APPENDIX 2B

Design Criteria

1.0 DESIGN BASIS

The Project Technical Requirements provide specific criteria for the Lodi Energy Center Project. These criteria are minimum requirements.

1.1 Overall Facility Configuration

The project will be a 1 x 1 combined cycle facility consisting of one (1) combustion turbine generators (CTG), one (1) heat recovery steam generator (HRSG) equipped with duct burners, one (1) steam turbine generator (STG) with a multi-cell mechanical draft cooling tower, and associated auxiliary systems and equipment.

The CTG and STG will be located outdoors with water proof enclosures provided by the respective supplier(s).

The combustion turbine generator utilized will be General Electric 7F, Siemens or other acceptable technology.

The CTG and duct burners will be fueled by pipeline-quality natural gas only. Two, 100% natural gas compressors will be provided for pressure augmentation.

Power will be generated in the CTG and stepped up through a single three-winding generator step up transformer (GSUT) to the utility grid at 230 kV. A low side generator breaker will be supplied for each of the CT and ST generator. The generators will be synchronized via this low side generator breaker.

The CTG will be equipped with dry low-NOx (DLN) combustors and inlet air evaporative coolers.

The CTG will exhaust to Heat Recovery Steam generator (HRSG) which include anhydrous ammonia type SCR systems for NOx and CO control. Catalysts for both NOx and CO will be included in the HRSG system for the reduction of harmful air emissions at the stack. One (1) Continuous Emissions Monitoring (CEMs) systems will be provided.

The project will be designed as an outdoor plant with major equipment located outdoors. The following buildings are included.

- Water Treatment Building
- Warehouse Building
- Cooling Tower Chemical Feed Building
- Power Distribution Centers (PDC)

- (1) CEMS building

The plant will be designed for an expected reliability of 92-96 percent over a 30-year life.

Site layout and design, including underground utilities, will be done to accommodate future noise barrier walls along with their foundations, to be located at exhaust duct inlet transition, and all four sides of the gas compressor.

1.2 Operating Mode and Basic Philosophy

- Operational flexibility and high reliability are of paramount importance.

- The plant will be designed to run on a continuous basis between maximum plant output and the minimum load at which emissions guarantees are met which is typically 50% of a CTG output. In other words, to be emissions compliant, the CTG will be required to generate at least 50% of the machine capability to be emissions compliant.

- The CTG will be designed to achieve short duration starts, typically 40-60 minutes from initiation of starting sequence to full load.

- The plant will not be designed to generate electricity while isolated from the utility grid. The anticipated number of operating hours per year is about 6800 hrs

- The BOP equipment and systems will be designed to support the start up times listed above.

- The plant control system design will be based on a Distributed Control System (DCS) utilizing both discrete I/O as well as dedicated packaged equipment PLCs such as separate PLC's for gas compressors, CEMS, and air compressors.

- The CTG, STG, and other BOP equipment will be operated primarily from a work station in the main plant control room located in the administration building.

- The power block will be designed so that it can be started and operated at any load by a single operator.

1.3 Redundancy in Design

Standby components will be provided for key auxiliary components that would cause an electrical production shut down by their failure. The stand by component will be installed and kept in a ready status for immediate service.

Specific Minimum Redundancy Requirements for Equipment:

COMPONENT	NUMBER OF COMPONENTS REQUIRED
Steam Jet Air Ejectors	1x100% Hogger 2x100% Holding Trains
Ammonia Tanks	N/A
Ammonia Forwarding Pumps	1
Auxiliary Boiler and Feed Pump	1 x 100%
Boiler Feedwater Pumps	2 x 100% (based on non-duct fired performance)
Closed Cooling Water Pumps	2 x 100%
Closed Cooling Water Heat Exchangers	2 x 100%
Condensate Pumps	3 x 50%
Circulating Water Pumps	3 x 50%
Demineralized Water Pumps	3 x 50%
Dew Point Heater (if required)	1 x 100%
Primary Fuel Gas Scrubber/Filter-Separator/Drains Tank Skids	1 x 100%
Final Performance Heater/ KO Drum Skid (by OEM if required)	1 x 100% per CTG
Filter-Separator Skids (main and pilot filters) (by OEM)	2 x 50% (main)/CTG 2 x 50% (pilot)/CTG
Diesel Fire Pump	N/A
Electric Fire Pump	N/A
Jockey Fire Pump	N/A
Air Compressors/Dryers	2 x 100%
Service Water Pumps	3 x 50%
Oil/Water Separator	1 x 100%
Sump Pumps	1 x 100% Per Sump
CTG Lubricating Oil Pumps (AC)	2 x 100% (Part of OEM Package)

COMPONENT	NUMBER OF COMPONENTS REQUIRED
CTG Lubricating Oil Pump (DC)	1 x 100% (Part of OEM Package)
CTG Lube Oil Coolers	2 x 100% (Part of OEM Package)
Unit Auxiliary Transformers	2 x 100%
Battery Chargers	2 x 100%
Uninterruptible Power Supply	1 x 100%
Station Battery (CTG comes with its own)	1 x 100% (covers STG, DCS, BOP, etc.)

1.4 Site-Specific Design Conditions

Site Design Data

Location	Lodi, CA
Project Name	NCPA – Lodi Energy Center

Site Conditions

Max Dry Bulb, Deg F (50 yr Extreme; ASHRAE 2005)	112
Max Mean Coincident Wet Bulb	79.4
Min Dry Bulb, Deg F (50 yr Extreme, ASHRAE 2005)	17.5
Min Mean Coincident Wet Bulb, Deg F	16.5
Elevation (feet above mean sea level)	10

Precipitation

Annual Average, in	16.03
Maximum Monthly Average, in	3.21
Minimum Monthly Average, in	0.0
24 hr. Maximum, 100 Year Storm, in	3.7

Wind Loading

Design Code:	California Building Code (CBC-2007)
Basic Wind Speed (3-Sec Wind Gust Speed)	70
Occupancy Category (ASCE 7-05, Table 1-1)	3
Exposure Category	C
Importance Factor, I (ASCE 7-05, Table 6-1)	1.15

Seismic

Design Code	California Building Code (CBC-2007)
Seismic Zone	4
Occupancy Category (Table 1613.5 (1) and (2))	3

Site Class	C
Seismic Design Category (Table 1613.5 (1) and (2))	Seismic Design Category is assigned to each structure based on its Occupancy Category and the severity of the design earthquake ground motion at the site.
Spectral Response Acceleration S_{DS} (Table 1613.5 (1) and (2))	0.5
Response Modification Factor, R (ASCE 7-05, Table 13.6-1)	2.5
Seismic Importance Factor, I	1.25

1.5 Air Emission Limitations

The plant design is based on being able to meet the proposed emission limits for the CTG/SCR as provided in the Air Quality section of the Application for Certification.

1.6 Fuel Gas

Pipeline-quality natural gas will be provided by PG&E, with site-specific tie in points to be determined. The gas piping from the gas utility interconnection point to the generating equipment will be part of power plant design and construction scope.

1.7 Water Supply

1.7.1 Raw Water Supply

Raw water for each site will be “Title 22” water obtained from the City of Lodi White Slough Water Pollution Control Facility (WPCF) located adjacent to the power plant.

1.7.2 Plant Wastewater

Facility waste water streams from the water treatment, the oily water separator, evaporative cooler, HRSG drum blow downs make are transferred to the cooling tower. Cooling tower blow down is then injected into the injection well.

1.7.3 Stormwater Runoff

By design the storm water will be sent to the WPCF via various sump pumping stations through out the facility.

1.8 Noise Limits

Project far field noise levels will meet local ordinance requirements of 60 dBA at the property line of the facility. Equipment noise mitigation features will be accounted for in the plant design as required to meet LORS.

1.9 Subsurface Conditions

It is not expected that hazardous materials will be encountered during site excavation as the site has been primarily used for agriculture. Full subsurface conditions can be found in the Site Geotechnical Report.

1.10 Electrical / Communication Interconnection

1.10.1 Permanent Electric Power Export and Backfeed

The facility will be connected to the electric utility system through high voltage (HV), circuit breakers and disconnect switches located adjacent to the associated GSUT. During facility startup and shutdown, the power required for the facility electrical auxiliary systems will be backfed from the utility system through the GSUT.

1.10.2 Stand-by Electric Power

Stand-by electric power of will be provided from the neighboring STIG plant via a 12kV interconnect.

1.10.3 Communications

Telephone and communication links between the facility and utility, the fuel supplier, and other outside parties will be provided by Owner. Appropriate interface will be provided in the final Plant Design.

1.11 Codes, Standards, and Specifications

The building code for the project location is the 2007 version of the California Building Code (CBC).

The following codes, standards, and specifications of U.S. organizations will be consulted to establish a basis for quality and safety in facility design and operation. Systems and equipment will be designed in accordance with the latest edition and addenda in effect at the date of contract execution, unless noted otherwise.

AASHTO	American Association of State Highway and Transportation Official
AFBMA	Anti-Friction Bearing Manufacturers Association
ACI	American Concrete Institute
AMCA	Air Moving and Conditioning Association
AGMA	American Gear Manufacturers Association
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
API	American Petroleum Institute (Applicable sections will be referenced)
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
CBC	California Building Code
CMAA	Crane Manufacturers Association of America
CTI	Cooling Technology Institute
EJMA	Expansion Joint Manufacturing Association
FM	Factory Mutual (Applicable sections will be referenced)
HEI	Heat Exchange Institute
HIS	Hydraulic Institute Standards
IBC	International Building Code
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society of North America
IFC	International Fire Code
ISA	Instrument Society of America
ISO	International Standards Organization
LPC	Lightning Protection Code
MBMA	Metal Building Manufacturers Association
MSS	Manufacturers Standardization Society of Valves and Fittings Industry
NACE	National Association of Corrosion Engineers
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
PFI	Pipe Fabrication Institute

RMA	Rubber Manufacturers Association
SDI	Steel Deck Institute Standards
SJI	Steel Joist Institute Standards
SMACCNA	Steel Metal & Air Conditioning Contractor National Association
SSPC	Society for Protective Coatings
TEMA	Tubular Exchanger Manufacturers Association
TIMA	Thermal Insulation Manufacturers Association
UL	Underwriters Laboratories
UMC	Uniform Mechanical Code
UPC	Uniform Plumbing Code

Design specifications and construction of the Project will also be in accordance with all applicable local, state, and federal laws, including but not limited to those set forth below.

