# STRUCTURAL ENGINEERING
# DESIGN CRITERIA

## 1.0 INTRODUCTION

An orderly sequence of events for the implementation of the Carrizo Energy Solar Farm (CESF or Project) is planned consisting of the following major activities:

- Conceptual design
- Licensing and permitting
- Detailed design
- Procurement
- Construction and construction management
- Start-up, testing, and checkout
- Project completion

The purpose of this appendix is to summarize the codes and standards and standard design criteria and practices that will be used during the project engineering, design and construction. These criteria form the basis of the design for the structural components and systems for the project. More specific design information will be developed during the detailed design phase to support equipment procurement and construction specifications. Section 2.0 summarizes the applicable codes and standards and Section 3.0 includes the general criteria for natural phenomena, design loads, architectural features, concrete, steel, and seismic design. Section 4.0 describes the structural design methodology for structures and equipment. Section 5.0 describes the hazard mitigation for the project.

## 2.0 DESIGN CODES, STANDARDS, LAWS AND ORDINANCES

The design and specification of work shall be in accordance with applicable laws and regulations of the federal government, the State of California, and with the applicable local codes and ordinances. The following Laws, Ordinances, Codes and Standards (LORS) have been identified as applying to structural engineering design and construction.

The edition and/or addenda to a law, ordinance, code, or standard that has been adopted and is in place at time of plant design and construction shall apply to work performed for this Facility.

### 2.1 FEDERAL

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

### 2.2 STATE

- Business and Professional Code Section 6704, *et seq.*; Section 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 where personnel have to descend. This also applies to construction or demolition of any building, structure, false work, or scaffolding which is more than three stories high or equivalent.

- Title 24, California Administration Code (CAC) Section 2-111, *et seq*.; Sections 3-100, *et seq*.; Section 4-106 *et seq*.; Section 5-102, *et seq*.; Section 6-TS-769, *et seq*.; Section 6-T8-3233, *et seq*.; Section ST8-3270, *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 UBC as minimum legal building standards.
- State of California Department of Transportation (Caltrans), Standard Specifications.
- State of California Occupational Safety and Health Administration (CALOSHA) Standards.

## 2.3 COUNTY

- San Luis Obispo County Ordinances.

### 2.3.1 Industry Codes and Standards

The following general design requirements and procedures will be followed in development of project specifications regarding the use of Codes and Industry Standards.

- Specifications for materials will generally follow the standard specifications of the American Society for Testing and Materials (ASTM) and the American National Standards Institute (ANSI).
- Field and laboratory testing procedures for materials will follow standard ASTM specifications.
- Design and placement of structural concrete will follow the recommended practices and the latest version of the American Concrete Institute (ACI), the International Conference of Building Officials, California Building Code (CBC), and the Concrete Reinforcing Steel Institute (CRSI).
- Design, fabrication, and erection of structural steel will follow the recommended practices and the latest version of the American Institute of Steel Construction Code (AISC) and CBC.
- Steel components for metal wall panels and roof decking will conform to the American Iron and Steel Institute (AISI) Specification for the Design of Light Gage Cold-Formed Structural Members.
- Welding procedures and qualifications for welders will follow the recommended practices and codes of the American Welding Society (AWS).
- Preparation of metal surfaces for coating systems will follow the specifications and standard practices of the Steel Structures Painting Council (SSPC), National Association for Corrosion Engineers (NACE), and the specific instructions of the coatings manufacturer.
- Fabrication and erection of grating will follow applicable standards of the National Association of Architectural Metals Manufacturers (NAAMM).
- Design and erection of masonry materials will follow the recommended practices and codes of the latest revision of the ACI Concrete Masonry Structures Design and Construction Manual and the International Conference of Building Officials, California Building Code (CBC).
- Plumbing will conform to the California Uniform Plumbing Code (CUPC).
- Design will conform to the requirements of the Federal and California Occupational Safety and Health Administration (OSHA and CALOSHA).
- Design of roof coverings will conform to the requirements of the National Fire Protection Association (NFPA) and Factory Mutual (FM).

The following Codes and Industry Standards shall be used:

- California Energy Commission (CEC), "Recommended Seismic Design Criteria for Non-Nuclear Power Generating Facilities in California."
- California Building Code (CBC).
- Structural Engineers Association of California, "Recommended Lateral Force Requirements and Tentative Commentary."
- Applied Technology Council, "Tentative Provision for the Development of Seismic Regulations for Buildings," (ATC-3-06).
- American Institute of Steel Construction (AISC).
  - S335 - "Specification for Structural Steel Buildings - Allowable Stress Design and commentary."
  - S303 - "Code of Standard Practice for Steel Buildings and Bridges."
  - S329 - "Allowable Stress Design Specifications for Structural joints using ASTM A325 or A490 Bolts."
  - M016 - "Manual of Steel Construction Allowable Stress Design."
- American Iron and Steel Institute (AISI) "Specification for the Design of Cold-Formed Steel Structural Members," Edition Cold-Formed Steel Design Manual Parts I-VII.
- AWS D1.1 American Welding Society (AWS) "Structural Welding Code-Steel."
- American Concrete Institute (ACI)
  - ACI 318/318R "Building Code Requirements for Structural Concrete (ACI 318) and commentary (ACI 318R)."
  - ACI 318.1 and Commentary - ACI 318.IR.
  - ACI 530 "Building Code Requirements for Concrete Masonry Structures and Commentary (ASCE 5) (TN4S 402)."
  - ACI 212.3R "Chemical Admixtures for Concrete."
  - ACI 302.lR "Guide for Concrete Floor and Slab Construction."
  - ACI 35OR "Environmental Engineering Concrete Structures."
- Structural and Miscellaneous Steel.
  - ASTM A569/A569M - Standard Specifications for Steel Carbon (0.15 m maximum percent) Hot-Rolled Sheet and Strip, Commercial Quality.
  - American Society for Testing and Materials (ASTM). The following codes and standards shall be included as a minimum:
  - ASTM A36/A36M "Standard Specification for Structural Steel."
  - ASTM A992 Specification for Structural Steel.
  - ASTM A53 "Standard Specification for Pipe, Steel Black and Hot-Dipped, Zinc Coated, Welded and Seamless."
  - ASTM A276 "Standard Specification for Stainless and Heat Resisting Steel Bars and Shapes."
  - ASTM A500 "Standard Specification for Cold-forced Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes."
  - ASTM A695 "Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel."
  - ASTM A307 "Standard Specification for Carbon Steel Bolts and Studs."
  - ASTM A153/Al53 "Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware."

