APPENDIX 2D

Civil and Structural Engineering Design Criteria

2.0 CIVIL/STRUCTURAL DESIGN CRITERIA

This section describes the civil, structural, and architectural design basis for the facility's structures, and general civil work. All civil/structural work will be designed in accordance with applicable codes, industry standards, and local, state, and federal regulations.

2.1 Facility Description

The plant complex will consist of two (2) CTGs, two (2) HRSGs, an STG, cooling tower, administration and water treatment buildings, transformers, high voltage equipment, BOP equipment, power distribution centers, water treatment area, miscellaneous enclosures, utility racks, and access platforms.

The CTGs and STG will not be enclosed in a building. Grading of the finished site will be as indicated on the plant grading and drainage drawings. The project will include a perimeter fence around the site. Main access to and from the site will be by the paved main entrance road.

2.1.1 Plant Layout and Access

The facility will be laid out to accommodate the spaces required to service equipment as well as to maintain and operate the plant. Access aisles and clearance will be provided for safe operation, maintenance, inspection, and equipment removal. Provisions will be made for personnel walkways including, doors, stairs, landings, ladders, and other approved access means.

Personnel and plant maintenance equipment access to plant equipment, piping and their related features will include the following:

- In plant equipment areas, personnel access aisles for operation and maintenance activities will nominally be 4'-0" wide and 7'-6" high.
- The plant will be subdivided into separate fire areas as determined by a Fire Risk Eval`uation for the purpose of limiting the spread of fire, protecting personnel, and limiting the resultant consequential damage to the plant. Fire areas will be separated from each other by fire barriers, spatial separation, or other approved means.
- The plant will be arranged to facilitate the economic performance of maintenance activities with appropriate use of:
    - Mobile Cranes
    - Forklifts
    - Monorails
- Adequate clear space will be provided above equipment to ensure that foundation bolts or other devices do not obstruct removal.
- Plant fire protection and life safety features will be considered in the plant layout and be designed in accordance with local codes, permits, and insurance requirements.

- Location of natural gas relief valves, any potential chemical releases, and significant heat rejection to ambient air will be separated from CTG and generator air intakes.

2.2 Sitework

Clearing, excavation, backfill, and grading will be performed as required to construct the facility and achieve finished site grades as described in this section.

2.2.1 Site Clearing

The site will be cleared of trees, shrubs, and vegetation to the extent necessary to construct the facility. Provisions for special features (i.e., trees, monuments, or other items) that are to remain and be protected during construction shall be made.

2.2.2 Excavation

Excavation work will consist of the removal of earth, sand, gravel, vegetation, organic matter, rock, boulders, and debris to the lines and grades necessary for construction.

Materials suitable for backfill will be stockpiled at designated locations using proper erosion protection methods. Disposal of any excess uncontaminated backfill material will be to a designated landfill area.

Dewatering of excavations will be done if and when necessary to support construction activities.

2.2.3 Backfilling

Backfilling will be done in uniform layers of specified thickness. Soil in each layer will be properly moistened to obtain its specified density. To verify compaction, representative field density and moisture-content tests will be taken during compaction.

Structural fill supporting foundations and other critical structures, and general site fill will be compacted in accordance with the criteria specified by the Geotechnical Investigation Report.

2.2.4 Grading

Site grading design will comply with applicable land development regulations. Graded areas will be smooth, compacted, free from irregular surface changes, and sloped to drain. Final earth grade adjacent to equipment and buildings will be below finished floor elevations and will be sloped away from foundations as necessary to maintain proper drainage.

Prior to any further construction all graded areas under roadways, foundations, or other supportive areas will have a compacted subgrade consisting of at least the top 6 inches

scarified and compacted to 95% of the maximum density based on the modified proctor test (ASTM D-1557) density. Backfill for all embankments, non-supportive and unpaved areas will be compacted to at least 90% of the maximum density based on the modified proctor test (ASTM D-1557) in 6-inch lifts, except trench fill and fill beneath roads will be compacted to 95% of the maximum density based on the modified proctor test (ASTM D-1557).

