.3	

	Critical Cyber Asset information.			
R4.3	The Responsible Entity shall, at least annually, assess adherence to its Critical Cyber Asset information protection program, document the assessment results, and implement an action plan to remediate deficiencies identified during the assessment.		3.4.1.2.3	-
R5	Access Control		9.4.6	CII Protection Procedures.pdf
R5.1	The Responsible Entity shall maintain a list of designated personnel who are responsible for authorizing logical or physical access to protected information.		9..4.6	-
R5.2	The Responsible Entity shall review at least annually the access privileges to protected information to confirm that access privileges are correct and that they correspond with the Responsible Entity's needs and appropriate personnel roles and responsibilities.		9.4.6.1	-
R5.3	The Responsible Entity shall assess and document at least annually the processes for controlling access privileges to protected information.		9.4.6.2	-
R6	Change Control and Configuration Management – The Responsible Entity shall establish and document a process of change control and configuration management for adding, modifying, replacing, or removing Critical Cyber Asset hardware and software, and implement supporting configuration management activities to identify, control, and document all entity or vendor-related changes to hardware and software components of Critical Cyber Assets pursuant to he change control process.		8.2.4 8.2.16.3 8.2.16.4 8.2.16.7 10.3	-
CIP-004-1	Cyber Security – Personnel and Training		Corporate Security Policy Handbook	Other Documentation
R1	Awareness		6.5.1	2009 PacifiCorp Security Awareness Program.PDF

R2	Training		6.5.3	2009 PacifiCorp Security Training Program.PDF
R2.1	This program will ensure that all personnel having such access to Critical Cyber Assets, including contractors and service vendors, are trained within ninety calendar days of such authorization.		6.5.3	-
R2.2	Training shall cover the policies, access controls, and procedures as developed for the Critical Cyber Assets covered in CIP-004.		6.5.3	-
R2.3	The Responsible Entity shall maintain documentation that training is conducted at least annually, including the date the training was completed and attendance records.		6.5.3	-
R3	Personnel Risk Assessment		4.6	PacifiCorp Personnel Risk Assessment Program.pdf
R3.1	The responsible entity shall insure that each assessment conducted include, at least, identity verification (e.g. SSN verification in the U.S.) and seven-year criminal check.		-	
R3.2	The responsible entity shall update each personnel risk assessment at least every seven years after the initial personnel risk assessment or for cause.		-	
R3.3	The responsible entity shall document the results of personnel risk assessments of its personnel having authorized cyber or authorized unescorted physical access to Critical Cyber Assets, and that personnel risk assessments of contractor and service vendor personnel with such access are conducted pursuant to Standard CIP-004		-	
R4	Access		9.4.3	PacifiCorp Logical Access Program.doc PacifiCorp Physical Access Program.doc Access Management Policy-DS5-1.doc
R4.1	The responsible entity shall review and properly maintain the list(s) of its personnel who have such access to Critical Cyber Assets quarterly, and update the list(s) within seven calendar days of any change of personnel with such access to Critical Cyber		9.4.4	-

	Assets, or any change in the access rights of such personnel.			
R4.2	The responsible entity shall revoke such access to Critical Cyber Assets within 24 hours of personnel terminated for cause and within seven calendar days of personnel who no longer require such access to Critical Cyber Assets.		9.4.5	-
CIP-005-1	Cyber Security – Personnel and Training		Corporate Security Policy Handbook	Other Documentation
R1	Electronic Security Perimeter		11.3.5.1	-
R1.1	Access points to the Electronic Security Perimeter(s) shall include any externally connected communication end point (for example, dial-up modems) terminating at any device within the Electronic Security Perimeter(s).		11.3.5.1.1	-
R1.2	For a dial-up accessible Critical Cyber Asset that uses a non-routable protocol, the Responsible Entity shall define an Electronic Security Perimeter for that single access point at the dial-up device.		11.3.5.1.2	-
R1.3	Communication links connecting discrete Electronic Security Perimeters shall not be considered part of the Electronic Security Perimeter. However, end points of these communication links within the Electronic Security Perimeter(s) shall be considered access points to the Electronic Security Perimeter(s).		11.3.5.1.3	-
R1.4	Any non-critical Cyber Asset within a defined Electronic Security Perimeter shall be identified and protected pursuant to the requirements of Standard CIP-005.		11.3.5.1.4	-
R1.5	Cyber Assets used in the access control and monitoring of the Electronic Security Perimeter(s) shall be afforded the protective measures as a specified in Standard CIP-003, Standard CIP-004 Requirement R3, Standard CIP-005 Requirements R2 and R3, Standard CIP-006 Requirements R2 and R3, Standard CIP-007, Requirements R1 and R3 through R9, Standard CIP-008, and Standard CIP-009.		11.3.5.1.5	-

R1.6	The Responsible Entity shall maintain documentation of Electronic Security Perimeter(s), all interconnected Critical and non-critical Cyber Assets within the Electronic Security Perimeter(s), all electronic access points to the Electronic Security Perimeter(s) and the Cyber Assets deployed for the access control and monitoring of these access points.		11.3.5.1.6	-
R2	Electronic Access Controls		11.3.5.2	PacifiCorp Network Boundray Standard.pdf -
R2.1	These processes and mechanisms shall use an access control model that denies access by default, such that explicit access permissions must be specified.		11.3.5.2.1	-
R2.2	At all access points to the Electronic Security Perimeter(s), the Responsible Entity shall enable only ports and services required for operations and for monitoring Cyber Assets within the Electronic Security Perimeter, and shall document, individually or by specified grouping, the configuration of those ports and services.		11.3.5.2.2	-
R2.3	The Responsible Entity shall maintain a procedure for securing dial-up access to the Electronic Security Perimeter(s).		11.3.5.2.3	-
R2.4	Where external interactive access into the Electronic Security Perimeter has been enabled, the Responsible Entity shall implement strong procedural or technical controls at the access points to ensure authenticity of the accessing party, where technically feasible.		11.3.5.2.4	-
R2.5	The processes for access request and authorization. **R2.5.2.** The authentication methods. **R2.5.3.** The review process for authorization rights, in accordance with Standard CIP-004 Requirement R4. **R2.5.4.** The controls used to secure dial-up accessible connections.		11.3.5.2.5	Access Program Overview.doc Access Management Policy-DSS-f.doc Firewall and SSL-VPN Change Request Form
R2.6	Appropriate Use Banner — Where technically feasible, electronic access		11.3.5.2.6	

	control devices shall display an appropriate use banner on the user screen upon all interactive access attempts. The Responsible Entity shall maintain a document identifying the content of the banner.		14.4.4	
R3	Monitoring Electronic Access		11.3.5.3	-
R3.1	For dial-up accessible Critical Cyber Assets that use non-routable protocols, the Responsible Entity shall implement and document monitoring process(es) at each access point to the dial-up device, where technically feasible.		11.3.5.3.1	-
R3.2	Where technically feasible, the security monitoring process(es) shall detect and alert for attempts at or actual unauthorized accesses. These alerts shall provide for appropriate notification to designated response personnel. Where alerting is not technically feasible, the Responsible Entity shall review or otherwise assess access logs for attempts at or actual unauthorized accesses at least every ninety calendar days.		11.3.5.3.2	-
R4	Cyber Vulnerability Assessment		11.3.5.4	-
R4.1	A document identifying the vulnerability assessment process;		11.3.5.4	-
R4.2	A review to verify that only ports and services required for operations at these access points are enabled;		11.3.5.4	-
R4.3	The discovery of all access points to the Electronic Security Perimeter		11.3.5.4	-
R4.4	A review of controls for default accounts, passwords, and network management community strings		11.3.5.4	-
R4.5	Documentation of the results of the assessment, the action plan to remediate or mitigate vulnerabilities identified in the assessment, and the execution status of that action plan.		11.3.5.4	-
R5	Documentation Review and Maintenance		11.3.5.5	-

R5.1	The Responsible Entity shall ensure that all documentation required by Standard CIP-005 reflect current configurations and processes and shall review the documents and procedures referenced in Standard CIP-005 at least annually.		11.3.5.5	-
R5.2	The Responsible Entity shall update the documentation to reflect the modification of the network or controls within ninety calendar days of the change.		11.3.5.5	-
R5.3	The Responsible Entity shall retain electronic access logs for at least ninety calendar days. Logs related to reportable incidents shall be kept in accordance with the requirements of Standard CIP-008.		11.3.5.5	-
CIP-006-1	Cyber Security – Physical Security		Corporate Security Policy Handbook	Other Documentation
R1	Physical Security Plan		7.7.1	-
R1.1	Processes to ensure and document that all Cyber Assets within an Electronic Security Perimeter also reside within an identified Physical Security Perimeter. Where a completely enclosed ("six-wall") border cannot be established, the Responsible Entity shall deploy and document alternative measures to control physical access to the Critical Cyber Assets.		7.7.1	-
R1.2	Processes to identify all access points through each Physical Security Perimeter and measures to control entry at those access points.		7.7.1	-
R1.3	Processes, tools, and procedures to monitor physical access to the perimeter(s).		7.7.1	-
R1.4	Procedures for the appropriate use of physical access controls as described in Requirement R3 including visitor pass management, response to loss, and prohibition of inappropriate use of physical access controls.		7.7.1	-
R1.5	Procedures for reviewing access authorization requests and revocation of access authorization, in accordance with		7.7.1	-

	CIP-004 Requirement R4.			
R1.6	Procedures for escorted access within the physical security perimeter of personnel not authorized for unescorted access.		7.7.1	-
R1.7	Process for updating the physical security plan within ninety calendar days of any physical security system redesign or reconfiguration, including, but not limited to, addition or removal of access points through the physical security perimeter, physical access controls, monitoring controls, or logging controls.		7.7.1	-
R1.8	Cyber Assets used in the access control and monitoring of the Physical Security Perimeter(s) shall be afforded the protective measures specified in Standard CIP-003, Standard CIP-004 Requirement R3, Standard CIP-005 Requirements R2 and R3, Standard CIP-006 Requirement R2 and R3, Standard CIP-007, Standard CIP-008 and Standard CIP-009.		7.7.1	-
R1.9	Process for ensuring that the physical security plan is reviewed at least annually. **R2.** Physical Access Controls **—** The Responsible Entity shall document and implement the operational and procedural controls to manage physical access at all access points to the Physical Security Perimeter(s) twenty-four hours a day, seven days a week. The Responsible Entity shall implement one or more of the following physical access methods		7.7.1	-
R2	Physical Access Controls		7.7.2	-
R2.1	Card Key: A means of electronic access where the access rights of the card holder are predefined in a computer database. Access rights may differ from one perimeter to another		7.7.2	-
R2.2	Special Locks: These include, but are not limited to, locks with “restricted key” systems, magnetic locks that can be operated remotely, and “man-trap” systems.		7.7.2	-
R2.3	Security Personnel: Personnel responsible for controlling physical access who may reside on-site or at a monitoring station.		7.7.2	-

R2.4	Other Authentication Devices: Biometric, keypad, token, or other equivalent devices that control physical access to the Critical Cyber Assets.		7.7.2	-
R3	Monitoring Physical Access		7.7.2	-
R3.1	Alarm Systems: Systems that alarm to indicate a door, gate or window has been opened without authorization. These alarms must provide for immediate notification to personnel responsible for response.		7.7.2	-
R3.2	Human Observation of Access Points: Monitoring of physical access points by authorized personnel as specified in Requirement R2.3.		7.7.2	-
R4	Logging Physical Access		7.7.2	-
R4.1	Computerized Logging: Electronic logs produced by the Responsible Entity's selected access control and monitoring method.		7.7.2	-
R4.2	Video Recording: Electronic capture of video images of sufficient quality to determine identity.		7.7.2	-
R4.3	Manual Logging: A log book or sign-in sheet, or other record of physical access maintained by security or other personnel authorized to control and monitor physical access as specified in Requirement R2.3.		7.7.2	-
R5	Access Log Retention		7.7.2	-
R6	Maintenance and Testing		7.7.2	-
R6.1	Testing and maintenance of all physical security mechanisms on a cycle no longer than three years.		7.7.2	-
R6.2	Retention of testing and maintenance records for the cycle determined by the Responsible Entity in Requirement R6.1.		7.7.2	-
R6.3	Retention of outage records regarding access controls, logging, and monitoring for		7.7.2	-

	a minimum of one calendar year.			
CIP-007-1	Cyber Security – Systems Security Management		Corporate Security Policy Handbook	Other Documentation
R1	Test Procedures		8.2.6.5	
R1.1	The Responsible Entity shall create, implement, and maintain cyber security test procedures in a manner that minimizes adverse effects on the production system or its operation.		8.2.6.5	-
R1.2	The Responsible Entity shall document that testing is performed in a manner that reflects the production environment.		8.2.6.5	-
R1.3	The Responsible Entity shall document test results.		8.2.6.5	-
R2	Ports and Services		10.5.5	-
R2.1	The Responsible Entity shall enable only those ports and services required for normal and emergency operations.		10.5.5	-
R2.2	The Responsible Entity shall disable other ports and services, including those used for testing purposes, prior to production use of all Cyber Assets inside the Electronic Security Perimeter(s).		10.5.5	-
R2.3	In the case where unused ports and services cannot be disabled due to technical limitations, the Responsible Entity shall document compensating measure(s) applied to mitigate risk exposure or an acceptance of risk.		1.5.4.2 Appendix A	-
R3	Security Patch Management		10.3.5	-
R3.1	The Responsible Entity shall document the assessment of security patches and security upgrades for applicability within thirty calendar days of availability of the patches or upgrades.		10.3.5	-
R3.2	The Responsible Entity shall document the implementation of security patches. In any		10.3.5	-

	case where the patch is not installed, the Responsible Entity shall document compensating measure(s) applied to mitigate risk exposure or an acceptance of risk.			
R4	Malicious Software Prevention		10.7	-
R4.1	The Responsible Entity shall document and implement anti-virus and malware prevention tools. In the case where anti-virus software and malware prevention tools are not installed, the Responsible Entity shall document compensating measure(s) applied to mitigate risk exposure or an acceptance of risk.		10.7	-
R4.2	The Responsible Entity shall document and implement a process for the update of anti-virus and malware prevention "signatures." The process must address testing and installing the signatures.		10.7	-
R5	Account Management		9.4.8	-
R5.1	The Responsible Entity shall ensure that individual and shared system accounts and authorized access permissions are consistent with the concept of "need to know" with respect to work functions performed.		9.4.8 9.11.2 9.4.4	-
R5.2	The Responsible Entity shall implement a policy to minimize and manage the scope and acceptable use of administrator, shared, and other generic account privileges including factory default accounts.		9.4.7	-
R5.3	At a minimum, the Responsible Entity shall require and use passwords, subject to the following, as technically feasible:		9.6.1.1	-
R6	Security Status Monitoring		9.11	Security Logging Standard
R6.1	The Responsible Entity shall implement and document the organizational processes and technical and procedural mechanisms for monitoring for security events on all Cyber Assets within the Electronic Security Perimeter.		9.11	Security Logging Standard

R6.2	The security monitoring controls shall issue automated or manual alerts for detected Cyber Security Incidents.		9.11	Security Logging Standard
R6.3	The Responsible Entity shall maintain logs of system events related to cyber security, where technically feasible, to support incident response as required in Standard CIP-008.		9.11	Security Logging Standard
R6.4	The Responsible Entity shall retain all logs specified in Requirement R6 for ninety calendar days.		9.11	Security Logging Standard
R6.5	The Responsible Entity shall review logs of system events related to cyber security and maintain records documenting review of logs.		9.11	Security Logging Standard
R7	Disposal or Redeployment		3.4.6	
R7.1	Prior to the disposal of such assets, the Responsible Entity shall destroy or erase the data storage media to prevent unauthorized retrieval of sensitive cyber security or reliability data.		3.4.6	-
R7.2	Prior to redeployment of such assets, the Responsible Entity shall, at a minimum, erase the data storage media to prevent unauthorized retrieval of sensitive cyber security or reliability data.		3.4.6	-
R7.3	The Responsible Entity shall maintain records that such assets were disposed of or redeployed in accordance with documented procedures.		3.4.6	-
R8	Cyber Vulnerability Assessment		11.3.5.4	-
R8.1	A document identifying the vulnerability assessment process;		11.3.5.4	-
R8.2	A review to verify that only ports and services required for operation of the Cyber Assets within the Electronic Security Perimeter are enabled;		11.3.5.4	-
R8.3	A review of controls for default accounts		11.3.5.4	-
R8.4	Documentation of the results of the assessment, the action plan to remediate or		11.3.5.4	-

	mitigate vulnerabilities identified in the assessment, and the execution status of that action plan			
R9	Documentation Review and Maintenance		11.3.5.5	-
CIP-008-1	Cyber Security – Incident Reporting and Response Planning		Corporate Security Policy Handbook	Other Documentation
R1	Cyber Security Incident Response Plan		13.2.1	Cyber Security Incident Response Plan (CSIRT)
R1.1	Procedures to characterize and classify events as reportable Cyber Security Incidents.		13.2.1	Cyber Security Incident Response Plan (CSIRT)
R1.2	Response actions, including roles and responsibilities of incident response teams, incident handling procedures, and communication plans.		13.2.1	Cyber Security Incident Response Plan (CSIRT)
R1.3	Process for reporting Cyber Security Incidents to the Electricity Sector Information Sharing and Analysis Center (ES ISAC). The Responsible Entity must ensure that all reportable Cyber Security Incidents are reported to the ES ISAC either directly or through an intermediary.		13.2.1	Cyber Security Incident Response Plan (CSIRT)
R1.4	Process for updating the Cyber Security Incident response plan within ninety calendar days of any changes		13.2.1	Cyber Security Incident Response Plan (CSIRT)
R1.5	Process for ensuring that the Cyber Security Incident response plan is reviewed at least annually.		13.2.1	Cyber Security Incident Response Plan (CSIRT)
R1.6	Process for ensuring the Cyber Security Incident response plan is tested at least annually. A test of the incident response plan can range from a paper drill, to a full operational exercise, to the response to an actual incident.		13.2.1	Cyber Security Incident Response Plan (CSIRT)
R2	Cyber security Incident Documentation		13.2.2	Cyber Security Incident Response Plan (CSIRT)
CIP-009-1	Cyber Security – Recovery Plans for Critical Cyber Assets		Corporate Security	Other Documentation

			Policy Handbook	
R1	Recovery Plans		12.2	Plans contained within the Living Disaster Recovery Planning System (LDRPS)
R1.1	Specify the required actions in response to events or conditions of varying duration and severity that would activate the recovery plan(s).		-	Plans contained within the Living Disaster Recovery Planning System (LDRPS)
R1.2	Define the roles and responsibilities of responders.		-	Plans contained within the Living Disaster Recovery Planning System (LDRPS)
R2	Exercises		-	Exercise results contained within the Living Disaster Recovery Planning System (LDRPS)
R3	Change Control		-	Plans contained within the Living Disaster Recovery Planning System (LDRPS)
R4	Backup and Restore		-	Plans contained within the Living Disaster Recovery Planning System (LDRPS)
R5	Testing Backup Media		-	Plans contained within the Living Disaster Recovery Planning System (LDRPS)

1.6 Reporting of a Security Incident

1.6.1 Security Incident

A security incident is defined as an event such as a breach, weakness or malfunction that has, or could have, resulted in the loss of, or damage to PPW Holding, Inc. personnel, information or physical assets. These include, but are not limited to, any of the following:

- Accidental or deliberate unauthorized destruction of information
- Accidental or deliberate unauthorized modification of information
- Accidental or deliberate unauthorized disclosure of PacifiCorp information systems
- Deliberately causing unavailability of PPW Holding, Inc. information systems
- Unauthorized access to PPW Holding, Inc. data, information, facilities or other assets.
- Misuse of PPW Holding, Inc. data, information, facilities or other assets.
- Theft of PPW Holding, Inc. data, information, facilities or other assets.
- Any other event which affects the security of PPW Holding, Inc.

1.6.2 Reporting of a Security Incident

To report an incident in accordance with this policy, always contact the enterprise help desk first. That should be preceded by contacting your immediate supervisor and:

By telephone or in person;

Physical Security events – Director of Corporate Physical Security Office, Gary Berndt (503-813-6338)

Cyber Security events – Director of Corporate Information Security Office, Michael Ball (503) 813-6327

All systems that are considered in-scope for the critical infrastructure protection standard (CIPS) must follow the reporting processes established in the sabotage reporting (CIP-001) documentation. The aforementioned personnel are responsible for contacting the correct resource(s) to facilitate the necessary reporting to ES-ISAC.

1.7 Information Security Program

The designated senior manager has delegated the authority for the information security program to the chief information office/managing director of application support and corporate security, who, in turn, has delegated this authority to the manager, Corporate Information Security Office (CISO). The CISO directs the PPW Holding, Inc. information security program; which consists of the subprograms listed below:

- Information Security Policies, Procedures, and Standards
- Security Risk Management
- Information Security Awareness
- Information Security Technology Assessment
- Security Architecture
- Information Security incident Management

1.8 Physical Security Program

The designated senior manager has delegated the authority for the physical security program to the director of Construction and Support Services, who, in turn, has delegated this authority to the , director, Corporate Physical Security Office (CPSO). The CPSO directs the PPW Holding, Inc. physical security program; which consists of the subprograms listed below:

- Physical Security Policies, Procedures, and Standards
- Security Risk Management
- Physical Security Awareness
- Facilities Security Assessment
- Physical Security System Design
- Physical Security incident Management
- Compliance Program
- Law Enforcement Liaison

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2 Roles and Responsibilities

2.1 Policy

Security is the individual and collective responsibility of all PPW Holding, Inc. personnel, business partners, and other authorized users. Security-related roles and responsibilities must be identified and separation of duties and responsibilities considered when defining roles. Access to information resources will be based on the individual's roles and responsibilities. Only authorized personnel will be approved for access to PPW Holding, Inc. information resources.

2.1.1 Roles and Responsibilities Summary

2.1.1.1 President, Pacific Power (designated Senior Manger)

The president of Pacific Power is the PPW Holding, Inc. representative responsible for security compliance and has delegated authority for the information security program to the chief information office/Managing Director, Application Support and Corporate Security. Delegated authority for the corporate physical security program has been given to the Director of Pacific Power Construction and Support Services. The president of Pacific Power is also responsible for approving the corporate security policy on an annual basis. The president of Pacific Power assumes the role "the senior manager" for the Critical Infrastructure Protection Standard. This designation is formally documented outside of this policy handbook.

2.1.1.2 Chief Information Office/Managing Director, Application Support and Corporate Security

The chief information office/managing director, application support and corporate security, is responsible for ensuring the secure implementation of the information technology infrastructure and has delegated authority for development, implementation, and management of the PPW Holding, Inc. information security program to the manager, Corporate Information Security Office (CISO). The chief information office/managing director, application support and corporate security are also responsible for information assurance.

2.1.1.3 Director of Pacific Power Construction and Support Services

The director of Construction and Support Services is responsible for ensuring prudent physical security measures and procedures are implemented to ensure the appropriate level of protection for company personnel, facilities and resources; owned leased and operated by PPW Holding, Inc. The director of Construction and Support Services responsible for establishing the overall strategic direction of the physical security program The director of Construction and Support Services is also responsible to ensure physical security measures support the reliability of the services provided to PPW Holding, Inc. customers and stakeholders.

2.1.1.4 Manager, Corporate Information Security Office (CISO)

The director, CISO, is responsible for setting the overall strategic and operational direction of the information security program and its implementation strategies, including the development of information security policies and processes. The manager, CISO, serves as the central point of contact for all information security issues; provides overall consultation and advice on information security policies, processes, requirements, controls, services, security awareness training, and issues; and assesses and ensures compliance with information security policies through inspections, reviews, and evaluations. The director, CISO, is responsible for reviewing the corporate security policy on an annual basis and submitting it to the compliance office for approval by the president of Pacific Power (in conjunction with the director, CPSO).

The director, CISO, is also responsible for developing privacy policy and compliance standards, helping to determine information sensitivity and providing guidance related to privacy policy.