- ASTM A182 “Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.”
- ASTM A185 “Standard Specification for Welded Steel Wire Fabric, Plain, for Concrete Reinforcement.”
- ASTM A615/A615 “Standard Specification Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.”
- ASTM A-706-60 Specification for Reinforcing Steel Bars in Concrete.
- Masonry Institute of America, “Reinforced Masonry Engineering Handbook.”
- American Water Works Association (AWWA).
- AWWA D100 “Welded Steel Tanks for Water Storage, (AWS D5.2).
- “Addendum D100A (AWS D5.2-84A).”
- AWWA C301 “Prestressed Concrete Pressure Pipe, Steel Cylinder Type for Water and Other Liquids.”
- AWWA C302 “Standards for Reinforced Concrete Water Pipe Noncylinder Type, Not Prestressed.”

- American Association of State Highway and Transportation Officials. (AASHTO) (GDHS-2), “A Policy on Geometric Design of Highways and Streets.”
- National Fire Protection Association Standards (NFPA).
- Steel Structures Painting Council Standards (SSPC).
- American Society of Nondestructive Testing (ASNT-TC-lA).

The following general design rules and guidelines will be used in development of project specification regarding Codes and Industry Standards.

- International Standard Organization (ISO)3945 “Mechanical Vibration of Large Rotating Machines with Speed Range from 10 to 200 revs/sec-Measurement and Evaluation of Vibration Severity In Situ.”

## 3.0 STRUCTURAL DESIGN CRITERIA

## 3.1 NATURAL PHENOMENA

The design criteria based on the natural phenomena are discussed below. Climatological data is from the Western Region Climate Center (WRCC) La-Panza Remote Operated Weather Station (ROWS) (approximately 8 mi west of the site) and represents available data for the years 1991 through 2006.

### 3.1.1 Rainfall

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 are obtained from the WRCC combined with local and regional hydrological data.

### 3.1.2 Wind Speed

The design wind speed will be based on the CBC wind speed maps for the area. This design wind speed will be used to determine wind loads for all structures as discussed in Subsection 3.2.3, Wind Loads.

### 3.1.3 Temperature

Systems and system component design criteria that require ambient temperature extremes shall use the range as reported by the WRCC.

### 3.1.4 Seismicity

The CESF is located in seismic Zone 4, as determined from Figure 16-2 of the CBC.

### 3.1.5 Basic Wind Speed

The CESF site is located in an area with a Basic Wind Speed of 70 mph, as determined from Figure 16-1 of the CBC.

## 3.2 DESIGN LOADS, LOAD COMBINATIONS, AND ALLOWABLE STRESSES

Design loads for all structures will be determined according to the criteria described below, unless the applicable building requires more severe design conditions.

### 3.2.1 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, piping, drains, electrical trays, bus ducts, and the contents of tanks and bins measured at full operating capacity. The contents of tanks and bins shall not be considered as effective in resisting column uplift due to wind forces, but shall be considered effective for seismic forces.

### 3.2.2 Live Loads

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

Equipment live loads are calculated loads based upon the actual weight and size of the equipment and parts to be placed on floors during dismantling and maintenance or to be temporarily placed on or moved over floors during installation.

Consideration will be given to designing appropriate areas of the ground floor for support of heavy equipment such as construction and maintenance cranes. Grating floors will be designed for a minimum live loading of 75 pounds per square foot (psf).

Live loads may be reduced in accordance with the provisions of CBC Section 1606. Live load reduction will not be permitted in areas where equipment laydown loads are considered.

All roof areas will be designed for wind loads as indicated in Subsection 3.2.3, Wind Loads. Ponding loading effect due to roof deck and framing deflections will be investigated in accordance with AISC Specification Article K2. AU (fire resistance rating, where A is a grade of rating and U is undeflected) roof areas will be designed for a minimum of 20-psf live load in addition to calculated dead loads.

Pipe hanger loads for the major piping systems will be specifically determined and located. Piping expansion and dynamic loads will be considered on an individual basis for their effect on the structural systems. Loads imposed on perimeter beams around pipe chase areas will also be considered on an individual basis.

Pipe loads for other areas will be treated as uniform loads per unit floor area, and will be carried to the columns and foundations as dead loads. Pipe loads will not be considered as reliable dead load for uplift.

Equipment loads will be specifically determined and located. For major equipment, structural members and bases 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 live load.

The Steam turbine support systems will be designed for the following loads:

- Deadloads
- Live loads
- Normal torque loads (turbine)
- Temperature and pressure loads
- Seismic loads
- Emergency loads, such as turbine accident loads, and any temperature and pressure loads present during the emergency

### 3.2.3 Wind Loads

Wind loads for all structures will be based on CBC and ANSI. A step function of pressure with height under Exposure C conditions will be used. The Importance Factor shall equal 1.0. Allowance shall not be made for the effect of shielding by other structures.

The design wind pressures will be determined by multiplying the velocity pressures by the appropriate pressure coefficients given in CBC Table No. 16-H using Method 1.

The overturning moment calculated from wind pressure shall not exceed two-thirds of the dead load resisting moment. The uplift forces calculated from the wind load pressure shall not exceed two-thirds of the resisting dead load. For determining stresses, all vertical design loads, except roof live loads, shall be considered to act simultaneously with the wind pressure.