2.2.5 Erosion Control

During project construction, erosion and sediment control measures will be implemented by the Contractor to prevent sediment-laden runoff from leaving the site. An Erosion and Sediment Control Plan will be developed in conjunction with the Stormwater Management Plan developed for the construction phase of the project. During this phase, the constructed stormwater management basin will be used as a sediment basin. Construction runoff will be directed to this basin where sediment will settle out before being discharged off site. In addition to the sediment basin, the plan will include the incorporation of silt fencing, straw bale dikes, storm inlet protection, swales, piping, and other measures to promote sediment and erosion control. The construction contractor will prepare a final version of these plans based on the preliminary plans submitted by the applicant to the city official/CBO.

2.2.6 Stormwater Management

A Stormwater Management Plan will be developed for the final stabilized site. The intent of the stormwater management plan will be to preserve the existing pre-development drainage patterns to the extent possible. The plan will include a stormwater collection system consisting of all or some of the following elements: detention/retention pond, swales, ditches, culverts, catch basins, and piping.

2.2.7 Roads and Parking

Asphalt site roads and parking will be provided for access, operation and maintenance as shown on the Site General Arrangement drawing. Alternative access, if required by local regulations, will be provided as shown on the General Arrangement drawing..

2.2.8 Site Area Paving

Areas within the power block will be surfaced with concrete or gravel as shown on the General Arrangement drawing. All roads will be paved with asphalt unless specifically shown otherwise on the General Arrangement drawing. Asphalt will be a minimum of 4 inches thick and will be placed in no less than 2 lifts. A minimum of 6 inches of 1.5 inch clean, uniformly graded, crushed stone over a geotextile fabric will be used in areas so designated on the General Arrangement drawing. **Local conditions may warrant the crushed stone layer to be thicker than 6", but in no case will it be greater than 10 inches.** Concrete aprons shown in the crane lift areas of the combustion turbines will be designed to support the crane loads during maintenance activities.

Site roads will be provided that conform to the following:

- Operating speed of 10 miles per hour.
- Minimum road width of 20 feet, with 2-foot shoulders.
- Minimum radius of curvature of 50 feet (centerline) unless restricted.
- AASHTO HS-20-44 loading conditions (minimum requirement).
- Maximum longitudinal slope of 5 percent (except as required for short distances for site entrance and exit roads in which case 8% will not be exceeded).
- Maximum transverse gradient of 2 percent.
- The road to the CT Generator from the plant loop road will be flat (0% slope) for a minimum distance of 70 feet from the face of the generator.

2.2.9 Wetlands Protection

Wetlands will be protected during construction as required and to comply with requirements specified by any laws, codes, and permits.

2.2.10 Landscaping and Fencing

A detailed landscape design, fine grading, furnishing and placement of trees, shrubbery, and/or grass, will be prepared. Any embankment area around the perimeter of the power block and any unpaved areas on site will be gravel.

Any offsite area that is disturbed during construction will be hydro-seeded and restored to the original contours.

A single chain-link fence around the site boundary, with a single 24-foot-wide automatic slide main gate, with a keypad for vehicle use, located at the main entrance will be provided. One manually operated vehicle gate located at another access point around the site will also be provided if an additional vehicle entrance is shown on the Site General Arrangement. The centerline of fence will be at least 6” inside of the property line to assure construction on Owner’s property.

2.3 Civil/Structural Design Requirements

2.3.1 Geotechnical Report

The project equipment foundations will be designed to the meet the requirements of the Geotechnical Report that was prepared during the plant development.

2.3.2 Codes and Standards

The governing building code, CBC2007 and local/state-building codes will be

incorporated into the design of buildings and structures. Steel structures will be designed in accordance with the design specifications for structural steel buildings published by the American Institute of Steel Construction (AISC). Reinforced concrete structures will be designed in accordance with the design requirements for concrete buildings and structures published by the American Concrete Institute (ACI).

Allowable variances and applicable local code interpretations will be established before project commencement.

Additionally all plant areas and structures will be designed and configured to meet OSHA requirements contained in Part 1910 of the U.S. Code of Federal Regulations.