2.1.1.5 Director, Physical Security Office (CPSO)

The director, CPSO, is responsible for formulating the overall strategic and operational direction of the physical security program and its implementation strategies, including the development of security policies and processes. The director, CPSO, serves as the central point of contact for all physical security issues; provides overall consultation and advice on physical security policies, processes, requirements, controls, services, security awareness training, and issues; and assesses and ensures compliance with physical security policies through inspections, reviews, and evaluations. The director, CPSO, is responsible for reviewing the corporate security policy on an annual basis and submitting it to the compliance office for approval by the president of Pacific Power (in conjunction with the manager, CISO).

The director, CPSO, is also responsible for developing relationships with local, state and federal law enforcement agencies where PPW Holding, Inc operates. In addition, the director, CPSO will track the impact of security incidents that target company personnel and facilities and makes recommendations on enhanced security measures.

2.1.1.6 Director, Internal Audit

The Director of Internal Audit is responsible for investigating, evaluating, and auditing programs and operations of PPW Holding, Inc. to ensure the efficiency and integrity of PPW Holding Inc. systems and to ensure that its assets and resources are fully protected.

2.1.1.7 Director, Quality Assurance and Business Continuity

The Director of the BCMO is responsible for setting the overall strategic and operational direction of the business continuity program, its implementation strategies including related policies and processes. The Director, BCMO serves as the central point of contact for all business continuity issues; provides overall consultation and advice on business continuity policies, processes, requirements, controls and services.

2.1.1.8 Technology Managers

All technology managers are responsible for securing the PPW Holding, Inc. computing environment, which includes information resources and infrastructure, by implementing appropriate technical and operational security processes and practices that comply with PPW Holding, Inc. corporate security policies.

2.1.1.9 All Officers and Managers

All officers, business and line managers, and supervisors, regardless of functional area, are responsible for implementing corporate security policies. All officers and managers ensure compliance with corporate security policies by organizations and information resources under their direction and provide the personnel, financial, and physical resources required to appropriately protect information resources.

2.1.1.10 All Personnel

All PPW Holding, Inc. personnel, including employees, consultants, subcontractors, business partners, and customers who access nonpublic available PPW Holding, Inc. information resources (such as mainframes or the internal PPW Holding, Inc. network) and other authorized users of PPW Holding, Inc. information resources and facilities are responsible for complying with all PPW Holding Inc. corporate security policies.

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3 Information Designation and Control

3.1 Policy

Information resources are strategic assets vital to the business performance of PPW Holding, Inc. These strategic assets must be protected commensurate with their tangible value, legal and regulatory requirements, and their critical role in PPW Holding , Inc's ability to conduct its mission.   These information resources belong to PPW Holding, Inc. as an organization and not to any individual or group of individuals. PPW Holding, Inc. information resources must comply with PPW Holding, Inc. policies and procedures on data stewardship.

3.2 Information Designation

3.2.1 Information Designation Categories and Levels

PPW Holding, Inc. uses two information designation categories; each category has three levels. The sensitivity and criticality level designations are determined during the business impact analysis, as projects are implemented, and/or as information is created.

Designation categories are as follows:

- Sensitivity
- Criticality

3.2.1.1 Sensitivity Category/Levels

Sensitivity determines the need to protect the confidentiality of the information. The levels of sensitivity, in decreasing order of necessity to protect the confidentiality of the information, are as follows:

- Business controlled seisntivity.
- Sencitive
- Nonsensitive

3.2.1.2 Criticality Category/Levels

Criticality reflects the need for continuous availability of the information. The levels of criticality, in decreasing order of necessity to protect the continued availability of the information, are as follows:

- Business-controlled criticality
- Noncritical

3.2.2 Sensitivity and Criticality Category Independence

Sensitivity and criticality are independent designations. All PPW Holding, Inc. information must be evaluated to determine both sensitivity and criticality. Information with *any* criticality level may have *any* level of sensitivity designation and vice versa.

3.2.3 Determination of Sensitivity and Criticality

It is the responsibility of the data owner to assure that the data has been properly categorized. Data owners can be formerly identified through process controls such as Sarbanes-Oxley compliance efforts or, by default, the data owner will be the department head where such data is created, utilized and managed.

3.3 Security Requirements

3.3.1 Security Requirements and Controls

A security requirement is a mandatory control used to secure an information or physical resource. A control may satisfy more than one requirement, or several controls may be needed to satisfy a security requirement depending on the sensitivity and criticality of the information resource and its operating environment. If a requirement cannot be addressed, compensating controls can be implemented to mitigate the risk.

Security requirements will be delivered through projects, security audits, security assessments and whenever there is a need for security controls. Security requirements can also be imbedded in security standards. Only the CISO and the CPSO can deliver formal security requirements to the business for the business.

3.3.2 Security Requirement Categories

PPW Holding, Inc. uses the following three categories of security requirements to protect information resources according to their sensitivity and criticality:

- Baseline.
- Mandatory.

- Discretionary.

3.3.3 Baseline Security Requirements

All information or physical resources must implement controls sufficient to satisfy the baseline security requirements. Baseline security requirements are established to protect the PPW Holding, Inc. computing environment and infrastructure from intentional or unintentional unauthorized use, modification, disclosure, or destruction. Baseline security requirements are also established to protect PPW Holding, Inc. physical assets and personnel from unauthorized access, theft, fraud, personnel safety and terrorism.

3.3.4 Mandatory Security Requirements

Additional security controls must be implemented to satisfy the mandatory security requirements to protect sensitive, critical and business-controlled information resources. For both information security and physical security, mandatory requirements are generally for compliance purposes – legal, company policy or regulation.

3.3.5 Discretionary Security Requirements

Additional security controls must be implemented to satisfy the discretionary security requirements to protect sensitive, critical, and business-controlled information resources. Discretionary security requirements are recommended during business impact assessments, project designs, in audit findings and when a specific risk is identified. These requirements are based on the risk, sensitivity and criticality of the resource to be protected. The executive sponsor assumes the risk of not implementing the recommended security requirements.

3.4 Handling Information and Media

All PPW Holding, Inc. information, whether in electronic or nonelectronic format, must be properly handled and controlled based on the information sensitivity and criticality categorization.

Labeling, retention, storage, encryption, release, and destruction of information must comply with established PPW Holding, Inc. policies and procedures.

3.4.1 Labeling of Information and Media

PPW Holding, Inc. information must be labeled based on the sensitivity of information. The information owner determines the sensitivity of the information. These labels are used to determine the commensurate security requirements for handling, storing, transmitting or destroying information in both print and electronic form. Information should be clearly marked or labeled so that people know how to apply the appropriate security protection. The CISO and compliance office are the final authority for questions of sensitivity and reserve the right to review and change inappropriate sensitivity levels.

PPW Holding, Inc. uses the following information labels:

- Confidential
- Restricted
- Internal
- External
- Critical Infrastructure Information (CII)

Specific information sensitive designations categories dictate how a document will be labeled [see 3.4.1.1, 3.4.1.2].

3.4.1.1 Labeling of Sensitive Categories

3.4.1.1.1 Business-Controlled Sensitive Information (Confidential)

Business-Controlled Sensitive information will always be labeled **Confidential.** This refers to information whose unauthorized disclosure, even within the organization, would cause damage to the interests of the organization. It would normally inflict harm by virtue of financial loss, loss of profitability or opportunity, embarrassment or reputation impugnment.

This information might include: High-level business plans and potential options, business and competition strategy, legal documents, very sensitive competitor/partner/contractor assessments, details of major acquisitions, divestments and mergers, and patent secrecy information.

3.4.1.1.2 Sensitive Information (Restricted)

Sensitive data will always be labeled **Restricted**. This refers to information whose unauthorized disclosure, even within the organization, could cause harm through embarrassment or loss of reputation, financial loss, loss of profitability or opportunity.

This information might include: Personnel information, customer information, or material classified as **Confidential or Restricted** by U.S. authorities.

3.4.1.2 Other labels

3.4.1.2.1 Internal Label

This is the default label for all information and covers the majority of information handled by PPW Holding, Inc. This label allows for “Internal use only” unless permission has been obtained from the data owner and legal council.

3.4.1.2.2 External Label

PPW Holding, inc. information which is appropriate for, and has been explicitly approved for external release by an authorized person.

3.4.1.2.3 Critical Infrastructure Information (CII) Label

All documentation that meets the criteria listed below must be labeled as CII. This documentation must be protected as defined in the Critical infrastructure Information (CII) Protection Procedure.

CII is defined as information concerning proposed or existing critical infrastructure (physical or virtual) that:

- Relates to the production, generation, transmission or distribution of energy;
- Could be useful to a person planning an attack on critical infrastructure;
- Is exempt from mandatory disclosure under the Freedom of Information Act;
- Gives strategic information beyond the location of the critical infrastructure.
- Examples of CII are procedures, critical asset inventories, on-line drawings, maps, floor plans, equipment layouts and configurations.

3.4.1.3 Qualifying Descriptors

Information labels may also include a qualifying descriptor. Such descriptors do not alter the information labeling requirements in any way; they simply clarify the type of information and/or the intended audience.

For example of labels/qualifying descriptors might include:

- ADDRESSEE ONLY
- "PERSONAL" or ADDRESSEE ONLY" to indicate that it should not be read by anyone else – this does not increase its sensitivity.
- RESTRICTED – HR USE ONLY
- RESTRICTED – GENERATION BUSINESS ONLY

Note: "RESTRICTED – GENERATION BUSINESS ONLY" and RESTIRCTED" have exactly the same level of information sensitivity – the restriction, in the case of the former, being who the information owner has decided should have access to the information.

- RESTRICTED – AEGIS PROJECT
- CONFIDENTIAL – COMPANY EXECUTIVE ONLY
- CONFIDENTIAL – LEGALL PRIVILEGED
- "LEGALLY PRIVILEGED" information must always by labeled CONFIDENTAL.

3.4.2 Retention of Information

All PPW Holding, Inc. information, whether in electronic or nonelectronic format, must be retained in accordance with legal retention requirements established by law and also with operational retention requirements established by the records management department.

3.4.3 Handling and Storage of Information

3.4.3.1 Sensitive Information

Sensitive information, whether in electronic or nonelectronic format, must be stored in a controlled area.

3.4.3.2 Business-Controlled Sensitivity, Critical, and Business-Controlled Criticality Information.

It may be recommended that certain business-controlled sensitivity, critical, and business-controlled criticality information, whether in electronic or nonelectronic format, be stored in a controlled area.

3.4.3.3 **Internal** information

Internal information requires access controls with handling and storage practices consistent with its “internal” designation.

3.4.3.4 Critical Infrastructure Information (CII)

Critical Infrastructure Information (CII) must be in a controlled area or secured enclosure when not in use by authorized personnel. For detailed handling instructions reference the Critical Infrastructure Information (CII) Protection Procdure.

3.4.4 Encryption of Information

3.4.4.1 Transmitted Across Untrusted Networks

Sensitive and business-controlled sensitivity information stored in nonsecure locations or transmitted across untrusted networks must be encrypted.

3.4.4.2 Stored Onsite and Offsite

Sensitive or business-controlled sensitivity information stored in a nonsecure location must be encrypted. Additionally, it may be recommended that sensitive or business-controlled sensitivity information stored in a secure on-site or off-site location be encrypted.

3.4.5 Releasing of Information

The release of information must be requested by contacting external communications. Any information that is labeled internal, restricted, confidential or CII must have an executive sponsor before it is released to external parties. The executive sponsor must explicitly approve the release of such information.

3.4.5.1 Sensitive Information

Sensitive information must be protected against unauthorized disclosure, whether formally or informally through conversations, email, voice, fax, and observed workstation screens.

3.4.5.2 Business-Controlled Sensitive Information

It may be recommended that certain business-controlled sensitivity information be protected against unauthorized disclosure, whether formally or informally through conversations, email, voice, fax, and observed workstation screens.

3.4.5.3 Releasing Information on Factory-Fresh or Degaussed Media

Before releasing information on electronic media outside PPW Holding, Inc., the information must be copied onto factory-fresh media (never used) or onto media that was appropriately degaussed to prevent inadvertent release of sensitive or business-controlled sensitivity information.

3.4.5.4 Precautions Prior to Maintenance

To prevent inadvertent disclosure of sensitive or business-controlled sensitivity information, all hardware and electronic media being released for maintenance outside of PPW Holding, Inc. facilities must, prior to release, undergo data eradication according to approved PPW Holding, Inc. procedures. If electronic media containing sensitive or business-controlled sensitivity information is released to a contractor or vendor for maintenance, the PPW Holding, Inc. must have in place a legally binding contract regarding the secure handling and storage of the data or media.

3.4.6 Disposal and Destruction of Information and Media

3.4.6.1 Disposal of Electronic Hardware and Media

To prevent inadvertent disclosure of sensitive or business-controlled sensitivity information, all electronic hardware and media must, prior to being disposed of, undergo data eradication according to approved PPW Holding, Inc. procedures. Unacceptable practices of erasure include a high-level file erase or high-level formatting that only removes the address location of the file. Acceptable methods of complete erasure include the following:

- Zero-bit formatting.
- Degaussing.

- Physical destruction.

3.4.6.2 Removal of Data Residue

As resources are allocated to data objects or released from those data objects (i.e., object reuse), information resources must have the capability to ensure that no accessible data is exposed to unauthorized users. Information resources must:

- Have the capability to overwrite memory and storage that renders the information unrecoverable to prevent disclosure of sensitive and business-controlled sensitivity information.

- Restrict the capability to overwrite memory and storage to an authorized user.

- Ensure that any previous information content of a resource is made unavailable upon the re-allocation of the resource for usage.

3.4.6.3 Disposal of Non-Electronic Information

When no longer needed, all PPW Holding, Inc. information designated as sensitive and business-controlled sensitivity in nonelectronic format must be destroyed by shredding, pulping, or burning.

3.4.7 Handling Non-PacifiCorp Information

3.4.7.1 Third-Party Information

Any information that does not belong to the PPW Holding, Inc. must be protected in accordance with legal requirements or contractual agreements with a third party except that when such requirements do not meet security standards for comparable PPW Holding, Inc. information, PPW Holding, Inc. must meet or exceed its own standards.

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4 Security Risk Management

4.1 Policy

Security risk management in PPW Holding, Inc. will be implemented to ensure cost-effective protection of information, applications, information resources, and the continuity of business operations. Security risk assessments are required for all critical, sensitive, and business-controlled information resources, whether developed and operated in house or by business partners. Site security reviews are also required for all facilities that house critical, sensitive, and business-controlled information resources, regardless of where they are located. Based on the results of security risk assessments and site security reviews, managers must develop (or acquire) and implement security measures to handle unexpected events, avoid unacceptable losses, and minimize the effect of emergencies on business operations.

4.2 Types of Security Risk Assessment

PPW Holding, Inc. implements the following five types of risk management:

- Information resource security risk management.
- Independent security risk management.
- Site security risk management.
- Personnel Risk Management
- Critical Infrastructure Protection Standard Risk Assessment

4.3 Information Resource Security Risk Assessment

Information resource security risk management is a holistic strategic and tactical approach aimed at protecting information resources by reducing their exposure to known or anticipated vulnerabilities. Security risk management consists of the following major processes:

- Information resource security risk assessment.
- Information resource security risk mitigation.
- Information resource security risk acceptance.

- Information resource security risk documentation

4.3.1 Information Resources Security Risk Assessment

4.3.1.1 Purpose

Security risk assessment is a process that will be performed for each sensitive, critical, or business-controlled information resource to:

- Identify the assets at risk and their value to the organization.
- Identify the threats.
- Identify the weaknesses and vulnerabilities.
- Evaluate threats and vulnerabilities to determine the risks that threaten
- loss of value.
- Identify possible safeguards (or countermeasures).
- Analyze the costs and benefits of the safeguards in reducing the risks.
- Complete the information resource risk assessment report.

4.3.1.2 Frequency of Security Risk Assessment

A security risk assessment will be performed in conjunction with system development. Additional risks may be identified as development progresses through requirements definition, design, coding, and testing.

4.3.1.3 Re-assessment

The security risk assessment will be re-assessed and updated as follows:

- At least every three years following deployment of a resource unless earlier re-assessment is warranted.
- After a significant audit finding.
- Whenever the information resource experiences significant enhancement or modification, including changes to the infrastructure, operating system, or hardware platform.

Note: The security risk assessment may be re-assessed and updated after an information security incident that violates an explicit or implied security policy and compromises the integrity, availability, or confidentiality of an information resource.

4.3.2 Information Resources Security Risk Mitigation

Security risk mitigation is a continuous process that reduces risk by implementing cost-effective security measures. The security risk mitigation process consists of the following:

- Selecting the appropriate safeguards (or countermeasures) that will reduce exposure to the risk.
- Assigning a priority ranking to the implementation of the safeguards.
- Assigning financial and technical responsibility for implementing the safeguards.
- Implementing and documenting the safeguards.
- Maintaining the continued effectiveness of the mitigation strategy by periodically reassessing the threats, vulnerabilities, effectiveness of the safeguards, and the residual risk.

4.3.3 Information Resource Security Risk Acceptance

Security risk acceptance is the process of acknowledging that some risk exists, even after cost-effective safeguards have been implemented, and formally deciding to accept that risk. If the level of residual risk is not acceptable, then further safeguards and security controls should be implemented to reduce exposure to acceptable levels.

Note: The vice president of the functional business area and the CIO/Managing Director of Application Support and manager, CISO are jointly responsible for acknowledging and accepting, in writing, the security risks inherent with using that information resource or initiating steps to mitigate the residual risk.

4.3.4 Information Resource Security Risk Management Documentation

All information resource security risk management documentation must be treated as “RESTRICTED INFORMATION” delivered to and retained by the executive sponsor, and a copy sent to the Corporate Information Security Office (CISO).

4.4 Independent Security Risk Management

4.4.1 Independent Security Risk Assessment

Independent security risk assessments are conducted by organizations that are separate and distinct from those responsible for the development and operation of the information resources.

Note: Independent processes (e.g., independent risk assessment, independent code review, independent security test validation, independent penetration testing and vulnerability scans) are evaluations conducted by independent personnel, contractors, or vendors for the purpose of applying rigorous evaluation standards to information resources. An independent process is conducted by an organization that is separate and distinct from those responsible for the development and operation of the information resource.

4.4.2 Criteria for Conducting Independent Security Risk Assessment

An independent security risk assessment may be recommended when information resources are:

- Publicly accessible.
- Developed, hosted, or managed primarily by PPW Holding, inc. personnel.
- Highly visible or have high impact.

Note: An independent security risk assessment may be required at any time by the CIO/VP IT; manager, CISO; Director of Internal Audit; or vice president of the functional business area.

4.5 Site Security Risk Assessment

Site security risk management consists of the following major processes:

- Site security review.
- Site security risk mitigation.
- Site security risk acceptance.
- Site security risk documentation.

4.5.1 Site Security Review

A site security review will be performed for each site that will host sensitive, critical, or business-controlled information resources to:

- Identify the location of the facility and structure-specific strengths and weaknesses.
- Identify the sensitive, critical, and business-controlled information resources hosted by that facility.

- Identify the threat events that could occur, including physical threats (power failure, fire, building collapse, water damage from plumbing failure and roof leak, etc.); environmental threats (earthquake, flooding, tornadoes, lightning, sink hole, etc.); and human threats (union lockouts, riot, disgruntled employee or customer, armed theft, etc.).

- Evaluate threats and vulnerabilities to determine the frequency and amount of harm that could possibly occur as a result of a physical, environmental, or human event.

- Identify possible additional administrative, technical, and physical security safeguards.

- Analyze the costs and benefits of the safeguards in reducing the risks.

- Complete the site security review report.

4.5.2 Frequency of Site Security Review

A site security review will be conducted at the following times:

- Before a new site becomes operational.

- After significant changes at the site, including significant changes in information resources located there.

- When a site has been compromised

- At least every three years, unless an earlier site security review is warranted.

4.5.3 Site Security Risk Mitigation

The site Security risk mitigation process is the same as the information resource risk mitigation process (see 4-3.2)

4.5.4 Site Security Risk Acceptance

Risk acceptance is acknowledging that some risk exists, even after cost-effective safeguards have been implemented, and then formally deciding to accept that risk.

Note: The executive sponsor responsible for acknowledging and accepting site security risk. For information resources residing at non-PPW Holding, Inc. facilities, the vice president of the functional business area is responsible for acknowledging and accepting site risk.

4.5.5 Site Security Risk Management Documentation

All site risk management documentation must be treated as “RESTRICTED INFORMATION” delivered to and retained by the executive sponsor, and a copy sent to the Corporate Information Security Office (CISO) and the Corporate Physical Security Office (CPSO).

4.6 Personnel Risk Management

Personnel risk management is applicable to CIPS-004-1.R3 . The ***personnel risk assessment program*** documentation provides the requirements that must be followed for all new hires, contractors/vendors, and existing employees who have or will have access to critical assets and critical cyber assets.

4.7 CIPS Risk Assessment

4.7.1 Critical Asset Identification Method

A “risk-based” assessment methodology or a set of “risk-based” assessment methodologies must be identified and documented. The methodology must take into consideration the guidelines provide from the North American Electric Reliability Corporation (NERC) as defined in their Risk Assessment Working Group documentation. The documentation must include procedures and evaluation criteria. It must also consider the following:

- Control centers and backup control centers performing the functions of the entities listed in the Applicability section of the NERC CIPS.
- Transmission substations that support the reliable operations of the Bulk Electric System.
- Generation resources and facilities critical to system restoration, including blackstart generators and substations in the electrical path of transmission lines used for initial system restoration.
- Systems and facilities critical to automatic load shedding under common control system capable of shedding 300 MW or more.
- Special Protection Systems that support the reliable operations of the Bulk Electric System.
- Any additional assets that support the reliable operations of the Bulk Electric System that PPW Holding, Inc. deems appropriate to include in the assessment.

4.7.2 Critical Asset Identification

PPW Holding, Inc. shall develop a list of the identified Critical Assets determined through an annual application of the “risk-based” assessment methodology. This list must be reviewed at least annually and updated as necessary.

4.7.3 Critical Cyber Asset Identification

A list of critical cyber assets that are essential to the operations of a critical asset shall be maintained. This list must be reviewed at least annually and updated as necessary. A critical cyber asset will have at least one of the following characteristics:

- The Cyber Asset uses a routable protocol to communicate outside the Electronic Security Perimeter
- The Cyber Asset uses a routable protocol within a control center
- The Cyber Asset is dial-up accessible (dial-up, related to CIPS, includes VPN and wireless solutions.)

4.7.4 Annual Approval

The senior manager or delegate(s) shall approve the list of Critical Assets and the list of Critical Cyber Assets annually.

4.8 Contracts and outsourcing

4.8.1 Secure IT Outsourcing

The security of PPW Holding, Inc IT assets and information must be maintained where the management of the IT assets or the processing of the PPW Holding, Inc. information has been outsourced to another organization. Security requirements, which should address the risks, security controls and management procedures for IT assets, must be defined in the contract between parties.

[see “PPW Holding, Inc. Application Service Provider Security Standards]

The contracts must address:

- Legal requirements to be met by the contractor
- Roles and responsibilities
- Physical and logical controls
- Physical and logical security
- Details of how integrity, confidentiality and availability will be maintained
- The right of PPW Holding, Inc. or its representative to audit all of the above.
- The security language within all outsourcing contracts must be approved by the CISO, CPSO and the CIO.

4.8.2 Procurement of Process Control Systems

The Idaho National Labs document title, "Cyber Security Procurement Language for Control Systems Version [latest version]" shall be used as the guideline for all contracts with vendors that supply process control system equipment, professional services or staff augmentation. This document can be currently found at: http://www.msisac.org/scada/documents/4march08scadaprocure.pdf

The procurement department is responsible for assuring this been integrated into the procurement standard operating procedures.