### 3.2.4 Seismic Loads

Seismic loads will be determined in accordance with the requirements specified in Section 3.6, Seismic Design Criteria.

### 3.2.5 Construction Loads

The integrity of the structures will be maintained without use of temporary framing struts or ties and cable bracing insofar as possible. However, construction or crane access considerations may dictate the use of temporary structural systems.

### 3.2.6 Load Combinations

At a minimum, the following load combinations will be considered. Applicable code prescribed load combinations will also be considered.

- Dead load
- Dead load plus live load plus all loads associated with normal operation of the equipment (e.g., temperature and pressure loads, piping loads, normal torque loads, impact loads, etc.)
- Dead load plus live load plus all loads associated with normal operation plus wind load
- Dead load plus live load plus all loads associated with normal operation plus seismic load
- Dead load plus construction loads
- Dead load plus live load plus emergency loads
- Dead load plus wind load
- Dead load plus seismic load

Every building component shall be provided with the strength adequate to resist the most critical effect resulting from the following combination of loads.

- Dead plus floor live plus roof live
- Dead plus floor live plus wind
- Dead plus floor live plus seismic
- Dead plus floor live plus wind plus roof live / 2
- Dead plus floor live plus roof live plus wind / 2
- Dead plus floor live plus roof live plus seismic.

Note: Use live load only where required by CBC in combination with seismic loads.

### 3.2.7 Allowable Stresses

Each load combination shall not exceed the allowable stress permitted by the appropriate code for that combination.

#### 3.2.7.1 <u>Concrete Structures</u>

The required strength (U) shall 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 = 1.4 (Dead + Live + 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

#### 3.2.7.2 Steel Structures

The required strength (S) based on the elastic design methods and the allowable stresses (Fs) defined in Part 1 of the AISC Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings is as follows:

- S = Dead = 1.0 Fs
- S = Dead + Wind = 1.33 Fs
- S = Dead + Seismic = 1.33 Fs; frame members and connections will conform to the
- additional requirements of CBC Sections 1627 and 2211
- S = Dead + Live = 1.0 Fs
- S = Dead + Live + Wind = 1.33 Fs
- S = Dead + Live + Seismic = 1.33 Fs; frame members and connections will conform to the additional requirements of CBC Sections 1627 and 2211

The Strength LRFD (load and resistance factor design) approach may be used as allowed by Code.

## 3.3 ARCHITECTURE

General design criteria for the architectural systems are discussed in the following subsections.

### 3.3.1 Architecture - Engineered Buildings

General design criteria for materials and installation of architectural systems or components will be as follows:

- **Exterior Walls.** These will be metal wall panel systems of the factory assembled or field erected type with exposed fasteners and minimum thickness of exterior sheet of 24 gauge galvanized steel.
- **Installed Walls.** Installed walls will be watertight and will provide a “U” factor in accordance with the California Code of Regulations, Title 24 and the ASHRAE Handbook. Sound attenuation will be provided for sound absorption on walls enclosing equipment as required.
- **Interior Walls.** Where durability is required, interior walls may be constructed of concrete block masonry, structurally designed and reinforced as required. In offices, shops, etc., metal studs with gypsum board will usually be used to form interior partitions. Insulation for sound control will be used where required by design.
- **Fire Exits.** Fire exits will be provided at outside walls as required by code. Exit signs will be provided. Fire doors will bear an Underwriters Laboratory (UL) certification level for class of opening and rating for door, frame, and hardware. Doors will conform to hollow metal door requirements and have fillers adequate to meet the fire rating.

- **Large Access Exterior Doors.** Large access exterior doors will be rolling steel type with weather seals and windlocks. Components will be formed from galvanized steel, factory assembled, and painted. Doors will be motor-operated with override manual operation.
- **Metal Roof Deck and Insulation System.** Roof deck and insulation system will be fluted steel decking with interlocking side laps.
- **Painting.** Exterior steel material that is not galvanized or factory finished will be painted. Painted color will match or harmonize with the color of the exterior face of the wall panels.
- **Color Schemes.** Color schemes will be selected for overall compatibility.

### 3.3.2 Architecture Prefabricated Metal Buildings

Prefabricated metal buildings (packaged to include exterior doors, wall louvers, windows, skylights, and related enclosure components) will be furnished as follows:

- **Building Enclosure.** Building enclosures will be of manufacturer's standard modular rigid frame construction with tapered or uniform depth rafters rigidly connected at ends to pinned base tapered or uniform depth columns. Purlins and girts will be cold-formed “C” or “Z” sections conforming to “Specifications for Design of Cold-Formed Steel Structural Members” of American Iron and Steel Institute. All other members will be hot rolled shapes conforming to “Specification for Design, Fabrication and Erection of Structural Steel for Buildings” of American Institute of Steel Construction. Metal roof coverings will be of pre-finished standing seam panels of 24 gauge minimum.
- **Steel.** Cold-formed components will conform to ASTM A570, Grade E, 42,000 psi minimum yield for material thicknesses equal to or less than 0.23 inch, or to ASTM A375, 50,000 pounds per square inch (psi) minimum yield for high tensile strength purlin or girt sections with material thicknesses equal to or less than 0.23 inch. Roof covering and wall covering will conform to ASTM A446, Grade A, galvanized 33,000 psi minimum yield. All cold-formed components will be manufactured by precision roll or break forming.

## 3.4 CONCRETE

Reinforced concrete structures will be designed in accordance with UBC and ACI 318, Building Code Requirements for Reinforced Concrete.

### 3.4.1 Materials

The materials described below will be specified and used as a basis for design.

