APPENDIX 2B

Engineering Appendixes

APPENDIX 2B

Engineering Design Criteria

This appendix summarizes the codes, standards, criteria, and practices that generally will be used in the design and construction of the engineering systems for the TID Almond 2 Power Plant (A2PP).

1.0 Civil Engineering Design Criteria

1.1 Introduction

This section summarizes the codes, standards, criteria, and practices that generally will be used in the design and construction of civil engineering systems for the A2PP. More specific project information will be developed during execution of the project to support detailed design, engineering, material procurement specification and construction specifications.

1.2 Codes and Standards

The design of civil engineering systems for the project will be in accordance with the laws and regulations of the federal government, the State of California, County of Stanislaus ordinances, and industry standards. The current issue or edition of the documents at the time of filing this Application for Certification (AFC) will apply, unless otherwise noted. In cases where conflicts between the cited documents exist, requirements of the more conservative document will be used.

1.2.1 Civil Engineering Codes and Standards

The following codes and standards have been identified as applicable, in whole or in part, to civil engineering design and construction of power plants.

- American Association of State Highway and Transportation Officials (AASHTO) – Standards and Specifications
- American Concrete Institute (ACI) – Standards and Recommended Practices
- American Institute of Steel Construction (AISC) – Standards and Specifications
- American National Standards Institute (ANSI) – Standards
- American Society of Testing and Materials (ASTM) – Standards, Specifications, and Recommended Practices
- American Water Works Association (AWWA) – Standards and Specifications
- American Welding Society (AWS) – Codes and Standards
- Asphalt Institute (AI) – Asphalt Handbook
- State of California Department of Transportation (CALTRANS) Standard Specification

- California Energy Commission (CEC) – Recommended Seismic Design Criteria for Non-Nuclear Generating Facilities in California, 1989
- Concrete Reinforcing Steel Institute (CRSI) – Standards
- Factory Mutual (FM) – Standards
- National Fire Protection Association (NFPA) – Standards
- California Building Code (CBC) 2007
- Steel Structures Painting Council (SSPC) – Standards and Specifications

1.2.2 Engineering Geology Codes, Standards, and Certifications

Engineering geology activities will conform to the applicable federal, state and local laws, regulations, ordinances, and industry codes and standards.

Federal. None are applicable.

State. The Warren-Alquist Act, Public Resources Code, Section 25000 et seq. and the CEC Code of Regulations (CCR), Siting Regulations, Title 20 CCR, Chapter 2, require that an AFC address the geologic and seismic aspects of the site.

The California Environmental Quality Act (CEQA), PRC 21000 et seq. and the CEQA Guidelines require that potential significant effects, including geologic hazards, be identified and a determination made as to whether they can be substantially reduced.

Local. California State Planning Law, Government Code Section 65302, requires each city and county to adopt a general plan, consisting of nine mandatory elements, to guide its physical development. Section 65302(g) requires that a seismic safety element be included in the general plan.

The site development activities will require certification by a Professional Geotechnical Engineer and a Professional Engineering Geologist during and following construction, in accordance with the California Building Code (CBC), Chapter 70. The Professional Geotechnical Engineer and the Professional Engineering Geologist will certify the placement of earthen fills and the adequacy of the site for structural improvements, as follows:

- Both the Professional Geotechnical Engineer and the Professional Engineering Geologist will address CBC Chapter 70, Sections 7006 (Grading Plans), 7011 (Cuts), 7012 (Terraces), 7013 (Erosion Control), and 7015 (Final Report).
- The Professional Geotechnical Engineer will also address CBC Chapter 70, Sections 7011 (Cuts) and 7012 (Terraces).

Additionally, the Professional Engineering Geologist will present findings and conclusions pursuant to PRC, Section 25523 (a) and (c); and 20 CCR, Section 1752 (b) and (c).

2.0 Structural Engineering Design Criteria

2.1 Introduction

This section summarizes the codes, standards, criteria, and practices that will be generally used in the design and construction of structural engineering systems for the A2PP. More specific project information will be developed during execution of the project to support detail design, engineering, material procurement specification and construction specifications.

2.2 Codes and Standards

The design of structural engineering systems for the project will be in accordance with the laws and regulations of the federal government, the State of California, County of Stanislaus ordinances, and the industry standards. The current issue or edition of the documents at the time of filing of this AFC will apply, unless otherwise noted. In cases where conflicts between the cited documents exist, requirements of the more conservative document will be used.

The following codes and standards have been identified as applicable, in whole or in part, to structural engineering design and construction of power plants.

- California Building Code, 2007 Edition
- American Institute of Steel Construction (AISC):
  - Manual of Steel Construction—13th Edition
  - Specification for Structural Steel Buildings, March 9, 2005
  - Specification for Structural Joints Using ASTM A325 or A490 Bolts, June 30, 2004
  - Code of Standard Practice for Steel Buildings and Bridges, March 18, 2005
- American Concrete Institute (ACI):
  - ACI 318-05, Building Code Requirements for Structural Concrete
  - ACI 301-05, Specifications for Structural Concrete for Buildings
- American Society of Civil Engineers (ASCE):
  - ASCE 7-05, Minimum Design Loads for Buildings and Other Structures
- American Society of Mechanical Engineers (ASME)
  - STS-1-2000, Steel Stacks
- American Welding Society (AWS)
  - D1.1—Structural Welding Code—Steel
  - D1.3—Structural Welding Code—Sheet Steel
- Code of Federal Regulations, Title 29—Labor, Chapter XVII, Occupational Safety and Health Administration (OSHA)
  - Part 1910—Occupational Safety and Health Standards
  - Part 1926—Construction Safety and Health Regulations

- National Association of Architectural Metal Manufacturers (NAAMM)—Metal Bar Grating Manual
- Hoist Manufacturers Institute (HMI), Standard Specifications for Electric Wire Rope Hoists (HMI 100)
- IEEE 980 – Guide for Containment and Control of Oil Spills in Substations
- National Electric Safety Code (NESC), C2-2007
- National Fire Protection Association (NFPA Standards)
  - NFPA 850 Fire Protection for Electric Generating Plants
- OSHA Williams-Steiger Occupational Safety and Health Act of 1970
- Steel Deck Institute (SDI)—Design Manual for Floor Decks and Roof Decks

2.2.1 CEC Special Requirements

Prior to the start of any increment of construction, the proposed seismic-force procedures for project structures and the applicable designs, plans and drawings for project structures will be submitted for approval.

Proposed seismic-force procedures, designs, plans, and drawings shall be those for:

- Major project structures
- Major foundations, equipment supports, and anchorage
- Large, field-fabricated tanks
- Switchyard structures

2.3 Structural Design Criteria

2.3.1 Datum

Site topographic elevations will be based on an elevation survey conducted using known elevation benchmarks.

2.3.2 Frost Penetration

The site is located in an area free of frost penetration. Bottom elevation of all foundations for structures and equipment, however, will be maintained at a minimum of 12 inches below the finished grade.

2.3.3 Temperatures

The design basis temperatures for civil and structural engineering systems will be as follows:

Maximum	110°F
Minimum	20°F

2.3.4 Design Loads

General. Design loads for structures and foundations will comply with all applicable building code requirements.