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5 Acceptable Use

5.1 Policy

PPW Holding, Inc. information resources will be used in an approved, ethical, and lawful manner to avoid loss or damage to PPW Holding, inc. operations, image, or financial interests and will be used to comply with official policies and procedures on acceptable use.

All employees, subsidiary companies, business partners and contractors granted access to PPW Holding, Inc. IT assets must be issued and sign acceptance of the PPW Holding, Inc. **Policy on Electronic Communications and Computer Use** (PECCU). The PECCU defines acceptable usage for PPW Holding, Inc. systems, network. Internal and email.

The policy statement below augment the PECCU by highlighting an important security aspect of the PECCU or introducing an element that is in addition to the PECCU.

5.2 Monitoring

5.2.1 Right to Monitor

PPW Holding, Inc. reserves the right to monitor, access, retrieve and delete the following:

- All e-mail sent or received
- Mailboxes and private directories
- All use of the Internet and all other communication techniques deployed by staff using the system
- All files and data held on PPW Holding, Inc. systems

5.2.1.1 Use constitutes Permission

Use of information resources residing on the PPW Holding, Inc. networked environment constitutes permission to monitor that use. This applies to employees, contractors, subcontractors, and business partners whose duties require access to conduct PPW Holding, Inc. business.

5.2.1.2 Public Web Site Monitoring

Authorized use by customers whose only access is through publicly available services, such as public web sites of PPW Holding, Inc., will only be monitored for site security purposes to ensure that information resources remain available to all users.

5.2.2 Notification of Monitoring

Where technically feasible, users will be notified that PPW Holding, Inc. networks, computers, and workstations may be monitored and viewed by appropriate, authorized personnel regardless of privacy concerns. Where feasible, this notification will appear in a warning banner whenever a user logs on to a system. Users will also be notified of PPW Holding, inc. monitoring policy during information security awareness training and published policy and procedure documents.

5.2.3 Video Surveillance Monitoring

PPW Holding, Inc. has the right to monitor company facilities and staff through the use of electronic monitoring devices such as CCTV and to record monitored activity for future reference. Where monitoring is taking place for general security purposes, signage should be posted indicating the premises is electronically monitored. When the need for covert monitoring is required, appropriate business unit management and union management should be notified.

5.3 Ensuring Compliance

Managers are responsible for ensuring personnel awareness and compliance with PPW Holding, Inc. security policies including the PECCU.

Employees who disregard security policies and/or the PECCU will be subject to disciplinary action in accordance with PPW Holding, Inc. policies and collective bargaining agreements up to and including dismissal.

5.4 Computer Misuse and Collection of Evidence

Any use of the computing facilities for unauthorized purposes is regarded as misuse, which may be regarded as a disciplinary matter. The CISO monitors the usage of IT systems in order to detect and investigate misuse.

No person shall monitor, assess or investigate a suspicion or detection of IT misuse, whether preliminary or full, unless authorized by PPW Holding, Inc. manager, CISO and/or human resources.

Note: Be aware that if specific processes in place are not observed in the gathering of evidence, such evidence may not be admissible in any proceedings that the business may with to raise (whether internally or externally)

5.5 Encryption and Email

5.5.1 Encryption

Employees may not use encryption capabilities for purposes of internal communications. External encryption capabilities must be approved in writing by the CISO.

5.5.2 E-Mail Policy

Access to non-PPW Holding, Inc. based email system while connected to a PPW Holding, Inc. network or while using a PPW Holding, Inc. owned computer system is strictly prohibited. While the PECCU does allow for limited “personal use” of PPW Holding, Inc. resources, the use of non-PPW Holding, Inc. email systems is absolutely not included in the acceptable personal use.

SPAM or unsolicited email is an annoyance and often makes it appear that there is unacceptable use of computing resources. To help assure that internal electronic mail systems are adequately protected from SPAM or unsolicited email, those who manage the email systems at PPW Holding, Inc. are charged with mitigating SPAM or unsolicited email to the best of their abilities and where technically feasible.

The storage of unencrypted email on local drives is strictly prohibited. This includes .PST files. .PST files should always be stored on a server that resides within the defined PPW Holding, Inc. network(s). All requests for storing .PST files locally must be approved through standard security exception processes and an encryption solution must accompany the request as well. No exceptions will be approved without an encryption solution that has been approved by the CISO.

5.6 Protection of Privacy

Sensitive and business-controlled information resources must protect the privacy-related data of customers and all personnel in accordance with the PPW Holding, inc. privacy policy.

5.6.1 Nonpublic Information Resources

PPW Holding, Inc. information resources not available to the general public may include the PPW Holding, Inc. network, workstations and the PPW Holding, Inc. Intranet. Since these resources may be monitored, all personnel and customers who access these information resources will have no expectation of privacy.

5.6.2 Publicly Available Information Resources

PPW Holding, Inc. information resources available to the general public may include Internet sites or stand-alone workstations for customer use.

5.6.3 Privacy Policy Statements

PPW Holding, Inc. policy statements concerning customer privacy, customer data collection (including cookies), and web transfer notification are available at www.pacificorp.com .

5.6.4 Tracking Devices on Web Sites

Use of persistent tracking devices (e.g., cookies and web bugs) must be in accordance with the PPW Holding, Inc. privacy policy. PPW Holding, Inc. policy addressing tracking devices may be found on a link from www.pacificorp.com .

5.6.5 Customer Data Collection

Customer data collection can take many forms and is strictly governed by the PPW Holding, Inc. privacy policy. PPW Holding, Inc. policy addressing customer data collection may be found on a link from www.pacificorp.com .

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6 Personnel Security

6.1 Policy

PPW Holding, Inc. will identify sensitive positions and ensure that individuals assigned to those positions have the appropriate level of clearance to minimize risk to PPW Holding, Inc. information resources. Personnel will be held accountable for carrying out their information security responsibilities. Managers will ensure personnel receive appropriate information security training and protect PPW Holding, Inc. resources when personnel depart under involuntary or adverse conditions.

6.2 Employee Accountability

6.2.1 Separation of Duties and Responsibilities

6.2.1.1 Required for Sensitive or Critical Information Resources

Personnel with access to sensitive or critical information resources must not be assigned duties that could cause a conflict of interest or present an undetectable opportunity for malicious wrongdoing, fraud, or collusion.

6.2.1.2 Recommended for Business-Controlled Information Resources

It may be recommended that certain personnel with access to business-controlled information resources not be assigned duties that could cause a conflict of interest or present an undetectable opportunity for malicious wrongdoing, fraud, or collusion. When it is not possible for duties to be assigned to separate individuals, the role performed must be clearly defined, associated activities logged, security-related functions audited, and compensating controls identified and implemented.

6.2.2 Job Descriptions

It is the intent of PPW Holding, Inc. to define and document the information security requirements for each position.

6.2.3 Performance Appraisals

It is the intent of PPW Holding, Inc. to evaluate the execution of information security responsibilities and the compliance with information security policies and procedures in personnel performance appraisals.

6.2.4 Condition of Continued Employment

It is the intent of PPW Holding, Inc to include the execution of information security responsibilities and the compliance with information security policies and procedures as a condition of continued employment for all personnel.

6.2.5 Sanctions

All personnel will be held accountable for carrying out their information security responsibilities. Violators of PPW Holding, Inc information security policies will be subject to progressive sanctions commensurate with the severity and frequency of the infraction, including disciplinary action or criminal prosecution.

6.3 Sensitive Positions

6.3.1 Definition of Sensitive Positions

Sensitive positions include those in which personnel could, in the normal performance of their duties, cause material adverse effect to PPW Holding, Inc. information resources and facilities. Such duties include, but are not limited to, the following:

- Making changes in the operating system, configuration parameters, system controls, and audit trails.
- Modifying security authorizations.
- Making revisions to sensitive programs and data that could be undetected.

6.3.2 Identification of Sensitive Positions

Managers at all levels are responsible for identifying sensitive positions within their organizations and then requesting the chief inspector to designate the positions as sensitive.

6.4 Background Investigations and Clearances

6.4.1 General Requirements

Personnel must have appropriate background investigations and personnel clearances as determined by PPW Holding Inc. before accessing PPW Holding, Inc. information resources (see ***Personnel Risk Assessment Program*** for details). For personnel without clearances, access will be restricted to baseline information services (see Section 9-4.2.1).

Appropriate background investigations must be conducted and personnel clearances obtained for personnel who access sensitive or critical information resources, require unescorted access to controlled areas, or perform the duties of a sensitive position.

It is recommended that appropriate background investigations and personnel clearances be obtained for personnel who access business-controlled information resources.

6.4.2 Access Privileges

6.4.2.1 Logon IDs

For personnel without clearances, access privileges of the logon ID will be restricted baseline information services (see Section 9-4.2.1).

6.4.2.2 Controlled Areas

All personnel whose duties require unescorted access to controlled areas, whether located at a PPW or non-PPW facility, must have an appropriate clearance as determined by the Human Resources and Compliance departments and Corporate Physical Security, before being granted unescorted access privileges.

6.4.3 Foreign Nationals

In certain situations, personnel may be permanent resident aliens and citizens of foreign countries and still provide critical services to PPW Holding, Inc., with prior approval of the responsible executive. Except for citizenship, foreign nationals must meet the same clearance requirements as all other personnel. The designated senior manager will approve access to information resources by foreign nationals (including contractors) and is responsible for all actions initiated by the foreign national.

Note: The Department of Homeland Security should be consulted to determine if any foreign national is on their watch list.

6.5 Security Awareness and Training

6.5.1 General Security Awareness

All managers must continually strive to incorporate security into training courses, training videos, service talks, internal newsletters, posters, case studies, and other tools and visual aids to increase security awareness among all personnel.

A corporate security awareness program must exist and this program must deliver security awareness reinforcement on at least a quarterly basis.

6.5.2 Annual Training

All personnel must participate at least annually in ongoing security awareness and training activities.

6.5.3 Information Resource Operational Security Training

For sensitive and critical information resources, appropriate operational security training must be developed and conducted. For business-controlled information resources, it is recommended that appropriate operational security training be developed and conducted.

Training for personnel having authorized cyber or authorized unescorted physical access to Critical Cyber Assets must receive specific security training. This specific training must cover the policies, access controls, and procedures as developed for the Critical Cyber Assts covered by CIP-004, and include, at a minimum, the following required items appropriate to personnel roles and responsibilities:

- The proper use of Critical Cyber Assets
- Physical and electronic access controls to Critical Cyber Assets
- The proper handling of Critical Cyber Asset information
- Action plans and procedures to recover or re-establish Critical Cyber Assets and access thereto following a Cyber Security Incident.

Documentation that the training is conducted at least annually must be maintained, including the date the training was completed and attendance records.

All personnel having such access to Critical Cyber Assets, including contractors and service vendors, must be trained prior to access aurhorization..

6.5.4 New Personnel Training

All new personnel must receive information security training.

6.6 Departing Personnel

6.6.1 Routine Separation

Routine separation of personnel occurs when an individual receives reassignment or promotion, resigns, retires, or otherwise departs under honorable and friendly conditions. Unless adverse circumstances are known or suspected, the individual will be permitted to complete his or her assigned duties and follow official employee departure procedures. When personnel leave under no adverse circumstances, the individual's manager, supervisor, or contracting officer must ensure the following:

- All accountable items, including keys, access cards, laptop computers, and other computer-related equipment are returned. Security keys and access to Critical Cyber Assets must be returned/deactivated within seven days.

- The individual's computer logon ID and building access authorizations are terminated coincident with the employee's or contractor's effective date of departure, unless needed in the new assignment.

- All sensitive information, in any format, in the custody of the terminating individual are returned, destroyed, or transferred to the custody of another individual.

6.6.2 Adverse Termination

Removal or dismissal of personnel under involuntary or adverse conditions includes termination for cause, involuntary transfer, and departure with pending grievances. In addition to the routine separation procedures, termination under adverse conditions requires extra precautions to protect PPW Holding, Inc. information resources and property. The manager, supervisor, or contracting officer of an individual being terminated under adverse circumstances must:

- Ensure that the individual is escorted and supervised at all times while in any location that provides access to PPW Holding, Inc. information resources.

- Immediately suspend and take steps to terminate the individual's computer logon ID(s), access to PPW Holding, Inc. information systems, and building access authorizations.

- Ensure prompt changing of all computer passwords, access codes, badge reader programming, and physical locks used by the individual being dismissed. Security keys and access to Critical Cyber Assets must be returned/deactivated within 24 hours.

- Ensure the return of accountable items and correct disposition of "RESTRICTED INFORMATION" as described under routine separation (see 6-7.1).

- Notify the Corporate Information Security Office and Director of Physical Security prior to initiating the termination process.

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7 Physical and Environmental Security

7.1 Policy

PPW Holding Inc. utilizes a fire-layer plan when securing company assets:

1. Environmental Design: Placing an asset, when applicable, in a location that enhances its security posture, and/or installing barriers such as fences, warning signs and site lightning.
2. Mechanical and Electronic Access Controls: Utilizing gates, doors, locks, and key/access management systems to allow only to authorized personnel.
3. Intrusion Detection Systems: Alarms, security personnel, and access logging systems and procedures that will alert PPW Holding Inc. to an attack or unauthorized access attempt.
4. Monitoring: Video systems and security personnel that will enable incident verification and historical analysis to assist with investigations, repairs, and further reinforcement of the physical security perimeter.
5. Quality Control: Regular testing and review of physical security systems and procedures to ensure they are functioning properly and are adequately meeting security needs

7.2 Facility Security

7.2.1 Physical Access Controls

7.2.1.1 Establishment of Controlling Areas

Controlled areas must be established within the facility wherever more stringent restrictions on physical access and more tightly controlled physical and environmental security are required to fully protect information resources. Typical controlled areas may include the following:

- Computer rooms.
- Telecommunications rooms.
- Wiring closets.
- Computer operations areas.

- Media and documentation storage areas.
- Operating system software support areas.
- Special authorization terminal areas.
- Security officers' controlled areas.
- Control Centers

Other designated areas, whether located at a PPW Holding, Inc or non-PPW Holding, Inc. facility.

7.2.1.2 Information Resources Stored in Controlled Areas

Sensitive and critical information resources must be located in a controlled area. It may be recommended that certain business-controlled information resources be located in a controlled area.

7.2.1.3 Access to Controlled Areas

Access to controlled areas is restricted to personnel whose duties require access to such facilities and who possess appropriate security clearances. Access to controlled areas must be authorized and tailgating is not allowed.

Access to controlled areas must be controlled by electromechanical or other secure means. Personnel authorized access to the controlled areas must always use their physical and/or technology electromechanical access control identification badge or device to gain entrance to the controlled area. It is their responsibility to ensure no one tailgates on their badge.

Personnel without an authorized physical and technology electromechanical access control identification badge or device must be escorted by authorized personnel while in the controlled area, unless authorized for specific and limited unsecured access for periods of overhaul, construction, and repair activities..

7.2.1.4 Access Control Lists

Each controlled area must establish an access control list of people who are authorized access to specific control areas. Access control lists must be updated when new personnel are assigned to the controlled area or when someone leaves. Access control lists must also be reviewed and updated periodically. Documentation demonstrating regular review and updates to the access control lists must be retained.

7.2.1.5 Training for Controlled Areas

Personnel with access to controlled areas must be trained in their responsibilities regarding controlled areas. Alarm events indicating possible attempts to gain unauthorized access must be quickly responded to.

7.2.1.6 Physical Access Control Devices

Physical access control devices using biometrics, smart cards, tokens, mantraps, or lockable cabinets will be installed to supplement traditional facility locks and keys to limit access. Alarm events indicating possible attempts to gain unauthorized access must be quickly responded to.

7.2.1.7 Implementation of Additional Physical Access Security

7.2.1.7.1 Requirement for Sensitive or Critical Information Resources

Additional physical access security (e.g., locked cabinet or desk, biometric workstation lock), based on risk associated with the information resource, must be implemented for sensitive and critical information resources.

7.2.1.7.2 Requirement for Business-Controlled Information Resources

It is recommended that additional physical access security (e.g., locked cabinet or desk, biometric workstation lock), based on risk associated with the information resource, be implemented for business-controlled information resources.

7.2.1.8 Identification Badge

Identification badges must adhere to the following criteria:

- Persons authorized access to controlled areas must be identified by a picture badge conspicuously displayed on their person.
- Persons using a badge not issued to them or making any attempt to alter a badge will be subject to disciplinary action.
- Employees must report lost or stolen badges immediately to the issuer of the badge.
- Security access systems that limit access to controlled areas where persons have reported lost or stolen badges must immediately cancel the associated access privileges until the lost or stolen badge is recovered and returned to the issuer.
- Temporary badges must be controlled and issued by the manager of the organization or their designee to authorized personnel who arrive without their assigned badges during normal duty hours.

Note: It is recommended that the organization manager or designee make an unannounced verification of badges at least annually to ensure authenticity and to correct any badge discrepancies.

7.3 Physical Protection of Information Resources

Information resources must be protected against damage, unauthorized access, and theft, both in the PPW Holding, Inc. environment and when removed from this secure environment.

Note: Sensitive and business-controlled sensitivity information on information resources must be protected (e.g., encrypted) when leaving a secure environment.

7.3.1 Network Equipment, Network Servers, and Mainframes

Network equipment, network servers, and mainframes must be protected against damage, unauthorized access, and theft and, where possible, housed in separate rooms that can be accessed only by authorized personnel.

7.3.2 Workstations and Portable Devices

Workstations and portable information resources must be protected against damage, unauthorized access, and theft. Personnel who use or have custody of workstations and portable and transportable equipment, such as laptop computers, notebook computers, palm tops, handheld devices, wireless telephones, and removable storage media devices, are responsible for their safekeeping and the protection of any sensitive, critical, or business-controlled information stored on them.

7.3.3 Non-PacifiCorp Personal Digital Assistants and Handheld Devices

These types of devices shall not be connected to PPW Holding, Inc. network , workstations, servers or other information resource nor shall they store or process any PPW Holding, Inc. information.

7.3.4 Sensitive, Critical and Business-Controlled Media

Sensitive, critical, and business-controlled media, whether electronic or nonelectronic, must be protected against physical loss or damage, whether on PPW Holding, Inc. premises or not. Physical and administrative controls must be implemented to ensure that only authorized personnel can access sensitive and business-controlled sensitivity information. Personnel who have custody of sensitive, critical, or business-controlled media are responsible for their safekeeping (see Chapter 3).

7.4 Environmental Security

Environmental security controls must be implemented at the facility, room, and information resource level to protect critical and business-controlled criticality information resources as described below:

Safeguards must provide protection against lightning, wind, and building collapse.

Redundant power feeds, redundant communications paths, and additional temperature and humidity controls are recommended for facilities hosting critical and business-controlled criticality information resources.

Water and sewer utilities and the potential for flood, earthquakes, or other natural disasters must be evaluated for facilities hosting critical information resources. It is recommended that water and sewer utilities and the potential for flood, earthquakes, or other natural disasters be evaluated for facilities hosting business-controlled criticality information resources.

Surge protection must be implemented for all information resources.

Additional fire safeguards and additional power (electricity) controls must be implemented for critical information resources and are recommended for business-controlled criticality information resources.

7.5 Facility Business Continuance Management Planning

Physical security requirements must be included in facility business continuance management (BCM) planning to ensure the appropriate protection of information resources following a catastrophic event (see
Chapter 12).

7.6 Facility Contracts

Information, environmental, and physical security requirements must be included in contracts involving services performed for PPW Holding. Inc.

7.7 Requirements for CIPS

7.7.1 Physical Security Plan

A physical security plan will be created and maintained. This plan will be approved by the senior manager or delegate(s) and must address the minimum:

- Process to ensure and document that all Cyber Assets within an Electronic Security Perimeter also reside within an identified Physical Security Perimeter.
- Process to identify all access points through each Physical Security Perimeter and measures to control entry at those access points.

- Process, tools, and procedures to monitor physical access to the perimeter(s)

- Procedures for he appropriate use of physical access controls as described in the CIPS.

- Procedures for reviewing access authorization requests and revocation of access authorization, in accordance to CIP-004 Requirement R4.

- Procedure for escorted access within the physical security perimeter of personnel not authorized for unescorted access.

- Process for updating the physical security plan within ninety (90) days of any physical security system redesign or reconfiguration.

- Protect the cyber assets using in the access control and monitoring of the Physical Security Perimeter is protected in accordance with the requirements in the CIPS.

7.7.2 Other Physical Security Controls

All other physical security controls documented in CIP-006 must be documented and implemented as described with in the CIPS. This includes:

- Physical access at all access points

- Monitoring of Physical Access

- Logging Physical Access

- Access Log Retention

- Maintenance and Testing

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8 System Applications, and Product Development

8.1 Policy

Information resources must be developed under a formal system development methodology. Information security must be an integral part of the system development life cycle whether development is done in house, acquired, or outsourced.

8.2 General Development Concepts

8.2.1 Life Cycle Approach

Sensitive, critical, and business-controlled information resource development must utilize a formal system development methodology (SDM). Security must be addressed throughout the information resource life cycle process, from conception through design, development, deployment, operation, and retirement from service. All development, acquisition, or integration projects for information resources, whether performed in house or by a business partner, must incorporate the following general life cycle concepts:

- A comprehensive risk management approach.
- A quality assurance program that includes information security testing.
- Rigorous configuration management and change control processes.
- Separation of duties.
- Restrictions associated with testing.
- Information security in all phases of the information resource life cycle.

8.2.2 Risk Management

A secure computing environment must be implemented that is based on managing risks to an acceptable level. A risk-based approach to information security promotes using limited resources wisely to protect an information resource in a cost-effective manner throughout its life cycle. The security controls applied to information resources must be commensurate with the magnitude of harm that would result from loss, misuse, unavailability, unauthorized access, or unauthorized modification of the information resources (see Chapter 4, Risk Management).

8.2.3 Quality Assurance

Information resource development must include quality assurance (QA) and security-specific testing to ensure that security controls have been implemented and are functioning correctly. All software testing procedures and test results must be stored in the centralized repository, Quality Control. Any deviation from the practice must have the explicit approval of the director of quality assurance.

8.2.4 Change Control, Version Control, and Configuration Management

All information resources, whether developed in house, outsourced, or acquired, must be developed under rigorous change control, version control, and configuration management procedures to reduce the risk introduced by undocumented and untested changes. PPW Holding, Inc. information resources must not be developed or deployed unless a change control process is in place.

8.2.5 Separation of Duties

An individual or organization must not be assigned duties that could cause a conflict of interest or present an undetectable opportunity for accidental or malicious wrongdoing, fraud, or collusion. When it is not possible for duties to be assigned to separate individuals, the roles and functions performed must be clearly defined, associated activities logged, security-related functions audited, and compensating controls identified and implemented. The CISO reserves the right to validate the effectiveness of the compensating controls.

8.2.6 Test Environment Restrictions

All information resources must comply with the testing restriction policies below.

8.2.6.1 Separation of Test and Production Environments

Testing of hardware and software must be performed in a test environment not in a production environment.

8.2.6.2 Testing with Non-sensitive Production Data

Prior approval in writing is required from the executive sponsor and CIO/managing director of application support and corporate security, if non-sensitive production data is to be used in a test environment, regardless of where the testing is conducted. Such approved production data files must be identified as *"copies"* to prevent them from being re-entered into the production environment.

8.2.6.3 Testing with Sensitive and Business-Controlled Sensitivity Production Data

Prior approval in writing is required from the CISO, executive sponsor, and CIO/managing director of application support and corporate security if sensitive data, business-controlled sensitivity data, personally identifiable information, or any information identified as "RESTRICTED INFORMATION" is to be used in a test environment, regardless of where the testing is conducted. Such approved data files must be identified as "*copies*" to prevent them from being re-entered into the production environment.

8.2.6.4 Testing at Non-PPW Holding, Inc. Facilities with Production Data

Additional approval in writing is required from the manager, CISO, if production data is to be used in a test environment outside of PPW Holding, Inc facilities. Such approved files must be identified as *"copies"* to prevent them from being re-entered into the production environment.