- Comprehensive Environmental Response, Compensation, and Liability Act of 1980
- Clean Air Act and Amendments
- Environmental Protection Agency Regulations
- Federal Aviation Administration Regulations
- Federal Energy Regulatory Commission Regulations
- Federal Power Act
- Noise Control Act of 1972
- Occupational Safety and Health Act
- Occupational Safety and Health Standards
- Resource Conservation and Recovery Act (RCRA)
- Safe Drinking Water Act
- Solid Waste Disposal Act
- Superfund Amendments and Reauthorization Act of 1988
- Toxic Substances Control Act
- Bay Area Air Quality Management District
- California State Water Resources Board

In the event conflicts arise between the codes, standards of practice, specifications or manufacturer recommendations described herein and codes, laws, rules, decrees, regulations, standards, etc., of the locality where the equipment is to be installed, the more stringent code will apply

1.12 Banned Materials

No materials or products containing the following materials are allowed in the project:

- Asbestos
- PCB's
- Hexavalent Chrome
- Mercury (liquid) (Exception: A limited number of mercury tube level switches may be supplied)

END OF SECTION

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 one (1) CTG, one (1) HRSG, an STG, cooling tower, water treatment buildings, transformers, high voltage equipment, BOP equipment, power distribution centers, water treatment area, miscellaneous enclosures, utility racks, and access platforms.

The CTG 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 Design Mitigation Plan 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. 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.

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 structure and related equipment will be supported on reinforced concrete mat foundations. The detailed foundation 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 by the final Geotechnical Report, precast concrete piles or other equally suitable pile design will be utilized.

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 above final grade. However, the actual berm depth will be determined during detailed design. 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 truck unloading area is bermed to contain any spills that may occur during filling of the ammonia tank.

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 Oil/Water separator.

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 rating of the project site.

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 required by the service area, e.g. some horizontal surfaces will be bull floated, others will be floated and then roughened to provide for a non-slip surface.

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
- Warehouse Building
- Cooling Tower Chemical Feed 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 to closely match the existing STIG plant 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 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

3.0 MECHANICAL DESIGN CRITERIA

This section describes the primary mechanical equipment and systems, their functions, and the criteria upon which their design will be based for the Lodi Energy Center.

Codes and Standards
The design of the mechanical systems and components will be in accordance with the laws and regulations of the federal government, state of California, San Joaquin County ordinances, and industry standards. The current issue or revision of the documents at the time of the filing of this Application for Certification (AFC) will apply, unless otherwise noted. If there are conflicts between the cited documents, the more conservative requirements shall apply.

The following codes and standards are applicable to the mechanical aspects of the power facility.
• California Building Standards Code, 2001
• American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code
• ASME/ANSI B31.1 Power Piping Code
• ASME Performance Test Codes
• ASME Standard TDP-1
• American National Standards Institute (ANSI) B16.5, B16.34, and B133.8
• American Boiler Manufacturers Association (ABMA)
• American Gear Manufacturers Association (AGMA)
• Air Moving and Conditioning Association (AMCA)
• American Society for Testing and Materials (ASTM)
• American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)
• American Welding Society (AWS)
• Cooling Tower Institute (CTI)
• Heat Exchange Institute (HEI)
• Manufacturing Standardization Society (MSS) of the Valve and Fitting Industry
• National Fire Protection Association (NFPA)
• Hydraulic Institute Standards (HIS)
• Tubular Exchanger Manufacturer's Association (TEMA)

3.1 Combustion Turbine Generator (CTG)

The CTG will be supplied with a metal acoustical enclosure suitable for outdoor installation. The CTG's will use Dry Low NOx combustors to control exhaust gas NOx. The CTG's will also have evaporative coolers installed for performance enhancement capabilities.

The CTG generator will be either totally enclosed, water to air (TEWAC) cooled or hydrogen cooled, direct-drive, 2-pole, 60 Hz synchronous machine.

Mechanical auxiliary systems for the CTG, which are to be supplied as part of the CTG supplier scope, will be as follows:

- Lubricating and hydraulic oil system
- Oil-to-Water lube oil coolers
- Fuel gas system, including fuel gas metering valve
- Inlet air filtration (static filters) system
- Fire protection and detection system for the CTG
- Turbine compartment vent fans
- Generator compartment vent fans
- Lube oil filtration system
- Online/offline water wash system
- Starting Systems

CTG inlet air conditioning will be accomplished via an evaporative cooling system. The inlet cooling system will be provided by the OEM. The inlet cooling system will be designed to achieve a compressor inlet temperature that is within 2 deg F of the wet bulb temperature. The inlet cooling system will be complete with pumps, nozzles, interconnecting piping, valves, controls, and other equipment necessary to function across typical load and ambient range.

Equipment will be designed for outdoor installation in ambient conditions.

3.2 Steam Turbine Generator (STG)

The STG will be supplied with a metal acoustical enclosure suitable for outdoor installation.

The generator will be either totally enclosed, water to air (TEWAC) cooled or a hydrogen cooled, direct-drive, 2-pole, 60 Hz synchronous machine.

Mechanical auxiliary systems for the STG, which are to be supplied as part of the STG supplier scope, will be as follows:

- Lubricating and hydraulic oil system
- Oil-to-Water lube oil coolers
- Fire protection and detection system for the STG
- Starter System (Starting Motor and fluid drive for STG)
- Turbine compartment vent fans
- Generator compartment vent fans
- Lube oil filtration system

Equipment will be designed for outdoor installation.

3.3 Heat Recovery Steam Generators (HRSG's)

3.3.1 HRSG Description

The HRSG will be duct fired, three-pressure, reheat, natural circulation, drum type with horizontal gas flow, complete with manual main steam isolation valves, feedwater stop and check valves, relief valves, and a continuous and intermittent blowdown system. The high pressure (HP), intermediate pressure (IP), and low pressure LP sections will each consist of an economizer, evaporator, and superheater section. The reheat section will heat IP steam and exhaust steam from the HP section of the steam turbine for admission into the IP/LP turbine. The HRSGs will be designed and constructed to operate within the maximum exhaust gas flow and temperature ranges of the CTGs. The HRSGs will be designed for outdoor installation, with full enclosures over the drum areas.

The HRSG will be fabricated, assembled, inspected and tested in accordance with Section 1 (Power Boilers) of the ASME Boiler and Pressure Vessel Code. The HRSG external piping will be furnished, installed and tested in accordance with the requirements of ASME B31.1 (Power Piping) and Section 1 of the ASME, Boiler and Pressure Vessel Code.

The HRSG drums and internals will be sized for required steam separation at the predicted HRSG performance conditions for the minimum HRSG drum pressure. In addition, the steam drums will be designed to accommodate surges associated with startup, shutdown and rapid load changes.

Blowdown from each HRSG will be piped to its respective blowdown tank. Quench water to cool blowdown before discharge will be supplied from the raw water system. Rate of quench water flow will be automatically adjusted in accordance with blowdown temperature. The boiler blowdown tank will be located in the boiler blowdown sump.

All topside drains will be routed to grade. The bottom drains will terminate on the side of the HRSG and the valves will be accessible at grade. The drains will be headered together and the header drained into the boiler blowdown sump. Quench water will be provided to the sump from the raw water system. The nitrogen purge connections, one per drum, will terminate at the valve located within three feet of grade. In the event that long-term lay-up is required, plant operations will have to provide a nitrogen trailer with the required connectors, hoses and regulators.

The HRSG reheater section will be designed for "wet" operation during startup and in case of a steam turbine trip.

Each HRSG scope of supply will include an A36 structural carbon steel stack with

motorized stack dampers. The internal bottom portion of the breeching and stack (field welds and up ten (10) feet) will be coated and insulated with a "stalastic-type" material (such as Intertherm 228). Externally, the HRSG shall be insulated from the last tube row through the breeching up to the stack damper elevation. In addition, each HRSG scope of supply will include the necessary emissions control equipment (i.e., SCRs and/or CO catalysts) as specified in Section 1.

The gas path will be insulated with ceramic fiber blanket to provide a skin temperature of not more than 140°F, and lined with stainless steel (ASTM A-312 grade 309 where temperatures exceed 800°F).

Man-ways will be provided for access to each section of the HRSG between modules. The manways will be provided with a davit, or will be hinged. The size of the opening will be suitable for maintenance expected in that section, and in no case be less than 24 X 18 inches.

Operating areas of the HRSG will be provided with platforms. Exterior platforms, ladders, rails, and structural steel will be hot dip galvanized. Handrails will be fabricated from 1 ½ - inch diameter steel pipe. Penetrations through platform decking 6 inches or greater in diameter will be finished with plate material.

The vent valves, safety relief valves, silencers, and supporting steel frames will be provided by the HRSG supplier. All vent lines will be extended to a safe location (pointing away from any platforms).

Heat tracing and adequate draining of the HRSG in cold weather will be used to prevent freeze-up of the internal piping of the HRSG. Drain lines will be provided after the double block valves, as well as impulse lines from root valves up to and including transmitter blow-offs, and HP, IP, and LP Drum Level control valves. Drain line connections will also be provided on the vent side of the startup vent valve, power relief valve and safety valves. If silencers are provided with drains, the drain will be piped to a drain manifold.