Dead Loads. Dead loads will consist of the weights of structure and all equipment of a permanent or semi-permanent nature including tanks, bins, wall panels, partitions, roofing, drains, piping, cable trays, bus ducts, and the contents of tanks and bins measured at full operating capacity. The contents of the tanks and bins, however, will not be considered as effective in resisting structure uplift due to wind forces; but will be considered as effective for seismic forces.

Live Loads. Live load will consist of uniform floor live loads and equipment live loads. Uniform live loads are assumed equivalent unit loads that are considered sufficient to provide for movable and transitory loads, such as the weights of people, portable equipment and tools, small equipment or parts, which may be moved over or placed on the floors during maintenance operations, and planking. The uniform live loads will not be applied to floor areas that will be permanently occupied by equipment.

Lateral earth pressures, hydrostatic pressures, and wheel loads from trucks will be considered as live loads.

Uniform live loads will be in accordance with ASCE Standard 7, but will not be less than the following:

- Roofs — 20 pounds per square foot (psf)
- Floors and Platforms (steel grating and checkered plates) — 100 psf

In addition, a uniform load of 50 psf will be used to account for piping and cable trays, except that where the piping and cable loads exceed 50 psf, the actual loads will be used.

Furthermore, a concentrated load of 5 kips will be applied concurrently to the supporting beams of the floors to maximize stresses in the members, but the reactions from the concentrated loads will not be carried to the columns.

- Floors (elevated concrete floors) — 100 psf

In addition, elevated concrete slabs will be designed to support an alternate concentrated load of 2 kips in lieu of the uniform loads, whichever governs. The concentrated load will be treated as a uniform distributed load acting over an area of 2.5 square feet, and will be located in a manner to produce the maximum stress conditions in the slabs.

- Control Room Floor — 150 psf
- Stairs, Landings, and Walkways — 100 psf

In addition, a concentrated load of 2 kips will be applied concurrently to the supporting beams for the walkways to maximize the stresses in the members, but the reactions from the concentrated loads will not be carried to the columns.

- Pipe Racks — 50 psf

Where the piping and cable tray loads exceed the design uniform load, the actual loads will be used. In addition, a concentrated load of 8 kips will be applied concurrently to the supporting beams for the walkways to maximize the stresses in the members, but the reactions from the concentrated loads will not be carried to the columns.

- Hand Railings

Hand railings will be designed for a 200-pound concentrated load applied at any point and in any direction.

• Slabs on Grade	250 psf
• Truck Loading Surcharge Adjacent to Structures	250 psf
• Truck Support Structures	AASHTO-HS-20-44
• Special Loading Conditions	Actual loadings

Laydown loads from equipment components during maintenance and floor areas where trucks, forklifts or other transports have access will be considered in the design of live loads.

Live loads may be reduced in accordance with the provisions of CBC Section 1607.

Posting of the floor load capacity signs for all roofs, elevated floors, platforms and walkways will be in compliance with the OSHA Occupational Safety and Health Standard, Walking and Working Surfaces, Subpart D. Floor load capacity for slabs on grade will not be posted.

Earth Pressures. Earth pressures will be in accordance with the recommendations contained in the project-specific geotechnical report.

Groundwater Pressures. Hydrostatic pressures due to groundwater or temporary water loads will be considered.

Wind Loads. The wind forces will be calculated in accordance with CBC 2007 with a basic wind speed of 85 miles per hour (mph) and an exposure category of ‘C.’

Seismic Loads. Structures will be designed and constructed to resist the effects of earthquake loads as determined in CBC 2007, Section 1613. The Seismic Design Category is D. The occupancy category of the structure is III (per CBC Table 1604.5) and corresponding importance factor (I) is 1.25. Other seismic parameters will be obtained from the geotechnical report.

Snow Loads. Snow loads will not be considered.

Turbine Generator Loads. The combustion turbine generator loads for pedestal and foundation design will be furnished by the equipment manufacturers, and will be applied in accordance with the equipment manufacturers’ specifications, criteria, and recommendations.

Special Considerations for Steel Stacks. Steel stacks will be designed to withstand the normal and abnormal operating conditions in combination with wind loads and seismic loads, and will include the along-wind and across-wind effects on the stacks. The design will meet the requirements of ASME/ANSI STS-1-2000, “Steel Stacks,” using allowable stress design method, except that increased allowable stress for wind loads as permitted by AISC will not be used.

Special Considerations for Structures and Loads during Construction. For temporary structures, or permanent structures left temporarily incomplete to facilitate equipment installations, or temporary loads imposed on permanent structures during construction, the allowable stresses may be increased by 33 percent.

Structural backfill may be placed against walls, retaining walls, and similar structures when the concrete strength attains 80 percent of the design compressive strength (f'_c), as determined by sample cylinder tests. Restrictions on structural backfill, if any, will be shown on the engineering design drawings.

Design restrictions imposed on construction shoring removal that are different from normal practices recommended by the ACI codes will be shown on engineering design drawings.

Metal decking used as forms for elevated concrete slabs will be evaluated to adequately support the weight of concrete plus a uniform construction load of 50 psf, without increase in allowable stresses.

2.4 Design Bases

2.4.1 General

Reinforced concrete structures will be designed by the strength design method, in accordance with the CBC and the ACI 318, "Building Code Requirements for Structural Concrete."

Steel structures will be designed by the working stress method, in accordance with the CBC and the AISC Specification for Structural Steel Buildings.

Allowable soil bearing pressures for foundation design will be in accordance with the "Final Subsurface Investigation and Foundation Report" for the facility.

2.4.2 Factors of Safety

The factor of safety for all structures, tanks, and equipment supports will be as follows:

Against Overturning	1.50
Against Sliding	1.50 for Wind Loads 1.10 for Seismic Loads
Against Uplift Due to Wind	1.50
Against Buoyancy	1.25

2.4.3 Allowable Stresses

Calculated stresses from the governing loading combinations for structures and equipment supports will not exceed the allowable limits permitted by the applicable codes, standards, and specifications.

2.4.4 Load Factors and Load Combinations

For reinforced concrete structures and equipment supports, using the strength method, the strength design equations will be determined based on CBC 2007, Sections 1605.2.1, 1605.4, 1912, and ACI-318-08 Section 9.2. The Allowable Stress Design load combinations of CBC 2007 Section 1605.3 will be used to assess soil bearing pressure and stability of structures per CBC 2007 Sections 1805 and 1613, respectively.

Steel-framed structures will be designed in accordance with CBC 2007, Chapter 22 and the ANSI/AISC 360-05 Specification for Structural Steel Buildings, March 9, 2005. Connections will conform to Research Council on Structural Connections of the Engineering Foundation Specification for Structural Joints.

2.5 Construction Materials

2.5.1 Concrete and Grout

The design compressive strength (f'_c) of concrete and grout, as measured at 28 days, will be as follows:

Underground electrical duct bank encasement and lean concrete backfill (Class D)	2,000 psi
Structural concrete (Classes CSA & CLA)	3,000 psi
Structural concrete (Class BSA & BLA)	4,000 psi
Structural grout	5,000 psi

The classes of concrete and grout to be used will be shown on engineering design drawings or indicated in design specifications.