2.3.3 Combustion Turbine Support Structure

The combustion turbine support foundation will be designed in accordance with the manufacturer's recommendations and the Geotechnical Report. Both static and dynamic loading criteria set forth by the manufacturer will be considered. Site specific seismic and wind conditions will be reviewed and compared to the seismic and wind conditions that govern the manufacturer's loading criteria. In general, the structure will be a reinforced concrete mat foundation to support the equipment anchorages.

2.3.4 HRSG Structure

The HRSG structures and related equipment will be supported on reinforced concrete mat foundations. Foundation loads will be supplied by the HRSG manufacturer. The design will be based on the final Geotechnical Report.

The HRSGs and self-supported steel stacks and platforms will be supported by a reinforced concrete foundation. If required, precast concrete piles or other equally suitable pile design will be utilized only if specified in Section 1

2.3.5 Tank Foundations

The cylindrical vertical tanks will be supported on suitable foundations consisting of a ring-wall foundation or a mat foundation depending on the size of the tank.

2.3.6 Transformer Foundations and Protection

Transformer foundations will be designed and constructed in accordance with the requirements of NFPA, local codes and regulations, and manufacturer's recommendations.

Spill containment will be provided for the generator step-up transformer and unit auxiliary transformers, and will be topped with galvanized steel grating. Reinforced concrete retention pits, with a low point sump, will be provided for the transformers and will be sized to contain at least the full oil volume of the transformer. Transformer firewalls will be provided between oil-filled transformers and adjacent structures and equipment as

required by the National Electrical Safety Code. The walls will be constructed of reinforced concrete. The transformer pits will have a manually operated outlet valve and drain line routed to the oily water separator. The valve will be a PIV type, but of a different color than fire system PIVs to provide needed differentiation.

Smaller (oil volume < 500gals) oil filled transformers will be located in bermed areas to facilitate containment of any oil. The bermed area will be of sufficient volume to contain 110% of the transformer oil volume. The height of each berm will be limited to 8 inches. A valved drain will be located in the berm wall to allow drainage of rain and ground water from the bermed area. The drain will lead to the OWS sump.

2.3.7 Spill Containment Structures

Spill containment structures will be provided for any chemical injection skid and chemical storage areas including the ammonia storage tank. Chemical injection and storage areas will have local containment designs without means for drains to external sumps, however these will include a sump area. Spill containment at the chemical unloading areas will be provided to contain small spills at hose connection points.

Containment areas will be adequate for the particular fluids being contained, and provide retainage capacity for 110% of the maximum storage. The ammonia unloading area will be bermed.

A berm (for containment) will enclose the area comprising the CT auxiliary skid. The containment design will include a sump and drain line to the OWS Sump.

2.3.8 Loads and Load Combinations

2.3.8.1 Dead Loads

Dead loads will consist of the weight of all permanent construction including, but not limited to, fixed equipment, framing, piping, floors, walls, roofs, partitions, stairs, ductwork, cable tray, and any other structures, contents of tanks, bins, etc.

2.3.8.2 Live Load

Live load is the load superimposed by facility use. It does not include wind load, snow load, earthquake load, or dead load. The minimum live load design basis will be as follows:

- Platforms and walkways
  - Uniform Load, 60 pounds per square foot
  - Concentrated Load, 1,000 pounds on support beams
- Stairs
  - Uniform Load, 100 pounds per square foot
  - Concentrated Load, 1,000 pounds on support beams

- Equipment and piping (other than dead load)
- Supports for equipment and members to which supports are attached will, as a minimum, be designed for the following load cases:
  - Normal operating loads of equipment (excess over dead load)
  - Test loads of equipment and piping (excess over dead load).
  - Thermal force caused by thermal expansion of equipment and piping under all operating conditions.

2.3.8.3 Dynamic loads

These loads will be considered and applied in accordance with the manufacturer's specifications, criteria, or recommendations, and industry standards. Rotating parts will be considered as a vibrating mass.

2.3.8.4 Vehicle loads

Underground piping, conduits, trenches, sumps, and foundations accessible to truck traffic will be designed for HS-20-44 truck wheel loads per the AASHTO Standard Specification for Highway Bridges.

2.3.8.5 Seismic loads

All equipment will be designed to withstand the seismic loading requirement specified in the governing building code for the seismic zone defined in Section 1.

