APPENDIX B

STRUCTURAL AND SEISMIC ENGINEERING DESIGN CRITERIA

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B.1 INTRODUCTION

The project design, engineering, procurement, and construction activities will be in accordance with various predetermined standards and project-specific practices. This appendix summarizes the structural and seismic engineering codes and standards, design criteria, and practices that will be used during design and construction. These criteria form the basis for the project structural design work. More specific design information will be developed during detailed design 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 B.2 summarizes the applicable codes and standards, and Section B.3 includes the general criteria for natural phenomena, design loads, materials, seismic design, and architecture. Section B.4 describes the structural design methodology for structures and equipment. Section B.5 addresses project hazard mitigation.

B.2 DESIGN CODES AND STANDARDS

B.2.1 General Requirements

Work will be designed and specified in accordance with applicable laws and regulations of the federal government and the State of California and applicable local codes and ordinances. Except where noted otherwise, the latest issue of codes and standards, including addenda, in effect at the start of the project will be used. The codes and standards, including 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 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.

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

- Structural steel will be designed, fabricated, and erected in accordance with the American Institute of Steel Construction (AISC) Manual of Steel Construction - Allowable Stress Design.

- Steel components for metal wall panels and roof decking will conform to the American Iron and Steel Institute (AISI) Specification for the Design of Cold-Formed Steel Structural Members.

- Welding procedures and qualifications for welders will follow the recommended practices and codes of the American Welding Society (AWS).

- Metal surfaces for coating systems will be prepared following the specifications and standard practices of the Steel Structures Painting Council (SSPC) and the specific instructions of the coatings manufacturer.

- Masonry materials will be designed and erected in accordance with the ACI Building Code Requirements for Masonry Structures.

- Roof covering design will comply with the requirements of the National Fire Protection Association (NFPA) and Factory Mutual (FM).

- 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 design, fabrication, and construction. When no other code or standard governs, the California Building Code (CBC), 1998 Edition as amended by the Los Angeles County Code, will govern.

B.2.2 Government Rules and Regulations

The following laws, ordinances, codes, and standards are applicable to structural design and construction. In cases where conflicts between cited codes (or standards) exist, the requirements of the more stringent code will govern. The sections in the California Building Code (CBC) have been quoted throughout this document as reference. These sections are based on the 1998 editions of CBC. However, the latest edition of CBC at the start of the project will apply to the engineering design.

B.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).

B.2.2.2 State

- 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. This 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) Section 2-111, et seq.; Section 3-100, et seq.; Section 4-106, et seq.; Section 5-102, et seq.; Section 6-T8-769, et seq.; Section 6-T8-3233, et seq.; Section 6-T8-3270, et seq.; Section 6-T8-5138, et seq.; Section 6-T8-5465, et seq.; Section 6-T8-5531, et seq.; and Section 6-T8-5545, et seq. Adopts current edition of CBC as minimum legal building standards.

- 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

B.2.2.3 Local

- Los Angeles County Building Code

B.2.3 Industry Codes And Standards

B.2.3.1 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 311.4R	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
ACI 530	Building Code Requirements for Masonry Structures
ACI 530.1	Specifications for Masonry Structures

B.2.3.2 American Institute of Steel Construction (AISC)

Code of Standard Practice for Steel Buildings and Bridges

Manual of Steel Construction - Allowable Stress Design

Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design

Allowable Stress Design Specification for Structural Joints Using ASTM A325 or A490 Bolts

B.2.3.3 American Iron and Steel Institute (AISI)

Specification for the Design of Cold-Formed Steel Structural Members

B.2.3.4 American Society for Testing and Materials (ASTM)

ASTM A36	Standard Specification for Structural Steel
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A82	Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A106	Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A108	Standard Specification for Steel Bars, Carbon, Cold Finished, Standard Quality
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A185	Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A240	Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
ASTM A276	Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength

ASTM A325	Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A446	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality
ASTM A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A501	Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A569	Standard Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip Commercial Quality
ASTM A615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM B695	Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
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 C90	Standard Specification for Load-Bearing Concrete Masonry Units
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 C129	Standard Specification for Non-Load-Bearing Concrete Masonry Units
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 C270	Standard Specification for Mortar for Unit Masonry
ASTM C289	Standard Test Method for Potential Reactivity of Aggregates (Chemical Method)
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 D1752	Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM E329	Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

B.2.3.5 American Society of Mechanical Engineers (ASME)

Boiler and Pressure Vessel Code, Section VIII, Rules for Construction of Pressure Vessels, Division 2 - Alternative Rules

ASME STS-1, Steel Stacks

B.2.3.6 American Society of Civil Engineers (ASCE)

ASCE 7	Minimum Design Loads for Buildings and Other Structures

B.2.3.7 American Water Works Association (AWWA)

AWWA D100	Welded Steel Tanks for Water Storage

B.2.3.8 American Welding Society (AWS)

AWS D1.1	Structural Welding Code - Steel
AWS D1.4	Structural Welding Code - Reinforcing Steel

B.2.3.9 California Energy Commission

Recommended Seismic Design Criteria for Non-Nuclear Generating Facilities in California

B.2.3.10 Concrete Reinforcing Steel Institute (CRSI)

Manual of Standard Practice

B.2.3.11 International Conference of Building Officials

CBC	California Building Code

B.2.3.12 Metal Building Manufactures Association (MBMA)

Low Rise Building Systems Manual

B.2.3.13 National Fire Protection Association (NFPA)

NFPA 22	Standard for Water Tanks for Private Fire Protection
NFPA 24	Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 80	Standard for Fire Doors and Fire Windows
NFPA 850	Recommended Practice for Fire Protection for Electric Generating Plants

B.2.3.14 Steel Structures Painting Council (SSPC)

Steel Structures Painting Manual, Volume 2, Systems and Specifications

B.3 STRUCTURAL DESIGN CRITERIA

B.3.1 Natural Phenomena

The design criteria based on natural phenomena are discussed in this section. The climatological data listed were retrieved from the National Climatic Data Center for Los Angeles International Airport. The data cover a period of record from 1937 to 1998, unless otherwise noted. The detail design will be based on the latest available data at the start of the project.

B.3.1.1 Rainfall

Maximum 24 Hour: 6.19 inches
Maximum Monthly: 13.79 inches
Maximum Annual: 29.46 inches.

The rainfall design basis may vary for the different systems and system components. Precipitation amounts and intensities to be used with each design basis for various durations and return periods will be obtained from the TP-25.

B.3.1.2 Wind Speed

The maximum recorded 5-second wind speed for 1998 is 48 mph. The 1998 Annual Summary for Local Climatological Data introduced a 5-second measurement for wind speed. As a result, the Period of Record (POR) for this 5-second measurement is only one year. Previous data sets used a “peak gust” interpretation. For a POR of 45 years, the maximum recorded peak gust wind speed is 62 mph.