2.5.2 Reinforcing Steel

Reinforcing steel bars for concrete will be deformed bars of billet steel, conforming to ASTM A615, Grade 60 or A706, Grade 60.

Welded wire fabric for concrete will conform to ASTM A185.

2.5.3 Structural and Miscellaneous Steel

Structural and miscellaneous steel will generally conform to ASTM A36, ASTM A572, or ASTM A992 except in special situations where higher strength steel is required.

High-strength structural bolts, including nuts and washers, will conform to ASTM A325 or ASTM A490.

Bolts other than high-strength structural bolts will conform to ASTM A307, Grade A.

2.5.4 Concrete Masonry

Concrete masonry units will be hollow, normal weight, non-load-bearing Type I, conforming to ASTM C90, lightweight.

Mortar will conform to ASTM C270, Type S.

Grout will conform to ASTM C476.

2.5.5 Other Materials

Other materials for construction, such as anchor bolts, shear connectors, concrete expansion anchors, embedded metal, etc., will conform to industry standards and will be identified on engineering design drawings or specifications.

3.0 Mechanical Engineering Design Criteria

3.1 Introduction

This section summarizes the codes, standards, criteria, and practices that will be generally used in the design and construction of mechanical engineering systems for the A2PP. More specific project information will be developed during execution of the project to support detailed design, engineering, material procurement specification, and construction specifications.

3.2 Codes and Standards

The design of the mechanical systems and components will be in accordance with the laws and regulations of the federal government, State of California, County of Stanislaus ordinances, and industry standards. The current issue or revision of the documents at the time of the filing of this AFC will apply, unless otherwise noted. If there are conflicts between the cited documents, the more conservative requirements shall apply.

The following codes and standards are applicable to the mechanical aspects of the power facility.

- California Building Standards Code, 2007
- American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code
- ASME/ANSI B31.1 Power Piping Code
- ASME Performance Test Codes
- ASME Standard TDP-1
- American National Standards Institute (ANSI) B16.5, B16.34, and B133.8
- American Boiler Manufacturers Association (ABMA)
- American Gear Manufacturers Association (AGMA)
- Air Moving and Conditioning Association (AMCA)
- American Society for Testing and Materials (ASTM)
- American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)
- American Welding Society (AWS)
- Cooling Tower Institute (CTI)
- Heat Exchange Institute (HEI)
- Manufacturing Standardization Society (MSS) of the Valve and Fitting Industry
- National Fire Protection Association (NFPA)
- Hydraulic Institute Standards (HIS)
- Tubular Exchanger Manufacturer's Association (TEMA)

3.3 Mechanical Engineering General Design Criteria

3.3.1 General

The systems, equipment, materials, and their installation will be designed in accordance with the applicable codes; industry standards; and local, state, and federal regulations, as well as the design criteria; manufacturing processes and procedures; and material selection, testing, welding, and finishing procedures specified in this section.

Detailed equipment design will be performed by the equipment vendors in accordance with the performance and general design requirements to be specified later by the project architect/engineering firm. Equipment vendors will be responsible for using construction materials suited for the intended use.

3.3.2 Materials—General

Asbestos will not be used in the materials and equipment supplied. Where feasible, materials will be selected to withstand the design operating conditions, including expected ambient conditions, for the design life of the plant. It is anticipated that some materials will require replacement during the life of the plant due to corrosion, erosion, etc.

Pumps. Pumps will be sized in accordance with industry standards. Where feasible, pumps will be selected for maximum efficiency at the normal operating point. Pumps will be designed to be free from excessive vibration throughout the operating range.

Tanks. Large outdoor storage tanks will not be insulated except where required to maintain appropriate process temperatures or for personnel protection.

Overflow connections and lines will be provided. Maintenance drain connections will be provided for complete tank drainage.

Manholes, where provided, will be at least 24 inches in diameter and hinged to facilitate removal. Storage tanks will have ladders and cleanout doors as required to facilitate access/maintenance. Provisions will be included for proper tank ventilation during internal maintenance.

Heat Exchangers. The heat exchangers will be provided as components of mechanical equipment packages and may be air-cooled or water-cooled shell-and-tube or plate type. Heat exchangers will be designed in accordance with TEMA or manufacturer's standards. Fouling factors will be specified in accordance with TEMA.

Pressure Vessels. Pressure vessels will include the following features/appurtenances:

- Process, vent, and drain connections for startup, operation, and maintenance
- Materials compatible with the fluid being handled
- A minimum of one manhole and one air ventilation opening (e.g., handhole) where required for maintenance or cleaning access
- For vessels requiring insulation, shop-installed insulation clips spaced not greater than 18 inches on center

- Relief valves in accordance with the applicable codes

Piping and Piping Supports. Stainless steel pipe may be Schedule 10S where design pressure permits. Underground piping may be high-density polyethylene (HDPE) or polyvinyl chloride (PVC) where permitted by code, operating conditions, and fluid properties. In general, water system piping will be HDPE or PVC where embedded or underground and carbon steel where aboveground. Appropriately lined and coated carbon steel pipe may alternately be used for buried water piping.

Threaded joints will not normally be used in piping used for lubricating oil, and natural gas service. Natural gas piping components will not use synthetic lubricants. Victaulic, or equal, couplings may be used for low energy aboveground piping, where feasible.

Piping systems will have high point vents and low point drains. Drains with restricting orifices will be installed in low points of lines where condensate can collect during normal operation.

Hose and process tubing connections to portable components and systems will be compatible with the respective equipment suppliers' standard connections for each service.

Stainless steel piping will be used for portions of the lubricating oil system downstream of the filters. Carbon steel piping may be used elsewhere.

Valves

General Requirements. Valves will be arranged for convenient operation from floor level where possible and, if required, will have extension spindles, chain operators, or gearing. Hand-actuated valves will be operable by one person. Gear operators will be provided on manual valves 8 inches or larger.

Valves will be arranged to close when the handwheel is rotated in a clockwise direction when looking at the handwheel from the operating position. The direction of rotation to close the valve will be clearly marked on the face of each handwheel.

The stops that limit the travel of each valve in the open or closed position will be arranged on the exterior of the valve body. Valves will be fitted with an indicator to show whether they are open or closed; however, only critical valves will be remotely monitored for position.

Valve materials will be suitable for operation at the maximum working pressure and temperature of the piping to which they are connected. Steel valves will have cast or forged steel spindles. Seats and faces will be of low friction, wear resistant materials. Valves in throttling service will be selected with design characteristics and of materials that will resist erosion of the valve seats when the valves are operated partly closed.

Valves operating at less than atmospheric pressure will include means to prevent air in-leakage. No provision will be made to repack valve glands under pressure.

Drain and Vent Valves and Traps. Drains and vents in 600 pound class or higher piping and 900°F or higher service will be double-valved.

Drain traps will include air cock and easing mechanism. Internal parts will be constructed from corrosion-resistant materials and will be renewable.

Trap bodies and covers will be cast or forged steel and will be suitable for operating at the maximum working pressure and temperature of the piping to which they are connected. Traps will be piped to drain collection tank or sumps and returned to the cycle if convenient.