Each HRSG will be provided with sparging steam connections on all three drums at the lower downcomer connection, and additionally, a drum warming connection on the HP drum saturated steam lines.

3.3.2 Stack

The stack will be provided with emission sampling ports in accordance with EPA, State, and local regulatory requirements. A platform located at the sampling port elevation will be provided with ladder access, either from grade or from an adjacent HRSG platform. An expanded metal standoff shield will be provided by HRSG supplier to prevent human contact with 140°F or hotter surfaces, unless external insulation is being utilized with a stack damper as described in 3.2.1 above. A davit will be provided by the

HRSG supplier. An electric hoist and weatherproof 120 and 208-volt single-phase electrical outlets for powering tools and test equipment at the source test platform are to be provided. Aircraft warning lights will not be provided, in accordance with the FAA or the authority that has jurisdiction in the location of the site. Lightning protection will not be required.

3.3.3 Selective Catalytic Reduction System

SCR system will be provided with catalyst modules designed to facilitate eventual replacement. The system will include a monorail and a hoist for loading & removing SCR catalyst blocks.

Engineer will ascertain local process safety and site permitting requirements.

The HRSG scope of supply will include:

1 Each	Ammonia Injection Skid
1 Each	Ammonia Dilution Vessel
1 Each	Injection Grid
1 Lot	SCR Catalyst
2 Each	Blowers

The existing 12,000 gallon anhydrous ammonia tank will provide at least 9.45 days of supply for normal 1x1 fuel gas operation.

The system will also include ammonia piping to the ammonia injection skid.

HRSG local instrumentation will be provided by HRSG supplier. All transmitters & measurement elements, including flow measurement devices will be furnished and located at a reasonable distance from the measured location.

3.4 Auxiliary Boiler

The auxiliary boiler is to be designed, constructed, and installed in strict accordance with ASME Code Section I, and stamped and registered with the national board.

The auxiliary boiler will be used to maintain the HRSG and STG in a “hot standby” mode at all times, under all operating conditions. This will allow short startup times and will allow the plant to achieve emissions compliance in a much shorter time than if no auxiliary boiler was utilized.

3.5 Fire Protection System

3.5.1 General

NFPA 850 and the applicable fire code will provide the general guidance for the fire protection considerations of the facility. A Fire Mitigation Design Plan will be prepared to detail the site-specific fire protection features of the facility.

The fire prevention and protection design for the facility will be reviewed and must receive approval from the local Fire Marshal and Owner's insurance representative.

Automatic and manual fire protection systems employing detection and extinguishing equipment will be provided at all locations having potential fire hazard due to the presence of combustible materials or where major property damage could result. Yard hydrants and portable extinguishers will provide additional incipient fire extinguishing capability and overall protection throughout the plant site.

The fire protection water supply will be taken from an onsite fire/raw water storage tank and distributed to the site fire protection system via a new underground firewater loop with necessary hydrants. The fire loop will be pressurized by an electric motor driven fire pump with a diesel driven fire pump as a backup. Hose houses will not be installed around the yard since plant-operating personnel will only be trained to extinguish incipient fires and local fire department personnel will only use their own hose.

3.5.2 Fire Protection System

It is expected that the new plant fire protection system will be physically tied into the existing plant's underground firewater piping loop. The advantage to this design is obvious in that the entire site can take advantage of a single set (existing) of fire pumps.

As a minimum, the fire protection system will include:

Area of Building	**Standard**	**Detail**
Fire Extinguishers Site Wide	NFPA 10	Use Dry Chemical only if it is best option Wheeled 33 gallon AFFF and 50 pound dry chemical extinguishers in the fuel oil pump, storage, and heating areas.
Fire Hose & Standpipe	NFPA 14	Provide for the Warehouse

Fire Water Supply / Distribution Tank Fire Pumps/Controllers Underground piping/loop	 NFPA 22 NFPA 20 NFPA 24	A tank level monitor will be provided at ground level. An approved flow meter and piping to the firewater tank will be provided to test each fire pump. Emergency fire department water supply connections should be provided by installing a suction connection at the tank, and a fire hose pumper connection downstream of the fire pump discharge valves. Sectional control valves should be provided so that no more than five hydrants or individual suppression systems would be out of service in the event of a main break.
Fire Hydrants	NFPA 24	Hydrants will be spaced <=300 ft apart

Steam Turbine Generator		
STG Bearings	NFPA 13	Pre-action System w/ Rate-of-Rise for Steam Turbine and Generator Bearings
Lube Oil Reservoir and Piping	NFPA 13	Water Spray System w/ dry pilot actuation system
Hydrogen Seal Oil Unit	NFPA 13	Water Spray System w/ dry pilot actuation system
Enclosed "Under Tabletop" Area	NFPA 13	Water Spray System w/ dry pilot actuation system to protect the "under belly" of the steam turbo-generator and other plant equipment enclosed in the "STG building", beneath the STG tabletop
STG Enclosure "Above Tabletop"	NFPA 13	Water Spray System w/ dry pilot actuation system
Main Steam Stop Valve	N/A	Fyrquel or approved fire resistant hydraulic oil
Combustion Turbine Generator		
Turbine Enclosure	NFPA 850	Provided by OEM
Exhaust Bearing Tunnel	NFPA 17	Provided by OEM
Support buildings/structures	NFPA 2001	Provided by OEM
Mechanical package	NFPA 850	Provided by OEM
Electrical package	NFPA 850	Provided by OEM
HRSG	NFPA 8506	Provided by OEM

Transformers Generator Step-Up Auxiliary Other Transformers	 NFPA 15 NFPA 15	 Water Spray System w/ dry pilot actuation system for each transformer Water Spray System w/ dry pilot actuation system for each transformer Protection based on oil volume and location
PDC's	NFPA 72	Smoke detection throughout
Water Treatment Building **Electrical Room**	NFPA 13 NFPA 72	Wet pipe sprinkler (only if justified by combustible loading; generally not required) Smoke detectors
Boiler Feed pump	NFPA 13	Wet pipe sprinkler system
Chemical Skids	NFPA 13	Sprinkler system (if required by combustible loading; generally not required)
Cooling Tower Water Treatment Bldg.	N/a	N/a
Other Hazards Fuel Yard Area Cooling Tower Fan Deck	 NFPA 24& 54 NFPA 850	 Monitor Nozzle(s) mounted on hydrant(s) Monitor Nozzle(s) mounted on hydrant(s) with a water spray/fogging system with ammonia detectors Monitor Nozzle(s) mounted on hydrant(s)

3.5.3 Additional Fire Protection Features

Additional features of fire protection/detection include:

- One central fire detection control panel to monitor status of zones, with visual indications, audible alarm, and test provisions; and/or a remotely located fire detection control panel in a location where there is 24/7 manned coverage
- Area fire/smoke detectors where required for automatic suppression systems
- Fire alarm horns (audible throughout the site)

- Manual pull stations
- Interconnecting cabling
- Natural gas and ammonia leak detection

3.6 Compressed Air System

The compressed air system will be designed to supply service and instrument air for the facility. Dry, oil-free instrument air will be provided for pneumatic operators and devices throughout the plant. Compressed service air will be provided to appropriate areas of the plant as utility stations.

The instrument air system will be given demand priority over the service air system. A pressure control valve will be set at approximately 85 psi to cut off the air supply to the service air header once the system pressure falls below that set point

Two (2), 100 percent capacity packaged air-cooled air compressors will supply compressed air to the service and instrument air systems. The control system will be designed to allow either air compressor to become the "lead" and will provide instrument air system pressure indication and a low-pressure alarm. The instrument air system will include two parallel duplex instrument air dryers, a compressed air storage receiver, stainless steel piping, valves, instrumentation and controls.

3.6.1 Instrument/Service Air Requirements

The total instrument air flow capacity is based on the total quantity of air users, capacity of each air user, an average load factor of 25 percent, plus an additional 50 percent margin to account for air leakage. All instrument air will pass through the air dryers. Instrument air will be dried to a dew point of -40 degrees F.

3.6.2 Service Air Requirements

Utility hose stations will be located as necessary throughout the plant to allow all equipment to be accessed via air hose. Each hose station will have with a ball valve, an anti whip valve and a quick disconnect coupling.

3.6.3 Emergency Air Compressor Connection

An emergency air compressor connection consisting will be located in the air header ahead of the compressor discharge air receiver and in a location reachable by a portable air compressor air hose. This connector will be sized for at least the same flow rate as one of the plant air compressors. An oil trap will be supplied at the emergency connection to prevent oil from the emergency air compressor entering the instrument air system.

3.7 Compressed Gas Systems

All compressed gas tanks/cylinders and pressure regulators required to operate and maintain the facility will be provided. All interconnecting piping, valves, instrumentation and controls will be part of design.

3.7.1 Carbon Dioxide

A carbon dioxide system will be provided for fire protection at the CTG and STG.

3.8 Heating, Ventilating, and Air-Conditioning System

The design basis for sizing the system will be as follows:

Design Basis		
Area	Summer	Winter
Control Room, Electronics Room, and Office and Lab Areas	75°F, 50% R.H.	70°F
Battery Room	80°F, 50% R.H.	75°F
CEM Bldgs	80°F, 50% R.H.	60°F
Electrical and Control Equipment Rooms,	80°F, 50% R.H.	50°F
All other Areas (incl. Turbine building)	100°F (Ventilated)	50°F

The HVAC system will consist of building heating, building ventilation for fresh air makeup and cooling, and air-conditioning as required and will include:

Two 100-percent-capacity HVAC systems for the control and electronics rooms and one 100-percent-capacity HVAC system for the balance of the administration building, with miscellaneous piping, ductwork, insulation, dampers, louvers, and controls for an efficient and operable system. Systems will not take suction from areas where fumes might be present (e.g., maintenance shop area) to prevent introduction of irritants and gases such as CO, into administration areas.