In addition, equipment anchorages and supports will be designed to prevent overturning, displacement and dislocation in accordance with governing building code requirements. Piping, cable tray and ductwork will be investigated to determine if stops or other restraints are required.

2.3.8.6 Wind Loads

Wind pressures and shape factors will be applied to all system components and exposed equipment in accordance with governing building code.

Allowances will not be made for the effect of shielding by other structures.

The overturning moment calculated from wind pressure will not exceed two thirds of the dead load resisting moment. The uplifting forces calculated from the wind pressure will not exceed two-thirds of the resisting dead loads and adequate structure-foundation ties will be designed to resist wind forces.

2.3.8.7 Other Loads

Other expected loads (water hammer, dynamic loads from operating equipment, system

modulation, etc.) required to predict the response of structures will be considered where appropriate.

Proper load combinations will be used for structural steel and reinforced concrete to comply with applicable codes and standards and with vendor requirements.

2.3.9 Structural Steel

Structural steel will conform to ASTM A 36, ASTM A 992, ASTM A 572 Grade 50, or other materials as required and accepted by AISC, and will be detailed and fabricated in accordance with the AISC Code of Standard Practice and the AISC Specification for Structural Steel Buildings.

High-strength bolts will conform to ASTM A 325 or ASTM A 490. Other bolts will conform to ASTM A 307, Grade A. All bolts will be resistant to rusting for a minimum of 30 years.

Nonheaded anchor bolts will conform to ASTM A 1554 Grade 36, unless higher strength bolting materials are required by design. Exterior exposed anchor bolts that are not high-grade fine thread will be hot dipped galvanized.

Welded structural members will meet the requirements of AWS D1.1.

All outdoor structural steel will be hot-dipped galvanized. Galvanizing will be in accordance with the requirements of ASTM A 123, ASTM A 153, and/or ASTM A 653. Galvanized nuts and bolts will conform to ASTM B 695**.**

2.3.10 Steel Grating and Steel Grating Stair Treads

The steel to be used for grating and grating treads will conform to either ASTM A 36 or ASTM A 570.

Stair treads will have non-slip abrasive nosings. The treads will have end plates for attaching to stringers.

Grating will be rectangular and consist of welded steel construction. Grating will be hot-dipped galvanized after fabrication in accordance with ASTM A 123. All grating ends and openings larger than 8” will be banded. Grating in the areas subject to chemical attack will be fiberglass for walking surfaces, and cast or ductile iron with epoxy coated imbeds for trench grating (i.e. ABT Trench Systems).

Floor or platform openings around the exhaust duct, pressure vessels, piping, and equipment necessitated by expansion and movement requirements will be protected in accordance with OSHA standards, as applicable. One such requirement is that the largest allowable gap will be four (4) inches between the floor or platform opening and the structure.

2.3.11 Stairs and Ladders

Stairs will be provided between varying elevations. Vertical ladders may only be used where personnel access is infrequent.

Safety cages and/or other devices will be provided for fixed ladders as required by applicable codes and regulations. At a minimum, ladders that may expose a person to a fall of greater than twenty (20) feet will have a cage.

Gates will be installed as fall protection to protect all ladder openings. The gates will fall into two categories: a single bar gate and a gate that is equal to a guardrail (i.e. top rail, mid rail and equal strength).

A single bar gate may be used:

For offset platforms between fixed ladders used only for passing through (not a work area).

Caged ladders to a pass through area.

A guardrail equivalent gate is required as follows:

- A work platform that is accessed by a fixed ladder without a cage must be guarded by a guardrail or gate equivalent to a guardrail system so offset that a person cannot walk directly into the opening.
- A work platform this is accessed by a floor opening ladder way must be protected on all sides except that a gate equivalent guardrail system may be used.
- An open sided work platform that is accessed by a caged fixed ladder on the side of the platform, where the ladder's cage is at least as high as the guardrail system protecting the work platform, must have a guardrail equivalent gate.

Stairs, ladders and safety cages will be hot dipped galvanized. Ladder rungs will be of a non-slip design.