Low-pressure Water Valves. Low-pressure water valves will be the butterfly type of cast iron construction. Ductile iron valves will have ductile iron bodies, covers, gates (discs), and bridges; the spindles, seats, and faces will be bronze. Fire protection valves will be Underwriters Laboratories-approved butterfly valves meeting NFPA requirements.

Instrument Air Valves. Instrument air valves will be the ball type of bronze construction, with valve face and seat of approved wear-resistant alloy.

Nonreturn Valves. Nonreturn valves for steam service will be in accordance with ANSI standards and properly drained. Nonreturn valves in vertical positions will have bypass and drain valves. Bodies will have removable access covers to enable the internal parts to be examined or renewed without removing the valve from the pipeline.

Motor Actuated Valves. Electric motor actuators will be designed specifically for the operating speeds, differential and static pressures, process line flowrates, operating environment, and frequency of operations for the application. Electric actuators will have self-locking features. A handwheel and declutching mechanism will be provided to allow handwheel engagement at any time except when the motor is energized. Actuators will automatically revert to motor operation, disengaging the handwheel, upon energizing the motor. The motor actuator will be placed in a position relative to the valve that prevents leakage of liquid, steam, or corrosive gas from valve joints onto the motor or control equipment.

Safety and Relief Valves. Safety valves and/or relief valves will be provided as required by code for pressure vessels, heaters, and boilers. Safety and relief valves will be installed vertically. Piping systems that can be over-pressurized by a higher-pressure source will also be protected by pressure-relief valves. Equipment or parts of equipment that can be over pressurized by thermal expansion of the contained liquid will have thermal-relief valves.

Instrument Root Valves. Instrument root valves will be specified for operation at the working pressure and temperature of the piping to which they are connected. Test points and sample lines in systems that are 600 pound class or higher service will be double valved.

Heating, Ventilating, and Air Conditioning (HVAC). HVAC system design will be based on site ambient conditions specified in Section 2.0, Project Description.

Except for the HVAC systems serving the control room, maintenance shop, lab areas, and administration areas, the systems will not be designed to provide comfort levels for extended human occupancy.

Air conditioning will include both heating and cooling of the inlet filtered air. Air velocities in ducts and from louvers and grills will be low enough not to cause unacceptable noise levels in areas where personnel are normally located.

Fans and motors will be mounted on anti-vibration bases to isolate the units from the building structure. Exposed fan outlets and inlets will be fitted with guards. Wire guards will be specified for belt driven fans and arranged to enclose the pulleys and belts.

Air filters will be housed in a manner that facilitates removal. The filter frames will be specified to pass the air being handled through the filter without leakage.

Ductwork, filter frames, and fan casings will be constructed of mild steel sheets stiffened with mild steel flanges and galvanized. Ductwork will be the sectional bolted type and will be adequately supported. Duct joints will be leak tight.

Grills and louvers will be of adjustable metal construction.

Thermal Insulation and Cladding. Parts of the facility requiring insulation to reduce heat loss or afford personnel safety will be thermally insulated. Minimum insulation thickness for hot surfaces near personnel will be designed to limit the outside lagging surface temperature to a maximum of 140°F.

The thermal insulation will have as its main constituent calcium silicate, foam glass, fiber glass, or mineral wool, and will consist of pre-formed slabs or blankets, where feasible. Asbestos-containing materials are prohibited. An aluminum jacket or suitable coating will be provided on the outside surface of the insulation. Insulation system materials, including jacketing, will have a flame spread rating of 25 or less when tested in accordance with ASTM E 84.

Insulation at valves, pipe joints, steam traps, or other points to which access may be required for maintenance will be specified to be removable with a minimum of disturbance to the pipe insulation. At each flanged joint, the molded material will terminate on the pipe at a distance from the flange equal to the overall length of the flange bolts to permit their removal without damaging the molded insulation. Outdoor aboveground insulated piping will be clad with textured aluminum of not less than 30 mil thickness and frame reinforced. At the joints, the sheets will be sufficiently overlapped and caulked to prevent moisture from penetrating the insulation. Steam trap stations will be "boxed" for ease of trap maintenance.

Design temperature limits for thermal insulation will be based on system operating temperature during normal operation.

Outdoor and underground insulation will be moisture resistant.

Testing. Hydrostatic testing, including pressure testing at 1.5 times the design pressure, or as required by the applicable code, will be specified and performed for pressure boundary components where an in-service test is not feasible or permitted by code.

Welding. Welders and welding procedures will be certified in accordance with the requirements of the applicable codes and standards before performing any welding. Records of welder qualifications and weld procedures will be maintained.

Painting. Except as otherwise specified, equipment will receive the respective manufacturer's standard shop finish. Finish colors will be selected from among the paint manufacturer's standard colors.

Finish painting of uninsulated piping will be limited to that required by OSHA for safety or for protection from the elements.

Piping to be insulated will not be finish painted.

Lubrication. The types of lubrication specified for facility equipment will be suited to the operating conditions and will comply with the recommendations of the equipment manufacturers.

The initial startup charge of flushing oil will be the equipment manufacturer's standard lubricant for the intended service. Subsequently, such flushing oil will be sampled and analyzed to determine whether it can also be used for normal operation or must be replaced in accordance with the equipment supplier's recommendations.

Rotating equipment will be lubricated as designed by the individual equipment manufacturers. Oil cups will be specified. Where automatic lubricators are fitted to equipment, provision for emergency hand lubrication will also be specified. Where applicable, equipment will be designed to be manually lubricated while in operation without the removal of protective guards. Lubrication filling and drain points will be readily accessible.

4.0 Electrical Engineering Design Criteria

4.1 Introduction

This section summarizes the codes, standards, criteria, and practices that will be generally used in the design and construction of electrical engineering systems for the A2PP. More specific project information will be developed during execution of the project to support detailed design, engineering, material procurement specification, and construction specifications.

4.2 Codes and Standards

The design of the electrical systems and components will be in accordance with the laws and regulations of the federal government, the State of California, local ordinances, and industry standards. The current issue or revision of the documents at the time of filing this AFC will apply, unless otherwise noted. If there are conflicts between the cited documents, the more conservative requirement will apply.

The following codes and standards are applicable to the electrical aspects of the power facility:

- American National Standards Institute (ANSI)
- American Society for Testing and Materials (ASTM)
- Anti-Friction Bearing Manufacturers Association (AFBMA)
- California Building Standards Code
- California Electrical Code
- Insulated Cable Engineers Association (ICEA)
- Institute of Electrical and Electronics Engineers (IEEE)
- Illuminating Engineering Society (IES)

- National Association of Corrosion Engineers (NACE)
- National Electrical Code (NEC)
- National Electrical Manufacturers Association (NEMA)
- National Electrical Safety Code (NESC)
- National Fire Protection Association (NFPA)
- Underwriters Laboratories, Inc. (UL)

4.3 Switchyard and Transformers

4.3.1 Switchyard

The A2PP consists of three independent combustion turbine generators. All three generators tie into a new 115-kilovolt (kV) switchyard.