The basic wind speed for design purposes will be 85 mph based on Figure 6-1 of ASCE 7-95 for a 50-year recurrence interval. The basic wind speed will be used to determine the wind loads on structures as discussed in Section B.3.2.3.

B.3.1.3 Temperature

Extreme Maximum:	110ºF
Extreme Minimum:	27ºF
Annual Average:	62.7ºF.

B.3.1.4 Relative Humidity

The relative humidity ranges from 53 to 86 percent.

B.3.1.5 Seismicity

The plant site is located in Seismic Zone 4, as determined from Figure 16-2 of the CBC.

B.3.1.6 Snow

The plant site is located in a zero ground snow load area.

B.3.2 Design Loads

B.3.2.1 Dead Loads

Dead loads include the weight of all components forming the permanent parts of structures and all permanent equipment. The dead load of permanent plant equipment will be based on actual equipment weights. For major equipment, structural members and foundations will be specifically located and designed to carry the equipment load into the structural system. For equipment weighing less than the uniform live load, the structural system will be designed for the uniform live load.

The contents of tanks and bins at full operating capacity will be considered as dead loads. The contents of tanks and bins will not be considered effective in resisting uplift due to wind forces but will be considered effective for seismic forces.

A uniform load of 50 psf will be used to account for piping and cable trays, except in administration building areas, and will be carried to the columns and foundations as dead loads. Uniform piping and cable tray loads will not be considered effective in resisting uplift due to wind forces, but will be considered effective for seismic forces. Additional piping loads will be considered in the design of areas with heavy piping concentrations. After critical and/or heavy piping hanger loads and locations are established, the supporting members will be reviewed for structural adequacy.

For pipe racks, the weight of piping and cable trays will be treated as live load.

B.3.2.2 Live Loads

Live loads are the loads superimposed by the use and occupancy of the building or structure. They do not include wind loads, snow loads, or seismic loads.

Uniformly distributed live loads are specified to provide for movable and transitory loads, such as the weight of people, office furniture and partitions, portable equipment and tools, and other nonpermanent materials. These uniform live loads will not be applied to floor areas permanently occupied by equipment, with no access beneath. Uniform live loads for equipment laydown areas will be based on the actual weight and size of the equipment and parts that may be temporarily placed on floors during dismantling, maintenance, installation, or removal.

The design live loads will be as follows:

- **Ground Floor (Grade Slab)** - A uniform load of 250 psf, nonpermanent equipment weights, storage weights, or laydown weights, whichever is greater, will be used.

- **Grating Floors, Platforms, Walkways, and Stairs** - A uniform live load of 100 psf will be used. In addition, a concentrated load of 2 kips will be applied concurrently to the supporting beams to maximize stresses in the members, but the reactions from the concentrated load will not be carried to columns. Maximum deflection of the grating will be limited to 1/200 of the span.

- **Elevated Concrete Slabs** - A uniform load of 100 psf, nonpermanent equipment weights, storage weights, or laydown weights, whichever is greater, will be used.

  Elevated concrete slabs will be designed to support either the prescribed live load or a single concentrated load of 2 kips, whichever produces the greater stresses. The concentrated load will be treated as a uniformly distributed load acting over an area of 2.5 square feet and will be located to produce the maximum stress conditions in the slab. Metal decking for concrete slabs will be designed for a load during construction equal to the weight of concrete plus 50 psf (no increase in allowable stress).

- **Roof** - Roof areas will be designed for a minimum live load of 20 psf. Ponding loading effect due to roof deck and framing deflections will be investigated in accordance with

Section K2 of the AISC Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design.

- **Pipe Racks** - A minimum uniform load of 100 psf will be used for each level of the pipe racks, except that where piping and cable tray loads exceed 100 psf, the actual loads will be used. In addition, a concentrated load of 5 kips will be applied concurrently to the supporting beams to maximum stresses in the members, but the reactions from the concentrated loads will not be carried to columns.

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

  Roads pavements, underground piping, conduits, sumps, and foundations subject to truck traffic will be designed for wheel loadings in accordance with Appendix A, Section A.3.2.2.

- **Thermal Forces** - Thermal forces caused by thermal expansion of equipment and piping under all operating conditions will be considered.

- **Dynamic Loads** - Dynamic loads will be considered and applied in accordance with the manufacturer's criteria/recommendations and industry standards.

B.3.2.3 Wind Loads

Wind loads for structures and their components will be determined in accordance with ASCE 7, using a basic wind speed of 85 mph at 33 feet above grade. Category III and an Importance Factor of 1.15 will be used.

B.3.2.4 Seismic Loads

Seismic loads will be determined in accordance with the requirements specified in Section B.3.4.

B.3.2.5 Other Loads

Other expected loads required to predict the structural response of structures will be considered where appropriate (i.e., water hammer, test loads, etc.).

B.3.2.6 Load Combinations

Applicable code prescribed load combinations will be considered in the design of structures. As a minimum, the following load combinations will be considered:

- Dead load
- Dead load + live load + operating loads
- Dead load + live load + operating loads + wind load
- Dead load + live load + operating loads + seismic load
- Dead load + construction loads
- Dead load + live load + emergency loads
- Dead load + wind load
- Dead load + seismic load.

Operating loads include all loads associated with normal operation of the equipment (e.g., temperature and pressure loads, piping loads, normal torque loads, impact loads, etc.).

B.3.2.7 Strength Requirements

Each load combination will not exceed the stress or strength levels permitted by the appropriate code for that combination.

B.3.2.7.1 Concrete Structures. The required strength (U) of concrete structures will be at least equal to the following:

- U = 1.4 Dead + 1.7 Live
- U = 0.75 (1.4 Dead + 1.7 Live + 1.7 Wind)
- U = 0.9 Dead + 1.3 Wind
- U = 0.75 (1.4 Dead + 1.7 Live + 1.87 Seismic)
- U = 0.9 Dead + 1.43 Seismic
- U = 1.4 Dead + 1.7 Live + 1.7 Earth Pressure
- U = 0.9 Dead + 1.7 Earth Pressure.

B.3.2.7.2 Steel Structures. The required strength (S) based on elastic design methods and allowable stresses (without 1/3 increase allowed for wind or seismic loading) defined in the AISC Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design, will be at least equal to the following:

- S = Dead
- S = Dead + Live
- S = 0.75 (Dead + Wind)
- S = 0.75 (Dead + Seismic)
- S = 0.75 (Dead + Live + Wind)
- S = 0.75 (Dead + Live + Seismic).

For load combinations including seismic loading, frame members and connections will conform to the additional requirements of Sections 1633 and 2213 of the CBC.

