FOUNDATION AND CIVIL ENGINEERING DESIGN CRITERIA

1.0 INTRODUCTION

The design, engineering, procurement, and construction activities on the project will be in accordance with various predetermined standards and project-specific practices. This appendix summarizes the civil engineering codes and standards, design criteria, and practices that will be used during design and construction. These criteria form the basis of the design for the foundations and civil systems of the project. More specific design information will be developed during the detailed design phase to support equipment procurement and construction 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.

Section 2.0 summarizes the applicable codes and standards, and Section 3.0 includes the general criteria for foundations, design loads, and sitework.

2.0 DESIGN CODES AND STANDARDS

2.1 General Requirements

The design and specification of work will be in accordance with all applicable laws and regulations of the Federal Government, the State of California, and the applicable local codes and ordinances. Except where noted otherwise, the latest issue of all codes and standards, including addenda, in effect at the start of the project will be used. The codes and standards, including all addenda, in effect at the time of purchase will be used for material and equipment procurement.

A summary of the codes and the standards to be used in the design and construction follows:

- Seismic standards and criteria will follow the California Building Code (CBC).

- Specifications for materials will follow the standard specifications of the American Society for Testing and Materials (ASTM) and the American National Standards Institute (ANSI), unless noted otherwise.

- Field and laboratory testing procedures for materials will follow ASTM standards.

- Design and placement of structural concrete and reinforcing steel will be in accordance with the codes, guides, and standards of the American Concrete Institute (ACI) and the Concrete Reinforcing Steel Institute (CRSI).

- Specifications for materials for roads will follow the State of California Department of Transportation Standard Specifications.

- Design and construction of roads will follow the American Association of State Highway and Transportation Officials (AASHTO) and the State of California Department of Transportation standards.

- Design and construction of the sanitary sewer system will conform to the Uniform Plumbing Code (UPC).

- Design and construction will conform to federal and California Occupational Safety and Health Administration (OSHA and CAL-OSHA) requirements.

Other recognized standards will be used where required to serve as guidelines for the design, fabrication, and construction. Where no other code or standard governs, the CBC, 1998 Edition, will govern.

2.2 Government Rules and Regulations

The following laws, ordinances, regulations, and standards (LORS) are applicable to the civil engineering design and construction. In cases where conflicts between cited codes (or standards) exist, the requirements of the more stringent code will govern.

2.2.1 Federal

- Title 29, Code of Federal Regulations (CFR), Part 1910, Occupational Safety and Health Standards

- Title 29, CFR, Part 1926, National Safety and Health Regulations for Construction

- Walsh-Healy Public Contracts Act (Public Law [PL] 50-204.10)

- National Pollutant Discharge Elimination System (NPDES) (US Environmental Protection Agency [EPA])

2.2.2 State

- California Building Code
- Business and Professions Code Section 6704 et seq., Sections 6730 and 6736 – requires state registration to practice as a Civil Engineer or Structural Engineer in California
- Labor Code Section 6500, et seq. – requires a permit for construction of trenches or excavations 5 feet or deeper into which personnel have to descend; also applies to construction or demolition of any building, structure, false work, or scaffolding that is more than three stories high or equivalent
- Title 24, California Code of Regulations (CCR) – adopts current edition of CBC as minimum legal building standards
- State of California Department of Transportation, Standard Specifications
- Title 8, CCR, Section 1500 et seq., Section 2300 et seq., and Section 3200 et seq. – describes general construction safety orders, industrial safety orders, and work safety requirements and procedures
- Regulations of the following state agencies as applicable:
  - Department of Labor and Industry Regulations
  - Bureau of Fire Protection
  - Department of Public Health
  - Water and Power Resources
- Vehicle Code, Section 35780, et seq. Requires a permit from Caltrans to transport heavy loads on state roads.

2.2.3 Local

- California Building Code, 1998 edition
- City of Lemoore Engineering Services – Erosion Control and Storm Drain Design Standards

2.2.4 Engineering Geology Codes and Standards

The design and specification of work will be in accordance with all applicable laws and regulations of the Federal Government, the State of California, and with the applicable local codes and ordinances.

The site development activities will require certification during and following construction. The Geotechnical Engineer and Engineering Geologist will certify the placement of fills and adequacy of the site for structural improvements in accordance with the CBC. Additionally, the Engineering Geologist will present findings and conclusions pursuant to PRC Section 25523 (a) and (c) 20 CCR Section 1752 (b) and (c).

The following laws, ordinances, codes, and standards have been identified as applying to engineering geology design and construction. In cases where conflicts between cited codes (or standards) exist, the requirements of the more conservative code will be met.

2.2.4.1 Federal

None are applicable.