8.2.6.5 Critical Cyber Assets and Cyber Assets

For new Cyber Assets and significant change to existing Cyber Assets within the Electronic Security Perimeter(s) defined for the CIPS there must be assurances in place that prevent adverse affects to existing cyber security control. For the purposes of the Electronic Security Perimeter(s), a significant change must be, at a minimum, include implementation of security patches, cumulative service packs, vendor releases, and version upgrades of operating systems, applications, database platforms or other third-party software or firmware.

8.2.6.5.1 Test procedures

Cyber security test procedures shall be created, implemented and maintained in a manner that minimizes adverse effects on the production system or its operation.

8.2.6.5.2 Reflect Production

Testing shall be performed in a manner that reflects the production environment.

8.2.6.5.3 Results

The test results must be documented.

8.2.7 Development Requirements

8.2.7.1 Documentation Required for all Production Business Systems

Every user who develops or implements software and/or hardware to be used for PacifiCorp business activities must document the system in advance of its deployment. The documentation must be written so that persons of sufficient technical knowledge who may be unacquainted with it may run the system.

8.2.7.2 Designers & Developers must notify Management of Potential Problems

Systems designers and developers are individually responsible for notifying project management about any foreseen technical or social problems which might be caused by the applications they are building/modifying. Management must then decide what -- if any -- adjustments are appropriate.

8.2.7.3 Disabling Unnecessary Software Features at Installation Time

Software features which could be used to compromise security, and which are clearly unnecessary in the PacifiCorp computing environment, must be disabled at the time when software on multi-user systems is installed.

8.2.7.4 Prompt Implementation of Security Problem Fix Software, Scripts, Etc.

All security problem fix software, command scripts, and the like provided by operating system vendors, official computer emergency response teams (CERTs), and other trusted third parties must be applied in accordance with the company patch management strategy if applicable for maintaining security or operational integrity.

8.2.7.5 Vulnerability Identification Software for Internet-Connected Systems

To ensure that PPW Holding, Inc. technical staff has taken appropriate preventive measures, all systems directly-connected to the Internet (providing services directly to Internet hosts) must be subjected to a risk analysis performed via vulnerability identification software at least once a month.

8.2.8 Security Requirements Analysis and Specifications

8.2.8.1 Information Ownership must be Assigned

All systems containing non-public information must have an assigned data owner for any and all data contained within.

8.2.8.2 Approval before Disabling Critical Components of Security Infrastructure

Critical components of PPW Holding Inc.'s information security infrastructure may not be disabled, bypassed, turned-off, or disconnected without prior approval from the Information Security Manager. Doing any of these without proper approval subjects the involved individual to severe discipline including termination.

8.2.9 Security in Applications Systems

8.2.9.1 Protection against input buffer over-runs

All applications utilized within PPW Holding, Inc. must be coded such that they restrict input to valid and reasonable lengths appropriate for their use. Applications must be coded to protect against data of the wrong type or inappropriate length causing an inappropriate response or abnormal termination that might compromise the safety of the system or data.

8.2.9.2 Validation of data by type

All applications must validate the type of data before it is transmitted or stored permanently by the application in a database or data file, where it may be recalled later. Applications must not provide un-validated data to other applications, such that these other applications may act inappropriately on the data. An example of an inappropriate type would be a string stored in a numeric field.

8.2.9.3 Validation of content

All applications must validate data to assure that content is within expected ranges and appropriate values before it is transmitted or stored permanently by the application in a database or data file where it may be recalled later. An example of inappropriate content would be location code that is undefined, or an abbreviation of "Street", in a street address for a standard PPW Holding, Inc. address.

8.2.9.4 Restrictions on input sources

Transient and unsecured methods may not be utilized by PPW Holding, Inc. applications for input streams. An example of an unapproved method of providing input would be an account code passed in a URL for a web application.

8.2.10 Control of Internal Processing

8.2.10.1 Passing control to unprotected programs

No PPW Holding, Inc. application may transfer control to applications, subroutines or other programs that are not sufficiently secured for the data being processed and the functionality being provided

8.2.10.2 Message authentication

Messages received by applications must be authenticated to assure that the source of the message is authentic wherever business needs for communications integrity exist.

All communications with Non-PPW Holding, Inc. systems must be authenticated to assure that the communication is to an approved system wherever business needs for communications integrity exist.

8.2.10.3 Cryptographic controls

Encryption algorithms, key types, key management, and protocols must be approved.

PPW Holding, Inc information may not be encrypted without the approval of the Corporate Information Security Office (CISO).

8.2.11 Protection of System Test Data

8.2.11.1 Development Staff Access to Production Application Information

Business application software development staff must not be permitted to access production information, with the exception of the production information relevant to the particular application software on which they are currently working.

8.2.12 Access control to program source library

8.2.12.1 Restricted access to versions

Access to program source must be restricted so that program source code can only be acquired through an approved check-in / check-out process. All other access to source code must be restricted.

8.2.12.2 Check out/in process

All source control libraries must have a source control method that assures that code changes are tracked, with identification of the change, the author of the change and the time of the change submission. Source control must restrict individuals from checking out or making alterations to code that is already checked out to another individual.

8.2.12.3 File Integrity

All program source libraries must include some mechanism such as a file integrity tool, to assure that library content logs, and audit capabilities are not altered or corrupted

8.2.12.4 Audit Capability

All program source libraries must include an audit feature that allows library users to view historical changes to source code, including the author, date, and content of changes.

8.2.13 Security in Development and Support Processes

8.2.13.1 Special Sign-Off Required for Projects Involving Human Safety Issues

All in-house software projects that involve human safety risks must have a computer development project manager's signature on the testing approval papers prior to being used for production business purposes. These papers must state that this manager represents that--to the best of his/her professional ability and knowledge--all necessary controls have been integrated into the software in question and such controls have been adequately tested.

8.2.13.2 Rapid Roll-Back to Prior Versions of Production Software

Adequate "back off" procedures must be developed for all changes to production systems software and production application software. "Back off" procedures allow data processing activities to quickly and expediently revert to the prior version of such software, so that business activities can continue

8.2.13.3 Testing of Software and Information Prior to Third Party Distribution

Prior to distributing any software or information in computerized form to third parties, PacifiCorp workers must first have subjected the software or information in question to appropriate testing, including comprehensive scanning to identify the presence of computer viruses. There are two notable exceptions to this need for testing:

information contained within the body of an email message, and a file of information provided in text format.

8.2.13.4 Permissible Functionality of Systems Developed In-House

With the exception of emergency fixes, only those functions described in an approved system design document may be included in a production computer or communications system that has been developed in-house.

8.2.13.5 Access Controls Defined Prior to Cut-Over to Production Operation

All the user-level and administrative-level access controls required by PPW Holding, Inc. corporate security policies must be established and enabled before production information systems can be placed into operation.

8.2.13.6 When to Prepare Production Systems Change Documentation

Documentation reflecting all significant changes to production computer and communications systems at PPW Holding, Inc. must be prepared within a week from the time that a change took place. This documentation must reflect the proposed change, management approval, and the way in which the change was performed

8.2.14 External Software

8.2.14.1 Packaged Software and Unilateral Deactivation by Third Party Vendor

Every third party software package that PPW Holding, Inc. uses for production information systems purposes must be free of deactivation mechanisms that could be triggered by the vendor without PPW Holding, Inc.'s consent.

8.2.15 Technical Review of Operating System Changes

8.2.15.1 Approval Required for Changes to Production Operating Systems

Extensions, modifications, or replacements to production operating system software must be made only if approved by appropriate systems support management.

8.2.16 Operational Policies

8.2.16.1 Systems Designers & Developers Must Inform Management of Problems

All known potentially serious problems associated with information systems being designed or developed, that are not being adequately addressed by planned or existing projects, must be promptly reported to the appropriate management.

8.2.16.2 Prior Approval Required for Set-Up of Multi-User Systems

Workers must not establish intranet servers, electronic bulletin boards, local area networks, modem connections to existing internal networks, or other multi-user systems for communicating information without the specific approval of the CIO/managing director of application support and corporate security. This policy helps ensure that all PPW Holding, Inc. networked systems have the controls needed to prevent unauthorized access.

8.2.16.3 Security Mechanisms must not be Compromised for Customers

Customer requests that PPW Holding, Inc. security mechanisms be compromised must NOT be satisfied unless: (a) an Executive Vice President first approves it in writing, or (b) PPW Holding, Inc. is compelled to comply by law and such is verified by PPW Holding, Inc. legal counsel.

8.2.16.4 Controlled Process for Modification of Production Business Information

Privileges must be established such that system users are not able to modify production data in an unrestricted manner. Users may only modify production data in predefined ways that preserve or enhance its integrity. In other words, users must be permitted to modify production data ONLY when employing a controlled process approved by management.

8.2.16.5 Developers Embed Security in Systems if Commercial Solution Exists

In-house systems developers must embed security controls in the systems they build or enhance -- rather than requiring users to deal with security.

8.2.16.6 Prohibition against Trap Doors to Circumvent Access Controls

Programmers and other technically oriented staff must refrain from installing trap doors that circumvent the authorized access control mechanisms found in operating systems and/or access control packages.

8.2.16.7 Changes to Sensitive or Critical Information

Transactions affecting sensitive, critical, or valuable information must only be processed if the originating individual or system is authorized to submit such transactions.

8.2.16.8 Input Data Validation and Rejected Item Handling

All transactions to be input to a multi-user production computer system must first be subjected to reasonableness checks, edit checks, and/or validation checks. Transactions which fail such checks must either be: (a) rejected with a notification of the rejection sent to the submitter, (b) corrected and resubmitted, or (c) suspended pending further investigation.

8.2.16.9 Originator of Transactions must be Clearly Identified

Transactions affecting sensitive or critical information must be initiated by the originating individual or system that has been clearly identified and authenticated

8.2.16.10 Input Validation Procedures for Rejected or Suspended Input

Input transactions which are corrected for resubmission, or which are suspended and later approved for resubmission must be subjected to the same validation procedures that original input transactions receive. Examples of these validation procedures include reasonableness checks and format edit checks.

8.2.16.11 Keeping Security Functionality out of Business Applications

Whenever feasible and cost-effective, system developers must rely on system services for security functionality rather than incorporating such functionality into applications. Examples of system services include operating systems, network operating systems, database management systems, access control packages, front-end processors, firewalls, gateways, and routers.

8.2.16.12 Human Intervention Required for Important Decisions

All computer-assisted processes must involve human intervention prior to initiating any action that could result in human life threatening or human safety-threatening events.

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9 Information Security Services

9.1 Policy

Information security services will be implemented to ensure a viable secure computing infrastructure and to protect information resources from accidental or intentional unauthorized use, modification, disclosure, or destruction. Information security services in PPW Holding, inc. will include those controls needed to manage access, ensure accountability, protect confidentiality, maintain data integrity, administer security controls, and capture audit information for information resources.

9.2 Security Services Overview

Information security services are those concepts, properties, and processes utilized to protect information resources. Security services are as follows:

- Authorization determines whether, and to what extent, personnel should have access to specific computer resources.
- Accountability associates each unique identifier with one and only one user or process to enable tracking of all actions of that user or process on the information resource.
- Identification associates a user with a unique identifier (i.e., user account or logon ID) by which that user is held accountable for the actions and events initiated by that identifier.
- Authentication verifies the claimed identify of an individual, workstation, or originator.
- Confidentiality ensures that information is not made available or disclosed to unauthorized individuals, entities, or processes.
- Integrity ensures the correct operation of information resources, consistency of data structures, and accuracy of the stored information.
- Availability ensures information resources will be accessible by authorized personnel or other information resources when required.
- Security administration implements management constraints, operational procedures, and supplemental controls established to provide adequate protection of an information resource.
- Audit logging records operational and security-related events.

9.3 Authorization

Authorization is the process of determining whether, and to what extent, personnel should have access to computer resources. Information resources must be configured to ensure that no user is allowed access to an information resource (e.g., transaction, data, process, etc.) unless authorized by appropriate PPW Holding, Inc. management. Upon employment, personnel will be granted access to a standard baseline suite of information resources and information technology (IT) services.

9.3.1 Authorization Principals

Access must be granted based on personnel roles and the security principles of clearance, need to know, separation of duties, and least privilege.

9.3.1.1 Clearances

For personnel without clearances, access will be restricted to baseline information services (see Section 9-4.2.1).

9.3.1.2 Need to Know

For sensitive, critical, and business-controlled information resources, access must be limited in a manner that is sufficient to support approved business functions. Access to sensitive PPW Holding, Inc. information resources must be limited to personnel who need to know the information to perform their duties.

9.3.1.3 Separation of Duties

Only authorized personnel will be approved for access to PPW Holding, Inc. information resources. This approval must be specific to individuals' roles and responsibilities in the performance of duties and must specify the type of access (read, write, delete, execute), specific resources and information, and time periods for which the approval is valid. Separation of duties and responsibilities will be considered when defining roles.

9.3.1.4 Least Privilege

For sensitive, critical, and business-controlled information resources, access will be based on providing personnel with the minimum level of information resources and system functionality needed to perform their duties. Systems and applications must define as many levels of access as necessary to prevent misuse of system resources and protect the integrity and confidentiality of PPW Holding, Inc. information. PPW Holding, Inc. information resources must be capable of imposing access control based on specific functions (e.g., create, read, update, delete, execute, etc.).

9.3.2 Authorization Process

A business owner with knowledge of the data contained within the system must be responsible for approval of system changes and approval of access to the system.

Access requests must follow standardized processes and require segregation of duty between those that approve and those who grant access in the system.

9.3.2.1 Baseline Information Services

All personnel who have received HR approval to be hired or function in a staff augmentation role, will only be given the baseline information services (Internet access, email and active directory/Novell logon privileges). Additional services and/or access must be explicitly requested and approved.

9.3.2.2 Requesting Authorization

Requests for approval must be in accordance PPW Holding, Inc. policies and follow standard access management processes outlined with the organization.

9.3.2.3 Approval Requests

Approval requests must be in accordance PPW Holding, Inc. policies and follow standard access management processes outlined with the organization.

9.3.2.4 Periodic Review of Access Authorization

Formal access reviews occur on a quarterly basis for systems including critical cyber assets defined in CIP-002, applications containing non-public transmission data and those supporting the financial processes for Sarbanes Oxley. Evidence of this review is maintained by the access report administrator and by data owners.

9.3.2.5 Implementing Changes

System administrators and database administrators must implement all approved authorization requests for the information resources under their control. They must not add, modify, or revoke access to information resources except in accordance with PPW Holding, Inc. policies.

9.3.2.6 Revoking Access

Removal of access is required when the employee/contractor no longer has a business need for the access or leaves the company either through voluntary or involuntary termination. The supervisor must follow standard PPW Holding, Inc. policies.

If employee access must be terminated immediately, as in involuntarily termination or other emergency condition, a standard human resource process must be invoked to request immediate removal of access. The removal of access should be in accordance to 9.3.2.6 above and meet the CIP requirement for removal within 24 hours.

9.3.2.7 Emergency Access

For the purposes of maintaining business services the director, manager or supervisor of the asset owner or system owner are allowed to provide immediate access to others to restore functionality of the system. It is required that notification of this emergency access is documented and communicated to appropriate parties. After functionality has been restored, all emergency access privileges shall be revoked and/or reviewed for appropriateness.

9.3.3 Authorization Requirements

Information resources must comply with authorization requirements including, but not limited to, the following:

- The information resource must not allow access to resources without invoking the authorization process and checking the assigned rights and privileges of the authenticated user.
- The information resource must have features to assign user privileges (i.e., access permissions) to logon IDs, roles, groups, and information resources.
- Privileges on information resources, such as workstations, consoles, terminals, and any subsidiary networks, must not allow the user to bypass or upgrade his or her privileges established in centralized access control lists or databases.
- The information resource must have the capability to restrict session establishment or information resource access based on time of day, day of the week, calendar date of the login, and source of the connection. Information resources running on operating systems that do not have these capabilities must implement compensating controls (e.g., monitoring devices).
- The information resource must provide the administrator-configurable capability to limit the number of concurrent logon sessions for a given user.
- The information resource must not offer any mechanism to bypass authorization restrictions.

9.4 Accountability

9.4.1 Description

Accountability is the process of associating any action on the information resource with one and only one user, process, or other information resource and is essential for maintaining minimum levels of information security.

9.4.2 Types of Accountability

Accountability for access to information resources must be established at the site, network, and the individual level.

9.4.2.1 Site Accountability

Site accountability associates users or information resources with a specific location. Site accountability is established by issuing a site identification number or code (site ID) and restricted by system hardware or software to a unique system, network, or terminal address in a controlled environment.

9.4.2.2 Network Accountability

Network accountability associates users or information resources with a specific network or logical subnet to a network. Network accountability is established by issuing a network identification number or code (network ID) or through the network address.

9.4.2.3 Individual Accountability

Individual accountability associates each user or information resource (such as a workstation or terminal) with any action on an information resource. Individual accountability is established by issuing a unique user or logon identification number or code (user ID or logon ID). Machine accountability may be established for a specific information resource through its workstation address or other identifier. All information resources must be capable of individual accountability and must:

- Identify users each time they attempt to logon to the system.
- Authenticate that users are authorized to use the system.
- Associate all actions taken by a user with the user's unique identifier (user ID or logon ID).

9.4.3 Access Control

A list of personnel with authorized cyber or authorized unescorted physical access to Critical Cyber Assts shall be maintained. This list must include their specific electronic and physical access rights to Critical Cyber Assets.

9.4.4 Quarterly Review of Access to Critical Cyber Asset

This list of access to Critical Cyber Assets shall be reviewed quarterly, and updated within seven (7) calendar days of any change of personnel with such access or any change in the access rights of such personnel. The access list must ensure accuracy for contractors and service vendors is properly maintained.

9.4.5 Revocation of Access to Critical Cyber Asset

Access to Critical Cyber Assets must be terminated within 24 hours for personnel terminated for cause and within seven (7) calendar days for personnel who no longer require such access.

9.4.6 Access Control for Critical Infrastructure Information (CII)

A program for managing access to Critical Infrastructure Information must be documented and implemented.

9.4.6.1 Designated Personnel

A list of designated personnel who are responsible for authorizing logical and physical access to CII must be maintained. Personnel on this list must contain the following elements:

- Name
- Title
- Business phone
- The information for which they are responsible for authorizing access.

9.4.6.2 Access Verification Process

The list of personnel responsible for authorizing access to protected information must be verified at least annually.

9.4.7 Types of Accounts

Access to information resources will be managed through the use of multiple types of accounts, including the following:

- Regular.
- Privileged.
- Managed.
- Shared.
    - Training.
    - Machine.
- Generic.
- Regular Accounts

Regular accounts provide personnel with the minimum level of information resources and system functionality needed to perform their duties and do not carry special privileges above those required to perform the business function (see 9-4.1.4, Least Privilege). The manager or executive sponsor must authorize the establishment of regular accounts.

9.4.7.1 Privileged Accounts

Privileged accounts provide higher levels of access for individuals who perform system administration and user account maintenance functions or who administer restricted information resources such as databases. Privileged accounts will be used in accordance with the following:

Assignment must be restricted to personnel whose duties require additional privileges.

Privileged accounts must be assigned to a unique individual.

Use is restricted to performing those job functions required by the privileged account; individuals must use their regular user accounts to perform nonprivileged functions.

The number of privileged accounts for any information resource must be kept to a minimum.

An audit trail must be maintained on all privileged account usage (see 9-12, Audit Logging).

9.4.7.2 Managed Accounts

Managed accounts are accounts in which a PPW Holding Inc. entity is responsible for the lifecycle of the account from creation, deployment, usage, and retirement when no longer needed. Managed accounts must be assigned to the organization's incumbent manager.

9.4.7.2.1 Shared Accounts

Shared accounts have a single logon ID and are used by more than one person. Establishment of shared accounts will meet the following criteria:

- Shared accounts must be placed under management control.
- The requesting manager is responsible for the use of shared accounts.
- The requesting manager must control access to the password.
- If accountability is required, such as with privileged documents, the use of this account must be logged.

9.4.7.2.2 Training Accounts

Training accounts are variants of individual or shared accounts that are established on a specific information resource for student use while in class. Training accounts must be limited to the minimum functionality required to achieve the training and must not include access to PPW Holding, Inc. production systems.

9.4.7.2.3 Machine Accounts

Machine accounts are assigned to an information resource or other automated process used to identify actions or requests. Machine accounts must be placed under management control. Machine accounts must be created with the minimum access rights and privileges required to perform the necessary business function. These accounts must not be allowed root or administrative privileges. System administrators are responsible for the management and integrity of these accounts.

9.4.7.3 Generic Accounts

Generic accounts are used where accountability is not required. The manager of the CISO, must approve the use of generic accounts.

9.4.7.4 Guest Accounts

Guest accounts are not allowed for access to PPW Holding, Inc. network information resources. Guest accounts expose information resources to risk by allowing access to information resources through the use of a generic logon ID that utilizes either no password or a widely known password. Guest accounts incorporated into any software or established through any other means must be deleted or disabled.

9.4.8 Account Management

Accounts must be established in a manner that ensures access is granted on a need to know and least privilege basis.

9.4.8.1 Established Accounts

For new employees and contractors, all accounts will be established through the first day services process. This is initiated by HR services.

9.4.8.2 Documentation Account Information

The account information, or database, must contain the following information for each user account: logon ID, group memberships, access control privileges, authentication information, and security-relevant roles. Any security-related attributes that are maintained must be stored securely to protect their confidentiality and integrity.

9.4.8.3 Departing Personnel

Accounts must be deleted or passwords changed when personnel leave the organization and in accordance to all applicable regulations.

9.4.9 Handling Compromised Accounts

All personnel who suspect an account has been compromised must immediately notify management and follow the incident reporting process (see Chapter 13).

9.5 Identification

Identification is the process of associating a person or information resource with a unique (enterprise-wide) identifier; such as a user logon ID. The logon ID is used in conjunction with other security services, such as authentication measures, to track activities and hold users accountable for their actions. Users are responsible for all actions performed on PPW Holding, Inc. information resources under their logon ID.

9.5.1 Issuing Logon IDs

Logon IDs (or user IDs) are unique groups of letters, numbers, or symbols assigned to a specific person or information resource. All personnel using PPW Holding, Inc. information resources will be issued a logon ID in conjunction with the authorization process (see 9-4.2). No two users will be assigned the same logon ID except those using shared accounts (see 9-5.3.3.1).

9.5.2 Protecting Logon IDs

Logon IDs must be protected in accordance with the following:

Personnel must not share their logon IDs or permit others to use them to access PPW Holding, Inc. information resources.

Logon IDs must not be embedded in application code or batch files or stored in application files or tables unless approved compensating security controls are implemented.

9.5.3 Suspending Logon IDs

After 5 unsuccessful attempts to log on to an information resource, the logon ID or account must be suspended. A user having a computer logon ID suspended must call the Enterprise Service Desk and follow defined procedures for resolution. Computer logon IDs must be suspended if not utilized for a preset period of time not to exceed 180 days.

9.5.4 Failed Logon Attempts.

9.5.4.1 Recording Failed Logon Attempts

Failed logon attempts must be recorded for audit trail and incident reporting purposes.

9.5.4.2 User Notification of Failed Logon Attempts

Notification to the user of a failed logon attempt will reflect only that the logon failed. The reason for the failed logon attempt and information previously entered, including the disguised or clear password, must not be returned to the user.

9.5.5 Terminating Logon IDs

Logon IDs not used for a period of one year must be deleted.

9.5.6 Identification Requirements

Information resources must comply with security requirements including, but not limited to, the following:

- The information resource must, at a minimum, utilize logon IDs as the primary means of identification.
- The information resource must have the capability to automatically disable a logon ID that has not been used for an administrator-configurable period of time.
- The information resource must not allow an administrator to create, intentionally or inadvertently, a logon ID that already exists.
- A logon ID must not exist without associated authentication information. The information resource must not provide any process to bypass the authentication information for any logon ID.
- The information resource must have the capability of associating each internal process with the logon ID of the user who initiated the process. Processes that are not initiated by a user, such as print spoolers, database management servers, and any spawned subprocesses, must be associated with an identifier code, such as "system ownership."