- One 100-percent-capacity HVAC unit for the water treatment lab (may be part of other adjacent systems if not remotely located).
- Separate redundant exhaust fans for battery room.
- One 100-percent-capacity HVAC unit for the electrical switchgear room, control equipment room, and battery room sections of the water treatment building.
- Ventilation fans and electric or gas radiant heaters for maintenance, warehouse, and water treatment areas.

- Ventilation fans and electric unit heaters for boiler feed pump enclosures (when such enclosures are specified in Section 1).
- Multiple HVAC units per PDC (supplied as part of the package)
- Ventilation fans and unit gas heaters for the turbine building and auxiliary boiler building as required

For indoor areas not normally occupied, the heating system will be capable of maintaining a nominal indoor temperature of 50°F at the HVAC design outdoor conditions. Heating design will be based on the plant being shut down with no solar warming.

HVAC systems serving the control room, maintenance shop offices, lab areas, and administration areas will be designed to provide comfort levels for extended human occupancy. HVAC for other areas will be designed in consideration of equipment and environmental requirements, including dust control. Air velocities in ducts and from louvers and grills will be low enough to prevent unacceptable noise levels in areas where personnel are normally located.

Air-conditioning will include both heating and cooling of the filtered inlet air. Air filters will be housed in a manner that facilitates removal. The filter frames will pass the air being handled through the filter without leakage. Ductwork, filter frames, and fan casings will be constructed of galvanized mild steel sheets stiffened with galvanized mild steel flanges. Ductwork will be furnished and installed per UMC 1997. Duct joints will be leak tight. Grills and louvers will be of adjustable metal construction.

Fans and motors will be mounted on antivibration bases to isolate the units from the building structure. Exposed fan outlets and inlets will be fitted with guards. Wire guards will be specified for belt-driven fans and arranged to enclose the pulleys and belts.

Modules will be ground mounted (for ease of maintenance) in locations where they are least likely to be damaged, cause inconvenient obstruction, or be exposed to gasses or odors.

HVAC systems will meet requirements of NFPA 90A, standard for installation of air conditioning and ventilating systems. An air balance will be part of the scope.

3.9 Fuel System

3.9.1 Fuel Gas

The fuel gas system treats and delivers fuel gas to equipment at the desired conditions. The scope of the fuel gas system extends from the interface with the utility natural gas connection at the plant property boundary to the gas interfaces for the CTG. The fuel gas system will be designed to accommodate the reciprocating gas compressors and fuel

gas requirements of the CTG.

The fuel gas supply system includes 2 x 100% fuel gas compressor packages which will control gas pressure and temperature to CTG manufacturer requirements. Each compressor is sized to provide the natural gas needed for one CTG unit. The compressor package includes inlet-side scrubber(s) to remove coarse sludge from the incoming gas, discharge coalescing filter(s), and discharge cooler(s). The inlet scrubber and discharge coalescing filters will be located on either the gas compressor package skid or on a separate skid. The discharge cooler will be a separate skid package. The compressor package will include a recycle system to control discharge pressure across all CTG operating conditions.

A regulating station will reduce the utility supply gas pressure to match design conditions at the inlet of the gas compressor. The design will include the capability to increase the setpoint of the regulating station and manually adjust the volume pockets of the gas compressor in order to minimize electric power consumption of the compressor.

The fuel gas system will have provision to bypass the gas compressor for unusual situations where the gas compressor is unavailable and utility line pressure is sufficient to run the CTG. In such bypass situations, the fuel gas must flow through the inlet scrubber and discharge coalescing filter in the gas compressor area.

A duplex filter/coalescer will be located downstream of the gas compressor equipment near the CTG unit. Carbon steel interconnecting piping will be provided from the gas compressor area to the final filter/coalescer. All piping after the final filter/coalescer will be stainless steel. Condensate and other waste drained from the filter/coalescer will be routed to the waste water collection system.

3.10 Lubricating Oil Systems

Lubricating oil systems will be provided with the CTG and STG including all lubricating oil pressure and drain piping, as well as all valves, devices, and controls needed for an operable system. Lube oil pipe will be stainless steel. The CTG and STG lube oil is cooled by an oil to water heat exchanger.

3.11 Cranes/Monorails

Equipment will be arranged to allow maintenance to be performed via mobile crane access to the CTG, STG, and other major equipment. The CTG and STG will include a monorail lifting beam and hoist for turbine removal.

3.12 Pumps

3.12.1 General Service Pumps (200 HP and Smaller)

Pumps will be sized for maximum efficiency at the normal operating point. Pumps will be free from excessive vibration throughout their operating range.

Pumps will operate satisfactorily at various flow rates up to maximum pump output. Pump motors will be sized so the selected pump impeller will not overload the motor at any point on the pump head-capacity curve. Wear rings will be provided as appropriate.

Vent and drain valves will be fitted at high and low points on the pump casing. Pumps rated 25 hp and above typically have a recirculation line for protection. The recirculation line will normally be routed to the source from which the system takes suction. Restriction orifices will be used as appropriate.

Horizontal split-case pumps will allow the removable casing half and impeller to be withdrawn without disturbing any of the process piping or valves. Horizontal end-suction pumps will allow the impeller to be withdrawn without disturbing the motor or discharge piping.

Pumps will have expansion joints between the inlet and outlet side and piping connected to them as required by good engineering practice.
Strainers (startup or permanent) will be installed in the suction piping of horizontal pumps or sets of pumps. The driver will be mounted on an extension of the pump bedplate and will drive the pump through a flexible coupling.

Vertical shaft pumps will be designed to Hydraulic Institute standards and will generally be arranged to work with the pump casing submerged in a sump or tank. The suction branch will be arranged vertically downward and, if required for the service conditions, will be fitted with a strainer. When pumping fresh water or condensate, bearings situated below water level will be water lubricated. Discharge piping and non-return valves will be arranged to facilitate withdrawing the complete shaft and pump casing as a unit by splitting a pipe joint above floor level.

Pumps will have mechanical seals (25,000-hr life if available), if appropriate for the application. In general, major pumps will be specified to have mechanical seals. Pumps with mechanical seals will be arranged to facilitate seal removal. Shaft slingers will be specified to prevent packing gland leakage water from entering bearing housings.

Bearings requiring cooling water will include the necessary pipe work, valves, and strainers.

Couplings and any intermediate shafting will be provided with OSHA approved guards. Bedplates will be of ample proportions and stiffness to withstand the loads likely to be experienced in shipment and service.

3.12.2 Boiler Feed Pumps

Boiler feedwater pumps will provide feedwater consistent with the HRSG design conditions as stipulated in ASME, Section I, Power Boilers, paragraph PG-61. Where there is an intermediate pressure level in the steam generator, and the flow rate of the intermediate level is less than approximately a third of the high-pressure section, the boiler feedwater pump will include an interstage bleed. The interstage bleed will allow a single pump to feed the high pressure as well as the intermediate pressure levels of the HRSG. Where the flow rate of the intermediate level is more than a third of the high-pressure level, separate boiler feed pumps will be provided for the required pressure levels of the HRSG.

An interstage bleed type of pump will be provided with one recirculation valve installed on the high-pressure section. Minimum flow measurement will be taken from the high-pressure feedwater flow element. Recirculation flow will be directed to the low-pressure drum. No recirculation valve is required from the bleed section of a pump.

The boiler feedwater pump will be equipped with a "T-type" suction strainer (with at least 4 x pipe area) consisting of a 120 mesh enclosed by a permanent 80 mesh strainer. Each boiler feedwater pump will be provided with its own, closed lubrication system. Pump start up will require lubrication system start up before the pump is allowed to start. Pump shaft seals will be mechanical, designed for the proper temperature.

Vibration Probes - Vibration probes will be Bently Nevada Series 3300XL proximity probes.

Vibration Monitoring System - A separately mounted vibration monitor system will be provided to monitor the boiler feed pump and motor probes. Vibration monitors will be Bently Nevada Series 3500 and one vibration monitor will be provided for each set of two motor/pump sets.

DCS Alarm and Tripping - 4-20mA signals from the 3500/42M proximitor monitors for each boiler feed pump will be wired to the balance of plant DCS system for indication, alarming, and tripping.

Each HRSG will have two 100% boiler feed (very high flow operating cases will require dual pump operation).). The boiler feed pumps will be electrically driven, multistage, centrifugal pumps with the following:

- Heavy-duty baseplate for all components and accessories.
- Sleeve bearings and Kingsbury-type thrust bearings with forced oil lubrication.
- 400 series stainless steel shafts and chromoly cases (API 610 Table H-1 C-6).
- The pump system will include the following instrumentation:
  - Discharge Pressure
  - Discharge Temperature
  - Bearing Temperature

- Suction Pressure
- Suction Temperature
- Suction strainer differential pressure (transmitter plus local indication)
- Low NPSH alarm
- Vibration Detection

3.12.3 Condensate Pumps

Condensate pumps will be multistage, vertical, open shaft, canned type pumps with the suction nozzle in the discharge head (T-type head). The condensate pump will be selected specifically for low NPSH service. Pump sizing will assume the available suction pressure at the pump suction nozzle centerline is zero. The condensate pump will be equipped with a suction strainer. Loss through the suction strainer will be accounted for in setting the height of the surface condenser relative to the pump suction nozzle centerline. Condensate pumps will be provided with minimum flow recirculation lines satisfying the pump manufacturer's minimum flow requirements and with consideration for the gland steam condenser and air ejector minimum flow requirements. The pumps will be suitable for parallel operation over their full performance curve. Wetted parts of the pump will be stainless steel.