2.2.4.2 State – California Building Code

The Warren-Alquist Act (PRC Section 25000, et seq.) and the CEC Siting Regulations (20 CCR, Chapter 2) require that Applications for Certification address geologic and seismic issues. Detailed geologic and seismic information must be provided with respect to safety and reliability concerns and environmental impacts.

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

2.2.4.3 County

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 (f) requires that a seismic safety element be included in the general plan. Seismic and geologic hazard plans and regulations are often addressed under the seismic safety elements of general plans or in local building and grading ordinances.

2.2.4.4 Industry Codes and Standards

In addition to the California Codes discussed above, other laws, standards, and ordinances, which typically pertain to engineering geology, include the following:

- California Business and Professions Code Section 7835. Requires registration for geologists (including engineering geologists) who practice for others.

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. Where no other standard or code governs, the CBC will be used.

2.3 Industry Codes and Standards

2.3.1 American Association of State Highway and Transportation Officials (AASHTO)

- A Policy on Geometric Design of Highways and Streets

2.3.2 American Concrete Institute (ACI)

- ACI 117 – Standard Specification for Tolerances for Concrete Construction and Materials
- ACI 211.1 – Standard Practice for Selecting Proportions of Normal, Heavyweight, and Mass Concrete
- ACI 301 – Specifications for Structural Concrete for Buildings
- ACI 302.1R – Guide for Concrete Floor and Slab Construction
- ACI 304R – Guide for Measuring, Mixing, Transporting, and Placing Concrete
- ACI 305R – Hot Weather Concreting

- ACI 306R – Cold Weather Concreting
- ACI 308 – Standard Practice for Curing Concrete
- ACI 309R – Guide for Consolidation of Concrete
- ACI 311AR – Guide for Concrete Inspection
- ACI 318 – Building Code Requirements for Reinforced Concrete
- ACI 318.1 – Building Code Requirements for Structural Plain Concrete
- ACI 347R – Guide to Formwork for Concrete

2.3.3 American Society for Testing and Materials (ASTM)

- ASTM A82 – Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
- ASTM A116 – Standard Specification for Zinc-Coated (Galvanized) Steel Woven Wire Fence Fabric
- ASTM A121 – Standard Specification for Zinc-Coated (Galvanized) Steel Barbed Wire
- ASTM A185 – Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
- ASTM A392 – Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric
- ASTM A615 – Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- ASTM C31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field
- ASTM C33 – Standard Specification for Concrete Aggregates
- ASTM C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
- ASTM C76 – Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
- ASTM C94 – Standard Specification for Ready-Mixed Concrete

- ASTM C109 – Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 in. or 50 mm Cube Specimens)
- ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
- ASTM C138 – Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
- ASTM C143 – Standard Test Method for Slump of Hydraulic Cement Concrete
- ASTM C150 – Standard Specification for Portland Cement
- ASTM C172 – Standard Practice for Sampling Freshly Mixed Concrete.
- ASTM C231 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
- ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete
- ASTM C289 – Standard Test Method for Potential Reactivity of Aggregates (Chemical Method)
- ASTM C443 – Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
- ASTM C478 – Standard Specification for Precast Reinforced Concrete Manhole Sections
- ASTM C494 – Standard Specification for Chemical Admixtures for Concrete
- ASTM C586 – Standard Test Method for Potential Alkali Reactivity of Carbonate Rocks for Concrete Aggregates (Rock Cylinder Method)
- ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcinated Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
- ASTM C1064 – Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete
- ASTM C1107 – Standard Specification for Packaged Dry, Hydraulic Cement Grout (Nonshrink)
- ASTM D422 – Standard Test Method for Particle-Size Analysis of Soils

- ASTM D698 – Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft [600 kN-m/m])
- ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
- ASTM D1752 – Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
- ASTM D2216 – Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock
- ASTM D2922 – Standard Test Methods for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)
- ASTM D3017 – Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
- ASTM D3034 – Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
- ASTM D3740 – Standard Practice for Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
- ASTM D4318 – Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM E329 – Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

2.3.4 Concrete Reinforcing Steel Institute (CRSI)

- Manual of Standard Practice

2.3.5 International Association of Plumbing and Mechanical Officials

- UPC – Uniform Plumbing Code

2.3.6 International Conference of Building Officials

- CBC – California Building Code

3.0 CIVIL DESIGN CRITERIA

3.1 Foundations

3.1.1 General

Geotechnical exploration, testing, and analysis determine the most suitable bearing methods for foundations. Criteria will be established to permit design of the most economical foundation compatible with the life expectancy and service of the structure.

A summary of subsurface investigations, laboratory testing programs, and a geotechnical assessment of the proposed site are presented in the Preliminary Geotechnical Investigation prepared by Hultgren – Tillis Engineers, dated June 26, 2001.