The switchyard will consist of circuit breakers and lines to the grid. Each line will be equipped with the appropriate instrument transformers for protection and metering. Surge arresters will be provided for the outgoing lines in the area of the takeoff towers.

The switchyard will be located near the main step-up transformers and will require an overhead span for the connection.

The breakers will be of the dead tank design with current transformers on each bushing. Disconnect switches will be located on each side of the breakers to isolate the breaker, and one switch will be located at each line termination or transformer connection for isolation of the lines or transformer for maintenance.

Tubular bus used in the switchyard will be aluminum alloy. Cable connections between the tube bus and equipment will be ACSR, AAAC, or AAC cable. Tube and cables will meet all electrical and mechanical design requirements. Instrument transformers (current and capacitive voltage transformers) will be included for protection and synchronization where required.

A grounding grid will be provided to control step and touch potentials in accordance with IEEE Standard 80, Safety in Substation Grounding. Metallic equipment, structures, and fencing will be connected to the grounding grid of buried conductors and ground rods, as required for personnel safety. The substation ground grid will be tied to the plant ground grid.

Lightning protection will be provided by shield wires or lightning masts. The lightning protection system will be designed in accordance with IEEE 998 guidelines.

All faults will be detected, isolated, and cleared in a safe and coordinated manner as soon as practical to ensure the safety of equipment, personnel, and the public. Protective relaying will meet IEEE requirements and will be coordinated with the utility.

Revenue metering will be provided on the 13.8-kV generator bus to record net power to or from the switchyard. Meters and a metering panel will be provided.

4.3.2 Generator Circuit Breakers

Each generator will have a dedicated generator circuit breaker (GCB). The GCBs will be capable of handling the generator nameplate output. They will also be rated for the available through fault currents associated with the circuit.

The GCBs will serve two purposes. They will allow each generator to be isolated from the grid and they will be used to synchronize the generators with the grid.

During plant startup the GCBs will be open. When the generator is at full speed and synchronized with the grid, the GCBs will be closed to allow power flow from the generators to the grid.

4.3.3 Transformers

The generators will be connected to the 115-kV switchyards through main step-up transformers. The step-up transformers will be designed in accordance with ANSI standards C57.12.00, C57.12.90, and C57.91. The main transformers will be two-winding, delta-wye, ONAN/ONAF/ONAF. The neutral point of high-voltage winding will be solidly grounded. Each main step-up transformer will have metal oxide surge arrestors connected to the high-voltage terminals and will have manual de-energized ("no-load") tap changers located in high-voltage windings.

Two of the three generators will be provided with 13.8-kV to 4.16-kV auxiliary power transformer. The auxiliary transformers will be used to feed all of the electrical loads associated with the plant.

During plant startup, power will be backed through the generator step-up transformers to the auxiliary transformers. Once each generator has been started and synchronized with the utility bus, the generator circuit breakers will be closed. When this occurs, the generators will begin feeding power to the auxiliary transformers (only applies to the units connected to auxiliary transformers) and exporting power to the grid.

5.0 Control Engineering Design Criteria

5.1 Introduction

This section summarizes the codes, standards, criteria, and practices that will be generally used in the design and installation of instrumentation and controls for A2PP. More specific project information will be developed during execution of the project to support detailed design, engineering, material procurement specification and construction specifications.

5.2 Codes and Standards

The design specification of all work will be in accordance with the laws and regulations of the federal government, the State of California, and local codes and ordinances. A summary of general codes and industry standards applicable to design and control aspects of the power facility follows.

- American National Standards Institute (ANSI)
- American Society of Mechanical Engineers (ASME)
- The Institute of Electrical and Electronics Engineers (IEEE)
- International Society of Automation (ISA)
- National Electrical Manufacturers Association (NEMA)
- National Electrical Safety Code (NESC)
- National Fire Protection Association (NFPA)

- American Society for Testing and Materials (ASTM)

5.3 Control Systems Design Criteria

5.3.1 General Requirements

Electronic signal levels, where used, will be 4 to 20 milliamps (mA) for analog transmitter outputs, controller outputs, electric-to-pneumatic converter inputs, and valve positioner inputs.

The switched sensor full-scale signal level will be between 0 volt (V) and 125 V.

5.3.2 Pressure Instruments

In general, pressure instruments will have linear scales with units of measurement in pounds per square inch, gauge (psig).

Pressure gauges will have either a blowout disk or a blowout back and an acrylic or shatterproof glass face.

Pressure gauges on process piping will be resistant to plant atmospheres.

Pressure test points will have isolation valves and caps or plugs. Pressure devices on pulsating services will have pulsation dampers.

5.3.3 Temperature Instruments

In general, temperature instruments will have scales with temperature units in degrees Fahrenheit. Exceptions to this are electrical machinery resistance temperature detectors (RTDs) and transformer winding temperatures, which are in degrees Celsius.

Bimetal-actuated dial thermometers will have 4.5- or 5-inch-diameter (minimum) dials and white faces with black scale markings and will consist of every angle-type. Dial thermometers will be resistant to plant atmospheres.

Temperature elements and dial thermometers will be protected by thermowells except when measuring gas or air temperatures at atmospheric pressure. Temperature test points will have thermowells and caps or plugs.

RTDs will be 100-ohm platinum, 3-wire type. The element will be spring-loaded, mounted in a thermowell, and connected to a cast iron head assembly.

Thermocouples will be Type J or K dual-element, grounded, spring-loaded, for general service. Materials of construction will be dictated by service temperatures. Thermocouple heads will be the cast type with an internal grounding screw.

5.3.4 Level Instruments

Reflex-glass or magnetic level gauges will be used. Level gauges for high-pressure service will have suitable personnel protection.

Gauge glasses used in conjunction with level instruments will cover a range that includes the highest and lowest trip/alarm set points.

5.3.5 Flow Instruments

Flow transmitters will typically be the differential pressure-type with the range similar to that of the primary element. In general, linear scales will be used for flow indication and recording.

Magnetic flow transmitters may be used for liquid flow measurement below 200°F.

5.3.6 Control Valves

Control valves in throttling service will generally be the globe-body cage type with body materials, pressure rating, and valve trims suitable for the service involved. Other style valve bodies (e.g., butterfly, eccentric disk) may also be used when suitable for the intended service.

Valves will be designed to fail in a safe position.

Control valve body size will not be more than two sizes smaller than line size, unless the smaller size is specifically reviewed for stresses in the piping.

Control valves in 600-Class service and below will be flanged where economical. Where flanged valves are used, minimum flange rating will be ANSI 300 Class.

Critical service valves will be defined as ANSI 900 Class and higher in valves of sizes larger than 2 inches.

Severe service valves will be defined as valves requiring anticavitation trim, low noise trim, or flashing service, with differential pressures greater than 100 pounds per square inch (psi).

In general, control valves will be specified for a noise level no greater than 90 decibel A-rated (dBA) when measured 3 feet downstream and 3 feet away from the pipe surface.

Valve actuators will use positioners and the highest pressure, smallest size actuator, and will be the pneumatic-spring diaphragm or piston type. Actuators will be sized to shut off against at least 110 percent of the maximum shutoff pressure and designed to function with instrument air pressure ranging from 80 to 125 psig.