9.6 Authentication

Authentication is the process of verifying the claimed identity of an individual, workstation, or originator. While identification is accomplished through a logon ID, authentication is achieved when the user provides the correct password, personal identification number (PIN), or other authenticator associated with that identifier. Personnel must be required to identify and authenticate themselves to the information resource before being allowed to perform any other actions. Means of authentication, or authenticators, may include the following:

- Passwords.
- PINs.
- Shared secrets.
- Digital certificates.
- Smart cards and tokens.
- Biometric devices.

9.6.1 Passwords

Passwords are unique strings of characters that personnel or information resources provide in conjunction with a logon ID to gain access to an information resource. Passwords, which are the first line of defense for the protection of PPW Holding, Inc. information resources, must be treated as sensitive information and must not be disclosed.

Note: Password checkers will be run by the CISO on systems to check for badly formed passwords.

9.6.1.1 Password Selection Requirements

Passwords:

- **Must** consist of a minimum of eight characters, with at least one capital letter, one non-capital letter, one digit and one special character [i.e., !@#$%^&*()_+-=~`”’:;{}[]|\<,>.?/] .
- **Must not** contain two consecutive identical characters.
- **Must not** be a dictionary word

  Must not be names, initials, payroll numbers, telephone numbers, car registration numbers

  Must not be the same as the user id

  Must not be written down

  Must not be reused

  Must not use “password” as the password

  Must be changed immediately if compromised

  Must be changed immediately if shared during an emergency

  Must be changed frequently and certainly within 60 days

If there are limitation within a system that do not allow for compliance with the aforementioned criteria then equivalent or better password criteria must be applied based on what is allowable by the system. The CISO must be consulted for appropriate solutions and those solutions must be documented in configuration standards as approved by the CISO.

9.6.1.2 Password Selection Recommendations

Below are a few examples of ways to construct a strong password:

- H@rd2Cr@k! - Hard to Crack
- !4Sc0rE&7Yrns_aG0 - "For (**!4**)Score (**Sc0rE**)and (**&**) Seven (**7**) Years (**Yrs**) Ago (**_aG0**)"
- 2Be@0rN0t2bE! - "To (**2) Be** and/or (**@0r**) Not (**N0t**) **to be!"**
- Ne!Ply10s&Glf4$? - "Any (**Ne**) one (**!**) **Pl**a**y** Tennis (**10s**) and (**&**) **G**o**lf** for (**4**) money (**$**) **?"**
- Tp4tci2s4U2g! - "**T**he **p**assword for (**4**) **t**his **c**omputer **i**s two (**2**) **s**trong for you to (**4U2**) **g**uess**!"**
- BBslwys90! - "**B**ig **B**rother i**s** a**lw**a**ys** right (**90** degrees)**!"**
- Sw0tR8nB0! - "**S**ome **w**here over (**0**) **t**he rain (**r8n**) bow (**B0**) **!**"

9.6.1.3 Initial Password

Passwords must always be delivered in a secure manner. The initial password for users must be sent via First Class Mail, an encrypted delivery system, or personal delivery to the user. Passwords for privileged accounts must be hand-delivered. For all accounts, the initial password must be set to a temporary password and the user must be required to change the password at logon.

Note: Caution must be taken not to standardize on generic or global passwords when issuing new accounts or when re-setting forgotten passwords.

9.6.1.4 Re-set Passwords

Users who have forgotten their passwords or whose accounts have been disabled due to using an incorrect password after 5 attempts may request to have their password re-set by defined procedures. When requesting the re-set of a password, the user must be prepared to provide some predetermined shared secret that only the user would know for validation purposes (see 9-7.3, Shared Secret). Re-set passwords for privileged accounts must be hand-delivered. For all accounts, the password must be re-set to a temporary password and the user must be required to change the password at logon.

9.6.1.5 Non-guessable Voicemail Passnumber

Although voicemail passwords need not be in compliance with the PPW Holding, Inc. password construction standards users must, however, still pick a voicemail password which is different from their phone extension, their office number, their employee number, or any other number which could be easily guessed.

9.6.1.6 Password Expiration

The information resource must offer an authentication information-aging feature that requires users to periodically change authentication information, such as passwords. All PPW Holding, Inc. personnel must change their passwords when prompted by the system or risk being locked out, thus requiring assistance to re-set the account. Password expiration requirements are as follows:

- Prior to the expiration of authentication information such as passwords, the information resource will provide notification to the user.
- At a maximum, passwords for all accounts must be aged and changed every 60 days.

9.6.1.7 Password Protection

Passwords used to connect to PPW Holding, Inc. information resources must be treated as sensitive information and not be disclosed to anyone other than the authorized user, including system administrators and technical support staff. Requirements for protecting passwords include the following:

Passwords must not be shared except those used for shared accounts (see 9-5.3.3.1, Shared Accounts).

Passwords must not be written down.

Aside from initial password assignment and password re-set situations, if there is reason to believe that a password has been disclosed to someone other than the authorized user or has been otherwise compromised, the user must immediately change the password.

9.6.1.8 Password Storage

Passwords must be stored in an encrypted format. This includes passwords stored in batch files, automatic log-in scripts, software macros, keyboard function keys, or computers without access control systems.

9.6.1.9 Vendor Default Passwords

All vendor-supplied default passwords must be changed before connecting the system or introducing the software to the PPW Holding, Inc. network. This includes passwords used by contractors or consultants when configuring a system.

9.6.1.10 Password Requirements

Information resources must support the following password requirements:

- Deny access if the user does not comply with password selection or expiration criteria.
- Require re-authentication by the user, as well as re-confirmation of the new password, at the time of an attempted password change.

- Store passwords in a one-way encrypted format.
- Encrypt passwords in transmissions.

9.6.2 Personal Identification Numbers

Personal identification numbers (PINs) are a specialized type of authenticator used for limited applications. PINs are used in conjunction with unique identifiers to authenticate users to information resources. Like passwords, PINs must be treated as sensitive information and must not be disclosed. All personnel must comply with PPW Holding, Inc. policies regarding PIN management and usage and are directly responsible for all actions taken using an assigned identifier and PIN.

9.6.2.1 PIN Generation and Selection

To ensure that PINs retain integrity and confidentiality, PINs must be protected during generation and dissemination. All personnel are encouraged to change their PIN from the initial assignment. PINs must:

- Be a minimum of four characters in length, two of which are unique.
- Avoid obvious combinations or sequences.
- Avoid well-known or easily guessed combinations such as social security number, telephone number, or house address.

9.6.2.2 PIN Distribution

Secure delivery methods include First Class Mail, an encrypted delivery system, or personal delivery to the user. New or replacement PINs must not be delivered by telephone, facsimile, or electronic mail to protect against unauthorized disclosure.

9.6.2.3 PIN Protection

PINs must be committed to memory or stored in a secure location. Information resources must store PIN data in an encrypted format that meets PPW Holding, Inc. encryption standards. All access, additions, modifications, and deletions to the PIN data must be logged and monitored. If PIN authentication is performed over an open network, such as the Internet, PINs must be encrypted during transmission according to PPW Holding, Inc. encryption standards

9.6.2.4 Forgotten PINs

When requesting replacement of a forgotten PIN, the user must be prepared to provide some predetermined shared secret that only the user would know for validation purposes (see 9-7.3). All forgotten PINs must be replaced with new PINs, which must be securely delivered.

9.6.2.5 PIN Suspension

When using a PIN for authentication, the information resource must be disconnected after three incorrect entries and the PIN account suspended after six incorrect entries. When a suspended PIN account is reactivated, the user must be assigned a new PIN that is delivered via secure methods (see 9-7.2.2).

9.6.2.6 PIN Cancellation and Distribution

A PIN suspected of compromise must be cancelled immediately and a new PIN generated and delivered via secure methods (see 9-7.2.2). Unauthorized users who no longer require access to the system must be removed immediately. All PIN data must be destroyed when the user no longer requires access to the system or leaves PPW Holding, Inc. employment.

9.6.2.7 PINs Used for Financial Transactions

PINs used for financial transactions must comply with American National Standards Institute (ANSI) Financial Services Technical Publication X9.8, *PIN Management and Security*. Financial transactions at high risk for fraud may not be suitable for reliance on PINs as the primary authentication mechanism.

9.6.3 Shared Secret

A shared secret is an authentication mechanism used to re-set a user's password or PIN. When requesting the re-set of a password or PIN, the user must be prepared to provide some predetermined shared secret that only the user would know for validation purposes. Shared secrets must comply with the following:

- Be a minimum of eight characters.
- Be protected and stored as sensitive information.
- Be stored encrypted if stored electronically.
- Have the user's account suspended if the shared secret is entered incorrectly three times.
- Ensure an information resource utilizing shared secrets provides a secure process for recording an initial shared secret and changing the shared secret in the event of suspected compromise.

9.6.4 Digital Certificates and Signatures

9.6.4.1 Digital Certificates

A digital certificate contains a name, a public key, and a digital signature computed over the first two elements. The certificate's purpose is to relate a unique name to a specific public key and is used for decryption and nonrepudiation of messages and files.

9.6.4.2 Digital Signatures

A digital signature is a digital code that can be attached to an electronically transmitted message or file that uniquely identifies the sender. Digital certificates are required when using digital signatures. Digital signatures perform three important functions:

- Integrity allows the recipient of a given message or file to detect whether that message or file has been modified.
- Authentication makes it possible to verify cryptographically the identity of the person who signed a given message.
- Nonrepudiation prevents the sender of a message from later claiming that they did not send the message.

9.6.4.3 Certification and Signature Standards

The use of either a digital certificate or digital signature for use at PPW Holding, Inc. must be reviewed and approved by the CISO.

9.6.5 Smart Card Tokens

Smart cards and tokens are tangible objects that usually contain a built-in microprocessor to store and process information used to verify the identity of a user. Smart cards and tokens are valid methods of authentication. The CISO must approve all implementations of these technologies for accessing information resources. The CISO, in conjunction with the CIO, will set standards for the use and protection of smart cards and tokens

9.6.6 Biometrics

Biometric information is a valid method of authentication. Biometrics are technologies used to authenticate individuals by means of unchanging biological characteristics, such as fingerprints, palm prints, voice prints, or facial, iris, and retina scans. The CISO must approve all implementations of biometric technologies for accessing information resources. Biometric information is sensitive information and must be protected. The CISO, in conjunction with the CIO, will set standards for the use of biometric authentication and the storage of biometric information.

9.6.7 Nonrepudiation and Strong Authentication.

9.6.7.1 Nonrepudiation

Nonrepudiation is the security property that assures the sender cannot deny sending the message, the recipient cannot deny receiving the message, and actions can be conclusively traced to a specific individual. When required, an information resource must have the capability to support nonrepudiation.

9.6.7.2 Information Resource Nonrepudiation Requirements

Nonrepudiation requirements include the following:

- The information resource must incorporate government- and industry-approved standards for digital signatures, key management, time stamping, and evidence archiving.

- The information resource must facilitate nonrepudiation of transactions or communications by performing strong authentication of the associated parties and maintaining data integrity for related transactions or communications.

- The information resource must have the capability to record and archive security-related events associated with a specific communication or transaction and the related user, client, or server application.

9.6.7.3 Strong Authentication

Strong authentication consists of two-factor or multi-factor authentication tools, such as a smart card and PIN, or thumbprint and password, that move toward the concept of nonrepudiation or conclusive tracing of an action to an individual. Single-factor authentication tools, such as logon IDs and passwords, do not provide strong authentication.

9.6.8 Remote Access Authentication

PPW Holding, Inc. information resources must support and maintain access control for personnel using networked, dial-in, and Internet connections to PPW Holding, inc. information resources. Strong authentication or other stringent access controls must be implemented for personnel entering through dial-in, the Internet, or other non-PPW Holding, inc. communication networks. Source restrictions (i.e., destination verification of remote session source address) may be used as a substitution to strong authentication for remote access.

9.6.9 Session Management

A computer session is a unique period of activity performed on or by an information resource usually associated with a login by a user. All information resources must implement session management standards specific for the information resource platform.

9.6.9.1 Session Establishment

Information resources must comply with session establishment requirements including, but not limited to, the following:

- During a login, the information resource must allow the entire login sequence to be completed before providing any response to the initiator of the login.

- The information resource must generate an alarm after an administrator-configurable number of consecutive incorrect login attempts across multiple accounts.

- When the threshold for invalid consecutive attempts for a given logon ID is reached, the information resource must deactivate access for the logon ID until a security administrator unlocks it.

- Upon successful session establishment, the information resource must make available the date and time of the last successful login.

9.6.9.2 Session Expiration

Information resources must comply with session expiration requirements including, but not limited to, the following:

- After the specified period of inactivity during the session (applicable standards defined by the CIO or CIO designee), the information resource must terminate the session and connection and require a successful re-authentication to regain access.

- Following termination by the user or interruption by a power failure, system crash, or transmission problems, the session and connection must be dropped. The establishment of a new session will require the normal user identification, authentication, and authorization.

- The information resource must provide administrator-configurable session expiration (i.e., session lifetime). After the specified period of time, regardless of activity, the information resource must terminate the session, lock out the connection, and require a successful re-authentication to regain access.

9.6.9.3 Time-out Requirements (Re-authentication)

The inactivity time-out standard for PPW Holding, Inc. information resources is 15 minutes. After 15 minutes of inactivity, the information resource must, where the platform permits, automatically engage the password-protected screen saver or blank the screen and lock the keyboard to allow only the keying of the appropriate password. Manual re-authentication must be required before access to the information resource is re-established. For remote access, the session must be terminated and the information resource disconnected from the network.

Note: Refer to the specific platform configuration standards for the applicable time-out requirements.

9.6.9.3.1 Workstations

The inactivity time-out standard for all PPW Holding, Inc. workstations is 15 minutes. After 15 minutes of inactivity, the time-out event must, where the platform permits, automatically engage the password-protected screen saver or blank the screen and lock the keyboard to allow only the keying of the appropriate password. Manual re-authentication must be required before access to the workstation is re-established.

9.6.9.3.2 Applications

The inactivity time-out standard for all application sessions must be set at a minimum of 15 minutes, unless business and operational necessities dictate an extension on the period of inactivity. The business and operational needs and the risks associated with any extension of the xx-minute standard must be reviewed, approved, and documented in the development lifecycle process.

9.6.9.3.3 Remote Access

For remote access, the communications session will be limited to 8 hours. After 8 hours, the workstation will be disconnected from the network. The normal workstation inactivity time-out standard described above applies.

9.6.9.4 Failed Access Attempts

Failed access attempts and access attempts by unauthorized personnel or information resources must be rejected and recorded for audit trail and incident reporting purposes.

9.6.10 Authentication Requirements

All information resources must comply with authentication requirements including, but not limited to, the following:

- The authentication process should protect the information resource from a replay attack.
- During information resource recovery, authentication information must be recoverable without unauthorized disclosure or loss of data and information resource integrity.
- The information resource must support a configuration capability that prevents authentication information (e.g., password, PIN number, token, or smart card) from being displayed in clear text or otherwise made available to any other user, including an administrator.
- When the initial authenticator is created, the information resource must not divulge the authenticator to anyone other than the user and the authorized administrator.
- The information resource should have the ability to authenticate itself to the user and to other software application components during the authentication sequence.
- Where technically feasible, information resources must support process-to-process authentication.

9.7 Confidentiality

9.7.1 Description

Confidentiality is the security property that ensures that information is not made available or disclosed to unauthorized individuals, entities, or processes. Information resources must have the capability to ensure that information will be transmitted and stored in a way such that only authorized users are allowed access. Confidentiality is maintained through comprehensive and interrelated efforts that include, but are not limited to, the following:

- Information designation.

- Clearances and need to know.
- Physical security.
- Authentication of users.
- Encryption.

9.7.2 Encryption

Encryption is the primary means for providing confidentiality services for information that can be stored or sent over the network, Intranet, and Internet. Information resources that store or transmit sensitive or business-controlled sensitivity information must have the capability to encrypt information. The minimum encryption standard for PPW Holding, Inc. is triple DES with a 128-bit encryption key or the Advanced Encryption Standard (AES).

9.7.2.1 Required for Nonsecure Storage and Transmission over Untrusted Networks

Information resources storing or processing sensitive or business-controlled sensitivity information must implement approved encryption based on PPW Holding, Inc. encryption and key recovery policies. Encryption must be used for sensitive and business-controlled sensitivity information that is stored in nonsecure locations or transmitted over untrusted networks such as the Internet.

9.7.2.2 Recommended for Secure Storage

Additionally, encryption is recommended for sensitive and business-controlled sensitivity information stored in a secure location (onsite and offsite).

9.7.3 Utilization of Encryption Products

Encryption products must comply with requirements including, but not limited to, the following:

- Information resources using encryption must utilize only algorithms and standard encryption products that are approved by PPW Holding, Inc. and meet industry best practices.
- All encryption products must support functionality of or integrate with applications to make encryption keys available to management. Any use of encryption without such technology must be approved in writing by the CISO.

9.7.4 Key Management

Key management is the generation, recording, transcription, distribution, installation, storage, changing, disposition, and control of cryptographic keys. Key management must be rigorous and disciplined because attacks against encryption keys are far more likely to occur and succeed than attacks against encryption algorithms.

9.7.4.1 Protecting Encryption Keys

Encryption keys must be treated as sensitive information and access to those keys must be restricted on a need to know basis. The following principles apply to the protection and access of encryption keys:

- If keying material is generated and stored, the information resource must provide secure key storage that is resistant to compromise through a logical or physical attack.

- If hardware-based key generation and storage is utilized, the key must be stored in such a way that it cannot be retrieved in clear text.

9.7.4.2 Recommended Practices

The best way to mitigate the risk of keys being attacked is to store them in hardware on a secure physical device. PPW Holding, Inc. information resources should adhere to key management practices that include, but are not limited to, the following:

- Key management should be fully automated and not require manual steps.

- All keys should be generated and stored in hardware.

- Keys should never leave the hardware and never be stored in the host's memory.

- All access to the hardware should be through a trusted path.

9.7.4.3 Key Management Requirements

Information resources must comply with key management requirements including, but not limited to, the following:

- If the information resource supports key recovery, then access to the key must be restricted to authorized personnel.

- The information resource must have the capability to enforce the immediate revocation of user accounts and the associated key(s).

- Encryption keys must not appear in clear text outside a cryptographic device.

9.7.5 Elimination of Residual Data

The information resource must have the capability to ensure that there is no residual data exposed to unauthorized users (see 3-5.6.2, Removal of Data Residue).

9.8 Integrity

Integrity is the security property that ensures correct operation of information resources, consistency of data structures, and accuracy of stored information. Information resources must be installed and maintained in a manner that ensures the integrity of the information resources and their data.

9.8.1 Information Resource Integrity

Information resource integrity ensures that information resources perform their intended functions in an unimpaired manner, free from deliberate or inadvertent unauthorized manipulation. Integrity provides assurance that under all conditions the operating hardware and software maintain logical correctness, reliability, and effective protection mechanisms.

Information resources must comply with information resource integrity requirements including, but not limited to, the following:

- Security features designated in approved hardening guidelines must be invoked.
- No information resource may undermine the integrity of underlying platforms or supporting infrastructure.
- The information resource must perform integrity checks for system functions.
- The information resource must retain the existing security parameters even after a restart or recovery.
- Backup capability must be provided to restore the information resource to its former state.
- Boundary checking must be implemented to prevent buffer overflow conditions.
- The information resource must provide appropriate alert messages before executing potentially damaging commands.
- The information resource must provide an administrator with the capability of retrieving the date and time associated with any security-related activity and the logon ID of the user who initiated the activity.
- The information resource must provide mechanisms to detect duplicate authentic financial transactions.
- The information resource must monitor the status of its components in real time to ensure that all components are still active and to prevent components from failing without detection.

9.8.2 Data Integrity

Data integrity is the security property that ensures that data meets a given expectation of quality and has not been exposed to accidental or malicious modification or destruction. Information resources must comply with data integrity requirements including, but not limited to, the following:

- Information resources must have the capability to ensure that data is not modified, altered, or deleted without authorization in either storage or in transit.
- Any unauthorized modification of data must yield an auditable security-related event.
- The information resource must have the capability of identifying the originator of any information before that information is used in any restricted function of the information resource.
- The information resource must log any attempt by the administrator to authorize any user to bypass the administrator-configured data integrity controls.
- The information resource must protect data integrity by performing data integrity checks.
- When data integrity checks fail, the information resource must reject the data.

9.9 Availability

Availability is the security property that ensures information resources will be accessible by authorized personnel or information resources when required. Availability is maintained through comprehensive and interrelated efforts that include, but are not limited to, the following:

- Business continuity and contingency planning (see Chapter 12).
- Capacity planning and scalability.
- Redundancy.
- Secure backup and recovery.
- High availability.

9.9.1 Capacity Planning and Scalability

For all information resources, capacity planning and scalability must be considered for both the information resources and network components, such as routers, firewalls, proxies, and encryption. Whenever technically feasible, scalable information resources should be considered that require little or no change to the configuration or the application when adding hardware or data storage.

9.9.2 Redundancy

Redundant systems for servers and firewalls may be recommended where warranted to ensure the availability of critical and business-controlled criticality information resources. The implementation of redundant systems should be based on a cost benefit analysis and the recovery time objective (RTO).

9.9.3 Secure Backup and Recovery

All information resources must have the capability to perform secure backups and recovery. The information resource must have the capability to check the integrity of data read from a backup file when performing a restore function (see 12-8, Backup of Information Resources).

9.9.4 High Availability

High availability should be implemented where warranted, based on a cost benefit analysis and RTO. Resources or processes that may be deployed to ensure high availability include, but are not limited to, the following:

- Fault-tolerant information resources.
- Redundant hard drives (e.g., Randomly Accessed Independent Disk [RAID] array), systems, and servers.
- Uninterruptible power supplies (UPS), power conditioning systems, and backup generators.
- Hot-swappable components.
- Secondary storage devices.
- Continuous monitoring.
- Automated fail-over and fail-back systems.

9.10 Secure Administration

Security administration includes management constraints, operational procedures, and supplemental controls established to protect information resources. Sensitive, critical, and business-controlled information resources must implement logical access security.

9.10.1 Security Administration Requirements

Security administration functions that must be implemented for PPW Holding, Inc. information resources include, but are not limited to, the following:

- Activating protective features (e.g., the login feature).
- Displaying users logged on.
- Creating, retrieving, updating, or deleting all security-related attributes of users, interfaces, and software and data elements.
- Overriding or altering vendor-provided security defaults.
- Configuring security-relevant options.
- Configuring the display of security-related events.
- Recording and archiving the information resource configurations.
- Monitoring suspected activities related to a potential information security incident.
- Detecting information security incidents promptly, isolating and investigating the problem, and recovering securely from the incident.

9.10.2 Security Administration Documentation Requirements

Security administrative requirements must be appropriately documented. These security administration documentation requirements include, but are not limited to, the following:

- Cautions about functions and privileges that must be controlled when running a secure facility.
- Administrator functions related to security, including adding or deleting users, changing user security characteristics, generating keying material, and revoking user-related security parameters.
- Guidelines on consistent and effective use of security features, including their interaction and how to generate a new security configuration.
- Guidelines for retaining accountability tracking information for an administrator-specified period of time.
- Procedures necessary to start the information resource in a secure manner.
- Procedures to resume secure operation after termination of information resource processes.

9.11 Audit Logging

Security audit events shall be captured pursuant to the ***security logging standard***. All audit logging must be managed to support applicable laws and regulations.

All devices supporting cyber assets within an electronic perimeter or constitute access control into an electronic perimeter as defined in the Critical Infrastructure Protection Standard must follow the [name logging standard documentation] specifically where technical feasible. All such logs must be centrally collected [received or retrieved] and archived where it is technically feasible.

The CISO is responsible for managing the centralized security log management environment.