3.1.2 Foundation Design Criteria

Allowable settlements for all foundations (based on predicted elastic or short-term, and consolidation or long-term settlements) will be limited as follows:

Major and minor foundations except as otherwise indicated:

- Total settlement: 1.5 inches
- Differential settlement: 0.1 percent between adjacent foundations

Large field erected tanks:

- Total settlement: 6.0 inches
- Differential settlement: 3.0 inches

Foundations for all critical structure and equipment will be supported on reinforced concrete mat foundations. Noncritical or lightly loaded structures and equipment will be founded on individual spread footings. The design of reinforced concrete foundations will satisfy the requirements of ACI 318.

Spread footings will have a minimum width of 3 feet, and a minimum width of 2 feet will be provided for wall footings. The bottom of footings will be located a minimum of 12 inches below finished grade.

Detailed foundation design criteria, including allowable bearing pressures, will be developed based on the results of additional subsurface investigations performed during the detailed design phase of the project. Allowable bearing pressures will include a safety factor of at least 3 against bearing failures.

3.1.3 Equipment Foundations

Each piece of equipment will be supplied with a reinforced concrete foundation suitable to its operation. Where the equipment could induce excessive vibration, the foundation will be provided with adequate mass to dampen vibratory motions. Special consideration will be given to vibration and stiffness criteria where specified by an equipment manufacturer. Equipment located within an enclosed building with a grade slab will generally be placed on a concrete pad that is raised above the grade slab to keep the equipment off the floor surface.

Minimum temperature and shrinkage reinforcing steel will be provided for equipment foundations unless additional reinforcement is required for the equipment loads. Anchor bolts designed to develop their yield strength will be provided for critical equipment. For noncritical or lightly loaded equipment, concrete expansion anchors may be used to secure equipment to foundations.

3.1.4 Rotating Equipment Foundations

Dynamic behavior will be considered in the design of foundations subjected to significant rotating equipment loads, such as foundations for the combustion turbine, steam turbine, and the boiler feedwater pumps. A dynamic analysis will be performed to determine the natural frequencies and dynamic responses of the foundation. To account for soil and structure interaction, geotechnical data will be used to determine the soil stiffnesses and damping coefficients used in the dynamic analysis.

Dynamic responses will satisfy the equipment manufacturer's criteria and/or industry standards in terms of maximum velocity/displacement amplitudes that are considered acceptable for machine and human tolerances. To avoid resonance during machine operation, the resonant frequency of the foundation will typically be less than 80 percent or greater than 120 percent of the machine operating speed.

3.2 Design Loads

3.2.1 General

Design loads for structures and equipment foundations are discussed in Appendix H2 of the AFC. Design loads for pavements and buried items will be determined according to the criteria described below, unless the applicable building code requires more severe design conditions.

3.2.2 Wheel Loads

Loads exerted on roadway pavements, buried piping, electrical duct banks, and culverts will be reviewed and selected prior to design of the underlying items. As a minimum, these items will be designed for HS20-44 loadings in accordance with AASHTO Standard Specifications. Loadings exceeding the HS20-44 loadings will be considered where found applicable during the detailed design phase.

A surcharge load of 250 psf will be applied to plant structures accessible to truck traffic.

3.3 Site

3.3.1 Site Arrangement

The site arrangement will conform to all applicable laws, regulations, and environmental standards. The principal elements to be considered in selection of the site arrangement are the physical space requirements and relationships dictated by each of the major plant systems, and the constraints imposed by the physical size and existing topography of the site. Distances from the main plant to various systems will be minimized for economy.

However, adequate clearance between various plant systems will be provided as needed for construction, operations, maintenance, and fire protection. The plant will be configured to minimize construction costs and visual impacts while remaining operationally effective. Utility interconnections will be optimized as much as practical.

3.3.2 Site Preparation

Site preparation will consist of clearing and grubbing, excavating soils to design grade, and preparing fill slopes and embankments designed so as to be stable and capable of carrying anticipated loads from either equipment or structures.

Root mats or stumps, if any, will be removed to a depth of not less than 2 feet below existing grade, and holes will be refilled with material suitable for embankment and compacted. Materials from clearing and grubbing operations will either be removed from the site or, if suitable, reused onsite.

3.3.3 Earthwork

Excavation work will consist of the removal, storage, and/or disposal of earth, sand, gravel, vegetation, organic matter, loose rock, boulders, and debris to the lines and grades necessary for construction. Material suitable for backfill will be stored in stockpiles at designated locations using proper erosion protection methods. Excess material will be removed from the site and disposed of at an acceptable location. If contaminated material is encountered during excavation, its disposal will comply with applicable federal, state, and local regulations.

The site is currently a grass-covered field. The surface slopes gently down at a 1 to 1-1/2 percent grade to the northeast.