Handwheels will be furnished only on those valves that can be manually set and controlled during system operation (to maintain plant operation) and do not have manual bypasses.

Control valve accessories, excluding controllers, will be mounted on the valve actuator unless severe vibration is expected.

Solenoid valves supplied with the control valves will have Class H coils. The coil enclosure will normally be a minimum of NEMA 4 but will be suitable for the area of installation. Terminations will typically be by pigtail wires.

Valve position feedback (with input to the DCS for display) will be provided for all control valves.

5.3.7 Instrument Tubing and Installation

Tubing used to connect instruments to the process line will be stainless steel for primary instruments and sampling systems.

Instrument tubing fittings will be the compression type. One manufacturer will be selected for use and will be standardized as much as practical throughout the plant.

Differential pressure (flow) instruments will be fitted with three-valve manifolds; two-valve manifolds will be specified for other instruments as appropriate.

Instrument installation will be designed to correctly sense the process variable. Taps on process lines will be located so that sensing lines do not trap air in liquid service or liquid in gas service. Taps on process lines will be fitted with a shutoff (root or gauge valve) close to the process line. Root and gauge valves will be main-line class valves.

Instrument tubing will be supported in both horizontal and vertical runs as necessary. Expansion loops will be provided in tubing runs subject to high temperatures. The instrument tubing support design will allow for movement of the main process line.

5.3.8 Pressure and Temperature Switches

Field-mounted pressure and temperature switches will have either NEMA Type 4 housings or housings suitable for the environment.

In general, switches will be applied such that the actuation point is within the center one-third of the instrument range.

5.3.9 Field-mounted Instruments

Field-mounted instruments will be of a design suitable for the area in which they are located. They will be mounted in areas accessible for maintenance and relatively free of vibration and will not block walkways or prevent maintenance of other equipment.

Field-mounted instruments will be grouped on racks. Supports for individual instruments will be prefabricated, off-the-shelf, 2-inch pipestand. Instrument racks and individual supports will be mounted to concrete floors, to platforms, or on support steel in locations not subject to excessive vibration.

Individual field instrument sensing lines will be sloped or pitched in such a manner and be of such length, routing, and configuration that signal response is not adversely affected.

Liquid level controllers will generally be the nonindicating, displacement-type with external cages.

5.3.10 Instrument Air System

Branch headers will have a shutoff valve at the takeoff from the main header. The branch headers will be sized for the air usage of the instruments served, but will be no smaller than 3/8 inch. Each instrument air user will have a shutoff valve, filter, outlet gauge, and regulator at the instrument.

6.0 Chemical Engineering Design Criteria

6.1 Introduction

This section summarizes the general chemical engineering design criteria for the A2PP project. These criteria form the basis of the design for the chemical components and systems of the project. More specific design information is developed during detailed design to support equipment and erection specifications. It is not the intent of this appendix to present the detailed design information for each component and system, but rather to summarize the codes, standards, and general criteria that will be used.

6.2 Design Codes and Standards

The design and specification of all work will be in accordance with the laws and regulations of the federal government, the State of California, and local codes and ordinances. Industry codes and standards relevant to chemical engineering design to be used in design and construction are summarized below.

- ANSI B31.1 Power Piping Code
- ASME Performance Test Code 31, Ion Exchange Equipment
- American Society for Testing and Materials (ASTM)
- California Building Code (CBC)
- Occupational Safety and Health Administration (OSHA)
- Steel Structures Painting Council Standards (SSPC)
- Underwriters Laboratories
- American Waterworks Association (AWWA)

Other recognized standards will be used as required to serve as design, fabrication, and construction guidelines when not in conflict with the above-listed standards.

The codes and industry standards used for design, fabrication, and construction will be the codes and industry standards, including all addenda, in effect as stated in equipment and construction purchase or contract documents.

6.3 General Criteria

6.3.1 Design Water Quality

Service Water. The existing Almond Power Plant well will be used to supply service water (such as fire water, eye wash station water, etc.) to the A2PP.

Reverse Osmosis Membrane System. Raw water will be filtered and purified via a reverse osmosis (RO) system to remove suspended solids and the majority of the dissolved solids. The RO permeate will be forwarded to an RO storage tank that will supply the evaporative cooler makeup demand and demineralized water system. The high total dissolved solids RO reject stream will be discharged to the City of Ceres wastewater treatment plant.

Demineralized Water System. Demineralized water will be produced by an RO and ion exchange system. The high-quality demineralized water will be used for the combustion turbine water injection, on-line water wash, and SPRINT systems. The demineralized water will be the highest practical quality. Minimum quality requirements are detailed in Table 6-1.

TABLE 6-1
Demineralized Water Purity Requirements

Parameter	Units	Value
Total Solids	ppm	5.0
Total Dissolved Solids	ppm	3.0
Silica as Silicon Dioxide (SiO_2)	ppm	0.1
Conductivity*	μΩ/cm	< 0.1 @ 25°C
pH*	Standard Units	6.5 – 7.5
Sodium + Potassium $(Na+K)_{max}$	ppm	0.1
$Chlorides_{max}$	mg/L	0.5
$Sulfates_{max}$	mg/L	0.5

*measured in the absence of carbon dioxide (CO_2)
°C = degrees Celsius
mg/L = milligrams per liter
ppm = parts per million
μΩ/cm = micromho per centimeter

Construction Water. Water for use during construction will be supplied from the TID lateral line 2, when available, and alternatively from the existing Almond Power Plant hydrants.

Fire Protection Water. The source of water for fire protection will be from the existing Almond Power Plant fire water tank. The tank will have a minimum capacity of 2 hours of firewater reserved in the tank.

6.3.2 Chemical Conditioning

Reverse Osmosis Membrane System Chemical Conditioning. Chemical feed systems will supply the following water-conditioning chemicals to the RO system to minimize corrosion and control, the formation of mineral scale, and biofouling:

- Dechlorination: Sodium bisulfite to remove chlorine residual
- Mineral scale dispersant: Polyacrylate based solution
- Corrosion inhibitor: Phosphate based
- pH control: Sulfuric acid for alkalinity consumption and scaling tendencies
- Clean-in-place (CIP): Chemical cleaning solution contains sodium hydroxide, sodium hypochlorite, and citric acid
- Biocide: Sodium hypochlorite, stabilized bromine, or sodium bromide will be fed into the system to prevent bio-fouling

Process Water Chemical Conditioning

The plant process water from the City of Ceres wastewater treatment plant will be chlorinated using sodium hypochlorite (bleach).

6.3.3 Chemical Storage

Storage Capacity. Dechlorination feed equipment will consist of a 250-gallon returnable tote with two full capacity scale inhibitor metering pumps.

The scale inhibitor feed equipment will consist of a 250-gallon returnable tote with two full-capacity scale inhibitor metering pumps.

Corrosion control feed equipment will consist of a 250-gallon returnable tote with two full-capacity scale inhibitor metering pumps.

The sulfuric acid feed equipment will consist of a 1,500-gallon storage tank. The tank will be accompanied by two, full-capacity sulfuric acid metering pumps.