3.12.4 Circulating Water Pumps

The circulating water pumps will be single stage, vertical, open shaft pumps with single suction impeller design in accordance with HI Standards. Head vs. capacity curves will rise continuously toward shut off head without reversing slope. An auxiliary source of water will be provided for pump shaft bearing lubrication when pumps operate in conditions where line bearings may be dry on start up, or when quality of the pumped water may cause damage to bearings. All wear rings will be fully renewable

Each pump will be provided with a motor operated discharge valve.

Each motor will be provided with a reverse rotation lock device to ensure the motor and pump do not reverse-rotate and cause damage. All wetted components will be suitable for worst-case water quality.

3.12.5 Fire Water Pumps

It is not expected that additional fire pumps will be required beyond what is already installed at the existing plant. However, if new pumps are deemed necessary, a modularized system containing one each FM (Factory Mutual) approved pump of the following types will be provided for the plant fire suppression system. Fire water pumps will be tested in accordance with NFPA requirements.

- Electric Fire Water Pump

- Diesel Fire Water Pump
- Jockey Fire Water Pump

3.12.6 Positive Displacement Pumps

Rotary positive displacement pumps will be either gear or screw type. All rotary positive displacement pumps will be provided with an exterior relief valve to protect the pump and piping upstream from an inadvertently isolated discharge valve.

3.13 Storage Tanks

Large outdoor storage tanks will be freeze protected as required through the use of insulation and heaters and nozzle insulation and heat tracing.

Overflow connections and drop downs to grade lines will be provided. Maintenance drain connections will be provided for complete tank drainage.

Manholes, where provided, will be at least 24 inches in diameter and hinged to facilitate removal. Storage tanks will have ladders and cleanout doors as required to facilitate access/maintenance. Provisions will be included for proper tank ventilation during internal maintenance. Ladders and platforms will be galvanized and designed in accordance with API and OSHA standards.

Local level indication will be provided with level transmitters for monitoring in the control room and a float system for local monitoring.

Bolted tanks will utilize encapsulated nuts for interior bottom seams and polycapped bolts in sidewalls and deck vapor areas.

Tanks will be designed using the following criteria:

Tank	Quantity	Description	Size in Gallons (see note)
Fire/Raw Water Storage	1	Carbon Steel Bolted Fab & Erect AWWA D103-97/NFPA 22 with factory applied exterior and interior coating	TBD
Demineralized Water Storage	1	Carbon Steel Bolted Fab & Erect AWWA D103-97 with factory applied exterior and interior coating	200,000
Water Wash Drain Tank	1	Horizontal, Cylindrical Double Wall Tank, Fiberglass	5,000
Gas Turbine Drains Tank	1	Horizontal, Cylindrical Double Wall Tank, Fiberglass, Integral with Water Wash Drain Tank	500 To be integral with water wash drain tank (divided)

Tank	Quantity	Description	Size in Gallons (see note)
Closed Cooling Water Head Tank	1	Horizontal, Cylindrical Carbon Steel	1,000
Oil/Water Separator	1	Double Wall Carbon Steel	500
Service Water Tank	1	Carbon steel	15,000

3.14 Pressure Vessels

Pressure vessels will be ASME stamped and will include, at minimum, the following features/appurtenances:

Vessel	Quantity	Description	Capacity Gallons
Blowdown Tanks	1	Vertical, Carbon Steel per ASME Section VIII with Stainless Steel Wear Plate	4,000
Compressed Air Receiver	1	Vertical, Carbon Steel per ASME Section VIII	500
Steam Turbine Drain Tank	1	Vertical, Carbon Steel, ASME Section VIII with Stainless Steel Wear Plate	1,000

Pressure vessels will be ASME stamped and will include, at minimum, the following features/appurtenances:

- Process, vent, and drain connections for startup, operation, and maintenance.
- Materials compatible with the fluid being handled.
- A minimum of one manhole and one air ventilation opening (e.g., handhole) where required for maintenance or cleaning access.
- Relief valves in accordance with the applicable codes.

3.15 Heat Exchangers

3.15.1 Heat exchangers will be shell-and-tube or plate type and will be designed in accordance with Tubular Exchanger Manufacturers Association (TEMA) or manufacturer's standards. Fouling factors will be specified in accordance with TEMA. Cooling duty and fluid characteristics will be considered in determining fabrication materials, wall thickness, etc.

3.16 Piping and Piping Supports

Piping will be designed, selected, and fabricated in accordance with the following criteria:

3.16.1 Design Temperature and Pressure

The design pressure and temperature for piping will be consistent with conditions established for the design of the associated system.

The design pressure of a piping system will be the maximum of:

- The set pressure of a relief valve mounted in the line
- The set pressure of a relief valve installed on equipment that is connected to the line, adjusted accordingly to account for static head and friction loss
- If the system has no PSV or can be isolated from a PSV, the maximum pressure upstream equipment can generate (i.e., pump shutoff pressure).
- The maximum sustained pressure that may act on the system plus 25 psi.

The main and process steam piping design pressures will be in accordance with applicable codes. All design pressure values will be rounded up to the next 5-psig increment.

The design temperature of a piping system will be based on:

- The maximum sustained temperature which may act on the system plus 25°F

If a heat exchanger of piece of equipment in which heat is being removed can be taken out of service or bypassed, then the line downstream of that equipment will be designed for the resulting higher temperature.

3.16.2 General Design and Selection Criteria

Piping will be designed in accordance with the requirements of the Code for Pressure Piping, ASME B31.1-Power Piping, and other codes and standards referenced in Section 2, Codes and Standards. Pipe stress analysis will be performed in accordance with ASME B3 1.1. All pipe supports will be suitable to restrain the piping where subjected to external loads as stipulated by the California Building Code – Seismic and Wind Load Criteria. Vents and drains will be provided, as service requires.

Material selection will generally be based on the design temperature and service conditions in accordance with the following:

- Carbon steel piping materials will be specified for design temperatures up to and including 800°F.

- One and one-quarter percent chromium alloy steel piping materials will be specified for design temperatures ranging from 805°F to 950°F. 21/4 percent chromium alloy steel piping may be specified for design temperatures ranging from 955°F to 1100°F, however, 9 percent chromium alloy steel piping will be specified for high pressure steam and hot reheat steam systems which have a design temperature of approximately 1065°F.

- Scale free piping materials such as cleaned carbon steel, stainless steel or non-metallic will be used as follows:

  Piping applications requiring a high degree of cleanliness generally including injection water supply piping after strainers, air compressor inlet piping, miscellaneous lubricating oil system piping, and sampling piping after process isolation valves.

  Lubricating oil piping; carbon steel piping shall be pickled and stainless steel piping shall be swabbed.

  Fiberglass reinforced plastic piping materials will be used only in applications requiring corrosion-resistant material.

3.16.3 Piping Materials

Piping materials will be in accordance with applicable ASTM, and ASME standards. Materials to be incorporated in permanent systems will be new, unused, and undamaged. Piping materials will be in accordance with the following criteria:

- Steel and Iron Pipe. Carbon steel piping 2-inch nominal size and smaller will be ASTM A53 or A106, Grade B, SCH 80 minimum.
- Carbon steel piping 3 inch through 24-inch nominal size will be ASTM A53 Grade B seamless (welded seam pipe shall be used for low pressure air and water) or A106Grade B, with the indicated grades as a minimum. Carbon steel piping larger than 24-inch nominal size will be ASTM A672 or API 5L Grade B or ASTM A139 Grade B.
- Low chrome alloy pipe will be in accordance with ASTM A335 Grades P5, P11, P22 or P91 seamless or welded.
- Stainless steel pipe will be ASTM A312 Grades TP304, TP304L, TP316, or TP 316L seamless or welded. All stainless steel piping materials will be fully solution annealed prior to fabrication. The Type 316 materials will be utilized for high resistance to corrosion. The Type 30 and 3 16L materials will be utilized for applications requiring hot working (welding, etc.) and for additional corrosion resistance at welds.
- Schedule numbers, sizes, and dimensions of all carbon steel and alloy steel pipe will conform to ASME B36. 10M. Sizes and dimensions of stainless steel pipe designated as Schedule 5S, 10S, 40S, or 80S will conform to ASME B36.19M. Schedule numbers, sizes, and dimensions of stainless steel pipe not covered by ASME B36. 19M will conform to ASME B36.10.
- Alloy Steel Pipe. Steel piping for acid service will be Alloy 20.

- Galvanized Steel Pipe. Galvanized carbon steel piping will be ASTM A53 Grade B. The piping will be hot-dip galvanized.
- The use of galvanized steel pipe will be limited to systems where a degree of corrosion resistance is required or where codes require the use of galvanized steel pipe rather than black steel pipe.
- Underground piping materials will be non-metallic, ductile iron or cathodically protected carbon steel (see 3.1.7). The material selection will be in accordance with service requirements. Metallic underground piping will be wrapped in accordance with American Water Works Association (AWWA) standards.
- Polypropylene Lined Pipe. Polypropylene lined pipe will be ASTM A53 steel pipe with an applied liner of polypropylene.
- Fiberglass Reinforced Plastic Pipe. Fiberglass reinforced plastic pipe will be selected accordance with the specific service requirements.
- Polyvinyl Chloride Pipe. Polyvinyl chloride (PVC) pipe will conform to ASTM D1785 or ASTM D2241.
- Chlorinated Polyvinyl Chloride Pipe. Chlorinated polyvinyl chloride (CPVC) pipe will conform to ASTM F441.
- High Density Polyethylene Pipe. High-density polyethylene pipe (HDPE) will conform to ASTM D3350 with a Plastic Pipe Institute rating of PE 3406 or 3408.

3.16.4 Fitting Materials

Fittings will be constructed of materials equivalent to the pipe with which they are used, except for special cases such as lined steel pipe.