B.3.2.8 Factors of Safety

Minimum factors of safety for foundations supporting structures, tanks, and equipment supports will be as follows:

- Overturning - 1.50
- Sliding - 1.10 for seismic load
  - 1.50 for wind load
- Buoyancy - 1.25
- Uplift due to wind - 1.50.

B.3.3 Materials

B.3.3.1 Structural Steel

B.3.3.1.1 General. Structural steel will conform to ASTM A36 or other materials as required and accepted for use by the AISC Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design.

High-strength bolts for connections will conform to ASTM A325. Bolts other than high-strength bolts will conform to ASTM A307, Grade A. Nonheaded anchor bolts will conform to ASTM A36, unless higher strength bolting materials are required by design. Drilled-in expansion bolts for concrete will be Hilti-Kwik Bolts or equivalent.

Structural steel will be detailed and fabricated in accordance with the AISC Code of Standard Practice and the AISC Specification for Structural Steel Buildings. Structural material will be fabricated and assembled in the shop to the greatest extent possible. Structural members will be welded in accordance with AWS D1.1. Columns will be milled to bear on the baseplate or cap plate. Connections will have a minimum of two bolts.

Exterior structural steel will be either hot-dip galvanized or shop primed and finish painted after installation. Interior structural steel will be shop primed after fabrication. Surface preparation and painting will be in accordance with Steel Structures Painting Council standards. Galvanizing will be in accordance with the requirements of ASTM standards.

B.3.3.1.2 Design and Testing. Steel structures will be designed by the Working Stress Method in accordance with the CBC and the AISC Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design. Connections will be in accordance with the AISC Manual of Steel Construction and the AISC Allowable Stress Design Specification for Structural Joints Using ASTM A325 or A490 Bolts.

Steel structures will be designed as “rigid frame” (AISC Specification Type 1) or “simple framing” (AISC Specification Type 2), using single-span beam systems, vertical diagonal bracing at main column lines, and horizontal bracing at the roof and major floor levels.

Type 1 rigid frames will be generally limited to prefabricated metal buildings. All other framed structures will use Type 2 design and construction.

Metal roof and floor decking attached with appropriate welding or fasteners may be considered effective as horizontal diaphragms, provided they are previously qualified by the manufacturer. Grating floors will not be considered as providing horizontal rigidity.

Mill test reports or certificates of conformance will be required certifying that material is in conformance with the applicable ASTM specification. In addition, the fabricator will be required to provide an affidavit stating that steel has been furnished in accordance with the requirements of the drawings and the specifications, including specified minimum yield strength.

B.3.3.1.3 Handrails, Guardrails, and Toe Plates. Handrails and/or guardrails, except for pre-engineered equipment, will be fabricated from standard weight steel pipe and fittings, either galvanized or painted. Handrails will have toe plates where there is no curb.

B.3.3.1.4 Steel Grating and Grating Stair Treads. The steel to be used for grating and grating treads will conform to either ASTM A36 or ASTM A569. Grating will be rectangular and consist of welded steel construction. Grating will be hot-dip galvanized after fabrication.

Stair treads will have nonslip abrasive nosing and will have end plates for attaching to stringers. Outdoor grating will have a serrated surface.

The Hilti Grating Disk system, or equivalent, will be used for fastening. Grating will have at least a 1-inch bearing support.

Floor and platform openings necessitated by expansion and movement requirements around piping and equipment will be protected as follows:

- Openings exceeding 1-1/2 inches wide around penetrating objects will be protected by toe plates.
- Openings exceeding 8 inches wide around penetrating objects will be protected by toe plates and handrails.

B.3.3.1.5 Stairs and Ladders. Stairs will be the means of travel from one elevation to another. Vertical ladders, ship ladders, etc., will be installed only where personnel access is infrequent.

Fixed ladders will have safety cages and/or other fall-prevention devices as required by the applicable codes and regulations. Stairs will have handrails on both sides.

B.3.3.2 Concrete and Reinforcing Steel

B.3.3.2.1 General. Materials for concrete will comply with ACI 301. Cement will be Portland cement meeting the requirements of ASTM C150. Fine aggregates will be clean natural sand. Coarse aggregates will be crushed stone or gravel. Aggregates will conform to the chemical and physical requirements of ASTM C33. Only clean water of potable quality and satisfying the requirements of ASTM C94 will be used.

Admixtures such as plasticizers and retarders may be used to improve workability and control setting time. Concrete will have an entrained air content between 3 and 6 percent by volume. Air entraining admixtures will meet ASTM C260 requirements. Water reducing admixtures will conform to ASTM C494, Type A. Calcium chloride or admixtures containing calcium chloride will not be used.

Concrete reinforcing will be deformed bars of intermediate grade billet steel conforming to ASTM A615, Grade 60, or welded wire fabric conforming to ASTM A185.

B.3.3.2.2 Mix Design. Concrete mix designs will be proportioned and furnished in accordance with ACI 211.1, ASTM C94, and CBC Section 1905. Proportions for the concrete mixture will be selected to meet the strength requirements specified in design documents. Generally, a minimum concrete compressive strength of 4000 psi at 28 days will be required for structural concrete. Final concrete mix designs will be established based on historical strength performance data or trial mixtures meeting the requirements of Section 1905 of the CBC.

B.3.3.2.3 Testing and Material Certification. Certified mill test reports on chemical and physical properties confirming compliance with ASTM C150 will be required for each shipment of cement used.

Certificates of Conformance will be obtained from the supplier certifying that aggregates used comply with the chemical and physical requirements of ASTM C33. Gradation analyses of fine and coarse aggregates, performed in accordance with ASTM C136, will also be provided.

Manufacturer will certify that the admixture provided conforms to the specified ASTM standard and that it contains no chlorides except those that may be contained in the water used in manufacturing the admixture.

The slump, air content, and temperature of the concrete at the point of discharge from the conveying vehicle will be tested in accordance with specified minimum testing frequencies. Concrete strength will be evaluated in accordance with ASTM C94 and CBC Section 1905.

Mill test reports certifying that reinforcing steel is in accordance with ASTM and project specifications will be required.

B.3.3.2.4 Design. Reinforced concrete structures will be designed by the Ultimate Strength Method in accordance with the CBC and ACI 318, Building Code Requirements for Reinforced Concrete.

B.3.4 Seismic Design Criteria

This section provides the general criteria and procedures to be used for the seismic design of buildings, structures, and structural components.

B.3.4.1 Seismic Performance Objectives

The seismic performance objectives for this facility are:

- Resist minor levels of earthquake ground motion without damage
- Resist moderate levels of earthquake ground motion without structural damage, but with some nonstructural damage
- Resist major levels of earthquake ground motion without collapse, but with some structural as well as nonstructural damage

To achieve these objectives and to meet the requirements of the California Energy Commission (CEC) and local codes, the facility will be designed in accordance with the CBC.