- **Reinforcing Steel.** Reinforced steel shall meet the requirements of ASTM A615, Grade 60.
- **Cement.** Cement will be Portland cement in all concrete mixes meeting the requirements of ASTM C150.
- **Aggregates.** Fine aggregates will be clean natural sand. Coarse aggregates will be crushed gravel or stone. All aggregates shall meet the requirements of ASTM C33.
- **Admixtures.** Plasticizers and retarders will be used to control setting time and to obtain optimum workability. Air entrainment of 4 to 6 percent by volume will be used in all concrete mixes.

Calcium chloride will not be permitted. Interior slabs to be trowel finished may use less air entrainment.

- **Water.** Clean water of potable quality shall be used in all concrete.

### 3.4.2 Design

The system of structural concrete and steel reinforcing strength combinations will be used as follows:

- Concrete strength 4,000 psi minimum (at 28 days)
- Reinforcing strength - 60,000 psi, Grade 60

### 3.4.3 Mixes

Concrete strength will be determined by ASTM C39.

### 3.4.4 Reinforcing Steel Test

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

## 3.5 STRUCTURAL STEEL

Steel framed structures will be designed in accordance with the CBC and the AISC Specification for the Structural Steel Building, Allowable Stress Design, and Plastic Design. In addition, steel framed structures will be designed in accordance with the criteria discussed in the following subsections.

### 3.5.1 Materials

Structural steel shapes, plates, and appurtenances for general use will conform to ASTM A-36 and A-992. Structural steel required for heavy framing members may consider use of ASTM A572. Structural steel required for tube girts will conform to ASTM A500, Grade B. Connection bolts will conform to ASTM A325. Connections will conform to AISC Specification for Structural Joints. Welding electrodes will be as specified by the AWS. All structural steel will be shop primed after fabrication. Test reports certifying all material is in compliance with the applicable specification will be provided as required.

### 3.5.2 Design

All steel framed structures will be designed as “rigid frame” (AISC specification type 1) or “simple” space frames (AISC Specification Type 2), utilizing single span beam systems, vertical bracing at main column lines, and horizontal bracing at the roof and major floor levels. Suspended concrete slabs will be considered as providing horizontal stability by diaphragm action after setup and curing. Deflections of the support steel will be controlled to prohibit “ponding” of the fresh concrete as it is placed. Metal roof decks attached with welding washers or fasteners may be considered to provide a structure with lateral force diaphragm action.

Connections will be in accordance with AISC standard connection design for field bolted connections.

## 3.6 SEISMIC DESIGN CRITERIA

This section provides the general criteria and procedures that will be used for seismic design of structures, equipment, and components.

The project is located in Seismic Zone 4 as designated by the California Building Code (CBC). The seismic performance objectives for this facility are as follows:

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

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

It should be noted that structures having one or more of the features listed in Table 16-L and Table 16-M shall be designated as having a vertical and a plan irregularity, respectively. All structures, regular or irregular, shall be designed by static or dynamic procedures in accordance with CBC Section 1627 - Criteria Selection.

Additional provisions for torsional irregularity, discontinuous lateral load-resisting element, story drift limitation, etc. shall be considered in accordance with Section 1628.6 through and including Section 1628.10 of the CBC Code.

### 3.6.1 STRUCTURES

#### 3.6.1.1 <u>Water Treatment Area</u>

The superstructure will be constructed of ASTM A36 and/or A992 structural steel, the design for which will conform to Chapter 22 of CBC.

Lateral forces will be resisted by braced frames or moment-frame connections in conjunction with bracing in the roof steel.

Seismic forces will be computed by the Static Force Procedure given by Chapter 16 of CBC. The seismic dead load, W, will include the total dead load of the superstructure and the weight of any permanent equipment attached to the superstructure.

Elements of structures and nonstructural components and equipment, including piping and cable tray and their supports, will be seismically designed in accordance with Sections 1630 and 1631 of CBC.

#### 3.6.1.2 <u>Control/Administration and Warehouse/Shop Buildings</u>

The one-story Control/Administrative and Warehouse Shop Buildings will be approximately 40 feet by

75 feet in plan with a 15 foot to 20 foot eve height. The final dimensions and eve heights will be determined following detailed design and the purchase of equipment. As with the water treatment structure, these buildings will be constructed of ASTM A36 and/or A992 structural steel and designed in accordance with CBC.

The seismic forces will be computed as described previously for the water treatment structure.

### 3.6.2 Non-building Structures

Non-building structures such as ACC Supports, tanks, equipment skid, and the neutralization basin will be designed to resist seismic forces in accordance with Section 1632 of CBC.

## 4.0 STRUCTURAL DESIGN METHODOLOGY

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

## 4.1 STRUCTURES

### 4.1.1 Steam Turbine Foundations

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

#### 4.1.1.1 Foundation Loads

Foundation loads will be furnished by the steam turbine supplier 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 from project specific criteria
- Seismic Loads from project specific criteria
- Hydrostatic Loads
- Temperature and pressure Loads
- Operating Dynamic Loads
- Emergency loads such as turbine accident Loads.

#### 4.1.1.2 Induced Forces

The steam turbines and associated equipment will be securely anchored to the foundation using cast-in-place steel anchor bolts, guides and variable supports designed to resist the equipment forces.

#### 4.1.1.3 Structural Criteria

The foundations will be designed and constructed as monolithic reinforced concrete structures using the criteria from Section 3.4, Concrete and Appendix D. The foundation system will likely be a pile supported rigid mat.

The foundation design will address the following considerations:

- Soil bearing capacities and earth pressures
- Allowable settlements
- Equipment, structure, and environmental loads
- Natural frequencies of rotating equipment
- Access and maintenance
- Equipment performance criteria
- Dynamic effects of the rotating machinery.

Environmental loading will be determined in accordance with Section 3.1, Natural Phenomena. Wind loads will be determined using the velocity pressures specified in Section 3.2.3, Wind Loads.

Seismic loading to the foundation from the steam turbine will be calculated using equivalent lateral forces applied at the center-of-gravity of the equipment in accordance with the criteria specified in Section 3.6, Seismic Design Criteria, for rigid equipment.