The chemical cleaning solution tanks will consist of a 55-gallon drum and solution mixing tank for each of the three CIP chemicals. The cleaning solution is prepared by mixing sodium hydroxide (caustic), sodium hypochlorite (bleach), and citric acid.

The sodium hypochlorite feed equipment will consist of a 3,000-gallon bulk storage tank and two full-capacity hypochlorite metering pumps. A 1,000-gallon bulk storage tank and two full-capacity metering pumps will be provided for the feeding of either stabilized bromine or sodium bromide.

Facilities for feeding a non-oxidizing biocide will include 200- to 400-gallon totes and two full-capacity chemical metering pumps.

Containment. Chemical storage tanks containing corrosive fluids will be surrounded by curbing. Curbing and drain piping design will allow a full tank capacity spill without overflowing the curbing. For multiple tanks located within the same curbed area, the largest single tank will be used to size the curbing and drain piping. For outdoor chemical containment areas, additional containment volume will be included for stormwater.

Closed Drains. Waste piping for volatile liquids and wastes with offensive odors will use closed drains to control noxious fumes and vapors.

Coatings. Tanks, piping, and curbing for chemical storage applications will be provided with a protective coating system. The specific requirements for selection of an appropriate coating will be identified prior to equipment and construction contract procurements.

6.3.4 Wastewater Treatment

The primary wastewater collection system will collect process wastewater from all of the plant equipment, including the evaporative coolers and water treatment equipment.

Wastewater from the water treatment system will consist of the reject stream from the RO units that will initially reduce the concentration of dissolved solids in the plant makeup water before it is treated in the mixed bed ion exchange vessels.

General plant drains will collect area washdown, sample drains, and drainage from facility equipment areas. Water from these areas will be collected in a system of floor drains, hub drains, sumps, and piping and routed to the wastewater collection system. Drains that potentially could contain oil or grease will first be routed through the existing oil/water separator.

Wastewater from combustion turbine water washes will be collected in a water wash drains tank. The wastewater will be discharged to the existing oil/water separator and then sent to the wastewater tank.

7.0 Geologic and Foundation Design Criteria

7.1 Introduction

This section provides a description of the site conditions and preliminary foundation-related subsurface conditions. Soil-related hazards addressed include soil liquefaction, hydrocompaction (or collapsible soils), and expansive soils. Preliminary foundation and earthwork considerations are addressed based on the results of general published information available for the project area and collected for the AFC, and established geotechnical engineering practices.

Information contained in this appendix reflects the codes, standards, criteria, and practices that will be used in the design and construction of site and foundation engineering systems for the facility. More specific project information will be developed during execution of the project to support detailed design, engineering, material procurement specification, and construction specifications. This information will be included in a geotechnical engineering study, which, if requested, will be provided to the CEC upon completion.

7.2 Scope of Work

The scope of services for the preparation of this appendix included an assessment of soils-related hazards, a summary of preliminary foundation and earthwork considerations, and preliminary guidelines for inspection and monitoring of geotechnical aspects of construction based on available published data as analyzed in Section 5.4, Geologic Hazards and Resources.

7.3 Site Conditions

The proposed TID Almond 2 Power Plant project site will cover approximately 4.6 acres and is located in Stanislaus County, California, in the Central Valley, about 3 miles south of the Crow's Landing Road exit off of Highway 99 in Ceres, California. Elevation of the site is approximately 80 feet above mean sea level. The A2PP project site is adjacent to the existing Almond Power Plant, just to the north of the existing plant site.

7.4 2G.4 Site Subsurface Conditions

7.4.1 Stratigraphy

Borings will be performed at the project site to verify the soil consistency and characteristics.

7.4.2 Seismicity / Ground Shaking

The project site lies within a seismically active region. Large earthquakes have occurred in the past and will occur in the future. The region is influenced by the San Andreas Fault system that separates the North American and Pacific plate boundaries. This boundary has been the site of numerous large-scale earthquakes. The closest fault system to the project site, excluding the inactive Tesla-Ortigalita fault zone, is the Foothills fault system containing the Bear Mountains and Melones fault zones, located approximately 25 miles east of the site. More seismic data will be provided after a detailed geotechnical report is completed. Currently, the project area is considered to be seismically active and is designated as IBC Seismic Design Category D.

7.4.3 Ground Rupture

Ruptures along the surface trace of a fault tend to occur along lines of previous faulting. A ground rupture is caused when an earthquake event along a fault creates rupture at the surface. Because no known faults exist at the project site, the likelihood of ground rupture to occur at the project site is low. However, a ground rupture study at the project site will be performed as part of the geotechnical investigation in order to verify this assumption.

7.4.4 Liquefaction Potential

During strong ground shaking, loose, saturated, cohesionless soils can experience a temporary loss of shear strength. This phenomenon is known as liquefaction. Liquefaction is dependent on grain size distribution, relative density of the soils, degree of saturation, and intensity and duration of the earthquake. The potential hazard associated with liquefaction is seismically induced settlement. Soil liquefaction can lead to foundation bearing failures and excessive settlements when:

- The design ground acceleration is high (up to 0.4g)
- The water level is relatively shallow
- Low standard penetration tests (SPT) blow counts are measured in granular deposits (suggesting low soil density)

From available data, the depth to groundwater at the project site is fairly deep, possibly 21 to 24 feet deep, and the native soil generally consists of medium dense to very dense silty sand, gravelly sand, clayey sand, and sandy gravel. Therefore, the likelihood that liquefaction will occur at the site is considered very low. Further geotechnical investigation will be required to confirm this assumption.

7.4.5 Groundwater

The depth to groundwater at the project site is relatively deep. The groundwater elevation will be confirmed during a more thorough geotechnical investigation prior to major plant construction.

7.5 Assessment of Soil-related Hazards

7.5.1 Expansive Soils

Expansive soils shrink and swell with wetting and drying. The shrink-swell capacity of expansive soils can result in differential movement beneath foundations. Expansive soils have not been identified as a potential hazard in the San Joaquin Valley area. Based on this, the likelihood of expansive soils to be present at the site is low.

Laboratory test results for representative soil samples at the top 10 feet below grade will be tested to determine overall soil expansiveness. The soils near the project site are generally not clayey and indicate no soils with a potential for expansion. A soil investigation will be performed at the project site to confirm these assumptions.

7.5.2 Collapsible Soils

Soil collapse (hydrocompaction) is a phenomenon that results in relatively rapid settlement of soil deposits due to addition of water. This generally occurs in soils having a loose particle structure cemented together with soluble minerals or with small quantities of clay. Water infiltration into such soils can break down the interparticle cementation, resulting in collapse of the soil structure. Collapsible soils are usually identified with index tests, such as dry density and liquid limit, and consolidation tests where soil collapse potential is measured after inundation under load.

Based on the available data, the potential for soil collapse at the site is expected to be remote. However, this will be confirmed by testing soil samples retrieved from borings at the project site.

