APPENDIX 10B

Structural Engineering Design Criteria

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10B1 Introduction

This appendix summarizes the codes, standards, criteria and practices that will be generally used in the design and construction of structural engineering systems for the Walnut Creek Energy Park (WCEP). More specific project information will be developed during execution of the WCEP to support detailed design, engineering, material procurement specification and construction specifications.

10B2 Codes and Standards

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

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

- California Building Code (CBC), 1998 Edition.
- American Institute of Steel Construction (AISC):
  - Manual of Steel Construction – 9th Edition
  - Specification for the Design, Fabrication and Erection of Structural Steel for Buildings – ASD
  - Specification for Structural Joints Using ASTM A325 or A490 Bolts
  - Code of Standard Practice for Steel Buildings and Bridges
- American Concrete Institute (ACI):
  - ACI 318 – 99, Building Code Requirements for Structural Concrete
- ACI 301 – 99, Specifications for Structural Concrete for Buildings
- ACI 350R – 89, Environmental Engineering Concrete Structures
  - ACI 543R – 00, Design, Manufacture, and Installation of Concrete Piles
- American Society of Civil Engineers (ASCE):
  - ASCE 7-98 – Minimum Design Loads for Buildings and Other Structures

- American Welding Society (AWS):
  - D1.1 – Structural Welding Code – Steel
  - D1.3 – Structural Welding Code – Sheet Steel
- Code of Federal Regulations, Title 29 – Labor, Chapter XVII, Occupational Safety and Health Administration (OSHA).
  - Part 1910 – Occupational Safety and Health Standards
  - Part 1926 – Construction Safety and Health Regulations
- National Association of Architectural Metal Manufacturer (NAAMM) – Metal Bar Grating Manual.
- Hoist Manufacturers Institute (HMI), Standard Specifications for Electric Wire Rope Hoists (HMI 100).
- National Electric Safety Code (NESC), C2-1993.
- National Fire Protection Association (NFPA Standards).
  - NFPA 850 Fire Protection for Electric Generating Plants.
- OSHA Williams-Steiger Occupational Safety and Health Act of 1970.
- Steel Deck Institute (SDI) – Design Manual for Floor Decks and Roof Decks.
- Design of Large Steam Turbine-Generator Foundations, ASCE 1987.

10B3 CEC Special Requirements

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

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

- Major WCEP structures
- Major foundations, equipment supports, and anchorage
- Large, field-fabricated tanks
- Turbine/generator pedestal; and
- Switchyard structures

10B4 Structural Design Criteria

10B4.1 Topographic Elevations

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

10B4.2 Frost Penetration

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

10B4.3 Temperatures

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

Maximum: 110° F

Minimum: 20° F

10B4.4 Design Loads

10B4.4.1 General

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

10B4.4.2 Dead Loads

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

10B4.4.3 Live Loads

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

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

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

a. Roofs: 20 psf

b. Floors and Platforms (Steel grating and checkered plates): 100 psf

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

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

c. Floors (Elevated Concrete floors): 100 psf

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

d. Control Room Floor: 150 psf

e. Stairs, Landings and, Walkways: 100 psf

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

f. Pipe Racks: 100 psf

Where the piping and cable tray loads exceed the design uniform load, the actual loads will be used. In addition, a concentrated load of 15 kips will be applied concurrently to the supporting beams for the walkways to maximize the stresses in the members, but the reactions from the concentrated loads will not be carried to the columns.

g. Hand Railings

Hand railings will be designed for either a uniform horizontal force of 50 plf applied simultaneously with a 100 plf uniform vertical live load, or a 200-pound concentrated load applied at any point and in any direction, whichever governs.

h. Slabs on Grade: 250 psf

i. Truck Loading Surcharge Adjacent to Structures: 500 psf during normal operation and 1,000 psf during construction

j. Truck Support Structures: AASHTO-HS-20-44

k. Special Loading Conditions: Actual loadings

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

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

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

10B4.4.4 Earth Pressures

Earth pressures will be in accordance with the recommendations contained in the WCEP geotechnical report.