B.3.4.2 General Criteria

The plant site is located in Seismic Zone 4 according to CBC Figure 16-2, Seismic Zone Map of the United States. For seismic load calculations, the Importance Factor for Category 3 structures (power plants) is 1.00 based on the 1998 CBC (Table 16-K). Accordingly, an Importance Factor of 1.00 will be used for all plant buildings, structures, and structural components except special use structures requiring higher Importance Factors as noted in Table B-1.

Buildings and structures conforming to CBC Section 1629.8.3 will be designed using the static lateral force procedure of CBC Section 1630. Nonbuilding structures will be designed in accordance with CBC Section 1634.

Buildings and structures conforming to CBC Section 1629.8.4 will be designed using the dynamic lateral force procedure of CBC Section 1631. The ground motion representation used will be the elastic design response spectrum constructed in accordance with CBC Figure 16-3.

Lateral forces on elements of structures and nonstructural components supported by structures will be determined in accordance with CBC Section 1632 requirements.

Water storage tanks will meet the seismic design requirements of AWWA D100, Appendix A.

B.3.4.3 Critical Structures

Critical structures are those structural components that are necessary for power production and are costly to repair or replace or that require a long lead time to repair or replace; or are used for the storage, containment, or handling of hazardous or toxic materials.

Seismic loads for critical structures will be determined by the static lateral force procedure of the CBC. Table B-1 identifies the critical structures and the associated seismic load coefficients that will be used in their design.

B.3.5 Architecture

B.3.5.1 General

Architectural work will be in accordance with the applicable laws, ordinances, codes and industry standards, design criteria, guidelines, general requirements, and material selection specified in this section.

The plant will be laid out to accommodate the spaces required for plant equipment and operations. Aisles and clearances will provide access for operation, minor maintenance, and equipment removal. Personnel walkways to equipment (for routine maintenance only), doors, stairs, and other access points will be provided. Plant security and life safety features will also be considered in the plant layout.

B.3.5.2 Criteria

These criteria are intended to govern the architectural design of structures and facilities.

Safety, construction, fire protection and firewalls, and requirements for the physically handicapped will be in accordance with the requirements of the applicable local, state, and national codes and standards. Requirements of the Americans with Disabilities Act will also be included in the design.

The Administration/Maintenance Building will be a 60 foot by 120 foot multi-story steel structure with insulated siding. The lower level will house the maintenance and shop areas and will consist of reinforced concrete walls which will also serve as a retaining wall for the slopes along the north, south, and east sides of the building.

The upper levels will house the administrative areas which will include offices, library, conference room, lunchroom, utility rooms, men's and women's toilet, and locker room and shower facilities.

The offices, library, lunchroom, corridors, conference room, and toilet/locker areas will have suspended acoustical ceilings. Electrical rooms and HVAC equipment spaces will have exposed structure.

For sloping roofs, roofing will be standing seam metal with insulation and a vapor barrier; for flat roofs, roofing will be single-ply membrane over metal decking with insulation.

Reinforced concrete grade slabs will be treated with a sealer and/or floor hardener, as applicable, to accommodate maintenance or laydown. Interior wall partitions will be concrete block masonry, concrete, or gypsum wallboard on metal studs. Stairs will be concrete, galvanized grating, or checkered plate. Floor drains will be provided as necessary.

B.3.5.3 Materials

Asbestos- and lead-containing materials will not be used in the new facilities.

B.3.5.3.1 Concrete Masonry. Concrete masonry unit (CMU) partitions will generally be used in traffic and spillage areas, in toilets and locker rooms, in the battery and electrical rooms, and as fire boundaries where required by code.

CMU will be both hollow, normal weight, nonload-bearing Type I conforming to ASTM C 129, and load-bearing Grade N, Type I conforming to ASTM C 90. Mortar will conform to ASTM C 270, Type M. CMU will be reinforced as required.

Masonry structures will be designed and constructed in accordance with ACI 530, Building Code Requirements for Masonry Structures; ACI 530.1, Specifications for Masonry Structures; and Chapter 21 of the CBC.

B.3.5.3.2 Preformed Metal Siding. Exterior siding will be either an insulated or an uninsulated field-assembled system. Exterior face panels will be 24 gauge minimum; interior face panels will be 22 gauge minimum. Panels will be fabricated from galvanized sheet steel.

The wall system will be designed to withstand the specified wind loading with practical and economical support girt spacing.

Wall insulation will be noncombustible glass fiber to produce a maximum U-factor of 0.08 Btu/hr/ft^2/°F.

B.3.5.3.3 Metal Studwall Partitions. Except when CMU partitions are required, ceiling-height interior partitions will generally be of metal stud and painted gypsum board construction.

B.3.5.3.4 Roofing. Roofing will be either single-ply membrane over rigid insulation board, mechanically fastened to the metal roof deck, or standing seam metal with insulation and vapor barrier. The completed roofing system will conform to UL requirements for Class A roofs and to Factory Mutual wind uplift Class 90. The completed roof will have an overall maximum U-factor of 0.05 Btu/hr/ft^2/°F.

B.3.5.3.5 Metal Roll-Up Doors. Roll-up doors will have insulated door curtains constructed of interlocking roll-formed galvanized steel slats to withstand the specified wind pressure. Doors will be manually operated.

B.3.5.3.6 Hollow Metal Doors, Frames, and Hardware. Personnel doors will be flush hollow metal on pressed steel door frames, with hinges, locksets, closers, weatherstripping, and accessory hardware. Fire doors and frames will conform to NFPA 80 for the class of door furnished.

B.3.5.3.7 Louvers. Louvers will be operable, extruded-aluminum section alloy, with stainless steel fastenings and removable aluminum bird screen. Blades will be stormproof. Louver free area will be a minimum of 50 percent of louver face area. Louvers will be designed for manual or gravity operation.

B.3.5.3.8 Floor Finish. Floor finishes will generally be concrete with curing and sealing protection.

The battery room and other chemical areas will generally receive special coatings.

B.3.5.4 Painting

Generally, exposed wall surface, structures, and structural components will be prime painted or otherwise treated to protect them from corrosion in accordance with the applicable codes, industry standards, and manufacturer's recommendations.

B.3.5.4.1 Structural and Miscellaneous Steel. Structural and miscellaneous steel will receive shop-applied inorganic zinc primer. Field touchup will be performed after erection. Structural steel requiring fireproofing will either receive no painting or a primer compatible with the selected fireproofing material.

B.3.5.4.2 Masonry Walls and Concrete Walls and Floors. Concrete floors in areas not exposed to chemical contaminants will not be coated. Indoor masonry walls in areas requiring paint but not exposed to chemical contaminants will be painted with one coat of acrylic filler and a compatible finish coat.