Load combinations and their respective strength factors for the foundation designs will be as indicated in Section 3.2.6, Load Combinations and Subsection 3.2.7, Allowable Stresses.

#### 4.1.1.4 Analytical Techniques

The steam turbine foundations will be designed using static analysis techniques assuming a rigid mat. The mats will be sized such that the allowable settlement and bearing pressure criteria developed from a detailed subsurface investigation will not be exceeded. The foundations will be analyzed as combined footings 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 steam turbine foundations will be checked for dynamic response of the operating steam turbines. Calculations based on the fundamental principles of dynamic behavior of structures will be used to determine the natural frequencies of the support system. Where soil-structure interaction effects are important, low strain soil properties will be used to calculate soil springs using the procedures from Vibrations of Soils and Foundation by Richart, Hall, and Woods or similar procedure. Each concrete foundation will be analyzed as a rigid body on soil springs with the equipment modeled as a rigid mass located at its center of gravity and rigidly attached to the foundation. The foundations will be proportioned such that the principal natural frequencies will be at least 25 percent removed from the equipment operating speed. Should the resultant foundation design prove to be uneconomical, the dynamic behavior of the foundation will be evaluated and compared to ISO (3495) Criteria for Vibration Severity. The resultant vibration level will be within the “Good” range of this standard.

A procedure for the dynamic analysis of large fan foundations supported by soil, piers, or piles may be used to evaluate the dynamic behavior of the turbine foundations.

### 4.1.2 Steam Drum Foundation

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

#### 4.1.2.1 <u>Foundation Loads</u>

Foundation loads will be furnished by the steam drum manufacturer and will be superimposed with loads for the foundation itself. Typical loading data supplied by the manufacturer includes the following:

- Dead Load
- Live Load
- Wind load
- Seismic load
- Hydrostatic load
- Temperature and pressure Test Load

#### 4.1.2.2 <u>Induced Forces</u>

The steam drum and associated equipment will be securely anchored to the foundation using cast-in-place steel anchor bolts designed to resist the equipment forces.

### 4.1.3 Buildings

The Control Room/Administration Building, Water Treatment Structure, and the Warehouse/Shop Building will provide support, enclosure, protection, and access to the systems contained within their boundaries.

#### 4.1.3.1 <u>Foundation Loads</u>

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

#### 4.1.3.2 <u>Induced Forces</u>

The buildings and associated major equipment will be securely anchored to the foundations using cast-in-place steel anchor bolts designed to resist any induced forces.

#### 4.1.3.3 Structural System

The buildings will be designed as an AISC Type 2 simple braced frame and moment frames. For the purpose of resisting seismic lateral loads, structures will be classified as regular structures with concentric braced frames in accordance with the definitions of Chapters 16 and 22 of the California Building Code.

#### 4.1.3.4 Structural Criteria

The steel frames of the buildings will be designed and constructed using the materials and criteria set forth in Section 3.5, Structural Steel.

Environmental loading will be determined in accordance with Section 3.1, Natural Phenomena. Wind loads will be determined using the velocity pressures specified in Section 3.2.3, Wind Loads.

Seismic loading for the buildings will be calculated using equivalent lateral forces applied to the structure in accordance with the procedures of CBC Chapter 16.

The foundations of the buildings will be designed and constructed using reinforced concrete according to the criteria set forth in Appendix D and Section 3.4, Concrete.

The foundation design will address:

- Soil bearing capacities and earth pressures
- Allowable settlements
- Equipment, structure, and environmental loads
- Access and maintenance
- Equipment performance criteria.

Load combinations and their respective allowable stresses will be as indicated in Subsection 3.2.6, Load Combinations and Subsection 3.2.7, Allowable Stresses.

#### 4.1.3.5 Analytical Techniques

The steel frames will be analyzed on a two dimensional plane frame or a three-dimensional space frame model. All loads will be applied as static forces.

The building foundations will be designed using static analysis techniques assuming rigid spread footings or concrete pile caps. Footings will be sized such that the allowable settlement and bearing pressure criteria developed from a detailed subsurface investigation will not be exceeded assuming a linear soil pressure distribution. The footings will be proportioned such that the resultant of the soil pressure coincides as nearly as possible with the resultant of the vertical loading.

### 4.1.4 Air Cooled Condenser Foundation

The air cooled condenser will be divided into cells. The foundation will be supported on piles or on a structural mat depending on the recommendation of the geotechnical engineer and detailed engineering.

#### 4.1.4.1 Foundation Loads

Foundation Loads will be determined using project specific design criteria.

The design of the air cooled condenser column foundations will include the following loads:

- Dead loads
- Live loads (including water)
- Operating weight
- Shut down weight
- Wind loads
- Seismic loads

#### 4.1.4.2 Induced Forces

The air cooled condenser columns will be supported by structural steel columns that will be securely anchored to the foundation using cast-in-place anchor bolts.

#### 4.1.4.3 Structural System

The air cooled condenser supplier will design the structural support system.

#### 4.1.4.4 Structural Criteria

The predominant forces acting on the air cooled condenser will result from wind or seismic loading.

Wind loads will be determined from American Society of Civil Engineers (ASCE) ASCE 7, Minimum Design Loads for Buildings and Other Structures. Consideration will be given to along wind and across-wind responses.

Seismic loads will be determined in accordance with CBC Section 1632 - Non-building Structures.

The foundation design will address the following consideration:

- Soil bearing capacities and earth pressures
- Allowable settlements
- Structure and environment loads

Load combinations and their respective strengths will be as indicated in Section 3.2.7.1, Concrete Structures.

#### 4.1.4.5 Analytical Techniques

The Air Cooled Condenser foundation will be analyzed using static analysis techniques. The foundation will be sized such that bearing pressure criteria developed from a detailed subsurface investigation will not be exceeded. The foundation will be proportioned to resist the vertical gravity loads concurrent with the controlling lateral loads.