Graded areas will be smooth, compacted, free from irregular surface changes, and sloped to drain. Cut and fill slopes for permanent embankments will be designed to withstand horizontal ground accelerations for Seismic Zone 4. For slopes requiring soil reinforcement to resist seismic loading, geogrid reinforcement will be used for fills and soil nailing for cuts. Slopes for embankments will be no steeper than 2:1 (horizontal:vertical). Construction will be at the existing plant grade, which is fairly level; therefore, major cuts and fills are not anticipated.

Areas to be backfilled will be prepared by removing unsuitable material and rocks. The bottom of an excavation will be examined for loose or soft areas. Such areas will be excavated fully and backfilled with compacted fill.

Backfilling will be done in layers of uniform, specified thickness. Soil in each layer will be properly moistened to facilitate compaction to achieve the specified density. To verify compaction, representative field density and moisture-content tests will be taken during compaction. Structural fill supporting foundations, roads, parking areas, etc., will be compacted to at least 95 percent of the maximum dry density as determined by ASTM D698. Embankments, dikes, bedding for buried piping, and backfill surrounding structures will be compacted to a minimum of 90 percent of the maximum dry density. General backfill placed in remote and/or unsurfaced areas will be compacted to at least 85 percent of the maximum dry density.

Where fills are to be placed on subgrades sloped at 6:1 (horizontal:vertical) or greater, keys into the existing subgrade may be provided to help withstand horizontal seismic ground accelerations.

The subgrade (original ground), subbases, and base courses of roads will be prepared and compacted in accordance with California Department of Transportation (Caltrans) standards. Testing will be in accordance with ASTM and Caltrans standards.

3.3.4 Site Drainage

The site drainage system will be designed to comply with all applicable federal, state, and local regulations.

Runoff from possible oil contamination areas, such as the lube oil storage area and transformer areas, will be contained and routed to an oil/water separator.

3.3.4.1 Storm Sewer System

The storm sewer system within the limits of the power block will consist of a system of drop inlets and storm drain pipes. Inlets will be constructed of cast-in-place or precast

concrete with top grates. The minimum cover requirement, loading, and material selection for pipes will be adequate for HS20 truck loading. The storm drain piping will discharge to ditches along the perimeter of the power block area and then to an onsite detention pond.

3.3.4.2 Pre- and Post-Development Runoff Conditions

The existing site is a grass-covered field. The additional runoff from the proposed development will be routed to the onsite stormwater detention pond.

Erosion and Sedimentation Control. Erosion and sedimentation control will be provided to retain sediment onsite and prevent violations of water quality standards.

Permanent erosion and sedimentation control measures within the plant site will include the runoff collection system (inlets and drainage piping) and surfaced traffic areas. Final grading within the limits of the new facilities will include aggregate surfacing. These measures will minimize the possibility of any appreciable erosion, and the resulting sedimentation, occurring on the site.

Temporary erosion and sediment control measures which comply with the state and local requirements will be used during the construction phase.

3.3.5 Roads

Access to the plant site will be from an existing public street to the west of the power block facility.

Access within the plant site will be provided by a loop road consisting of two 10-foot asphalt-paved lanes.

All roads will be surfaced with aggregate during the construction period. Periodic watering or applications of a dust palliative material will be used to minimize the dust problem during the dry seasons.

The minimum radius to the inside edge of pavement (EOP) or aggregate surface at intersections of the roads will be 40 feet.

Because of the flat terrain of the plant site, grades for all roads will be minimal.

3.3.6 Fencing and Security

Chain-link security fencing, topped with barbed wire, will be provided around the power plant facility site, substation, and other areas requiring controlled access.

Fencing heights will be in accordance with applicable codes and regulatory requirements.

A controlled access gate will be located at the main entrance to the secured area.

3.3.7 Sanitary Waste System

Sanitary wastes will be conveyed to a county-approved onsite sanitary waste disposal system consisting of a septic tank and a leaching field. If required, because of the proximity of the ground water, a mounded septic system will be used.

3.3.8 Spill Protection

Spill containment measures will be provided for chemical storage tanks and chemical additive/lube oil skid areas. The containment structure for the aqueous ammonia storage tank will be sized for 125 percent of the tank capacity. All other chemical storage tanks will be provided with a containment structure with a volume equal to at least 110 percent of the tank capacity. In addition, all outdoor containment structures will have a volume equal to at least the capacity of the tank plus the volume of rainfall from a 25-year storm event. Concrete curbs will be provided for chemical additive/lube oil skid areas. Where required for protection of the containment structure, appropriate surface coatings will be provided.

3.4 Geotechnical Investigation

A Preliminary Geotechnical Investigation for the project has been prepared by Hultgren-Tillis Engineers and is dated June 26, 2001.