B.3.5.4.3 Gypsum Wallboard. Exposed surfaces will receive one coat each of sealer and compatible acrylic finish.

B.4 STRUCTURAL DESIGN METHODOLOGY

This section describes the structural aspects of the design of the proposed facility. Each major structural component of the plant is addressed by defining the design criteria and analytical techniques that will be employed.

B.4.1 Structures

B.4.1.1 Combustion and Steam Turbine Foundations

Each combustion and steam turbine foundation will be designed to support the turbine and generator components.

Each foundation will be designed to resist the loadings furnished by the manufacturer plus loadings from natural phenomena and structural framing, if applicable, and will be constructed of reinforced concrete.

B.4.1.1.1 Foundation Loads. Equipment foundation loads will be furnished by the combustion and steam turbine manufacturer and will be combined with the other loads imposed on the foundation. Typical loading data supplied by the manufacturer include the following. The combustion and steam turbine foundations will be designed for these loads:

- Dead loads
- Live loads
- Wind loads
- Seismic loads
- Normal torque loads
- Normal machine unbalance loads
- Emergency loads, such as turbine accident or generator short-circuit
- Thermal loads due to thermal expansion or contraction of the machines, connected piping, and turbine pedestal components
- Shrinkage and creep loads
- Condenser vacuum load (steam turbine only)

B.4.1.1.2 Induced Forces. The combustion and steam turbines and associated equipment will be securely anchored to their foundations using cast-in-place steel anchor bolts designed to resist the equipment forces and seismic or wind loads.

B.4.1.1.3 Structural System. The combustion turbine foundation system will consist of a reinforced concrete mat bearing directly on undisturbed soil or compacted fill. The steam turbine generator will be provided with a reinforced concrete rigid frame pedestal and a reinforced concrete mat bearing directly on soil. The condenser for the steam turbine will be located adjacent to the turbine on a foundation mat.

B.4.1.1.4 Structural Criteria. Each foundation will be designed and constructed as a monolithic reinforced concrete structure using the criteria from Section B.3 and Appendix A, Section A.3.1. The foundation design will address the following considerations:

- Allowable soil pressures
- Allowable settlements
- Equipment, structure, and environmental loads
- Factors of safety against overturning and sliding
- Equipment performance criteria
- Natural frequencies and dynamic effects of rotating equipment

- Access and maintenance

Soil pressures will satisfy the allowable bearing pressure criteria that will be developed during project detailed design to provide a minimum safety factor of 3 against bearing failure. Total and differential settlements will be limited to the values specified in Appendix A, Section A.3.1.2.

Environmental loadings will be determined in accordance with Sections B.3.1 and B.3.2. Wind loads will be applicable since the equipment will not be housed in an enclosed building. Foundation seismic loading will be calculated as specified in Section B.3.4. Seismic forces will be applied at the center of gravity of the equipment.

Load combinations and their respective strength requirements for the foundation design will be as indicated in Sections B.3.2.6 and B.3.2.7. Factors of safety against overturning and sliding will satisfy the requirements of Section B.3.2.8.

B.4.1.1.5 Analytical Techniques.

Steam Turbine Pedestal and Foundation. Computer analyses will be used for both static and dynamic loads on the steam turbine pedestal and foundation. The pedestal deck and columns will be modeled as a 3-dimensional (3-D) space frame structure using 3-D beam elements. The foundation mat will be modeled using 3-D plate bending elements.

The interaction between the mat and supporting soil will be modeled using a system of vertical and horizontal springs attached to a fixed boundary.

Static analyses will be performed to obtain structure displacements and internal forces and moments produced by the static portion of the load combinations, including seismic loads.

Dynamic analyses will be performed to confirm the adequacy of the pedestal and foundation to support the operating machinery and sustain the dynamic loads associated with machinery operation within specified displacement and stress limits. Dynamic analyses may not be required where the effects of particular dynamic loads are specified by the manufacturer in terms of equivalent static loads.

Combustion Turbine Foundation. The mat foundation for each combustion turbine will be designed using static analysis techniques. If adequate rigidity is provided, the mat will be analyzed as a rigid mat foundation to determine the resulting soil pressures and internal forces and moments. The foundation will be analyzed assuming a linear soil pressure distribution.

If its rigidity is in question, the foundation mat will be considered as a flexible system and modeled as a plate structure using 3-D plate bending elements. The interaction between the mat and supporting soil will be modeled using a system of vertical and horizontal springs attached to a fixed boundary. A computer analysis will be performed using finite element techniques.

The foundation will be checked for dynamic response to the operating turbine. A dynamic analysis will typically be performed by considering the mat foundation as rigid and using a lumped mass model. The lumped mass model will include soil springs and dashpots to account for soil and structure interaction. An analysis will be performed to determine the natural frequencies of the foundation using the lumped mass model. In the case when the rigidity of the mat foundation is in question, the mat will be considered as flexible and will be modeled by plate elements, and a dynamic analysis will be performed using finite element computer analysis.

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.

B.4.1.2 Heat Recovery Steam Generator (HRSG) Foundation

Each HRSG foundation will be designed to support the HRSG, the HRSG stack, and the associated equipment.

Each foundation will be designed to resist the loadings furnished by the manufacturer and will be constructed of reinforced concrete.

B.4.1.2.1 Foundation Loads. Foundation loads will be furnished by the HRSG manufacturer and will be superimposed with loads for the foundation itself. Typical loading data supplied by the manufacturer include the following:

- Dead loads
- Live loads
- Wind loads
- Seismic loads
- Temperature and pressure loads.

The HRSG foundation will also be designed to resist a superimposed uniform live load of 250 psf over the area not otherwise occupied by equipment.

B.4.1.2.2 Induced Forces. The HRSG and associated equipment will be securely anchored to the foundation using cast-in-place steel anchor bolts designed to resist the equipment forces and seismic or wind loads.

B.4.1.2.3 Structural System. The HRSG foundation system will consist of a reinforced concrete mat bearing directly on undisturbed soil or compacted fill.

B.4.1.2.4 Structural Criteria. The foundation will be designed and constructed as a monolithic reinforced concrete structure using the criteria from Section B.3 and Appendix A, Section A.3.1. The foundation design will address the following considerations:

- Allowable soil pressures
- Allowable settlements
- Equipment, structure, and environmental loads
- Factors of safety against overturning and sliding
- Equipment performance criteria
- Access and maintenance.

Soil pressures will satisfy the allowable bearing pressure criteria which will be developed during the detailed design phase of the project to provide a minimum safety factor of 3 against bearing failure. Total and differential settlements will be limited to the values specified in Appendix A.

Environmental loadings will be determined in accordance with Sections B.3.1 and B.3.2. Wind loads will be applicable since the equipment will not be housed in an enclosed building. Seismic and wind loadings to the foundation will be supplied by the HRSG manufacturer and will reflect the structural system used by the HRSG to resist lateral loading.