7.6 Preliminary Foundation Considerations

7.6.1 General Foundation Design Criteria

For satisfactory performance, the foundation of any structure must satisfy two independent design criteria. First, it must have an acceptable factor of safety against bearing failure in the foundation soils under maximum design load. Second, settlements during the life of the structure must not be of a magnitude that will cause structural damage, endanger piping connections, or impair the operational efficiency of the facility. Selection of the foundation type to satisfy these criteria depends on the nature and magnitude of dead and live loads, the base area of the structure and the settlement tolerances. Where more than one foundation type satisfies these criteria, then cost, scheduling, material availability, and local practice will probably influence or determine the final selection of the type of foundation.

Based on the information collected from the preliminary geotechnical report, no adverse foundation-related subsurface and groundwater conditions would be encountered that would preclude the construction and operation of the proposed structures. The site can be considered suitable for development of the proposed structures, pursuant to completion of a geotechnical investigation, and the preliminary foundation and earthwork considerations discussed in this appendix.

7.6.2 Shallow Foundations

Completion of the geotechnical investigation will determine if the proposed structures can be supported directly on the native soils. Engineered fill material may be required directly under the more heavily loaded shallow-depth foundations. Shallow foundation construction will require the earthwork measures discussed in Subsection 2G.7, Preliminary Earthwork Considerations.

Allowable bearing pressures will include a safety factor of at least 3 against bearing failures. Settlements of footings are expected to be limited to 1 inch, and differential settlement between neighboring foundations to less than 0.5 inch. Tanks can usually undergo much larger settlements.

Frost depth is likely to be less than 5 inches at the site, but will be confirmed through a geotechnical investigation. Pursuant to a geotechnical investigation, exterior foundations and foundations in unheated areas should be placed at a depth of at least 1 foot below the ground surface for protection. Interior footings in permanently heated areas can be placed at nominal depths. The minimum recommended width is 3 feet for spread footings and 2 feet for wall footings.

7.6.3 Deep Foundations

Compressible soils are not expected based on the information obtained from preliminary geotechnical reports. However, if compressible soils are present at the project site, which would preclude use of shallow foundations mentioned above, drilled shaft foundations will be needed. A typical drilled shaft could be 24 inches in diameter and 10 feet deep based on preliminary geotechnical investigation. These types of drilled shafts are expected to develop allowable loads of 15 to 20 tons in compression, 10 tons in uplift. The length, size, allowable bearing, uplift, and lateral capacity of the drilled shafts for the project site, if needed, will be determined using available software programs.

7.6.4 Corrosion Potential and Ground Aggressiveness

Corrosivity tests will be conducted to determine whether the site soils are noncorrosive or corrosive for buried steel based on the chloride content and pH values.

7.7 Preliminary Earthwork Considerations

7.7.1 Site Preparation and Grading

The subgrade preparation would include the complete removal of all vegetation and topsoil. The majority of the vegetation on the site consists of weeds and grasses with a maximum root depth of less than a foot. Topsoil can be stockpiled and may be reused in remote areas of the site where no future construction is expected.

As shown on the Proposed Drainage Plan, any site fill work should be performed as detailed below. All soil surfaces to receive fill should be proof-rolled with a heavy vibratory roller or a fully loaded dump truck to detect soft areas.

7.7.2 Temporary Excavations

All excavations should be sloped in accordance with Occupational Safety and Health Act (OSHA) requirements. Sheet piling could also be used to support any excavation. The need for internal supports in the excavation will be determined based on the final depth of the excavation. Any excavation below the water table should be dewatered using well points or other suitable system installed prior to the start of excavation.

7.7.3 Permanent Slopes

Cut and fill slopes shall be 2h:1v (horizontal to vertical) maximum. Embankments for creek diversions, if required, shall be 5h:1v maximum.

7.7.4 Backfill Requirements

All fill material will be free of organic matter, debris, or clay balls, with a maximum size not exceeding 3 inches. Structural fill will also have a Plastic Index of less than 15, a Liquid Limit of less than 30, and a maximum fine content (passing the 200 sieve) of 30 percent. Granular, uniformly graded material with a maximum aggregate size of 0.5 inch may be used for pipe bedding. Based on the available site grading, it is anticipated that fill material will be available on site.

Structural fill will be compacted to at least 95 percent of the maximum dry density as determined by ASTM D 1557 when used for raising the grade throughout the site, below footings or mats, or for rough grading. Fill placed behind retaining structures may be compacted to 90 percent of the maximum dry density as determined by ASTM D 1557. Initially, structural fill will be placed in lifts not exceeding 8 inches loose thickness. Thicker lifts may be used pursuant to approval based on results of field compaction performance. The moisture content of all compacted fill will fall within 3 percentage points of the optimum moisture content measured by ASTM D 1557, except the top 12 inches of subgrade will be compacted to 95 percent of ASTM D 1557 maximum density.

Pipe bedding can be compacted in 12-inch lifts to 90 percent of the maximum dry density as determined by ASTM D 1557. Common fill to be placed in remote and/or unsurfaced areas may be compacted in 12-inch lifts to 85 percent of the maximum dry density as determined by ASTM D 1557.

7.8 Inspection and Monitoring

A California-registered Geotechnical Engineer or Engineering Geologist will monitor geotechnical aspects of foundation construction and/or installation and fill placement. At a minimum the Geotechnical Engineer/Engineering Geologist will monitor the following activities:

- Surfaces to receive fill will be inspected prior to fill placement to verify that no pockets of loose/soft or otherwise unsuitable material were left in place and that the subgrade is suitable for structural fill placement.
- Fill placement operations will be monitored by an independent testing agency. Field compaction control testing will be performed regularly and in accordance with the applicable specification to be issued by the Geotechnical Engineer.
- The Geotechnical Engineer will witness drilled shaft installation if required.
- Settlement monitoring of significant foundations and equipment is recommended on at least a quarterly basis during construction and the first year of operation, and then semi-annually for the next 2 years.

7.9 Site Design Criteria

7.9.1 General

The project will be located in the San Joaquin Valley, California. The approximate 4.6-acre site slopes from south to north, with no existing permanent type of structures on the project site. The site would be accessible via a service road, which borders the plant site to the south and ties into Crows Landing.

7.9.2 Datum

The site grade ranges from approximately 80 to 85 feet above mean sea level, based on the U.S. Geological Survey (USGS) Quad Map information and the 1929 National Geodetic Vertical Datum (NGVD). Final site grade elevation will be determined during detail design.

7.10 Foundation Design Criteria

7.10.1 General

Reinforced concrete structures (spread footings, mats, and deep foundations) will be designed consistent with Section 2.0, Structural Engineering Design Criteria.

Allowable soil-bearing pressures for foundation design will be in accordance with this appendix and the detailed geotechnical investigation for the site.

7.10.2 Groundwater Pressures

Hydrostatic pressures due to groundwater or temporary water loads will be considered.

7.10.3 Factors of Safety

The factor of safety for structures, tanks and equipment supports with respect to overturning, sliding, and uplift due to wind and buoyancy will be as defined in Appendix 2B, Structural Engineering Design Criteria.

7.10.4 Load Factors and Load Combinations

For reinforced concrete structures and equipment supports, using the strength method, the load factors and load combinations will be in accordance with Appendix 2B, Structural Engineering Design Criteria.

7.11 References

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