2.3.12 Structural Concrete

Concrete will comply with ACI 301 and ASTM C94. Materials will be handled and stored as recommended in ACI 304. Mixes will be formulated to produce durable concrete of the required strength for the anticipated exposure conditions.

Admixtures may be added at the discretion of the Contractor with the consent of the Engineer, provided that qualifying mix designs are made accordingly.

Where concrete is to be placed by pumping, special consideration will be given to the concrete mix to provide workability, quality, and strength required for the pumping operation.

Calcium chloride or admixtures containing calcium chloride will not be used.

2.3.13 Reinforcing Steel

Concrete reinforcing will be deformed bars of intermediate grade, billet steel conforming to ASTM A 615, Grade 60. Welded wire fabric will conform to ASTM A 185.

2.3.14 Concrete Finishing

Permanently exposed vertical concrete surfaces will receive a "smooth form finish" meaning that all tie holes and surface defects will be patched and all fins exceeding 1/8" will be removed.

Horizontal surfaces will be finished as outlined in specification 03300, "Cast-in-Place Concrete.

Concrete surfaces, both vertical and horizontal, that are to receive a protective coating (i.e. containment areas, and chemical treatment areas) will be finished in accordance with the applicable coating manufacturers recommendation.

2.4 Enclosures

2.4.1 General

Construction materials used in enclosures will meet the definition of noncombustible or limited combustible, except roof coverings which should be Class A in accordance with NFPA 256, Standard Methods of Fire Tests of Roof Coverings. Metal roof deck construction, where used, should be "Class 1" or "fire classified." Particular attention will be focused on sloping floors and adding drains around equipment to preclude any pooling of water.

Enclosure loads will take into consideration added dead load for items including but not limited to cable trays, pipe, and other items hung from the structure.

Two-hour fire barriers will be provided for the following enclosures:

- Power Distribution Centers (PDC)
- Fire Pump Enclosure (if supplied)
- Other as required by Code or local fire authority.

2.4.2 Power Distribution Centers (PDCs)

The electrical switchgear, MCCs, DCS remote I/O panels, metering, protective relaying, batteries and other miscellaneous equipment will be housed in single-story, insulated Power Distribution Centers (PDC). PDCs will be factory assembled. PDCs will have a

controlled environment, both heated and cooled. There will be minimum of (2) separate entries into each PDC. Consideration will be given in the PDC layout and construction to facilitate equipment maintenance and replacement

2.4.3 Site Buildings

The following buildings will be erected on the site:

- Water Treatment Building
- ZLD Building
- Administration/Warehouse Building
- Cooling Tower Chemical Feed Building
- Switchyard Control Building

Each building will be a "pre-engineered" building and will be erected on site. The buildings will conform to CBC2007 and ADA requirements. Each building will have dedicated HVAC, lighting and building services such as water and sewer connections as applicable.

The administration building will include office spaces, restroom and locker room facilities and kitchen facilities.

2.4.4 Fire Pumphouse Module (if supplied)

The fire pumphouse module, including a jockey pump and one electric fire water pump will be located adjacent to the fire/service water tank. Suitable access doors will be provided for maintenance of the pumps.

2.4.5 CEMS Enclosures

The CEMS enclosures will be single-story, insulated, pre-fabricated shop-assembled (modular) metal building supported on a reinforced concrete foundation. The enclosures will be located at ground level. The buildings will contain continuous emissions monitoring equipment and other miscellaneous electrical equipment such as lighting panels. The buildings will be provided with HVAC equipment to maintain proper temperature control for the electronic equipment. Door access will be provided for installation and maintenance of equipment.

2.4.5.1 Concrete Masonry

Hollow load bearing or nonload-bearing concrete masonry unit (CMU) partitions may be used as fire boundaries where required by code in accordance with the UL Fire Resistance Directory. CMU's will be either hollow, normal weight, nonload bearing Type I conforming to ASTM C 129, or load-bearing Grade N, Type I conforming to ASTM C 90.4. CMU's will be filled with mortar and will conform to ASTM C 270, Type M. CMU's will be reinforced as required to meet load capacity.