Load combinations and their respective strength requirements for the foundation design will be as indicated in Sections B.3.2.6 and B.3.2.7. Factors of safety against overturning and sliding will satisfy the requirements of Section B.3.2.8.

B.4.1.2.5 Analytical Techniques. The HRSG foundation will typically be designed, using static analysis techniques, as a rigid mat. The foundation will be analyzed assuming a linear soil pressure distribution. Manual calculations will be performed to determine the resulting soil pressures and internal forces and moments.

If its rigidity is in question, the foundation mat will be considered as a flexible system and modeled as plate structure using 3-D plate bending elements. The interaction between the mat and supporting soil will be modeled using a system of vertical and horizontal springs attached to a fixed boundary. A computer analysis will be performed using finite element techniques.

B.4.1.3 Stacks

Each stack will be carbon steel and will be supported by a structural steel frame above the HRSG.

B.4.1.3.1 Structural System. Each steel stack will consist of a cylindrical steel shell that is supported by a structural steel frame above the HRSG. The steel frame will transfer all stack loads to the HRSG structural support steel.

B.4.1.3.2 Structural Criteria. The predominant forces acting on the stacks will result from wind or seismic loading. Each stack will be designed as indicated in this section.

The steel stack and supports will be capable of enduring specified normal and abnormal design operating conditions in combination with wind or seismic loads for the design life of the facility. The design will be in accordance with the design methods of ASME STS-1, Steel Stacks, and the AISC Manual of Steel Construction - Allowable Stress Design, except that increased allowable stresses for wind or seismic loadings will not be used.

Design values for yield strength and modulus of elasticity of the stack material will depend on the composition of the material and the maximum temperature of the metal at design operating conditions and will be as prescribed by the ASME Pressure Vessel Code, Section VIII, Division 2, Part AM.

Wind loads will be determined from ASCE 7, Minimum Design Loads for Buildings and Other Structures, using Exposure Category C. Consideration will be given to along-wind and across-wind responses, ovalling, and interference effects. Seismic loads will be determined in accordance with CBC Section 1634, Nonbuilding Structures.

The allowable longitudinal, circumferential, and shear stresses for the design of the stack shell will be determined in accordance with ASME STS-1.

The minimum shell thickness will be 1/4 inch plus 1/16 inch corrosion allowance. The corrosion allowance will be considered in the generation of seismic loads but not in the resistance to seismic or wind loads. Allowable stresses for stiffeners, platform members, and other miscellaneous steel components will be in accordance with the AISC Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design. Allowable stresses for the shell will not be increased for wind or seismic loadings.

B.4.1.3.3 Analytical Techniques. Stack moments, shears, and axial forces will be calculated using static analysis procedures. Longitudinal stresses resulting from axial loads and flexure will be combined and compared to a single allowable stress.

Circumferential stresses will also be compared to a single allowable value. Interaction between longitudinal and circumferential stresses will be considered.

B.4.1.4 Buildings and Enclosures

The various plant buildings and enclosures will provide support, protection, and access to the systems contained within their boundaries.

B.4.1.4.1 Foundation Loads. Foundation loads will be determined from the analysis and design of the superstructure and from the support of the equipment contained within the structure. The following loads will be considered:

- Dead loads
- Live loads
- Equipment and piping loads
- Wind loads
- Seismic loads.

B.4.1.4.2 Induced Forces. Each building and enclosure will be securely anchored to its foundation using cast-in-place steel anchor bolts designed to resist any induced forces.

B.4.1.4.3 Structural System. Buildings and enclosures will be designed as AISC Type 1 rigid frames or as Type 2 simple braced frames. For the purpose of resisting seismic lateral loads, the structures will be classified as regular structures with a concentric braced frame, an ordinary moment-resisting frame, or a special moment-resisting frame, in accordance with the definitions of the CBC Chapters 16 to 22.

The foundation system for the Administration/Maintenance Building will consist of lower level reinforced concrete retaining walls and a reinforced concrete mat foundation.

The foundation systems for enclosures will typically consist of individual spread footings to resist the column loads, and an isolated slab-on-grade floor system.

B.4.1.4.4 Structural Criteria. Building and enclosure steel frames will be designed and constructed using the materials and criteria set forth in Section B.3.

Environmental loading will be determined in accordance with Sections B.3.1 and B.3.2. Seismic loading for the buildings and enclosures will be calculated using equivalent static lateral forces applied to the structure in accordance with the procedures of CBC Section 1630 or dynamic lateral forces in accordance with CBC Section 1631.

Building and enclosure foundations will be designed and constructed using reinforced concrete according to the criteria set forth in Section B.3 and Appendix A, Section A.3.1. The foundation design will address the following considerations:

- Allowable soil pressures
- Allowable settlements
- Equipment, structure, and environmental loads
- Factors of safety against overturning and sliding
- Equipment performance criteria
- Access and maintenance.

Soil pressures will satisfy the allowable bearing pressure criteria that will be developed during project detailed design to provide a minimum safety factor of 3 against bearing failure. Total and differential settlements will be limited to the values specified in Appendix A, Section A.3.1.2.

Load combinations and their respective strength requirements for the foundation design will be as indicated in Sections B.3.2.6 and B.3.2.7. Factors of safety against overturning and sliding will satisfy the requirements of Section B.3.2.8.

B.4.1.4.5 <u>Analytical Techniques</u>. Building and enclosure foundations will be designed as simple spread footings or mat foundations, using static analysis techniques. The foundations will be analyzed assuming a linear soil pressure distribution.

B.4.2 Tanks

B.4.2.1 <u>Field-Erected Storage Tanks</u>

Field-erected storage tanks will typically be vertical, cylindrical shells consisting of stainless steel or carbon steel construction with a protective interior coating. Tank roofs will be either self-supported domes or cones. Tank bottoms will be ground-supported, flat-bottomed, with a slope of 1 percent. Tanks will have ladders, landing platforms, and handrails to provide access to working areas. Vents, manholes, overflow piping, and grounding lugs will be provided as necessary.

B.4.2.1.1 <u>Foundation Loads</u>. Foundation loads will be determined using project-specific design criteria. Tank and foundation design will include the following loads:

- Dead loads (including contained fluid load)
- Live loads
- Wind loads
- Seismic loads (including hydrodynamic loads).

B.4.2.1.2 Induced Forces. Storage tanks will be securely anchored to their foundations using cast-in-place steel anchor bolts designed to resist tank-induced forces.

B.4.2.1.3 Structural System. Each tank will be a cylindrical steel shell that resists lateral loading through shear in the tank wall. Overturning will be resisted by anchor bolts connecting the tank wall to the foundation.