## 4.2 TANKS

### 4.2.1 Vertical, Cylindrical Field Erected Storage Tanks

The vertical, cylindrical field erected reclaimed water and demineralized water storage tanks will generally be of carbon steel construction and will have a protective interior coating.

The tank roof will be of the self-supported dome or cone type. The tank bottom will be ground supported. The tank will be provided with ladders, landing platforms, and handrails as required to provide access to all working areas. Vents, manholes, overflow piping, and grounding lugs will also be provided as necessary.

#### 4.2.1.1 Foundation Loads

The design of tanks and foundations will include the following loads:

- Dead Loads
- Live Loads
- Wind Loads
- Seismic Loads
- Hydrodynamic Loads

Foundation loading magnitudes from tanks will not exceed bearing allowable of the soil.

#### 4.2.1.2 Induced Forces

Storage tanks will be properly anchored to the foundation.

#### 4.2.1.3 Structural System

Storage tanks will resist lateral loading through shear in the tank walls. Overturning will be resisted by applicable dead loads or by anchor bolts connecting the tank wall to the foundation.

#### 4.2.1.4 Structural Criteria

The foundation will be designed and constructed as a reinforced concrete ringwall using the criteria from Appendix D and Section 3.4, Concrete.

The tank structures will be designed and constructed using the criteria established in AWWA D100.

Environmental loading will be determined in accordance with Section 3.1, Natural Phenomena. Wind loads will be determined using the velocity pressures specified in Section 3.2.3, Wind Loads, multiplied by the appropriate pressure coefficient from Table No. 16-H of CBC.

Seismic loads will be determined in accordance with Section 3.6, Seismic Design Criteria and AWWA D100, Section 13.

The seismic overturning moment will be determined from AWWA D100, Section 13.3.3.1 for Z = 0.4. The structure coefficient will be determined from Table 16 of this AWWA Code. The value of Cl will be determined from Section 13.3.3.1. The site amplification factor, S, will be determined from Table 17.

Load combinations and their respective allowable strengths will be as indicated in Section 3.2.6, Load Combinations, Section 3.2.7, Allowable Stresses, and Section 3 of AWWA D100.

Design loads will be applied at the center of gravity of the tank. The design of the tank foundation will include the moment resulting from lateral displacement (hydrodynamics) of the tank contents in accordance with AWWA D100, Section 133.2.

Piping connections will be designed with a minimum 2 inches of flexibility in all directions as specified in AWWA D100, Section 135.

#### 4.2.1.5 <u>Analytical Techniques</u>

The tank foundation will be designed using static analysis techniques. The foundation will be proportioned to resist the dead load of the tank and the overturning moment determined from AWWA D100. The foundation will also be proportioned to resist maximum anchor bolt uplift force. The foundation will be proportioned to resist the vertical gravity loads concurrent with the controlling lateral loads.

The tank structure will be designed and proportioned such that during the application of any load, or combination of loads, the maximum stresses as stipulated in AWWA D100 will not be exceeded.

### 4.2.2 Horizontal, Cyclindrical Shop Fabricated Storage Tanks

The tanks will be constructed of carbon steel and provided with ladders, landing platforms, and handrails, as required, to provide access to all working areas. Each tank will be provided with a fill connection, fill drain, overflow, vent connections, manholes, and grounding lugs as necessary.

#### 4.2.2.1 <u>Foundation Loads</u>

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 the following:

- Dead Loads

- Live Loads
- Wind Loads
- Seismic Loads
- Temperature and pressure Test Loads
- Hydrodynamic Loads

**4.2.2.2 Induced Forces**

The tanks will be securely anchored to the foundation using cast-in-place steel anchor bolts designed to resist all induced forces.

**4.2.2.3 Structural System**

The tanks will be supported by integral legs or saddle supports designed to resist gravity and environmental loading.

**4.2.2.4 Structural Criteria**

The foundation will be designed and constructed as a monolithic reinforced concrete structure using the criteria from Appendix D and Section 3.4, Concrete. The foundation will likely be a pile supported rigid mat.

Environmental loading will be determined in accordance with Section 3.1, Natural Phenomena. Wind loads will be determined using the velocity pressures specified in Section 3.2.3, Wind Loads, multiplied by the appropriate pressure coefficient from Table No. 16-H of CBC.

Seismic loading will be calculated using equivalent lateral forces applied at the center of gravity of the tank or tank component in accordance with the criteria specified in Section 3.6, Seismic Design Criteria.

Load Combinations and their respective allowable strengths will be as indicated in Section 3.2.6, Load Combinations and Subsection 3.2.7, Allowable Stresses.

**4.2.2.5 Analytical Techniques**

The tank foundations will be designed using static analysis techniques assuming a rigid mat. The mat will be sized such that the allowable settlement and bearing pressure criteria developed from a detailed subsurface investigation will not be exceeded. The foundation will be analyzed assuming a linear soil pressure distribution. The mat 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 typically be designed by a tank manufacturer in accordance with the American Society of Mechanical Engineers (ASME) code, ANSI code, and the ASTM standards. Gravity and lateral loadings will be transferred to the foundation by integral legs or a saddle support system.

## 4.3 EQUIPMENT

### 4.3.1 Steam Turbine Accessories

The foundations will be designed to resist the loading furnished by the manufacturer and will be constructed of reinforced concrete.

#### 4.3.1.1 Equipment Loads

Equipment loads will be determined by the manufacturer based on project performance criteria. Typical loading used for design include the following:

- Dead Load
- Live Load
- Operating Loads
- Construction Loads
- Wind Load
- Seismic Load
- Temperature and pressure Test Loads
- Emergency Loads such as turbine accident Loads

#### 4.3.1.2 Induced Forces

The steam turbine and associated equipment will utilize steel anchor bolts, fasteners, welds, and other equipment anchorage devices to resist equipment induced forces.