- Steel Fittings. Steel fittings 21/2 inches and larger will be of the butt welding type and steel fittings 2 inches and smaller will be of the socket welding type, except galvanized steel fittings will be threaded.
- Butt Welding Fittings. The wall thickness of butt welding fittings will be equal to the pipe wall thickness with which they are used. The fittings will be manufactured in accordance with ASME B 16.9. ASME B 16.28, and ASTM A234 or ASTM A403.
- Forged Steel Fittings. Forged steel fittings will be used for socket weld and steel threaded connections and will conform to ASME B 16.11.
- Cast Steel Flanged Fittings. Cast carbon steel flanged fittings will conform to ASME B 16.5 and will be of materials conforming to ASTM A2 16 WCB.

3.16.5 Flanges, Gaskets, Bolting, and Unions

Flanged joints will be in accordance with the following requirements:

- Flange Selection:
  - Flanges mating with flanges on piping, valves, and equipment will be of sizes, drilling, and facings which match the connecting flanges of the piping, valves, and equipment.
  - Flange class ratings will be adequate to meet the design pressure and temperature values specified for the piping with which they are used.
  - Flanges will be constructed of materials equivalent to the pipe with which they are used.
  - Mating flanges will be of compatible material.

- Steel Flanges:
  - Steel flanges will conform to ASME B 16.5;
  - Carbon steel flanges will be forged in accordance with ASTM A105;
  - Chromium alloy steel and stainless steel flanges will be forged in accordance with ASTM A182.

- Brass and Bronze Flanges. Brass and bronze screwed companion flanges will be plain faced and will conform to Class 150 or Class 300 classifications of ASME B 16.24. Drilling will be in accordance with ANSI Class 125 or Class 250 standards. Gaskets will be suitable for the design pressures and temperatures.

- Compressed Fiber Gaskets. Compressed fiber gaskets will be in accordance with ANSI B 16.21, and materials will be suitable for a maximum working pressure of 600 psig and a maximum working temperature of 750°F. Compressed fiber gaskets will be used with flat face flanges and raised face slip-on flanges.

- Spiral Wound Gaskets. Spiral wound gaskets will be constructed of a continuous stainless steel ribbon wound into a spiral with non-asbestos filler between adjacent coils. Spiral wound gaskets shall be in accordance with ASME B 16.20. Spiral wound gaskets will be used with raised face flanges, except for raised face slip-on flanges.

- Gaskets containing asbestos are not acceptable. Gaskets will be suitable for the design pressures and temperatures.

3.16.6 Cathodic Protection

Where required, underground piping steel will be cathodically protected, and electrically isolated from above-ground piping and other steel components.

Under ground firewater piping and components, made of steel, will be protected by a cathodic protection system. All cast iron and HDPE piping and components do not require cathodic protection.

3.16.7 Piping Fabrication

Piping fabrication will generally be in accordance with the requirements of the Piping Fabrication Institute (PFI).

3.16.7.1 Welder Qualification and Welding Procedures

Welding procedures, welders, and welding operators will be qualified in accordance with ASME Section IX code requirements. Backing rings will not be allowed for shop or field welds except where specifically permitted.

3.16.7.2 Nondestructive Examination and Inspection

Inspection and testing of piping will be performed in accordance with the requirements of ASME B3 1.1. Nondestructive examination will generally include visual, radiographic, magnetic particle and liquid penetrant, and ultrasonic examinations.

- Visual examination of welds will be performed by personnel qualified and certified in accordance with AWS QCI, Standard for Qualification and Certification of Welding Inspectors.
- Nondestructive examination shall be performed by personnel certified in accordance with ASNT Recommended Practice SNT-TC-IA.
- Radiographic examination will be performed on welds or welds to pressure retaining components as required by ASME B31.1 LODE.
- Magnetic particle, ultrasonic and liquid penetrant examination will be performed as required by ASME B3 1.1 Code.

3.16.8 Pipe Supports and Hangers

The term “pipe supports” includes all assemblies such as hangers, floorstands, anchors, guides, brackets, sway braces, vibration dampeners, positioners, and any supplementary steel required for pipe supports.

3.16.8.1 Design and Selection Criteria

All support materials, design, and construction will be in accordance with the latest applicable provisions of the Power Piping Code, ASME B31.1. Seismic design of piping systems will be in accordance with criteria as stipulated by the California Building Code.

3.17 VALVES

Valve pressure classes, sizes, types, body materials, and end preparations will generally be as described herein. Special features and special application valves will be utilized where required. Steel body gate, globe, angle, and check valves will be designed and constructed in accordance with ASME B16.34 as applicable.

3.17.1 Iron Body Valves

Iron body gate, globe and check valves will have iron bodies and will be bronze mounted. The face-to-face dimensions will be in accordance with ASME B16.10.

3.17.2 Butterfly Valves

Rubber-seated butterfly valves will be generally constructed in accordance with AWWA C504 Standard for Rubber-Seated Butterfly Valves. The valves will also generally conform to the requirements of MSS Standard Practice SP-67, Butterfly Valves.

3.17.3 Branch Line Isolation Valves

Isolation valves will be provided in 2-inch and smaller branch lines from main piping headers and equipment.

3.18 INSULATION AND LAGGING

The insulation and lagging to be applied to piping, equipment, and ductwork for the purposes of reducing heat loss, and personnel protection will be in accordance with the following criteria:

3.18.1 Insulation Materials and Installation

Insulation materials will be inhibited and of a low halogen content so that the insulation meets the requirements of ASTM C795 and ASTM C929 regarding stress-corrosion cracking of austenitic stainless steel. Insulation materials will contain no asbestos. All piping operating above 140°F will be insulated in areas required for personal protection. All piping will be insulated as required for energy conservation, prevention of condensation and noise attenuation. Equipment and ductwork operating at elevated temperatures will be insulated with calcium silicate or mineral fiber insulation.

3.18.2 Lagging Materials and Installation

All insulated surfaces of equipment, ductwork, piping, and valves will be lagged, except where removable covers are used.

3.18.3 Freeze Protection

All above ground piping smaller than 2-inch nominal diameter and subject to freezing will be insulated and provided with electric heat tracing. In addition, all piping will be evaluated for freeze protection by the following methods: Insulation, electric heat tracing, low point drains, high point vents and schedule 80 piping.

3.19 Lubrication

Types of lubrication specified for facility equipment will be suited to the operating conditions and will comply with the recommendations of equipment manufacturers.

The startup charge of flushing oil will be the manufacturer's standard lubricant for the intended service. Subsequently, such flushing oil will be sampled and analyzed to determine whether it can also be used for normal operation or must be replaced in accordance with the equipment supplier's recommendations.

Rotating equipment will be splash lubricated, force lubricated, or self-lubricated. Oil cups will be provided as necessary. Where automatic lubricators are fitted to equipment, provision for emergency hand lubrication will also be specified. Where applicable, equipment will be designed to be manually lubricated while in operation without the removal of protective guards. Lubrication filling and drain points will be readily accessible.

4.0 ELECTRICAL DESIGN CRITERIA

This section describes the facility's principal electrical equipment and systems, their functions, and the general criteria upon which their design will be based. An overview is shown on the main single-line diagram.

4.1 Interconnections to Electrical Utilities

Power generated will be delivered to the utility transmission system through a 230kV breaker on the high voltage side of each generator step-up transformer Startup power will be backfed through this same interconnect from the utility system. Protection, control and communication interface will be at the utility plant fence line.

4.2 Electric Power System – General

Power will be generated by a single Combustion Turbine Generator (CTG) and a Steam Turbine Generator (STG). A single 3-winding generator step-up transformer will step up the voltage from each generator for connection to the utility high voltage system. The CT generator will be connected to an 18kV generator breaker with isolated phase bus duct. The line side of the generator breaker will then be connected to the Generator Step Up Transformer (GSUT) via isolated phase bus duct. The ST generator will also be connected to a generator breaker and the line side of that breaker will be connected directly to the GSUT via underground cable. The HV side of the GSUT will be connected to the existing 230kV switchyard via overhead HV cable.

The following general criteria will be used to design the electrical system:

- The electrical systems, equipment, materials, and their installation will be designed in accordance with applicable industry codes and standards, project design criteria, and other requirements as specified.
- Facility power will be supplied through two (2) 18kV-4.36kV unit auxiliary transformers connected to the 4.16kV switchgear. Emergency power will be provided by connection to a 12kV line currently in place at the existing plant. This connection will be made into a 480V switchgear via a 12kV-480V transformer. During normal startup, power required for auxiliaries will be supplied from the utility through the CT generator step-up transformer to the medium voltage (MV) unit auxiliary transformers.
- The 4160V system will be fed from the MV unit auxiliary transformers. Each of the 4160V switchgears will be double-ended, low-resistance grounded, and located in a separate Power Distribution Centers (PDC).
- The 480V system will be fed from 4.16-480kV secondary unit substation transformers. Each 480V low-voltage switchgear will be double-ended and high-resistance grounded. The 480V motor control centers will be fed from the 480V low-voltage switchgear.

- Equipment will be sized to handle the maximum required current. The unit auxiliary transformers, 4160V equipment, and 480V switchgear will all be sized to handle the load of the entire plant configuration.
- Equipment short-circuit ratings will be based on the maximum short-circuit currents under all operating conditions and will take into account equipment design margins. There are no provisions for future loads.
- Motors greater than 200 hp will be supplied from the 4160V system. Motor-operated valves and motors from ¾ hp up to and including 200 hp will be supplied from the 480V system. Motors less than ¾ hp will be fed from the 120V system.
- The electrical power distribution system design and cable sizing will be selected to limit the cable voltage drop from source to load to not more than 5 percent. The allowable voltage variation at the load equipment will be limited to ±10 percent of the load nominal voltage rating under normal continuous operating conditions. The electrical system design will also be based on motor starting and system capability requirements.
- Electrical and controls equipment requiring access for normal operation and/or maintenance will be accessible from permanent floors or platforms without scaffolding, portable ladders, or lifts. Access space and clearance for electrical equipment will be per manufacturer's recommendation and in accordance with NEC requirements.