The tank foundation system will typically consist of a reinforced concrete ringwall or mat foundation. The interior of the ring will consist of compacted backfill with a layer of compacted sand to serve as a bearing surface for the tank bottom. If soil conditions could result in excessive settlements or soil overstress, a complete concrete mat may be required.

B.4.2.1.4 Structural Criteria. Tank structures will be designed and constructed using the criteria established in AWWA D100 or NFPA 22, as applicable.

Foundations will be designed and constructed as reinforced concrete structures using the criteria from B.3 and Appendix A, Section A.3.1. Foundation design will address the following considerations:

- Allowable soil pressures
- Allowable settlements
- Fluid, structure, and environmental loads
- Factors of safety against overturning and sliding.

Soil pressures will satisfy the allowable bearing pressure criteria that will be developed during project detailed design to provide a minimum safety factor of 3 against bearing failure. Total and differential settlements will be limited to the values specified in Appendix A, Section A.3.1.2.

Environmental loadings will be determined in accordance with Sections B.3.1 and B.3.2. Seismic loads will be determined in accordance with Section B.3.4 and AWWA D100, Section 13.

Load combinations and their respective strength requirements for the foundation design will be as indicated in Sections B.3.2.6 and B.3.2.7 and in Section 3 of AWWA D100. Factors of safety against overturning and sliding will satisfy the requirements of Section B.3.2.8.

Tank foundation design will include the moment resulting from lateral displacement (hydrodynamics) of the tank contents in accordance with AWWA D100, Section 13.3.3.2.

B.4.2.1.5 Analytical Techniques. Tank foundations will typically be designed as circular ringwalls using static analysis techniques. Each ringwall will be proportioned to resist the design load of the tank and the maximum overturning moment due to wind or seismic loading. The ringwall will also be proportioned to resist maximum anchor bolt uplift force. Circumferential reinforcing steel will be provided in the ringwall to develop the hoop stress produced by the lateral soil pressure within the ringwall.

Tank structures will be designed and proportioned such that during the application of any load, or combination of loads, the allowable stresses as stipulated in AWWA D100 are not exceeded.

B.4.2.2 Shop-Fabricated Storage Tanks

Shop-fabricated storage tanks will be either vertical or horizontal, cylindrical, carbon steel shells. The tanks will have ladders, landing platforms, and handrails, to provide access to working areas. Each tank will have nozzles for fill connection, fill drain, overflow, vent connections, manholes, and grounding lugs as necessary.

B.4.2.2.1 Foundation Loads. Foundation loads will be furnished by the tank manufacturer and will be superimposed with loads for the foundation itself. Typical loadings supplied by the manufacturer include:

- Dead loads
- Live loads
- Wind loads
- Seismic loads (including hydrodynamic loads)
- Temperature and pressure loads.

B.4.2.2.2 Induced Forces. Each tank will be securely anchored to its foundation using cast-in-place steel anchor bolts or concrete expansion anchors designed to resist tank-induced forces.

B.4.2.2.3 Structural System. Each tank will consist of a cylindrical steel shell, either supported by integral legs or saddle supports, or with a flat bottom bearing directly on the foundation.

Foundations will typically consist of individual pads bearing directly on undisturbed soil or compacted fill. For tanks located in buildings, the pads may be constructed integrally with the grade slab.

B.4.2.2.4 Structural Criteria. Tanks will be designed by a tank manufacturer in accordance with the relevant ASME code, ANSI code, and ASTM standards.

Foundations will be designed and constructed as monolithic reinforced concrete structures using the criteria from Section B.3 and Appendix A, Section A.3.1. Foundation design will address the following considerations:

- Allowable soil pressures
- Allowable settlements
- Fluid, structure, and environmental loads
- Factors of safety against overturning and sliding

Soil pressures will satisfy the allowable bearing pressure criteria that will be developed during project detailed design to provide a minimum safety factor of 3 against bearing failure. Total and differential settlements will be limited to the values specified in Appendix A, Section A.3.1.2.

Environmental loadings will be determined in accordance with Sections B.3.1 and B.3.2. Seismic loading will be calculated using equivalent static lateral forces applied at the center of gravity of the tank or tank component in accordance with the criteria specified in Section B.3.4.

Load combinations and their respective strength requirements for the foundation design will be as indicated in Sections B.3.2.6 and B.3.2.7. Factors of safety against overturning and sliding will satisfy the requirements of Section B.3.2.8.

B.4.2.2.5 <u>Analytical Techniques</u>. The tank foundations will typically be designed using static analysis techniques assuming a rigid mat. The foundations will be analyzed assuming a linear soil pressure distribution. The mats will be proportioned such that the resultant of the soil pressure coincides as nearly as possible with the resultant of the vertical loading.

The tanks will be designed and analyzed by a tank manufacturer to satisfy the requirements of the relevant ASME code, ANSI code, and ASTM standards.

B.4.3 Equipment and Equipment Foundations

Plant equipment will be designed in accordance with manufacturers' standards and applicable codes and industry standards. Equipment will be designed to resist project-specific environmental loadings, as applicable.

Foundations will be designed to resist the loadings furnished by the manufacturers and will be constructed of reinforced concrete.

Specific criteria for the combustion and steam turbine foundations and HRSG foundations are addressed in Sections B.4.1.1 and B.4.1.2.

B.4.3.1 Equipment/Foundation Loads

Equipment and foundation loads will be determined by the manufacturers using project-specific design criteria. Typical loadings used for design will include:

- Dead loads
- Live loads
- Operating loads
- Wind loads
- Seismic loads
- Emergency loads.

Foundation loads furnished by the equipment manufacturers will be superimposed with loads for the foundation itself.

B.4.3.2 Induced Forces

The equipment will use steel anchor bolts, concrete expansion anchors, welds, and other equipment anchorage devices to resist equipment-induced forces.

B.4.3.3 Structural System

Foundations will typically consist of individual pads bearing directly on undisturbed soil or compacted fill. For equipment located in buildings, the pads may be constructed integrally with the grade slab.

B.4.3.4 Structural Criteria

Plant equipment will be designed to resist project-specific criteria in accordance with the manufacturers' standards and applicable codes and industry standards.

Environmental loading will be determined in accordance with Sections B.3.1 and B.3.2. Seismic loading will be calculated using equivalent static lateral forces applied at the center of gravity of the equipment or component in accordance with the criteria specified in Section B.3.4.

Seismic lateral forces on equipment supported by structures will be determined in accordance with CBC Section 1632, with Z equal to 0.4, I_p equal to 1.5 for fire equipment and 1.0 for other equipment, and Ca in accordance with CBC Table 16-Q. Refer to Table B-1 for Soil Profile Type, Seismic Source Type, and Distance to Seismic Source. Equipment bases, foundations, support frames, and structural members used to transfer equipment seismic forces to the main lateral load-resisting system will be designed for the same seismic load as the equipment.