#### 4.3.1.3 Structural Criteria

The steam turbine and generator and accessories will be designed to resist project specific design loads and CBC specified loads.

Environmental loading will be determined in accordance with Section 3.1, Natural Phenomena. Wind loads will be determined using the velocity specified in Section 3.2.3, Wind Loads, multiplied by the appropriate pressure coefficient from Table No. 16-H of CBC.

The seismic loading and design of the steam turbine and accessories will be in accordance with project specific criteria and CBC. Seismic loading will be calculated using equivalent lateral forces applied at the center of gravity of the equipment or component in accordance with the criteria specified in Section 3.6, Seismic Design Criteria.

The procedures established for the analysis of regular and irregular structures will be as specified in CBC Chapter 16 and Section 3.6.1, Structures.

Lateral forces on elements of structural and nonstructural components will be determined in accordance with CBC Section 1630 with Z equal to 0.4, I equal to 1.0, and Cp in accordance with CBC Table 16-0, or as defined by the Geotechnical Report. These seismic forces will be combined with forces due to normal operating loads.

Lateral forces on equipment will be determined in accordance with CBC Section 1630 with Z equal to 0.4, I equal to 1.0, and Cp in accordance with CBC Table 16-0 or as defined by the Geotechnical Report. Equipment bases, foundations, support flames, and structural members used to transfer the equipment seismic forces to the main lateral load resisting system will be designed for the same seismic load as the equipment.

Load combinations will be as indicated in Section 3.2.6, Load Combinations. These load combinations are in addition to those normally used in design and those specified in applicable codes and standards. For all load combinations, including seismic, the stresses in the structural supporting members and connections will remain in the elastic range.

#### 4.3.1.4 Analytical Techniques

The steam turbine and auxiliary equipment will be designed and constructed in accordance with applicable requirements of codes and standards referenced in this Appendix. Stamps will be affixed to denote conformance to the appropriate codes.

### 4.3.2 Main, Standby, and Auxiliary Transformers

The main and auxiliary power transformers, transformer equipment, material and accessories will conform to the applicable standards of ANSI C57.12, National Electrical Manufacturers Association (NEMA) TR1, ANSI/Institute of Electrical and Electronics Engineers (IEEE) C59, and project specific criteria. The power transformer will be designed, fabricated, and tested in accordance with ANSI C57.12 series, NEMA TR 1, and project specific criteria.

#### 4.3.2.1 Foundation Loads

Foundations loads will be furnished by the transformer manufacturers and will be superimposed with loads for the foundation itself. Typical loadings supplied by the manufacturer include the following:

- Dead Loads
- Live Loads
- Wind Loads
- Seismic Loads

#### 4.3.2.2 Induced Forces

The power transformers, transformer equipment, and accessories will utilize steel anchor bolts, fasteners, welds and other equipment anchorage devices to resist equipment induced forces.

#### 4.3.2.3 Structural System

The transformer will be regarded as a rigid-body for foundation design purposes.

#### 4.3.2.4 Structural Criteria

The power transformers, transformer equipment, and accessories will be designed to resist project specific design loads, CBC specified loads, and loads from applicable codes and standards.

The foundation(s) will be designed and constructed as a monolithic reinforced concrete structure using the criteria from Appendix D and Section 3.4, Concrete. The foundation will likely be a soil supported or pile supported rigid mat. The foundation will incorporate an integral containment basin capable of holding 130 percent of the transformer coolant contents prior to passage through an oil water separator.

Environmental loading will be determined in accordance with Section 3.1, Natural Phenomena. Wind loads will be determined using the velocity pressures specified in Section 3.2.3, Wind Loads, multiplied by the appropriate pressure coefficients from CBC Table No. 16-H.

The seismic loading and design of the power transformers, transformer equipment, accessories, and foundations will be in accordance with project specific criteria and CBC Chapter 16. Loading will be approximated using equivalent lateral forces applied to the center of gravity of the equipment or component using the criteria specified in Section 3.6, Seismic Design Criteria.

Lateral forces on equipment will be determined in accordance with CBC Section 1630 with Z equal to 0.4, I equal to 1.0, and Cp in accordance with CBC Table 16-0. Equipment bases, foundations, support frames, and structural members used to transfer the equipment seismic forces to the foundation system win be designed for the same seismic load as the equipment.

Load combinations will be as indicated in Section 3.2.6, Load Combinations. These load combinations are in addition to those normally used in design and those specified in applicable codes and standards. For load combinations, including seismic, the-stresses in the structural supporting members and connections will remain in the elastic range. Structural allowable strengths will be as indicated in Section 3.2.7, Allowable Stresses.

#### 4.3.2.5 Analytical Techniques

The power transformers, transformer equipment, and accessories will be designed and constructed in accordance with applicable requirements of codes and standards referenced in Appendix G, Electrical Engineering Design Criteria.

The power transformer foundation(s) will be designed using static analysis techniques assuming a rigid mat. The mat will be sized such that the allowable settlements and bearing pressure criteria developed from a detailed subsurface investigation will not be exceeded. The foundation will be analyzed assuming a linear soil pressure distribution. The mat will be proportioned such that the resultant of the soil pressure coincides as nearly as possible with the resultant of the vertical loading.

### 4.3.3 Miscellaneous Equipment

Where possible, all miscellaneous equipment will be designed to project specific criteria. This miscellaneous equipment includes, but is not limited to, motor control centers, batteries, low voltage power and lighting systems, isolated bus ducts, pumps, lube oil cooling units, fire detection and protection systems, and switchgear. Standardized components such as motors pumps, small fans, and other similar products that represent manufacturers' standard stock items will not be designed to meet project specific seismic loading criteria.

Miscellaneous equipment will meet all applicable codes and standards as well as the individual manufacturer's standards.