4.3 Plant DC Power Systems

Plant DC will be supplied from 125VDC and 24VDC battery systems. Emergency power for the CTG critical loads will be supplied by the 125VDC battery system supplied with each CTG. Control power for the plant electrical equipment, e.g. switchgear will be supplied by the station 125VDC battery system.

The station 125VDC system will consist of one (1), 100% capacity battery bank, two 100% capacity battery chargers, battery management system, a switchboard, and the required 125VDC panelboards. The batteries will be lead-acid. This system will supply DC power requirements for the uninterruptible power supply (UPS) system, medium and low voltage switchgear, balance of plant, and any critical DC loads. The station 125VDC system will be sized to supply the plant emergency loads for a period long enough to allow a safe shutdown of all plant equipment including the CTG, gas compressor, etc. The battery will be sized in accordance with IEEE 485. Battery racks will be designed to applicable project specific seismic zone requirements.

Each battery charger will be sized to supply the normal DC loads while simultaneously recharging a fully discharged battery in twelve (12) hours or less. Each charger will be designed such that it may be operated as a battery eliminator with the battery disconnected.

The batteries will be connected to the DC switchboard through a disconnect switch. The switchboard and panelboards will be designed for indoor installation and constructed in accordance with NEMA PB-1 and PB-2. Each panelboard will be provided with 20 percent

spare breakers and will be fully equipped.

The following 125VDC typical loads will be fed from the station battery:

- MV and LV switchgear control power
- BOP DCS Power Supply
- CTG control system
- Plant UPS Power System
- ST/CT Lube Oil Systems

4.4 Uninterruptible Power Supply (UPS) System

Single phase UPS inverters will supply 120VAC single-phase power to the UPS panelboards that supply critical AC loads. The UPS inverter will be fed from the station 125VDC battery. The UPS system will include one inverter, one alternate source transformer, one static transfer switch, one manual bypass switch, and required panelboards. The manual bypass switch will operate to completely bypass either inverter while continuing to provide power to all panelboards. In the case of an inverter failure, the alternate 480 VAC source will supply power to the AC panelboard via the alternate source transformer and the associated static transfer switch. The alternate source transformer will be shielded and non-regulating.

The following loads will be supplied from the UPS:

- DCS operator stations
- CEMS PLC and DAS computer
- Solenoid operated valves (via DCS)
- Communication equipment
- Revenue metering SCADA equipment
- CTG UPS loads
- Fire Protection Alarm System

4.5 Main Generators

The gas turbine generator will be of either Totally Enclosed Water to Air (TEWAC) or hydrogen cooled design. The combustion turbine generator will be synchronized to the utility's transmission system using the associated low side (18 kV) generator breaker.

The steam turbine generator will be of either Totally Enclosed Water to Air (TEWAC) or hydrogen cooled design. The steam turbine generator will be synchronized to the utility's transmission system using the associated low side (18 kV) generator breaker.

The CTG and STG will be capable of remote automatic generator control and will be supplied with metering quality CTs, PTs and meters capable of supplying signals to the DCS and performance monitoring systems.

4.6 Generator Step-up Transformer (GSUT)

A single 3-winding, delta-wye, ONAN/ONAF/ONAF 65°C rise GSU transformer will connect the CTG and the STG to the 230kV system. The neutral point of the HV winding of each transformer will be solidly grounded. The GSU transformer will have metal oxide surge arresters adjacent to the HV terminals.

Transformer accessories will include a magnetic liquid-level gauge, pressure-relief device, buckholz relay, oil preservation device, valves for top and bottom filter press connections, drain/sampling valves, grounding pads, bushing-mounted current transformers, combustible gas detector, and hot spot winding temperature elements.

The GSUT will include a manual de-energized tap changer located in the HV winding with taps ranging from 5 percent above normal to 5 percent below normal in 2.5 percent increments. The tap changer will have manual locking provisions.

GSU transformer auxiliaries will be powered from a 480V, three-phase source.

4.7 Unit Auxiliary Transformers (UAT)

Two (2) 18kV-4.36kV two-winding delta-wye ONAN/ONAF 65°C UAT will be provided to serve all plant auxiliary electric loads. Each UAT will be rated to supply facility startup and maximum operating power requirements. The neutral point of each 4160V UAT will be low-resistance grounded.

Transformer accessories will include a magnetic liquid-level gauge, pressure-relief device, sudden pressure relay, oil preservation device, valves for top and bottom filter press connections, drain/sampling valves, grounding pads, bushing-mounted current transformers, and hot spot winding temperature elements.

Each UAT will include a manual de-energized tap changer located in the HV winding with taps ranging from 5 percent above normal to 5 percent below normal in 2.5 percent increments.

4.8 Secondary Unit Substation Transformer (SUS)

Multiple 4.16-0.48kV two-winding delta-wye ONAN/ONAF 55°/65°C SUS transformers will be provided to serve the 480V switchgear and all 480V plant auxiliary electric loads. The SUS transformers will be rated to supply facility startup and maximum operating power requirements. The neutral point of the 480V SUS transformers will be high-resistance grounded with a ground fault detection scheme consisting of a pulsing contactor

in the neutral circuit to aid in identifying ground faults.

Accessories will include a magnetic liquid-level gauge, pressure-relief device, sudden pressure relay, oil preservation device, valves for top and bottom filter press connections, drain/sampling valves, grounding pads, bushing-mounted current transformers, and hot spot winding temperature elements.

The SUS transformers will include a manual de-energized tap changer located in the HV winding with taps ranging from 5 percent above normal to 5 percent below normal in 2.5 percent increments.

4.9 Power Distribution Centers (PDC)

Power Distribution Centers (PDC) will house all 4.16kV switchgear and motor control centers, 480V voltage switchgear, low voltage MCCs, DCS panels, power and lighting panels, revenue metering, protective relaying, station batteries, CAISO RIG and other miscellaneous equipment.

Each PDC will be equipped with redundant HVAC systems, smoke detection and lighting & convenience receptacles. Each electrical equipment area will be equipped with a wall mounted maintenance switch. This switch will be placed in the “maintenance” position whenever the switchgear area is occupied. When operated, this switch will remove all time delays in the main protective relays thereby making them essentially instantaneous trip relays. This action has the effect of lowering the arc flash hazard to a safe level as defined by NFPA 70E.

The PDC will be shipped to site with all wiring completed between all internal components.

4.10 Medium Voltage Switchgear

Two lineups of medium voltage switchgear will be provided. This switchgear will be 15kV class nominal, three-phase, three-wire with ratings not to exceed 3000A continuous and 50kA fault current duty. The medium voltage system will be high-resistance grounded via the CTG neutral grounding transformer when the generator breaker is closed, and will be ungrounded when the generator breaker is open. A set of zero-sequence PT’s and ground fault protection are required for each MV switchgear bus to monitor for bus ground faults prior to closing the generator breaker.

The medium voltage switchgear will be located indoors, will use vacuum interrupters, and will be rated to continuously distribute the full auxiliary load. Each lineup will contain voltage transformers, protective relaying for the GSUT, UAT, and feeder breakers and other load distribution equipment. All medium voltage breakers will be electrically operated from the DCS and equipped with a stored energy mechanism.

4.11 Medium Voltage Motor Controllers

The medium voltage motor controller lineup will be rated 4.16kV nominal, three-phase, three-wire with bus ratings not to exceed 1200 amps continuous and 250MVA fault current duty. The MV MCC will be NEMA Class E2 rated equipment. The MV MCC will be double high construction and drawout where possible. The MV MCC will contain vacuum and control power will be via an internal control power transformer. All motor controllers will be controlled from the DCS. The medium voltage motor controller lineup will consist of motor controllers and a main load-break switch.

The 4160V medium voltage controllers will be rated 4.16V nominal, three-phase, three-wire switchgear with ratings not to exceed 3000A continuous and 50kA fault current duty. The MV controllers switchgear will be sub-fed by the main 4.16kV switchgear through a cable connection.

4.12 Low Voltage Switchgear

The low voltage switchgear will be rated 480V nominal, three-phase, three-wire with ratings not to exceed 4000 amps continuous and 100 kA fault current duty. The low voltage switchgear will use electrically operated air-break power circuit breakers controlled from the DCS. Each power circuit breaker will have a solid-state trip device. If an electric fire pump is required, its feeder will be mechanically operated only. The low voltage switchgear will supply power to the low-voltage MCCs. The low voltage switchgear will be located indoors. The low-voltage switchgear will receive 480V power from the 4.16kV-0.480kV transformer through non-segregated phase bus duct.

A multimeter will be mounted on the front of each low-voltage switchgear to display bus voltage and current, kW, and kVAR for the incoming feed to that low-voltage switchgear.

Each low voltage switchgear will be designed with an integral high resistance grounding system with a self-contained annunciator and pulsing contactor. Ground fault detection will be provided with an alarm indication to the DCS.

All low voltage switchgear will have provisions and to accommodate a future vertical section.

4.13 Low Voltage Motor Control Centers

Low voltage motor control centers (MCCs) will be rated 480V nominal, three-phase, three-wire and will supply 480V non-motor loads, motors from ¾ hp up to and including 200 hp, motor-operated valves, and lighting and distribution panels. Thermal magnetic molded-case circuit breakers will be used for non-motor loads. Each motor starter will consist of a padlockable motor circuit protector; three-phase overload protection; three-pole contactor; hand-off-auto switch; stopped and running indication lights; and control power transformer. Control power transformers will be sized to handle each individual motor space heater

load. The MCC bus bracing and starter interrupting ratings will be consistent with the short-circuit currents calculated during detail design. All motor control centers will be installed indoors.