9.11.1 Audit Log Review

Audit logs will be reviewed in accordance any, and all, applicable laws and regulations. The review of logs will primarily be for the purposes of forensics for general computing environments. For critical environments such as financial environments or cyber assets deemed in scope for the Critical Infrastructure Protection Standard (CIPS), logs will be reviewed periodically and programmatically for anomalies which may indicate malicious intent.

9.11.2 Audit Log Retention

Security audit logs will be retained for no less than 90 days unless obligated to do so otherwise.

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10 Hardware and Software Security

10.1 Policy

PPW Holding, inc. will manage the procurement, configuration, operations, and maintenance of information resource hardware and software, whether located on PPW Holding, Inc. or non-PPW Holding, Inc. premises, in a manner that ensures information security. Hardware and software security must be implemented and maintained with the appropriate level of technical and administrative controls to protect PPW Holding, Inc. technology and operations infrastructure from intentional or unintentional unauthorized use, modification, disclosure, or destruction. Change control procedures, virus protection procedures, and standard configurations of hardware and software must be implemented to reduce PPW Holding, Inc. exposure to unnecessary risks and vulnerabilities.

10.2 General Guidelines for Hardware and Software

10.2.1 Securing the PacifiCorp Computing Infrastructure

The PPW Holding, Inc. computing infrastructure must be protected through the implementation of information security standards, processes, and procedures.

Note: The CIO, is responsible for implementing and maintaining a secure PPW Holding, inc. computing infrastructure by setting standards and developing the security processes and procedures.

10.2.2 Using Approved Hardware and Software

All PPW Holding, Inc. information resources must use only hardware and software acquired from official PPW Holding, Inc. sources.

All PPW Holding, Inc. information resources must use only software listed in the Technology Blueprint located here:

http://idoc.pacificorp.us/Article/Article17442.html

and/or which has been formally approved by the CIO or the CIO designee.

Personnel wishing to use information resources not contained within these documents must obtain approval through the exception process obtainable by contact the enterprise service desk.

10.2.3 Testing of Hardware and Software

Thorough testing of all new or modified hardware and software is required to ensure that there is no adverse effect on the security of PPW Holding, Inc. information resources (see Chapter 8).

10.2.4 Tracking Hardware and Software Vulnerabilities

Vulnerabilities in hardware and software platforms must be reviewed on a regular basis. All vulnerability advisories involving the software and hardware in use within the PPW Holding, inc. information resources must be tracked. Designated personnel in CISO must be on software and hardware vendor advisory mailing lists and other forums.

10.2.5 Maintaining Inventory

It is recommended that thorough inventory is kept on all hardware and software assets. It is mandatory that all cyber assets within the ESP and those that make up the perimeter are inventoried on regular intervals in compliance with the critical infrastructure protection standard requirements.

10.2.6 Licensing Hardware and Software

Computer hardware and software purchased for the PPW Holding, Inc. must be registered or licensed to PPW Holding, Inc. or the appropriate business platform.

10.2.7 Using Diagnostic Hardware and Software

Diagnostic hardware and software that enable the bypass of implemented security features or allow network monitoring (e.g., network scanning, sniffers) must be used only by authorized personnel for approved purposes (see Chapter 14, Compliance and Monitoring).

10.3 Configuration and Change Management

10.3.1 Scope

The PPW Holding, Inc. configuration and change management process applies to all PPW Holding, Inc. information resources regardless of where the information resource is hosted or managed.

10.3.2 Configuration Control

To effectively manage information resources, initial or baseline configurations of the information resources must be established prior to deployment. Configurations of information resources must be periodically reviewed to identify new vulnerabilities and security requirements.

10.3.3 Standard Configuration

Standard configurations of hardware and software must be used to maintain a high level of information security, enable cost-effective and timely maintenance and repair, and protect PPW Holding, Inc. information resources against unexpected vulnerabilities.

10.3.4 Change/Version Control

Changes to information resources and configurations must be managed to ensure that PPW Holding, Inc. information resources are not inadvertently exposed to unnecessary risks and vulnerabilities. All changes must be appropriately approved and documented. Change control records must be maintained to support and document system software maintenance, software and hardware upgrades, and any local system modifications.

10.3.5 Patch Management

An effective patch management process must be implemented to investigate, prioritize, test, track, and control the deployment and maintenance of software releases, and to resolve known security vulnerabilities. The patch management process must be addressed by all information resources installed in the PPW Holding, Inc. Computing Environment. Personnel involved in the patch management process must be trained to ensure a viable vulnerability mediation process.

Patch management involves acquiring, testing, and installing multiple patches (code changes) to software systems, including operating system software, supporting software and packages, firmware, and application software. Patch management tasks include: maintaining current knowledge of available patches; deciding what patches are appropriate for particular information resources; prioritizing the patches to be installed; testing patches in a nonproduction environment first in order to check for unwanted or unforeseen side effects; developing a backout plan, which includes backing up the systems about to be patched to be sure that it is possible to return to a known-good working configuration should something go wrong with the patch; ensuring that patches are installed properly; testing information resources after installation; and documenting all associated procedures, such as specific configurations required.

Patch management is critical to ensure the integrity and reliability of information resources. Patch management should be capable of:

- Highly granular patch update and installation administration (i.e., treating patches and mainframes, servers, desktops, and laptops separately).
- Tracking machines, and updating and enforcing patches centrally.
- Verifying successful deployment on each machine.
- Deploying client settings, service packs, patches, hot fixes, and similar items network-wide in a timely manner in order to address immediate threats.

- Initiating from a central management console.
- Providing scheduling, desktop management, and standardization tools to reduce the costs associated with distribution and management.
- Providing ongoing deployment for both new and legacy systems in mixed hardware and OS environments.
- Automating the repetitive activity associated with rolling out patches.
- Analyzing the operating system and applications to identify possible security holes.
- Scanning the entire network (IP address by IP address) and providing information such as service pack level of the machine, missing security patches, key registry entries, weak passwords, users and groups, and more.
- Analyzing scan results using filters and reports to proactively secure information resources (e.g., installing service packs and hot fixes, etc.).

10.3.6 Significant Changes

Significant changes to sensitive, critical, and business-controlled information resources require [reassessment of security controls and must be reviewed with the CISO.

10.3.6.1 Computing Platform

A significant change to an information resource (hardware and software) is determined by the extent of the change and the impact on the protection features. Any change to the information resource that adversely affects security controls is considered a significant change.

10.3.6.2 Application

A significant change to an application system is determined by the impact of the change on the input, processing, or output associated with the application. Any change to the application system that adversely affects security controls is considered a significant change.

10.3.7 Change Management for Pilots and Proofs of Concept

Pilots and proofs of concept must be subject to the same change control requirements as production systems. The executive sponsor must ensure that change control procedures are followed during testing and implementation

10.3.8 Emergency Change Management Provisions

For Critical Cyber Assets that are associated with an emergency situation, such as, during or after storms, flood, fires, malicious acts or other similar special operating situations, an abbreviated change management process must be followed which includes approvals and audit tracking.

10.4 Hardware Security

Hardware security must be implemented based on PPW Holding, Inc. published standards on all computer hardware including, but not limited to, the following:

- Mainframes.
- Network devices.
- Servers.
- Workstations.
- Portable devices.

10.4.1 Mainframes

Appropriate security controls must be enabled. For mainframe implementation of this security policy, contact the mainframe manager.

10.4.2 Network Devices

Appropriate security controls must be enabled on all network devices, including routers, hubs, and switches (see Chapter 11, Networks and Communications).

10.4.3 Servers

PPW Holding, Inc. servers must be protected commensurate with the level of sensitivity and criticality of the information and business function. Server installation and deployment must comply with standard configuration and deployment guidelines unique to the individual server platform. Servers in production, including web and database servers, must not be used for development or testing.

10.4.3.1 Hardening Servers

All information resources must be implemented on servers hardened to PPW Holding, Inc. standards. Hardening control standards must be implemented specific to each platform. These standards must be updated as new vulnerabilities are uncovered and updates are available. Servers must not be deployed to a production environment prior to hardening.

Note: The CIO or the CIO designee is responsible for the distribution of server hardening standards.

10.4.3.2 Using Web Servers

All PPW Holding, Inc. web servers, regardless of location, must use approved hardware and software with standard configurations to reduce likelihood of loss or compromise due to exploitation of configuration vulnerabilities. For web or Internet projects under the direct control of PPW Holding, Inc., the development and testing must be conducted on specifically designated development web servers. Web servers must not be implemented on individual workstations without prior written approval by the CIO.

10.4.3.3 Using Database Servers

Database servers must use security controls appropriate for the level of sensitivity and criticality of the information they contain. Database servers must be separate from other servers, including Web and application servers (see section 10-5.3.4 for an exception). Database servers located inside PPW Holding, Inc. firewalls must not be directly accessible from Web servers or other systems located outside firewalls. Database servers must not be deployed to a production environment before hardening.

10.4.3.4 Combining Web and Database Servers

A Web server and database server may be placed on the same host if all the following requirements are met:

- Application is not sensitive or critical.
- Application is not Internet accessible.
- Application is not on the DMZ.
- Application is not enclaved with sensitive or critical applications.
- Application is operationally standalone, that is, does not interact with other database servers.
- Host meets PPW Holding, Inc. server hardening standards.

10.4.4 Workstations

All workstations must have appropriate security controls. All personnel are responsible for protecting the information resources at their individual workstations and abiding by all information security policies and procedures that apply to their individual environment.

All PPW Holding, Inc. workstations must have an approved personal firewall installed and personnel must connect to the PPW Holding, inc. intranet at least once per week to receive the latest software patches, antivirus pattern recognition files, and personal firewall patterns. Appropriate configuration of the workstation to receive these patches and pattern updates is required.

10.4.4.1 Physical Security

All PPW Holding, inc. workstations must be protected, at a minimum, by secure physical access to the facility or room. Other physical security controls may include, but are not limited to: unique workstation identification (inventory control), identification card reader, screen protector or positioning screen to restrict viewing from passersby, lockable keyboard, physical lock and key, and desk-fastening security equipment.

10.4.4.2 Screen Saver and Screen Locking

Where feasible, all workstations must be configured at deployment to use password protected screen savers. After a period with no activity, password-protected screen savers will blank the screen; a password is then required to resume work. The maximum period of inactivity that initiates the screen saver must be 15 minutes or less as dictated by security needs. Users must protect the screen saver password just as they protect all other system passwords.

10.4.5 Portable Devices

Portable information resources must be protected against damage, unauthorized access, and theft. All personnel who use or have custody of portable devices, such as laptop computers, notebook computers, palm tops, handheld devices, wireless telephones, and removable storage media devices, are responsible for their safekeeping and the protection of any sensitive, critical, or business-controlled information stored on them. In addition, sensitive and business-controlled sensitivity information on portable devices must be protected (e.g., encrypted) when leaving a secure environment. Theft of a portable device, either known or suspected must be reported immediately to the Corporate Physical Security Office.

All PPW Holding, Inc. portable workstations such as laptop and notebook computers must have an approved personal firewall installed and connect to the PPW Holding, Inc. Intranet at least once per week to receive the latest software patches, antivirus pattern recognition files, and personal firewall patterns. Appropriate configuration of the portable workstations to receive these patches and pattern updates is required.

10.5 Software Application Security

Security attributes and capabilities must be selection criteria in the acquisition or development of all PPW Holding, Inc. software. The collection of features of the operating system, application, database management system, and utility software must be complementary and enhance the security of the system.

10.5.1 Software Safeguards

Software configuration and installation must include only the features and functions necessary to perform the required business activities. Precautions must include, but are not limited to, the following:

- Activating or enabling all safeguards embedded in computer software and protecting these safeguards against compromise, subversion, or unauthorized manipulation.
- Disabling or removing all features and files that have no demonstrable purpose.
- Disabling or removing default privileged logon IDs, changing all default passwords, and removing guest accounts.
- Prohibiting use of administrative and root accounts for running production applications.
- Limiting access to the specific files required.
- Restricting access to systems software utilities to a small number of authorized users.

10.5.2 Secure Transaction Compliance

10.5.2.1 Financial Requirements

Financial requirements must be implemented when processing e-Commerce financial transactions (these requirements are set by dominant financial institutions, such as banks and VISA).

10.5.2.2 Health Insurance Portability and Accountability Act Requirements

Health Insurance Portability and Accountability Act (HIPAA) requirements must be implemented when processing health or medical information.

10.5.3 Version Control

All software that can be modified must be managed through the authorized PPW Holding, Inc. change control and management process (see 10-4, Configuration and Change Management). Software containing modifications, such as exits and supervisor calls, must be documented detailing the extent of the modifications. The modifications must be fully reviewed, tested, documented, and installed in a controlled environment to avert possible adverse effects on the security of the production environment.

10.5.3.1 Updating Software

Only authorized personnel may perform updates to the production application programs or operating system libraries/directories.

10.5.3.2 Distributing software

Controls must be in place to regulate and manage the distribution of PPW Holding, Inc. system-wide production applications to field sites. These controls must ensure that the correct version is installed on all nodes and that the code cannot be modified on the field computer systems.

10.5.3.3 Prohibited Software

Software that is unlicensed, borrowed, downloaded from online services, public domain shareware/freeware, or unapproved personal software must not be installed. All requests for software must be made by contacting the enterprise service desk for support. (see 5-5.1, Acquiring Hardware and Software).

10.5.4 Operating Systems

All PPW Holding, Inc. information resources must use approved operating systems, including all approved updates and patches. Operating systems must have controls in place to prevent a compromise of the integrity of the computer operating system environment and must be configured to comply with operating system security requirements specified by PPW Holding, Inc. policies.

10.5.5 Ports and Services

Only those ports and service required for normal and emergency operations shall be enabled. All other ports and services shall be disabled. For Cyber assets within the Electronic Security Perimeter(s), those ports and services used for testing purposes must be disabled prior to production use.

10.5.6 Application Software

PPW Holding, Inc. information resources must use only approved application software. Application software must be compatible with installed security software. Security activities for application software must be incorporated in the applicable life-cycle process during development. Application software developed in house or outsourced for sensitive, critical, or business-controlled information resources must undergo a formal security assessment.

10.5.7 Database Management Systems

All PPW Holding, Inc. information resources must use PPW Holding, Inc.-approved database management systems (DBMSs) that have been configured to comply with PPW Holding, Inc. security policies.

10.5.7.1 DBMS Activity Logs

Each production DBMS must have a journal file to protect against accidental destruction of data or interruption in service. Journal files must be backed up as specified in the DBMS or the applicable business continuity plan (see Chapter 12, Business Continuity and Contingency Planning).

10.5.7.2 DBMS Security Features and Views

All database tables must utilize the security features of the DBMS or equivalent to preserve the integrity of the database. Views and discretionary access controls must be used to protect sensitive, critical, and business-controlled information and enforce need to know.

10.5.8 COTS Software

Commercial-off-the-shelf (COTS) software must be acquired and distributed from a PPW Holding, Inc.-approved source. The IT department approves COTS software for use within the PPW Holding, inc. computing environment. Requests for unapproved COTS software must be submitted to the enterprise service desk so that it can be routed for review and approval. Computer software purchased for PPW Holding, Inc. must be registered to PPW Holding, Inc.

10.5.9 COTS Vulnerability Assessment

A COTS software security evaluation must be performed for all proposed additions to the PPW Holding, Inc. computing environment. It is recommended that the COTS vulnerability assessment be updated for sensitive, critical, and business-controlled information resources.

10.5.10 Independent Code Review

Custom programs or COTS applications that contain custom programming or scripts may be subject to an independent code review. The independent code review will review the source code and documentation to verify compliance with software design documentation and programming standards and to ensure the absence of malicious code (see 8-6.3.6, Conduct Independent Security Code Review).

10.5.11 Browser Software

Workstations should use the approved PPW Holding, Inc. standard browser software. All web applications developed for PPW Holding, Inc. use must be compatible with the PPW Holding, Inc. standard browser software. The standard browser software must support encryption.

10.5.12 Third-Party Software

Third-party software is defined as follows:

- Software developed for PPW Holding, Inc. by a vendor, contractor, or other third party.
- Other limited-distribution custom-built applications.
- COTS software that has been modified with custom programming scripts or languages.

10.5.12.1 Ownership

Third-party software developed under contract or funded by PPW Holding, Inc. must be considered the property of PPW Holding, Inc. unless otherwise stated in the contract.

10.5.12.2 Licensing and Escrow of Custom-Build-Applications

Third-party software not owned by PPW Holding, Inc. but considered a required component of an information resource used in an essential business activity must be licensed to the PPW Holding, Inc. The vendor of this software must periodically escrow the source code.

10.5.12.3 Assurance of Integrity

A written integrity statement must be provided with significant third-party software that provides assurances that the software does not contain undocumented features or hidden mechanisms that could be used to compromise the software or operating system security.

10.6 Remote Control Software

The purpose of the remote control software policy is to establish the rules for the configuration, maintenance, deployment and use of remote control software. These rules are necessary to preserve the integrity, availability and confidentiality of PPW Holding, Inc. information assets.

10.6.1 Remote Control Software (RCS)

This is a tool that allows PPW Holding, Inc. administrative/support personnel the ability to access a server or a workstation as if they were sitting at the physical console. When Remote Control Software is active, administrative/support personnel are able to observe activity on the target system or take control of a system directly and perform tasks. RCS typically consist of client and server pieces, where the server component runs on the machine controlled.

10.6.1.1 General Remote Control Software Requirements

The following apply to all installations of RCS:

- RCS products must be approved by the CISO prior to being installed in all environments – production and test/development
- The CISO will specify the environments in which a particular piece of software may be deployed. Environments may be broken down by machine type [workstation, server], platform [NT, Novell], server task [web server, database, email], network location [DMZ, internal], and access point [internal LAN, VPN, dial-up]
- RCS products must authenticate users before allowing access to remote control functionality. This authentication must comply with current authentication and access control policies, including the following:

- Accounts must uniquely identify a single individual (with the exception of vendor accounts).

- Password must not be sent in clear text over any network

- Intruder Detection and account lockout policies must be enforced.

- It is acceptable to use the same credentials [username/password] to authenticate to both the RCS and the underlying OS on the machine being controlled.

- RCS must use an authentication model which can be centrally managed to corporate standards.

- The CISO will approve implementation standards created and maintained by IT which specify the configuration of security controls for RCS products

- Access via remote control must be logged. At a minimum, connection attempts must be logged on both success and failure. RCS products should, where technically feasible, use the native logging capabilities of the OS of the machine being controlled.

- Remote control access must be justified and approved separately from other types of access. A user having administrative privileges on a given machine will not automatically receive remote control access for that machine, without approval from the CISO.

- Procedures for requesting access and obtaining approvals will be developed and documented by the CIO or the CIO designee.

- Remote control sessions must not be left open when not actively being used.

- RCS products must be updated with all vendor-issued patches, fixes and upgrades as soon as they become available from the vendor.

- No more than one instance of any RCS product(s) may be installed on any system without prior approval of the CISO.

10.6.1.2 Workstations

The following applies to hardware workstations, not virtual. Unlike servers, workstations will often have a user logged in at the console. Allowing remote control of workstations opens the possibility of user impersonation and privilege escalation if proper controls are not in place. The following items apply to RCS products which allow remote control of workstations:

- RCS products installed on workstations must be configured to notify and obtain approval from the currently logged in user, before allowing remote control connections to be established

- Persons controlling workstations remotely must not be allowed to blank the screen or lockout the keyboard or mouse from use by the person actually at the console.

- RCS products must disconnect remote control sessions after a fixed period of inactivity at the remote end.

- Provisions for exempting security or operationally sensitive workstations must be available.

10.6.1.3 Servers

The following applies to hardware servers, not virtual servers.

- RCS products must not allow access to any server to which someone is currently logged in at the console unless the console user can be notified and provide consent to the connection, or the RCS supports multiple sessions.

- RCS products should automatically log the remote user off the console when the remote connection is terminated.

10.7 Protection against Viruses and Malicious Code

All PPW Holding, Inc. information resources must be protected against the introduction of viruses and other types of malicious code that can jeopardize information security by contaminating, damaging, or destroying information resources. See Chapter 13, Incident Management, for more detailed information on handling virus and malicious code infections.

10.7.1 Virus Protection Software

10.7.1.1 Installation

All information resources within PPW Holding, Inc. must have active virus protection software installed and enabled. Unauthorized personnel must not modify the configuration of virus protection software after installation.

10.7.1.2 Scanning

To ensure PPW Holding, Inc. perimeter security, Security Information Services will conduct scans for malicious code on the firewalls, FTP servers, mail servers, Intranet servers, Internet application protocols, and other information resources as necessary.

10.7.1.3 Updating

Centralization of automatic updates to virus software is key to updating information resources with the latest version of virus detection software and updated files of virus types (signature files). The managers, computing operations/infrastructures, are responsible for ensuring that virus protection software and signature files are current and distributed to PPW Holding, Inc. information resources. Virus protection software and signature files must be periodically updated or immediately updated whenever a new threat is perceived.

10.7.2 Other Protection Measures

10.7.2.1 Protecting shared and Retrieved Files

All personnel must run virus protection software prior to using shared or retrieved files from workstations, laptops, removable media, and other information resources.

10.7.2.2 Evaluating Active Content of CGI Code

A code review must be conducted on sensitive and critical information resources that contain active content code or CGI scripts. A code review is recommended for business-controlled information resources that contain active content code or CGI scripts. In addition to the code review, information resources that contain active content code or CGI scripts may be subject to an independent code review (see 8-6.3.6).

10.7.2.3 Protecting Applications

All application software and supporting files must be protected such that an error will be generated if there is an unauthorized attempt to modify the software. All activities involving modification of software must be logged.

10.7.2.4 Creating Backups before Installation

To assist with the post-virus restoration of normal computer activities, all computer software must be copied prior to its initial usage, and such copies must be stored in a secure location. These copies must not be used for ordinary business activities but will be reserved for recovery from computer virus infections, hard disk crashes, and other computer problems (see Chapter 12).

10.7.2.5 Checking for Viruses before Distribution

All software, information, or any other type of digital media must be tested to identify the presence of computer viruses and other malicious code prior to distributing to PPW Holding, Inc. organizations, personnel, businesses, or the public.

10.8 Audit Logs

Audit logs must record events and situations including, but not limited to, the following:

Significant operation-related activities.

Security-related events. (for security logging requirements, see the **PacifiCorp Security Logging Standard**)

10.8.1 General Guidelines

Audit logs must be sufficient to facilitate reconstruction of events if a compromise or malfunction is suspected or has occurred. For events where immediate attention is required, the audit utility may trigger alarms that are directed to the proper location for action.

10.8.2 Protection of Audit Logs

Audit logs must be treated as **restricted** information; protected from unauthorized access, modification, or destruction; and reviewed periodically for action. Access to logs must be granted based upon need to know and least privilege.

10.8.3 Retention of Audit Logs

Audit logs must be retained for 90 days or as directed by the PPW Holding, Inc. records management office and/or compliance office.

10.8.4 Review of Audit Logs

Audit logs must be reviewed periodically for potential security incidents and security breaches. Audit logs may be reviewed to evaluate the damage caused by a security breach. In this process, audit logs may also support the recovery of data lost or modified.

10.8.5 Operating System Audit Logs

Operating systems must include the means for identifying, journaling, reporting, and assigning accountability for potential compromises or violations of system integrity. Operating system software must have and audit capability to create, maintain, and protect an audit trail from modification or unauthorized access or destruction. All operating system supporting cyber assets in-scope of the CIPS must manage logs in accordance to the standard.

10.8.6 Application Audit Logs

Critical or sensitive application that have logging functions, such as database management software used to store information, must implement their logging functions. Business-controlled applications may implement logging when appropriate. All cyber assets in-scope of the CIPS must manage logs in accordance to the standard.

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11 Network and Communications

11.1 Policy

PPW Holding, Inc. network infrastructure must be protected at a level commensurate with its value to PPW Holding, Inc.. Such protection must include the implementation of the physical, administrative, and technical security controls and processes that will safeguard the availability and integrity of the network in accordance with PPW Holding, Inc. policies and procedures.