All equipment foundations and supports will be designed to resist project specific loading and the loading furnished by the equipment manufacturer.

#### 4.3.3.1 Foundation Loads

Foundation loads will be furnished by the equipment manufacturers and will be superimposed with loads for the foundation itself. Typical loading supplied by the manufacturer include the following:

- Dead Load
- Live Load
- Wind Load
- Seismic Load
- Temperature and pressure Test Loads (as applicable)

#### 4.3.3.2 Induced Forces

All miscellaneous equipment will utilize steel anchor bolts, fasteners, welds, and other equipment anchorage devices to resist equipment induced forces.

#### 4.3.3.3 Structural System

Each individual piece of equipment will have its own unique structural system, and it is the responsibility of each manufacturer to assure its adequacy.

#### 4.3.3.4 Structural Criteria

All miscellaneous equipment will be designed to resist project specific and CBC specified loads where possible and loads from applicable codes and standards.

The seismic loading and design of miscellaneous equipment will be in accordance with project specific criteria and CBC Chapter 16.

Seismic loading will be calculated using equivalent lateral forces applied to the center of gravity of the equipment or component in accordance with the criteria specified in Section 3.6, Seismic Design Criteria.

Lateral forces on equipment will be determined in accordance with CBC Section 1630 with Z equal to 0.4, 1 equal to 1.0, and Cp in accordance with UBC Table 16-0. Equipment bases, foundations, support frames, and structural members used to transfer the equipment seismic forces to the main lateral load resisting system will be designed for the same seismic load as the equipment.

Load combinations will be as indicated in Section 3.2.6, Load Combinations. These load combinations are in addition to those normally used in design and those specified in applicable codes and standards. For all load combinations, including seismic, the stresses in the structural supporting members and connections shall remain in the elastic range. Structural allowable strengths will be as indicated in Section 3.2.7, Allowable Stresses.

#### 4.3.3.5 <u>Analytical Techniques</u>

All miscellaneous equipment and accessories will be designed and constructed in accordance with applicable requirements of codes and standards.

All structural supports required for the miscellaneous equipment will be designed using static analysis techniques.

## 4.4 PIPING

Piping will include all high point vents, low point drains, instrument piping, lube oil piping, steam piping and other piping as required for the complete system. Insulation, hangers, valves, and other piping accessories will also be provided. Piping, pipe supports, and pipe accessories will be constructed of carbon, alloy, and stainless steel.

The foundations and support superstructures will be designed to resist the loadings generated by the piping system.

### 4.4.1 Piping Loads

All piping loads will be determined using project specified loading, UBC, and CBC specified loads. Typical loading for a piping system include the following:

- Dead Load
- Live Load
- Wind Load
- Seismic Load
- Temperature and pressure test Loads

### 4.4.2 Induced Forces

The design and configuration of all hangers and accessories will utilize steel anchor bolts, fasteners, welds, and other pipe anchorage devices. All pipe anchorage will be designed to resist induced forces.

### 4.4.3 Structural Criteria

All piping, pipe supports, and pipe accessories will be designed to resist project specific loads, UBC, CBC specified loads, and loads from applicable codes and standards, and be in accordance with the criteria established in Appendix D, Foundation and Civil Engineering Design Criteria.

Environmental loading will be determined in accordance with Section 3.1, Natural Phenomena. Wind loads will be determined using the velocity pressures specified in Section 3.2.3, Wind Loads, multiplied by the appropriate pressure coefficients from Table No. 16-H of CBC.

The seismic loading and design of piping systems and pipe supports will be in accordance with project specific criteria. Seismic analysis of piping and components will be designed in accordance with Sections 1630 and 1631 of CBC.

Load combinations will be as indicated in Section 3.2.6, Load Combinations. These load combinations are to act in conjunction with those normally used in design and the applicable codes and standards specified in this Appendix. For all load combinations, including seismic, the stresses in the structural supporting members will remain in the elastic range. Structural allowable strengths will be as indicated in Section 3.2.7, Allowable Stresses.

#### 4.4.4 Analytical Techniques

All piping, piping supports, and pipe accessories will be designed and constructed in accordance with applicable requirements of the codes and standards referenced in this Appendix.

Structural supports required for piping will be designed using static analysis techniques using the procedures established in this Appendix.

## 5.0 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.

## 5.1 SEISMIC HAZARD MITIGATION CRITERIA

This appendix and Appendix D describe the civil and structural design criteria that will be applied to the project. The selection of the seismic design criteria for the project was based on the following considerations:

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

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

- The seismic hazards will be assessed by studying the geologic features of the surrounding area.

Major faults will be identified and information collected regarding each fault's proximity, capability, recurrence, and magnitude.
- The seismic risk associated with each source will be assessed considering historical magnitudes.
- Acceleration levels for various structural frequencies will be based on CBC Figure No 16-3, Normalized Response Spectra Shapes.
- Appropriate design criteria and analysis methods will be established for each major CESF structure, equipment, and component consistent with seismic performance criteria.

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

- 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.
- All equipment will be positively anchored to its supportive structure. Normal uplift capacity will be provided in the absence of calculated overturning forces.
- Anchorages will be designed to resist the project specific seismic loadings.
- Foundation systems will be selected and designed to minimize the effects of soil liquefaction.
- The design of piping connections to structures, tanks, and equipment will consider the 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.

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

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

## 5.2 METEOROLOGICAL AND CLIMATIC HAZARD MITIGATION

Meteorological and climatic data will form the design basis for the project. Portions of the data and the design bases that pertain to structural engineering have been provided in this Appendix.

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

- 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.
- Plant drainage systems will be designed to convey the runoff from a rainfall event with a 10-year recurrence interval.
- Ground floor levels of structures will be placed above the 100 year flood plain levels.
- The facility site will be graded to convey runoff away from structures and equipment.

The foregoing design features will be incorporated in accordance with 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.