10B4.4.5 Groundwater Pressures

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

10B4.4.6 Wind Loads

The wind forces will be calculated in accordance with CBC 1998, Chapter 16A, Division III, with a basic wind speed of 80 mph and a "C" exposure category.

10B4.4.7 Seismic Loads

Structures will be designed and constructed to resist the effects of earthquake loads as determined in CBC 1998, Chapter 16A, Division IV. The site is located on seismic zone 4. The occupancy category of the structure is 3 (Special Occupancy Structure) and corresponding importance factor (I) is 1.00. Other seismic parameters will be obtained from the geotechnical report.

10B4.4.8 Snow Loads

Snow loads will not be considered.

10B4.4.9 Turbine-Generator Loads

The combustion turbine-generators and the steam-turbine generators loads for pedestal and foundation design will be furnished by the equipment manufacturers, and will be applied in accordance with the equipment manufacturers' specifications, criteria and recommendations.

10B4.4.10 Special Considerations for Steel Stacks

Steel stacks will be designed to withstand the normal and abnormal operating conditions in combination with wind loads and seismic loads, and will include the along-wind and across-wind effects on the stacks. The design will meet the requirements of ASME/ANSI STS-1-1986, "Steel Stacks," using allowable stress design method, except that increased allowable stress for wind loads, as permitted by AISC, will not be used.

10B4.4.11 Special Considerations for Structures and Loads During Construction

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

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

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

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

10B5 Design Bases

10B5.1 General

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

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

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

Reinforced concrete for sumps, cooling tower basins, and other structures designed to contain water will meet the requirements of ACI 350.

10B5.2 Factors of Safety

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

Against Overturning: 1.50

Against Sliding: 1.50 for Wind Loads, 1.10 for Seismic Loads

Against Uplift Due to Wind: 1.50

Against Buoyancy: 1.25

10B5.3 Allowable Stresses

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

10B5.4 Load Factors and Load Combinations

For reinforced concrete structures and equipment supports, using the strength method, the strength design equations will be determined based on CBC 1998, Sections 1612.2, 1612.4, 1909.2 and using ACI-318-99 Eqs (9-2), (9-3). The Allowable Stress Design load combinations of CBC 1998 section 1612.3 will be used to assess soil bearing pressure and stability of structures per CBC 1998 Sections 1805 and 1629.1, respectively.

Steel framed structures will be designed in accordance with CBC 1998, Chapter 22, Divisions I, III and IV and the AISC Specification for the Structural Steel Buildings, Allowable Stress Design and Plastic Design, June 1, 1989. Connections will conform to Research Council on Structural Connections of the Engineering Foundation Specification for Structural Joints. Connections for moment frame structures will conform to the recommendations of FEMA Report 350 for seismic connections.

10B6 Construction Materials

10B6.1 Concrete and Grout

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

Electrical duct bank encasement and lean concrete backfill (Class L-1): 2000 psi

Structural concrete (Class S-1): 3000 psi

Structural concrete (Class S-2): 4000 psi

Grout (Class G-1): 5000 psi

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

10B6.2 Reinforcing Steel

Reinforcing steel bars for concrete will be deformed bars of billet steel, conforming to ASTM A 615, Grade 60.

Welded wire fabric for concrete will conform to ASTM A 185.

10B6.3 Structural and Miscellaneous Steel

Structural and miscellaneous steel will generally conform to ASTM A 36, ASTM A 572 or ASTM A992 except in special situations where higher strength steel is required.

High strength structural bolts, including nuts and washers, will conform to ASTM A 325 or ASTM A 490.

Bolts other than high strength structural bolts will conform to ASTM 307, Grade A.

10B6.4 Concrete Masonry

Concrete masonry units will be hollow, normal weight, non-load bearing Type I conforming to ASTM C 129.

Mortar will conform to ASTM C 270, Type M.

Grout will conform to ASTM C 476.

10B6.5 Other Materials

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