11.2 Network and Communications Security

11.2.1 Purpose

Physical, administrative, and technical security controls and processes that safeguard the availability and integrity of the network will be implemented to:

- Safeguard data traffic.
- Detect and prevent unauthorized access.
- Respond to computer security incidents.
- Detect and correct transmission line errors.
- Ensure message integrity throughout the system.
- Provide equipment security.
- Ensure that recovery procedures are in place and working.
- Implement appropriate auditing procedures.

11.2.2 Scope

Network and communications security policies apply to the following:

All transmission technologies used on behalf of PPW Holding, Inc. in PPW Holding, Inc. or non-PPW Holding, Inc. facilities. These technologies include, but are not limited to, local area networks (LANs), wide-area networks (WANs), voice communications, videoconferencing systems, voice messaging systems, desktop video communications, satellite broadcasts, facsimile transmission, and all other transmissions over landline, wireless, or Internet-based networks.

All types of information and network services, data, voice, image, and multi-media communications, regardless of transmission technology.

11.3 Network Architecture

Network architecture describes the appearance, functions, locations, and resources used in the network infrastructure. Network architectures must be designed with the appropriate level of administrative and technical security controls. PPW Holding, Inc. protects its network architecture through the following:

- Managing network addresses.
- Approving services and protocols.
- Securing network perimeters.
- Implementing network integrity controls.

11.3.1 Mapping Network Addressing

All network names and addresses must be managed and approved by a central addressing authority within Infrastructure Services. Internal network addresses must be protected, and access to internal network addresses will be based upon need to know and least privilege. When appropriate, Infrastructure Services will conceal network addresses and provide translation of nonroutable addresses.

11.3.2 Approving Services and Protocols

All information resources must use only network services and protocols approved by the IT department.

11.3.3 Securing Network Perimeters

Perimeters are clearly defined boundaries that must be established to securely control the traffic between PPW Holding, Inc. information resources and all other networks. All inbound or outbound network traffic must pass through appropriate access control devices, such as firewalls, before reaching PPW Holding, Inc. information resources. The CIO must ensure perimeter monitoring and may block the Internet Protocol (IP) address of a computer performing hostile reconnaissance or attacks against PPW Holding, Inc. networks. Other appropriate defensive measures to protect the PPW Holding, Inc. information resources may be utilized, as approved by the CIO and CISO.

11.3.4 Implementing Network Integrity Controls

The CIO must establish a system of controls to safeguard the data traffic, detect and correct transmission line errors, ensure message integrity throughout the system, and protect computers and other telecommunications endpoints. Adequate audit procedures must be employed to monitor and analyze network integrity.

11.3.5 Electronic Security Perimeter(s)

11.3.5.1 Electronic Security Perimeter

The identification and protection of an Electronic Security Perimeter(s) which all Critical Cyber Assets reside, as well as all access points on the perimeter must be documented and adhere to the ***Network Boundary Controls*** document. This document must, at a minimum, address the technical requirements stated in Critical Infrastructure Protection Standard.

11.3.5.1.1 Access Points

Access points to the Electronic Perimeter(s) must include any externally connected communication end point (for example, dial-up modems) terminating at any device within the Electronic Security Perimeter(s)

11.3.5.1.2 Dial-up Accessible

For a dial-up accessible Critical Cyber Asset that uses a non-routable protocol, that single access point at the dial-up device must be defined.

11.3.5.1.3 Communication Links

Communication links connecting discrete Electronic Security Perimeters must not be considered part of the Electronic Security Perimeter. However, end points of these communication links within the Electronic Security Perimeter must be considered access points to the Electronic Security Perimeter(s)

11.3.5.1.4 Non-Critical Cyber Assets

Any non-critical Cyber Asset within a defined Electronic Security Perimeter shale be identified and protected pursuant to the requirements of the CIPS standard CIP-005.

11.3.5.1.5 Cyber Assets Used in Access Control and Monitoring

Cyber Assets in the access control and monitoring of the Electronic Security Perimeter must be afforded the protective measures as specified in the CIPS standard CIP-003, CIP-004 RequirmentR3, CIP-005 Requirement R2 and R3, CIP-006 Requirement R2 and R3, CIP-007 Requirements R1 and R3 through R9, CIP-008 and CIP-009.

11.3.5.1.6 Documentation

Documentation shall be maintained regarding Electronic Security Perimeter(s), all interconnected Critical and non-critical Cyber Assets within the Electronic Security Perimeter(s), all electronic access points to the Electronic Security Perimeter(s) and the Cyber Assets deployed for he access control and monitoring of theses access points.

11.3.5.2 Electronic Access Controls

All organizational processes and technical and procedural mechanisms for control of electronic access at all electronic access points to the Electronic Security Perimeter must be documented and implemented.

11.3.5.2.1 Access Control Process and Mechanisms

These process and mechanisms must use an access control model that denies access by default, such that explicit access permissions must be specified.

11.3.5.2.2 Ports and Services

At all access points to the Electronic Security Perimeter(s), only ports and services required for operations and for monitoring Cyber Assets within the Electronic Security Perimeter shall be enabled. The configuration of those ports and services shall be documented, individually or by specified grouping.

11.3.5.2.3 Securing Dial-up Access Procedure

A procedure for securing dial-up access to the Electronic Security Perimeter(s) must be maintained.

11.3.5.2.4 External Interactive Access

Where external interactive access into the Electronic Security Perimeter has been enabled, strong procedural or technical controls shall be implemented to ensure authenticity of the accessing party, where technically feasible.

11.3.5.2.5 Documentation Requirements

The required documentation shall, at least, identify and describe the following:

- The process for access request and authorization.
- The authentication methods.
- The review process for authorization rights, in accordance with Standard CIP-004 Requirement R4.
- The controls used to secure dial-up accessible connections.

11.3.5.2.6 Appropriate Use Banner

Where technically feasible, electronic access control devices shall display an appropriate use banner (see Warning Banner, section 14.4.4) on the user screen upon all interactive access attempts.

11.3.5.3 Monitoring Electronic Access

An electronic or manual process(es) for monitoring and logging access at access points to the Electronic Security Perimeter(s) shall be implemented and documented. This process(es) must be available twenty-four hours a day, seven days a week.

11.3.5.3.1 Dial-up Accessible Critical Cyber Assets

For dial-up accessible Critical Cyber Assets that use non-routable protocols, a monitoring process(es) at each access point to the dial-up device shall be implemented and documented, where technically feasible.

11.3.5.3.2 Detection and Alerting

Where technically feasible, the security monitoring process(es) shall detect and alert for attempts at or actual unauthorized access. These alerts shall provide for appropriate notification to designated response personnel. Where alerting is not technically feasible, access logs shall be assessed for attempts at or actual unauthorized accesses at least every ninety (90) calendar days.

11.3.5.4 Cyber Vulnerability Assessment

A cyber vulnerability assessment of the electronic access points to the Electronic Security Perimeter(s) and the all Cyber Assets within the Electronic Security Perimeter(s) shall be performed at least annually. The vulnerability assessment must include, at a minimum, the following:

- A document identifying the vulnerability assessment process.
- A review to verify that only ports and services required for operations at these access points and Cyber Assets are enabled
- The discovery of all access points to the Electronic Security Perimeter
- A review of controls for default accounts, passwords, and network management community strings
- Documentation of the results of the assessment, the action plan to remediate or mitigate vulnerabilities identified in the assessment and the execution status of that action plan.

11.3.5.5 Documentation Review and Maintenance

All documentation shall be reviewed, updated and maintain to support compliance with the requirements of CIP-005 and CIP-007.

- All documentation required for CIP-005 reflects current configurations and processes and shall be reviewed at least annually
- All documentation shall be updated to reflect modifications of the network, systems or controls within ninety (90) days of the change.
- Electronic access logs shall be retained for at least ninety days (90). Logs related to reportable incidents shall be kept in accordance with the requirements of CIP-008.

11.4 Protecting the Network Infrastructure

11.4.1 Scope

The network infrastructure consists of the facilities, equipment, services, protocols, and applications used to transmit, store, and process information. The PPW Holding, Inc. network infrastructure is protected through the following:

- Ensuring physical security.
- Maintaining asset control.
- Protecting network configuration information.
- Implementing identification and authentication.
- Implementing authorization.
- Implementing hardening standards.
- Determining when a secure enclave is required.
- Establishing secure enclaves.
- Conducting intrusion detection.
- Conducting penetration testing.
- Conducting vulnerability scans.

11.4.2 Ensuring Physical Security

Servers and other components of the PPW Holding, Inc. networks must be located in areas secured to a level commensurate with the sensitivity and criticality of the information stored, processed, or transmitted. Access to network infrastructure components must be limited to only those personnel with a demonstrated need for access (see Chapter 7).

11.4.3 Maintaining Network Asset Control

All infrastructure components must be inventoried at regular intervals and labeled for asset management and physical protection (see Chapter 10).

11.4.4 Protecting Network Configuration Information

Network information, including, but not limited to, configurations, addresses, subnet masks, secure enclave locations, and firewalls must be protected and treated as "RESTRICTED INFORMATION" at a minimum. If such information is deemed to be critical infrastructure protection information (CII), the ***Critical Infrastructure Information Protection Procedures*** must be followed.

Access to network configuration information must be based upon the security principles of need to know and least privilege.

11.4.5 Implementing Identification and Authentication

Personnel must be required to identify and authenticate themselves to the network before being allowed to perform any other actions on the network (see Chapter 9).

11.4.6 Implementing Authorization

Access to information resources must be granted based on the job function, appropriate clearance, need to know, separation of duties, and least privilege (see Chapter 9).

11.4.7 Implementing Hardening Standards

Information resources supported by networking must be hardened to meet or exceed the requirements documented in PPW Holding, Inc. hardening standards specific to each platform. Hardening refers to the process of implementing additional software and hardware security controls.

Note: The CIO is responsible for the distribution of information resource hardening standards.

11.4.8 Determining When a Secure Enclave is Required

Information resources designated as sensitive or critical must be assessed by the CIO or the CIO designee, to determine if the resource should reside in a secure enclave. It may be recommended that certain business-controlled information resources also b e assessed for inclusion in a secure enclave. A completed business impact assessment and the architectural diagram must be submitted to the CIO or the CIO designee for review and determination of enclave requirements.

11.4.9 Establishing Secure Enclaves

Secure enclaves are network areas where special protections and access controls, such as firewalls and routers, are utilized to secure information resources. Secure enclaves apply security rules consistently and protect multiple systems across application boundaries. Secure enclaves must be implemented as follows:

- Employee protection for the highest level of information sensitivity in that enclave.
- Reside on network segments (subnets) separate from the remainder of PPW Holding, Inc. networks.
- Use “network guardians,” such as packet filtering or application proxy firewalls, to mediate and control traffic.

- Set enclave server rules and operational characteristics that can be enforced and audited.
- Allow only pre-defined, securable information traffic flows.
- Restrict administration to a small, well-defined set of system administrators.
- Employ intrusion detection systems.
- Audit the network boundary controls through the performance of network scanning procedures on a regular basis.

11.4.10 Scanning, Penetration Testing and Vulnerability Assessments

Only personnel authorized by the CISO will conduct scanning, penetration testing, and vulnerability scans and assessments of PPW Holding, Inc. information resources. During audits and investigations, internal audit may conduct scanning, penetration testing, and vulnerability assessments as deemed appropriate.

11.4.11 Conducting Intrusion Detection

Requests for intrusion detection must be directed to the manager, CISO, for approval. The CISO or the CISO designee will conduct intrusion detection for PPW Holding, Inc. networks.

11.4.12 Conducting Penetration Testing

Requests for penetration testing must be directed to the manager, CISO, for approval. The CISO or the CISO designee will conduct penetration testing for PPW Holding Inc. networks. Internal audit conducts penetration testing on PPW Holding, Inc. networks at its discretion.

11.4.13 Conducting Vulnerability Scans

Requests for vulnerability scans must be directed to the manager, CISO, for approval. The CISO or the CISO designee will conduct vulnerability scans on PPW Holding, Inc. information resources.

11.5 Internet Technologies

PPW Holding, Inc. uses Internet technologies in the following environments:

- Internet.
- Intranet.
- Extranet.

11.5.1 Internet

Access to the Internet from PPW Holding, Inc. information resources must be routed through PPW Holding, Inc approved access control technology, such as firewalls and filtering routers.

11.5.2 Intranet

An intranet is a network based on Internet technologies located within an organization's network perimeter. PPW Holding, Inc. operates and maintains an internet for the conduct of PPW Holding,. Inc. business. Access control technology, such as firewalls and filtering routers, must be used to protect the PPW Holding, Inc. intranet at the network perimeter to provide access control and support for auditing and logging.

11.5.3 Extranet

An extranet is a network based on Internet technologies that allows an organization to conduct business and share information among business partners, vendors, and customers. Business partners must be limited in their access to the specific information resources identified in the network connectivity request that is approved by the IT department.

11.6 Protecting the Network/Internet Perimeters

The perimeter between PPW Holding, Inc. network and the Internet environments must be protected through the following:

- Implementing Internet security requirements.
- Implementing firewalls.
- Establishing demilitarized zones (DMZs).
- Monitoring network traffic.

11.6.1 Implementing Internet Security Requirements

Internet-accessible information resources, such as those residing on DMZs, must implement Internet security requirements that include, but are not limited to, the following:

- Securely partitioning each Internet accessible environment, such as the Intranet and Extranet, from each other.
- Using firewalls or filtering devices to screen and monitor incoming and outgoing traffic.

- Supporting encryption to protect the storage and transmission of sensitive and business-controlled sensitivity information.

- Performing continual evaluation, testing, monitoring, and maintenance of the firewalls.

- Applying real-time monitoring, auditing and alerting to detect intrusion, abuse or mis-use.

11.6.2 Implementing Firewalls

A firewall is a safeguard or type of gateway that is used to control access to information resources. A firewall can control access between separate networks, between network segments, or between a single computer and a network. A current-generation firewall is generally not a single component, but a strategy composed of both hardware and software for protecting an organization's resource.

11.6.2.1 Firewall Configurations

PPW Holding, Inc. firewalls must be configured:

- Deny all services not expressly permitted.

- Audit and monitor all services, including those not permitted, to detect intrusions or misuse.

- Notify the firewall administrator and system administrator in near real time of any item that may need immediate attention.

- Run on a dedicated computer or device.

- If the logging function becomes disabled, an alert must be generated and sent to the firewall administrator.

- Disable or delete all nonessential firewall-related software, such as compilers, editors, and communications software.

11.6.2.2 Firewall Administrators

Each firewall or logical group of firewalls must have adequate resources assigned for firewall administration. Firewall administrators are responsible for ensuring compliance with standards for configuration and approved services and protocols.

11.6.2.3 Firewall Administration

All PPW Holding, Inc. firewalls must be located in a controlled environment. Firewall administration must be performed from the local console or via remote access if approved by the manager, network services and appropriately secured through strong authentication and encryption. Firewall configurations must be protected and treated as "RESTRICTED INFORMATION." Access to firewall configuration information must be based upon the security principles of need to know and least privilege.

11.6.2.4 Firewall System Integrity

Firewall system configuration and integrity must be validated and tested periodically by the firewall administrator.

11.6.2.5 Firewall Backup

The firewall (system software, configuration data, database files, etc.) must be backed up as determined in the approved architecture that meets the business needs.

11.6.3 Establishing Demilitarized Zones

Demilitarized zones (DMZs) are network segments between intranets, extranets, and the Internet that provide increased security for data transfer between information resources, vendors, and the public. Web servers and electronic commerce systems accessible to the public must reside within a DMZ with approved access control, such as a firewall or gateway. Sensitive, critical, and business-controlled data must not reside within a DMZ. All inbound traffic to the intranet from the DMZ must be passed through a proxy-capable device.

11.6.4 Monitoring Network Traffic

The PPW Holding, Inc. network perimeter must be monitored for network connectivity, services, and traffic. Monitoring must be conducted on both active and inactive connections.

11.7 Network Connections

11.7.1 Establishing Network Connections

The CIO must approve in advance the establishment of network connectivity. Any connectivity to the PPW Holding, Inc. network must allow monitoring.

11.7.2 Requesting Connections

The CIO provides the mechanism for requesting, reviewing, evaluating, and approving connectivity between non-PPW Holding, Inc. individuals and organizations wishing to establish connectivity to the PPW Holding, Inc. managed network.

11.7.3 Approving Connections

Requests for connectivity to the PPW Holding, Inc. managed network must be reviewed, evaluated, and approved by the CIO. All requests for connectivity must follow and comply with the requirements the request process described in Firewall Change Request Form (FCRF) and the Network Boundary Controls Standard.

11.8 Business Partner Requirements

Business partners must follow and comply with the requirements identified in the Network Boundary Controls Standard, including, but not limited to, the following:

- Initiating requests with the executive sponsor for access to the PPW Holding, Inc. network.
- Complying with all PPW Holding, Inc. corporate security policies.
- Allowing site reviews by internal audit or CISO
- Allowing audits by internal audit or CISO
- Reporting any security incident immediately to the CISO and executive sponsor.
- Notifying the executive sponsor when connectivity is no longer required.

11.9 Limiting Third-Party Network Services

Network services approved for third-party connectivity must be governed by the principle of least privilege and limited to those serves and devices needed to perform the business function requested. The default must be to deny all access except those services specifically approved by the CIO or the CIO designee.

11.10 Implementing Access and Administration Controls

When establishing third-party connections, access controls and administrative procedures must be implemented to protect the confidentiality of PPW Holding, Inc. information resources. The third-party must be responsible for protecting its private network infrastructure and information and must not rely on PPW Holding, Inc. to perform this function.

11.11 Remote Access

11.11.1 Authentication

Where remote access is required, all information resources must implement remote access security. Information resources should be capable of strong authentication on application or network connections requiring remote access. Remote access from a non-PPW Holding, Inc. site requires users or devices to authenticate at the perimeter or connect through a firewall.

Personnel outside PPW Holding, inc. firewalls must authenticate at the perimeter. In addition, personnel outside of PPW holding, Inc. firewalls must use an encrypted session, such as VPN or security socket layer (SSL), if transmitting sensitive or business-controlled sensitivity information through an untrusted network.

11.11.2 Virtual Private Networks

A virtual private network (VPN) provides end users with a way to securely access information on the PPW Holding, Inc. over an untrusted network infrastructure or an untrusted public network such as the Internet. PPW Holding, Inc VPN requirements include, but are not limited to, the following:

- Any PPW Holding, Inc. VPN Solution must provide end-to-end security strategy and capability.

- Any VPN solution used for business partner connectivity must be capable of filtering access to specific information resources, and the connection must allow monitoring.

- Any computing device connecting to the PPW Holding, Inc. Intranet through a VPN must implement an approved personal firewall configured to PPW Holding, Inc. standards, as defined by the CIO or the CIO designee.

11.11.3 Modem Access

11.11.3.1 General Modem Access

Modem access for all information resources to and from PPW Holding, Inc. networks must be approved in writing in advance by the CIO or the CIO designee, the telecommunications manager and the CISO.

Analog dialup lines must be run through PPW Holding, Inc. PBX systems. The phone line must be physically disconnected from the modem when not in use, if technically and business feasible.

11.11.4 Dial-in Access

All dial-in access to and from PPW Holding, Inc. networks must be approved in advance by the responsible PPW Holding, Inc. manager and implemented by the CIO or the CIO designee, the telecommunications manager and the CISO.
All approved dial-in access must be established through a PPW Holding, inc. centralized dial-in service.

It is expected that for production systems, PPW Holding, Inc. personnel are responsible to perform or observe or, at least, review and monitor the actual implementation of any required modifications. The appropriate change control processes must be followed.

11.11.5 Telecommuting

Personnel working at alternative work sites must only use PPW Holding Inc. approved computer hardware, software and virus protection software when working on PPW Holding, inc. business, when sharing files with the PPW Holding, Inc., or when communicating through phone lines or the Internet with PPW Holding, Inc.

11.11.6 Remote Management and Maintenance

To protect the integrity of the PPW Holding, Inc. computing environment, use of remote administration and maintenance software and associated security controls must be approved by the CIO and the CISO, in cooperation with the requesting organization.

11.12 Network Audit Logs

Network audit logs must record events and situations including, but not limited to, the following:

- Significant operation-related activities.
- Security-related events.

11.12.1 General Guidelines for Network Audit Logs

Network audit logs must be sufficient in detail to facilitate reconstruction of events if a compromise or malfunction is suspected or has occurred. For events where immediate attention is required, the audit utility may trigger alarms that are directed to the proper location for action.

11.12.2 Protection of Network Audit Logs

Network audit logs must be treated as “RESTRICTED INFORMATION” protected from unauthorized access, modification, or destruction; and reviewed periodically for action. Access to logs must be granted based upon need to know and least privilege.

11.12.3 Retention of Network Audit Logs

Audit logs must be retained for a minimum of 90 days or as directed by the compliance office.

11.12.4 Review of Network Audit Logs

Audit logs must be reviewed periodically for potential security incidents and security breaches. Audit logs may be reviewed to evaluate the damage caused by a security breach. In this process, audit logs may also support the recovery of lost or modified data.

11.12.5 Network and Security Enclave Audit Logs

Network and secure enclave audit logs must include the means for identifying, journaling, reporting, and assigning accountability for potential compromises or violations of network integrity. Network and secure enclave applications must have an audit capability to create, maintain, and protect an audit trail from modification or unauthorized access or destruction.

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12 Business Continuity Management

12.1 Policy

It is essential to ensure that PacifiCorp is ready to respond effectively and efficiently to man-made, natural or technological disasters. Planning should meet the demands of a wide spectrum of scenarios to protect the company's assets and ensure the continuance of critical business services.

12.2 Business Continuity Management

12.2.1 Scope

Business continuity management applies to all PPW Holding, Inc. business platforms and critical supporting corporate functions.

12.2.2 Business Continuity Objectives

Develop business continuity plans and exercise them on a regular basis in order to minimize the impact of a disruption.

Utilize business continuity management to identify potential impacts that threaten the business, provide a framework to effectively respond to disasters and build organizational resilience.

Apply established business continuity and disaster recovery techniques and practices to ensure compliance to regulatory and other statutory requirements for planning.

12.2.3 Business Continuity Plan Requirements

12.2.3.1 Business Continuity Plans

Using standardized business continuity practices and tools established by the PacifiCorp business continuity program office, each business area is responsible for the development, exercising and maintenance of their business continuity plans. These plans must be reviewed and updated regularly to ensure they reflect the current business environment.

12.2.3.2 Business Continuity Framework

The business continuity management program office promotes a framework for the development, exercise and maintenance of plans. The following activities support planning efforts across the business:

- Identify and implement industry best practices
- Develop policies, standards and tools
- Provide methodologies, tools and training
- Consult on recovery strategies and plan development
- Identify impacts and risks to support development of mitigation strategies
- Facilitate exercise activities
- Maintain business recovery facilities

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13 Incident Management

13.1 Policy

PPW Holding, Inc. information resources must be protected against events that may jeopardize information security by contaminating, damaging, or destroying information resources. All information security incidents must be reported in accordance with the policies and procedures provided below regardless of whether or not damage appears to have been incurred.

13.2 Cyber Security Incidents

13.2.1 Overview

Information security incidents are events, whether suspected or proven, deliberate or inadvertent, that threatens the integrity, availability, or confidentiality of information resources. The reporting of incidents enables the responsible organizations to review the security controls and procedures; establish additional, appropriate corrective measures, if required; and reduce the likelihood of recurrence. To protect the PPW Holding, Inc. computing environment, the manager, CISO, may get involved at any point on any level for information security related incidents impacting PPW Holding, Inc.   All cyber security incidents must follow the process defined in the ***Cyber Security Incident Response Plan*** (CSIRT), including but not limited to:

- Procedures to characterize and classify events as reportable Cyber Security Incidents
- Response actions, including roles and responsibilities of incident response teams, incident handling procedures and communication plans.
- Process for reporting Cyber Security Incidents to the Electronic Sector Information Sharing and Analysis Center (ES ISAC).
- Process for updating the Cyber Security Incident response plan within thirty (30) calendar days of any changes.
- Process for ensuring the Cyber Security Incident response plan is reviewed at least annually.
- Process for ensuring the Cyber Security Incident response plan is exercised at least annually.