Integral support structures provided by manufacturers with their equipment, such as the HRSG support structure and the combustion turbine air inlet support structure, will be designed to resist, at a minimum, the lateral forces specified in CBC Section 1634, Non-building Structures, and the applicable criteria of Section B.3.4.

Load combinations will be as indicated in Section B.3.2.6. These load combinations are in addition to those normally used in design and those specified in applicable codes and standards.

Equipment foundations will be designed and constructed as monolithic reinforced concrete structures using the criteria from Section B.3 and Appendix A, Section A.3.1. The foundation design will address the following considerations:

- Allowable soil pressures
- Allowable settlements
- Equipment and environmental loads
- Factors of safety against overturning and sliding
- Equipment performance criteria
- Access and maintenance.

Soil pressures will satisfy the allowable bearing pressure criteria that will be developed during project detailed design to provide a minimum safety factor of 3 against bearing failure. Total and differential settlements will be limited to the values specified in Appendix A, Section A.3.1.2.

Load combinations and their respective strength requirements for the foundation design will be as indicated in Sections B.3.2.6 and B.3.2.7. Factors of safety against overturning and sliding will satisfy the requirements of Section B.3.2.8.

B.4.3.5 Analytical Techniques

Equipment foundations will typically be designed using static analysis techniques assuming a rigid mat. Foundations will be analyzed assuming a linear soil pressure distribution. Mats will be proportioned such that the resultant of the soil pressure coincides as nearly as possible with the resultant of the vertical loading.

Equipment will be designed and analyzed by the manufacturer to satisfy the requirements of the relevant codes and industry standards.

B.5 HAZARD MITIGATION

The project will be designed to mitigate natural and environmental hazards caused by seismic and meteorological events. This section addresses the structural design criteria used to mitigate such hazards.

B.5.1 Seismic Hazard Mitigation Criteria

Appendix A and this appendix describe the civil and structural design criteria that will be applied to the project.

Project seismic design criteria were selected based on the following considerations:

- Compliance with applicable laws, ordinances, regulations, codes, and standards
- Life safety
- Structural behavior and performance
- Reliability of the plant
- Financial impacts from seismically induced outages
- Seismic probability and magnitude.

The project seismic design criteria were developed to incorporate these considerations using a systematic approach to correlate performance criteria with assumed risk level. The following procedure was used to establish the design criteria:

- The seismic hazards were assessed by studying the geologic features of the surrounding area. Major faults were identified, and information was collected regarding each fault's proximity, capability, recurrence, and magnitude.

- The seismic risk associated with each source was assessed considering historical magnitudes.

- A site seismic Zone 4 will be considered for structural design. The seismic zone factor (Z) for this zone is shown in Table B-1.

- When using the CBC dynamic lateral force procedure, acceleration levels for various structural frequencies will be based on CBC Figure 16-3, Design Response Spectra.

- Appropriate design criteria and analysis methods consistent with the seismic performance criteria were established for each major plant structure, equipment, and component.

Specific design features that will be incorporated into the plant to mitigate the identified seismic hazards include:

- Appropriate analysis techniques will be employed to calculate structure-specific seismic loads.
- Plant structures, equipment, piping, and other components will be designed to resist the project-specific seismic loads.
- Critical equipment will be positively anchored to its supporting structure.
- Anchorages will be designed to resist project-specific seismic loadings.
- Adequate factors of safety against overturning and sliding due to seismic loads will be provided.
- The design of piping connections to structures, tanks, and equipment will consider differential seismic displacements between components.
- Adjacent structures will be seismically isolated from one another.
- Structural elements will be designed to comply with special detailing requirements intended to provide ductility.
- Connections for steel structures will have a minimum load carrying capability without regard to the calculated load.
- Lateral and vertical displacements of structures and elements of structures will be limited to specified values.
- Appropriate measures will be taken to prevent saturation of foundation soils and eliminate the potential for soil liquefaction.
- Liquefaction and liquefaction-induced settlement will be mitigated, as appropriate.

The foregoing design features are intended to provide the degrees of safety for structures and equipment as follows:

- Resist minor earthquakes without damage. Plant remains operational.

- Resist moderate earthquakes without structural damage but with some nonstructural damage. Plant remains operational or is returned to service following visual inspection and/or minor repairs.

- Resist major earthquakes without collapse but with some structural and nonstructural damage. Plant is returned to service following visual inspection and/or moderate repairs.

B.5.2 Meteorological And Climatic Hazard Mitigation

Meteorological and climatic data were used to establish the project design basis. Portions of the data and the design bases that pertain to structural engineering are provided in this appendix.

Specific design features that will be incorporated into the plant to mitigate meteorological and climatic hazards include:

- Structures and cladding will be designed to resist the wind forces.

- Sensitive structures will be designed for wind-induced vibrational excitation.

- Roofs will be sloped and equipped with drains to prevent accumulation of rainfall.

- Site drainage systems will be designed to convey the runoff from a 24-hour rainfall event with a 10-year recurrence interval.

- Ground floor levels of structures will be placed above probable flood levels.

- Building drainlines will be installed with backflow prevention devices.

- The bases of plant equipment will be placed above probable flood levels.

- The plant site will be graded to convey runoff away from structures and equipment.

- Potentially collapsible soils will be removed and recompacted and other measures designed to prevent foundation soil saturation will be implemented as needed to eliminate the potential for soil collapse due to hydrocompaction.

The foregoing design features will be incorporated in accordance with the applicable codes and standards identified in this appendix.

The degree of safety offered by these features is consistent with the requirements of the applicable codes and standards and the economic benefits these features provide.

TABLE B-1

SEISMIC LOAD COEFFICIENTS OF CRITICAL STRUCTURES

Critical Structure	Formula*	Seismic Zone Factor (Z)	Importance Factor (I)	Numerical Coefficient (R)
Buildings	CBC 30-4	0.4	1.0	5.6**
Fire water tank	CBC 34-1	0.4	1.25	-
Flat bottom tanks and their foundations and anchorage	CBC 34-1	0.4	1.0	-
Other tanks and their foundations and anchorage	CBC 32-1 or 34-2	0.4	1.0	-
Foundations for steam and combustion turbine/generator and wet surface condenser	CBC 30-4	0.4	1.0	2.8
Foundation for heat recovery steam generator	CBC 30-4	0.4	1.0	2.8
Heat recovery steam generator exhaust stack and its foundation and anchorage	CBC 34-2	0.4	1.0	2.9

* Values for coefficients and Factors Ca, Cv, Na, and Nv shall be based on the following:
Soil Profile Type is SD.
Closest Seismic Sources are Type B at 6.4 km (Palos Verde) and 9.7 km (Newport Inglewood).
**Value is approximate and may be revised during detailed design to reflect the final configuration.