2.4.5.2 Pre-Formed Metal Siding

Exterior siding will be an insulated field-assembled siding system. Exterior face panels will be 24-gauge minimum; interior liner panels will be 24-gauge minimum standard sheets of galvanized steel. Exposed panel surfaces will have the manufacturer's standard baked-on finish.

The wall system will be designed to withstand the specified wind loading, with practical and equally spaced support girts.

Exterior panel surfaces exposed to weather will be oil coated with Hylar/Kynar 500 or equivalent finish. The interior surface of the exterior panels will be finished with the manufacturer's standard baked-on enamel finish.

The siding finish color will be selected from the manufacturer's standard colors.

Wall insulation will be noncombustible glass fiber or mineral wool to produce a minimum U-factor of 0.08 Btu/hr/ft^2/°F. Insulated metal panels will contain non-combustible insulation or listed as Class 1 or Class A per Factory Mutual Guide or UL listing.

2.4.5.3 Doors, Frames, and Hardware

Exterior personnel doors will be flush, hollow metal on pressed steel doorframes complete with windows, hinges, locksets, closers, weather-stripping, and accessory hardware. Fire doors and frames will conform to NFPA No. 80 for the class of door furnished.

2.5 Painting and Coatings

2.5.1 Equipment Painting

The painting and coatings will be applied by a contractor that is SSPC – QP1 qualified. The Contractor will perform coating or painting of all areas intended for coating or paint application as described below.

The following equipment and structures will be finish painted following installation except those that are indicated as shop finished below:

- Power island equipment; main and unit auxiliary transformers (shop finished)
- All field erected tanks (bolted tanks are shop finished)
- Uninsulated shop fabricated tanks (shop finished)
- Electrical cabinets and panels (shop finished)
- All carbon steel, such as valves, shop coated tanks, electrical junction boxes, etc.
- All uninsulated carbon steel pipes will be primed and final coated.
- Concrete secondary containment surfaces (including over curb edges)

Off the shelf components such as motor control centers, control boxes, motors, fans, valves, hangers, etc. will receive vendor's "Standard Shop Finish". The CTG's and STG will have compatible alkyd enamel finish over supplier standard primer after touch up in the field.

ITEMS NOT PAINTED OR COATED:

- Galvanized
- Aluminum
- Stainless Steel
- Special Alloys
- Machined Surfaces
- Surfaces to be insulated
- Resinous Materials
- Glass
- Ceramic
- Labels and Nameplates
- Interior Structural Steel

Structural and miscellaneous steel, including pipe supports located outdoors, will be hot dipped galvanized. Field touch-up will be performed after erection.

2.5.2 Coating System Applications

Acceptable Materials for Tank Lining and Exterior Coating (Field Applied Coatings)

Interior Lining
Demineralized Water and Reverse Osmosis Tanks (as applicable) will be lined with Plasite 7156 or equal.

Exterior Coating
The exterior of the tanks will be coated with a factory-applied system with an acrylic enamel finish.

Tanks that are lined or coated will have surface preparation and application in accordance with the instructions of the lining manufacturer. All linings will be free from holidays when tested with a low voltage (67.5 v) wet sponge holiday detector such as a Tinker-Rasor Model M-1 Holiday Detector. Lining will be selected based on the liquid that is stored with respect to the tank material. Minimum lining application will be a 2-coat process with a minimum of 4.0 mils lining per coat.

Scheme
Plant Equipment (uninsulated pipes, tanks, etc.) will be painted a non-reflective medium gray, with the exception that exposed fire system piping will be painted red and exposed natural gas and ammonia piping will be painted yellow.

2.5.3 Signage

Safety signs will be provided and installed throughout the facility in accordance with OSHA guidelines and general industrial practice. Identification for all exits and fire protection equipment will also be provided. Traffic marking and signs will be provided as necessary to assure proper traffic flow, control and safety. All requirements of the Fire Marshall having jurisdiction will be followed.

2.6 Testing

The services of an independent qualified materials testing laboratory will be engaged to sample, test and certify that the following construction work and materials are installed as specified:

- Earthwork materials and compaction
- Asphalt paving compaction
- Concrete slump
- Concrete strength
- Concrete air entrainment
- Grout strength.
- Masonry Grout & Mortar
- Structural Steel Installation

END OF SECTION