13.2.2 Cyber Security Incident Documentation Retention

Cyber Security Incident documentation that is relevant to the incident must be kept for three calendar years.

13.2.3 Reportable Incidents

Reportable incidents include, but are not limited to, the following:

- Physical loss, theft, or unauthorized destruction of PPW Holding, Inc. information resources; e.g., missing or damaged hardware, software, or electronic media.
- Unauthorized disclosure, modification, misuse, or inappropriate disposal of PPW Holding, Inc. information.
- Internal or external unauthorized access attempts to access information or the facility where it resides.
- Unauthorized activity or transmissions using PPW Holding, Inc. information resources.
- Internal or external intrusions or interference with PPW Holding, Inc. networks, such as denial-of-service attacks, unauthorized activity on restricted systems, unauthorized modification or deletion of files, or unauthorized attempts to control information resources.
- Information resources with system software that is not patched to the current level.
- Information resources with virus protection software that is not patched to the current level or is disabled.
- Information resources with virus pattern recognition files that are not current.
- Sudden unavailability of files or data normally accessible.
- Unexpected processes, such as e-mail transmissions that start without user input.
- Files being modified, though no changes in them should have occurred.
- Files appearing, disappearing, or undergoing significant and unexpected changes in size.
- Systems displaying strange messages or mislabel files and directories.
- Systems becoming slow, unstable, or inaccessible (e.g., will not boot properly).
- Data altered or destroyed, or access denied outside of normal business procedures.

- Detection of unauthorized personnel in controlled information security areas.
- Security violation, suspicious actions, or suspicion or occurrence of embezzlement or other fraudulent activities.
- Suspected bribery, kickbacks, and conflicts of interest.
- Revenue loss involving an information system.
- Prohibited mass electronic mailings.
- Potentially dangerous activities or conditions.
- Illegal activities.
- Violation of PPW Holding, Inc. information security policies and procedures.

13.3 Incident Prevention

The following actions by PPW Holding, inc. personnel can help prevent information security incidents:

- Display proper badge when in any PPW Holding, Inc. facility.
- Be aware of your physical surroundings, including weaknesses in physical security and the presence of any unauthorized visitor.
- Use only approved computer hardware and software with the latest patches installed.
- Install and maintain updated virus protection software and pattern recognition files.
- Do not download, install, or run a program unless you know it to be authored by a person or company that you trust.
- E-mail users should be wary of unexpected attachments.
- E-mail users should be wary of URLs, because they can link to malicious content. A common social engineering technique known as phishing uses misleading URLs to entice users to visit malicious Web sites.
- Install a personal firewall.
- Use a strong password of at least eight characters composed of upper- and lower-case alphabetic, numeric, and special characters.
- Encrypt information physically removed from a PPW Holding, Inc. facility or transmitted over a non-secure network such as the Internet.

- Back up data stored on local workstation.
- Follow best practices, including the following:
- Be wary of unexpected attachments. Know the source of the attachment before opening it. Remember that many viruses originate from a familiar e-mail address.
- Be wary of URLs in e-mail or instant messages. URLs can link to malicious content that, in some cases, may be executed without your intervention.
- Be wary of social engineering attempts to solicit restricted information, such as account numbers and passwords.
- Users of technology such as instant messaging and file-sharing services should be careful of following links or running software sent by other users. These are commonly used methods among intruders attempting to build networks of distributed denial-of-service agents.
- Use strong passwords of at least eight characters composed of upper- and lower-case alphabetic, numeric, and special characters.

13.4 Preliminary Cyber Security Incident Response Team (CSIRT) Activities

The following preliminary activities can improve the CSIRO's ability to respond to information security incidents:

- Develop an incident response plan. Predetermine necessary actions and responses to specific classes of incidents to facilitate the making of decisions under pressure with minimal information.
- Implement secure connections to make Intrusion Detection System (IDS) policy changes and attack signature updates.
- Verify automated responses from IDS, etc.
- Conduct penetration testing at times known only to personnel with a need to know.
- Regularly review available information sources such as advisories and research findings to maintain currency.
- Notify management of potentially harmful events.
- Prioritize the severity of information security incidents.
- Document lessons learned to improve CSIRT operations.

13.5 Incident Response

13.5.1 Incident Reporting

To report an incident in accordance with this policy, always contact the enterprise help desk first. That should be proceeded by contacting your immediate supervisor and:

By telephone or in person;

Physical Security events – Director of Corporate Physical Security Office, Gary Berndt (503-813-6338)

Cyber Security events – Director of Corporate Information Security Office, Michael Ball (503-813-6327)

All systems that are considered in-scope for the critical infrastructure protection standard must follow the reporting processes established in the sabotage reporting (CIP-001) documentation. The aforementioned personnel are responsible for contacting the correct resource(s) to facilitate the necessary reporting to ES-ISAC.

13.5.2 Information Resource Protection

When an information security-related situation or incident is suspected or discovered, personnel must take steps, as directed by the CSIRT, to protect the information resource(s) at risk. Appropriate actions are:

- Do not shut down or power off a system after a computer incident occurs unless directed to do so by the and CSIRT member.

- Do not make any changes to the equipment or network in question without direction from the CSIRT.

- Do not discuss or e-mail anyone about the situation or incident unless directed to do so by the CSIRT.

- Follow CSIRT instructions with regard to options and strategies for containment and recovery from the incident.

- Close and lock doors to protect unattended equipment.

- Turn off computer monitor so screen cannot be viewed.

- Challenge personnel without badges.

13.5.3 Incident Containment

Supervisors or managers who suspect, discover, or are notified of a security-related event must immediately notify the CSIRT and initiate appropriate response procedures to contain the incident, protect the confidentiality and integrity of PPW

Holding, Inc. information, and ensure business continuity. Appropriate actions following the identification of a security incident include, but are not limited to, the following:

- Notifying CSIRT for assistance to contain, eradicate, and recover from the security incident.
- Notifying the Director of Physical Security of a physical security incident.
- Documenting in a journal or log all conversations and actions taken during the incident handling and response process and making this log available to management personnel on request.
- Ensuring personnel follow contingency plans for recovering from disruptive incidents.

13.5.4 Processing Incident Reports

The CSIRRT is responsible for the following:

- Logging and tracking security incident reports.
- Ensuring appropriate response and resolution of security incidents.
- Engaging appropriate resources, such as external law enforcement, ES-ISAC, DHS and/or Infraguard.
- Evaluating and escalating incident reports requiring further action.
- Retaining incident reports, supporting evidence, and journals for 1 year or for a time period determined by the CISO and/or Director of Physical Security.

13.5.5 Incident Analysis

The CSIRT will analyze security incidents and prepare reports summarizing the causes, frequency, and damage assessments of information security incidents. CSIRT management will analyze the CSIRT reports to improve the information security program and keep PPW Holding, Inc. executive management apprised as to the state of information security.

13.5.6 Incident Escalation

It may be necessary to escalate an individual incident to external sources based on the following criteria:

- Number of sites and systems under attack.
- Type of data at risk.
- Severity of the attack.

- State of the attack.
- Source or target of the attack.
- Impact on the integrity of the infrastructure or cost of recovery.
- Attack on a seemingly “secure” information resource.
- Personnel awareness of the attack.
- New attack method use.

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14 Compliance and Monitoring

14.1 Policy

All PPW Holding, Inc. information resources are the property of PPW Holding, Inc. PPW Holding, Inc. has the legal right to monitor and audit the use of its information resources as necessary to ensure compliance with PPW Holding, Inc. policies, procedures, standards, and guidelines. The activities of any user of PPW Holding, Inc. computing resources may be subject to audit or monitoring, and any detected misuse of PPW Holding, Inc. computing resources may be subject to disciplinary action up to and including removal, termination, and criminal prosecution.

14.2 Compliance

The PPW Holding, Inc. ensures compliance with information security policies through processes that include, but are not limited to, the following:

- Inspections, reviews, and evaluations.
- Monitoring.
- Audits.
- Confiscation and removal of information resources.

14.3 Inspections, Reviews and Evaluations

14.3.1 Requirement

Inspections, reviews, and evaluations must be conducted for information resources and facilities to ensure compliance with PPW Holding, Inc. information security policies.

14.3.2 Information Resources

The CISO and/or director of internal audit will conduct inspections, reviews, and evaluations of information resources:

- As part of the development lifecycle
- When informally or formally requested by the supervisor or manager of an information resource.
- At the discretion of the CISO or the CIO/managing director, application support and corporate security as necessary to evaluate the security of information resources.

14.3.3 Facilities

Internal audit , the CISO and/or the director of physical security will conduct inspections, reviews, and evaluations of PPW Holding, Inc. facilities.

14.4 Monitoring

14.4.1 General Monitoring Activities

Monitoring is used to improve security for PPW Holding, Inc. information resources, to ensure appropriate use of those resources, and to protect PPW Holding, Inc. resources from attack. Use of PPW Holding, Inc. information resources constitutes permission to monitor that use. Nonbusiness (i.e., personal) information may be viewed when monitoring PPW Holding, Inc. information resources. All personnel are advised that the information on PPW Holding, Inc. nonpublicly available information resources may be monitored and viewed by appropriate, authorized personnel, regardless of privacy concerns (see 5-3, Monitoring). The PPW Holding, Inc. reserves the right to:

- Review the information contained in or traversing PPW Holding, Inc. information resources.
- Review the activities on such information resources.
- Act on information discovered as a result of monitoring and disclose this information to law enforcement and other organizations as deemed appropriate by PPW Holding, Inc. personnel.

Note: *"*All personnel" includes PPW Holding, Inc. employees, contractors, vendors, business partners, and any other authorized users of PPW Holding, Inc. information systems, applications, telecommunication networks, data, and related resources. It excludes customers whose only access is through publicly available services, such as public web sites of the PPW Holding, Inc.

These customers will only be monitored for site security purposes (see 5-3.1.2, Public Web Site Monitoring).

14.4.2 Internet Privacy Policy Statement

A privacy policy statement must be posted on all external facing PPW Holding, Inc. websites regardless of the where it is hosted. The privacy policy must be approved by PPW Holding, Inc. legal council.

14.4.3 User Monitoring Notification

Where possible, users will be notified by the display of an authorized PPW Holding, Inc. warning banner that the information on PPW Holding, Inc. networks and workstations may be monitored and viewed by authorized personnel, regardless of privacy concerns. This notice must, at a minimum, appear whenever the user first logs on to the system and be included in information security awareness training.

14.4.4 Warning Banner

PPW Holding, Inc. authorized banner must be displayed to users prior to granting session access to PPW Holding, Inc. information resources. The legal authority and obligations as indicated in the warning banner will apply throughout the entire session users have on PPW Holding, Inc. information resources.

Applications that are Single Sign-On (SSO) or Consolidated Sign-On (CSO) compliant are not required to display an additional warning banner page as long as the executive sponsor can guarantee the user will see a warning banner at login for the session. Applications are not SSO or CSO compliant must display a warning banner page where it is technically feasible.

Internal warning banners are not intended for display on PPW Holding, Inc. web sites where the PPW Holding, Inc. Internet Privacy Policy applies. At a minimum, the warning banner must accomplish the following:

- Identify the computer system as a PPW Holding, Inc. computer system.
- Provide notification of monitoring
- Be followed by a pause requiring manual intervention to continue.
- Identify the information resource as a PPW Holding, Inc. information resource and alert users that they have no expectation of privacy.
- Warn user that activities may be monitored and that unauthorized access is prosecutable.

Note: Deviations from the authorized standard warning banner are not allowed unless approved in writing by the manager, CISO

<u>THE APPROVED WARNING BANNER:</u>

WARNING! This system is for the use of authorized PacifiCorp users only. By accessing and using this system you are consenting to system monitoring for law enforcement and other purposes. Unauthorized use of this computer system may subject you to criminal prosecution and penalties.

14.4.5 What is Monitored

Monitoring of PPW Holding, Inc. information resources may include, but is not limited to, the following:

- Network traffic.
- Application and data access.
- Keystrokes and user commands.
- Email and Internet usage.
- Message and data content.

14.4.5.1 Requesting Monitoring

Requests for monitoring network traffic, application and data access, keystrokes and user commands, and email and Internet usage must be in writing and directed to human resources and the manager, CISO.

14.4.6 Infrastructure Monitoring

The CIO or the CIO delegate is responsible for ensuring security of the PPW Holding, Inc. infrastructure through the following:

- Providing security incident detection through perimeter virus scanning and intrusion detection services.
- Performing network vulnerability analysis
- Monitoring the PPW Holding, Inc. infrastructure

14.4.7 Intrusion Detection

Intrusion detection devices will be implemented to monitor the infrastructure. The manager of the CISO and the CIO must approve the use of all monitoring devices, except those used by infrastructure services.

Unauthorized installation and use of monitoring devices is strictly prohibited.

14.5 Audits

14.5.1 Description

Audits are independent reviews and examinations of records and activities performed to test for adequacy of controls and ensure compliance with established policies and operational procedures. Audits also recommend changes to controls, policies, or procedures. Audits are an effective method for determining the level of protection afforded PPW Holding, Inc. information and physical resources and of uncovering security deficiencies that need to be addressed.

14.5.2 Conducting Audits

The director of internal audit has the authority to conduct audits, investigations, and evaluations of PPW Holding, Inc. programs and operations to ensure the efficiency and integrity of PPW Holding, Inc.

14.5.3 Responding to Audits

Executives responsible for the audited information resource must respond to audit findings and ensure that the information resources under their control comply with PPW Holding, Inc. information security policies and procedures.

14.6 Confiscation and removal of Information Resources

The manager, CISO, may confiscate and remove any information resource suspected to be the object of inappropriate use or violation of PPW Holding, Inc. information security policies to preserve evidence that might be utilized in forensic analysis of a security incident. The manager, CISO, in coordination with internal audit or compliance office, as appropriate, will ensure that the chain of evidence (possession of the confiscated information resource) is preserved and documented.

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15 Wireless Networking

15.1 Policy

Wireless devices and the supporting network infrastructure are information resources that must be protected at a level commensurate with their value to PPW Holding, Inc. Such protection must include the implementation of controls and processes that address PPW Holding, Inc. information security requirements. Care must be taken when designing and implementing a wireless network.

15.2 Scope

This policy applies to all PPW Holding, Inc. functional organizations, employees, contractors, and business partners; information systems; applications; mainframe, mid-range, and windows environments; telecommunications; and the IT infrastructure, and to all related products developed in-house as well as under contractors.

15.3 Baseline Requirements

The following baseline requirements are key to ensuring basic functionality, maximum bandwidth, and appropriate network security:

- Wireless applications must be capable of "mutual" device and user authentication (i.e., the device, the user, and the network must recognize each to be who they say they are).

- There must be a secure link between a device and an access point (AP).

- The installation of access points, wireless cards, or any other wireless technology must be approved in advance by the CIO or the CIO designee because of the risks such installations can introduce to the PPW Holding, Inc. intranet, networks and all connected information resources.

- Wireless and wired networks must be developed and maintained separately.

15.4 Prevention of Unacceptable Risk

Connecting access points or using wireless technology without proper prior approval introduces an unacceptable risk to the PPW Holding, Inc. intranet and other assets. Non-approved wireless technology must be removed from the PPW Holding, Inc. computing environment.

15.5 Device Support

PacifiCorp IT will remotely manage all devices that connect to the network using 802.11x technology. Periodic software updates and product enhancements will be downloaded to APs as required to improve performance and enhance security. Access point management will also include constant operating assessments of the device. Any malfunctions or loss of effectiveness will generate an alert for resolution.

15.6 Procurement Requirements

When considering procurement of wireless hardware, software, and services, meeting the following requirements provides compliance with the PPW Holding, Inc. wireless security policy. For any particular wireless application, all of the requirements may not apply. The security requirements should be included in procurement documents to adequately protect the wireless application and reduce the residual risk to an acceptable level.

Wireless devices should be capable of supporting the following requirements:

- For devices intended for stationary deployment (e.g. in vehicles or on loading docks), capable of being solidly secured (e.g. to the vehicle or building), This requirement also applies to add-on modules.

- Capable of requiring a “power-on” password prior to the device operating. This is in addition to the specific user authentication password.

- Capable of ensuring device authentication and strong (at least two-factor) user authentication. The wireless device must have the capability to be configured to query a secondary device for access when the primary server is offline.

- Be WiFi Protected Access (WPA) certified. Security features including data link-level encryption, 802.1x-compliant authentication model, and regular rotation of encryption keys are built-in.

- Contain secure authorization software/firmware

- Where Extensible Authentication Protocol (EAP) is used, capable of proper password management (aging, complexity criteria, etc.). The wireless device must have the capability to support t password changes in a pre-established timeframe.

- Capable of ensuring users can be securely authenticated when operating locally or remotely. The device automatically senses when it is operating in a connected manner and user the proper authentication.
- Capable of implementing mutual authentication between the device and an access point.
- Capable of being Active Directory-compliant for authentication purposes. Exceptions must be documented.
- Capable of logging events.
- Contain cryptography to attain the desired levels of integrity, authentication and confidentiality. PPW Holding, Inc. minimum standard is 128-bit triple DES or AES.
- Capable of providing a secure channel for access point administration.
- Capable of supporting end-to-end cryptographic protection whenever traffic traverses network segments other than the wireless segment for transmitting sensitive and business-controlled sensitivity information.
- Capable of dynamic encryption key rotation. The wireless device must have the capability to support rotation of encryption keys in a pre-established timeframe.
- Capable of supporting a timeout mechanism that automatically prompts the user for a password after a period of inactivity. The period of inactivity must be configurable via the device set-up procedure and ignore the keep-alive process (pings or loop socket-to-socket packets) for automated programs.
- Capable of deactivating all communication ports and network associations during periods of inactivity.
- Capable of supporting static IP addresses and Dynamic Host Configuration Protocol (DHCP) on remote wireless equipment.
- Capable of shielding authentication credentials against interception through short interval "authentication tunnels" (e.g. TLC standard).
- Technical support for the integration of the wireless devices into the PPW Holding, Inc. infrastructure with other technological initiatives must be scoped, planned, available in a timely and accurate manner.

15.7 Compliance and Monitoring Requirements

Security assessments and audits are an essential tool for checking the security posture of a wireless technology and for determining corrective action to make sure the network remains secure. It is important to perform regular audits using wireless diagnostic hardware and software. Administrators should periodically check for rogue access points and against other unauthorized access.

Diagnostic hardware and software that enable the bypass of implemented security features or allow network monitoring (e.g., network scanning, sniffers) must be used only by authorized personnel for approved purposes.

Appendix A – Exception Form

Corporate Security Policy – Exception / Authorization Form

Instances where the PacifiCorp cannot conform to its cyber security policy must be documented as exceptions and authorized by the senior manager or delegate(s). Exceptions to the Responsible Entity's cyber security policy must be documented within thirty days of being approved by the senior manager or delegate(s). Documented exceptions to the cyber security policy must include an explanation as to why the exception is necessary and any compensating measures, or a statement accepting risk. ***Authorized exceptions to the cyber security policy must be reviewed and approved annually by the Senior Manager or Delegate(s) to ensure the exceptions are still required and valid.*** Such review and approval shall be documented.

Exception/Authorization Forms must be submitted on a per-standard basis. For each Security Policy standard where an exception or deviation is needed, a new form must be used.

All Fields are required:

Security Policy Standard[1]**:** ____

Requestor[2]**:** ____

Exception Type[4]**:** __________ **(Y / N) Permanent**[5] ` ______ **(Y / N) Temporary**[6]**:** ______

Description of Exception and Alternative[7]

Business or Operational Justification for Exception and Alternative[8]

Plan for Remediation or Mitigation of Temporary Exception and Alternative[9]

Corporate Security Comments[10]

Required Signatures:

Workstream Lead or Subject Matter Expert[11]	

Signature[12]		Date[13]	

Business Unit Stakeholder[14]	

Signature[15]		Date[13]	

Business Platform President[17]	

Signature[18]		Date[13]	

Director of Corporate Physical Security[20]	

Signature[21]		Date[13]	

Director of Corporate Information Security[23]	

Signature[12]		Date[13]	

Senior Management Official[26]	

Signature[27]		Date[13]	

Form Instructions and Details:

1. Security Policy Standard: Specify the exact standard to which you are requesting an exception/deviation.
2. Requestor: Identify the requestor of the exception by name and business unit.
3. Date: Include the effective date for the exception.
4. Exception Type: Exceptions are either Permanent or Temporary.
5. Permanent: The alternative solution proposed is ***not*** an interim measure.
6. Temporary: The alternative solution proposed is an interim measure.
7. Description of Exception and Alternative: Describe, **in detail**, the nature of the request. Explain in natural language the existing situation that warrants exception and the proposed alternative.
8. Business or Operational Justification for Exception and Alternative: Describe, **in detail**, the justification or reason behind why the exception and alternative are necessary. Inclusion of diagrams and supporting documentation may be appropriate.
9. Plan for Remediation or Mitigation of Temporary Exception and Alternative: Describe, **in detail**, how the exception and alternative will be remediated or mitigated in the future. Explain your plan to achieve a state of compliance, and when it will be fully realized.
10. Corporate Security Comments (Corporate Security Only): Space provided for Corporate Security to provide comments on the requested exception/alternative.
11. Workstream Lead or Subject Matter Expert: Include, by name, the person who is representing the workstream, or a delegate subject matter expert. In any case, this field is intended to record the person responsible for providing all information within the exception/alternative request.
12. Signature: Include the signature (or respective email) of the workstream lead or subject matter expert confirming validity and accuracy of the requested exception/alternative, as well as the justification and remediation plan language.
13. Date: Include the date that the respective workstream lead or subject matter expert signed the exception/alternative.
14. Business Unit Stakeholder: Include, by name, the NERC CIPS Compliance program stakeholder who is approving this exception/alternative for the Business Unit. This person is typically the highest level of management, Directors and above for example.
15. Signature: Include the signature (or respective email) of the business unit stakeholder stating approval of the requested exception/alternative, as well as the justification and remediation plan language.
16. Date: Include the date that the respective business stakeholder approved the exception/alternative.
17. Business Platform President: Include, by name, the business platform president to which this organizational chain reports. The workstream lead (or subject matter expert) and stakeholder must ultimately report to one of the presidents of the various business platforms (Pacific Power, Rocky Mountain Power or PacifiCorp Energy).
18. Signature: Include the signature (or respective email) of the business platform president stating approval of the requested exception/deviation, as well as the justification and remediation plan language.
19. Date: Include the date that the respective business platform president approved the exception/alternative.
20. Director of Corporate Physical Security: Include, by name, the respective Director of Corporate Physical Security approving this exception/alternative. If the exception addresses a physical security policy the Director of Corporate Security should approve.
21. Signature: Include the signature (or respective email) of the Director of Corporate Physical Security stating approval of the requested exception/alternative, as well as the justification and remediation plan language.
22. Date: Include the date that the Director of Corporate Physical Security approved the exception/alternative
23. Director of Information Security: Include, by name, the respective Director of Corporate Information Security approving this exception/alternative. If the exception addresses information security the Director of Corporate Information Security should approve.
24. Signature: Include the signature (or respective email) of the Director of Corporate Information Security stating approval of the requested exception/alternative, as well as the justification and remediation plan language.
25. Date: Include the date that the Director of Corporate Information Security approved the exception/alternative

26. Senior Manager or Delegate: Include, by name, the respective Senior Manager or delegate approving this exception/alternative.
27. Signature: Include the signature (or respective email) of the Senior Manager or delegate stating approval of the requested exception/alternative, as well as the justification and remediation plan language.
28. Date: Include the date that the Senior Manager or delegate approved the exception/alternative.