A minimum of 10% spare starters will be provided for the following: size 1 FVNR starters, size 2 FVNR starters, 150A breakers, 225A beakers in each lineup.

Placards will be placed on each motor control center starter to warn that operation of the equipment in "hand" position bypasses all permissives.

All motor control centers will have provisions and space to be extended a minimum of 1 vertical section.

4.14 Motors

This section addresses motors for BOP equipment. Motors will be the squirrel-cage induction type suitable for full-voltage across the line starting. The motor nameplate at service factor load will not be less than 1.15 times the maximum brake horsepower (KW) of the driven load. Motors will be provided with Class F insulation with Class B rise. Motor locked-rotor current will be limited to 650% of full load current at rated voltage. All medium voltage motors will be suitable for starting at 80% of the motor nameplate voltage.

All motors rated above 200 hp will be rated 4000 V, will be weather-protected Type II (outdoor), Type I (indoor only), totally enclosed fan cooled (TEFC), or totally enclosed water air cooled (TEWAC), depending on application. Motors rated 4000 V will include two resistance temperature detectors (RTDs) per stator winding and one RTD for each sleeve bearing wired to a terminal block.

All motors rated ¾ to 200 hp and fractional horsepower reversing motors (e.g. electric actuators) will be rated 460V, totally-enclosed fan-cooled (TEFC), and will be designed in accordance with the IEEE 841 standard.

Motors less than ¾ hp and smaller will be rated 110 VAC.

Motors rated 25 hp and above will have space heaters. The space heater will be serviceable or replaceable without disassembly of the motor. The space heater terminal box will be separate from the motor termination box. Where possible, the motor space heaters will be rated for 240 VAC but sized and energized at 120 VAC. Space heaters rated for 120VAC will also be allowed if 240VAC rated heaters are not available.

Motors will be furnished with oversized cast iron terminal boxes and will be capable of rotation in 90-degree steps. 4000 V motors will be provided with two grounding pads. Antifriction bearings will be grease lubricated, self-lubricating, and regreasable. Anti-friction bearings will have a L_{10} bearing life of 100,000 hours. 4000 V motors will be equipped with vibration switches or probes when specified and wired out to a terminal box

for customer wiring.

Motor data sheets will be provided for all three-phase motors, including those contained in vendor package equipment.

Routine tests will be performed on motors in accordance with NEMA MG-1 and IEEE 112.

4.15 Electrical Protection

Protective devices will be coordinated to the extent feasible to interrupt electric disturbances (fault, overload, abnormal operating condition, etc.) at the point nearest the fault, with the next upstream protective device providing back-up protection.

Protective devices will operate through a lockout relay (86) or equivalent latching device or circuit to prevent automatic restart/reclose of the equipment.

The settings of the 18kV generator breaker and generator protective devices will be fully coordinated with the utility system protection.

In general, relays will be micro-processor based, multi-function type. Drawout protective relays will have provisions for their removal without tripping their associated circuit breakers. Protective relays and lockout relays will be provided external test switches to allow for the functional testing of the protective relaying and their associated circuits. The test switches will be provided for voltage and current inputs as well as relay trip outputs (normally-open contacts on lockout relays).

As a minimum, the following protection will be provided for:

- CTG (provided by the turbine generator supplier)
  - Generator differential (87)
  - Negative sequence (46)
  - Loss of excitation (40)
  - Reverse power (32)
  - Stator ground (64G or 59GN)
  - Volts/hertz (24)
  - Overvoltage (59)
  - Overfrequency and underfrequency (81)
  - System Distance Backup (21)
  - Voltage balance (60 FL)
  - Field ground (alarm only)
  - Out of Step (78)
  - Breaker failure (50BF) (For generators with low-side breakers)
  - Accidental Energization (50/27)

- Power transformers (each GSU and UAT)
  - Transformer differential relay (87T) or overall unit differential (87U)
  - Transformer neutral overcurrent (51TN)
  - Transformer phase instantaneous overcurrent (50)
  - Transformer phase time overcurrent (51), other than main step-up transformers
  - Restricted ground fault protection (87GD) – Unit auxiliary transformer low voltage windings only.
  - Transformer fault pressure relay (63)
  - Oil level switch (71Q) (alarm only)
  - Oil temperature (26Q) (alarm only)
  - Winding temperature (49) (alarm only)
  - Overpressure (alarm only)
  - Main step-up and unit auxiliary transformer protection relays will be SEL-387E or equal.
- MV buses (4.16 kV)
  - Bus under voltage for alarm (27) and blown secondary VT fuse indication (60)
  - Incoming phase time overcurrent (51)
  - Incoming residual ground time overcurrent (51G)
  - Bus ground fault detection (59G) on the MV busses to detect bus faults prior to closing the generator breaker.
- 4.16-0.480kV transformers (protection located in the 4.16kV switchgear)
  - Phase time overcurrent (51)
  - Phase instantaneous overcurrent (50G – zero sequence)
- 4000 V motors
  - Thermal overload (49)
  - Phase overcurrent (51)
  - Phase instantaneous overcurrent (50– provided by contactor fuse)
  - Ground overcurrent (50G - zero sequence)
  - Phase reversal (47)
  - Stator overtemperature (when required by the P&IDs) (alarm and trip)
  - Bearing overtemperature (when required by the P&IDs) (alarm only)
  - Phase current unbalance (provided through thermal overload protection)
  - Vibration (when required by the P&IDs) (alarm and/or trip as indicated by P&IDs)
- LV switchgear buses (480 V)
  - Bus under voltage for alarm and blown secondary VT fuse indication
  - LT/ST protection on main, tie, and MCC feeder breakers
  - LT/ST/I protection on motor feeders
  - Ground fault alarm

- 480 V motors fed from MCCs
  - Thermal overload and motor circuit protector
- Panels, transformers, heaters and miscellaneous loads fed from MCCs
  - Thermal-magnetic molded-case circuit breaker

4.16 Metering

4.16.1 Metering - General

Metering class CT's & PT's will be provided in the generator breaker associated with each CTG. Space for the revenue metering should be provided in the PDC, but may be approved for outdoor installation if approved by CAISO and PG&E revenue metering representatives.

Metering of plant auxiliary power during standby will be provided by a PG&E revenue metering installation on the 18kV-4.16kV transformer. This revenue meter installation will be configured to monitor auxiliary power consumption when both generator breakers are open and the plant is in a standby mode. This meter will be enabled when both generator breakers are open and disabled if either one or both of the generator breakers are closed. The final aux electric metering configuration, metering instrument transformers and test switches will must be reviewed and approved by the local utility prior to installation.

Relaying class accuracy voltage and current transformers are acceptable for panel indication meter applications.

Test switches will be provided for the voltage and current inputs to each meter.

4.16.2 Metering Locations

Indication metering will be provided in the following locations:

- Each generator (voltage, current, kW, kVAR, kWHr, kVARHr, pf, and freq)
- Each 18kV breaker (voltage, current, kW, and kVAR)
- The 4.16kV main breaker (voltage, current, kW, and kVAR
- Each low voltage main breaker (voltage, current, kW, and kVAR
- Each medium voltage motor (current) – provided motor protection relays
- Low-voltage motor control centers (voltage, current, kW, and kVAR
- 125 VDC BOP systems:
  - Battery amperes (at DC switchboard)
  - Bus voltage (at DC switchboard)
  - Negative to ground (at DC switchboard)
  - Positive to ground (at DC switchboard)

  - Blown Fuse (at each fused switch in DC switchboard)
  - Each charger output volts and amperes

- 120 VAC UPS system
  - Each inverter input volts and amperes
  - Each inverter output amperes, voltage, and frequency

4.17 Annunciation to Plant Computer System

The following points at a minimum will be wired to the plant computer system for indication:

Revenue meters: (through datalink)

- MW export (if applicable)
- MW import (if applicable)
- MVAR import
- MVAR export
- MWHr export
- MWHr import (if applicable)
- MVARh export
- MVARh import
- System voltage

Generators (either through the datalink with the turbine control system, if available, or hard-wired directly to BOP DCS).

- Generator gross watts
- Generator gross watt-hours
- Generator gross amperes (each phase)
- Generator gross vars
- Generator gross var-hours
- Generator volts (each phase)

Generator Step-Up Transformer (GSUT):

- Common trouble alarm (DI)
- Transformer temperature (4-20mA)
- Water concentration (4-20mA)
- Hydrogen concentration (4-20mA)

Unit Auxiliary Transformer (UAT):

- Common trouble alarm (DI)

- Transformer temperature (4-20mA)

Each 4.16kV-480V Transformer:
- Common trouble alarm (DI)

Each Medium Voltage Switchgear Lineup:
- Bus voltage (through datalink)
- Main breaker current, kW, and kVAR (through datalink)
- Transformer and MCC feeders current, kW, and kVAR (through datalink)
- Motor feeders current (through datalink)
- Bus undervoltage indication (DI)
- Instrument voltage transformer blown fuse indication (through datalink)
- I/O as defined on standard schematics

Each 480V Switchgear:
- Ground fault alarm
- Bus phase A-to-B voltage (4-20mA)
- Main breaker phase B current (4-20mA)

125VDC System:
- One common trouble alarm from each battery charger
- One common trouble alarm from each 125VDC switchboard
- One common alarm from each battery management system

120VAC UPS System:
- One common trouble alarm from the UPS inverter
- Position of each main breaker/switch on each UPS panelboard
- Manual bypass switch position

4.18 Controls

4.18.1 Synchronizing

The CTG and STG will be synchronized automatically from the balance of plant DCS through the units respective synchronizing system, which is included as part of each generator package. In addition, the CTG will also be complete with vendor supplied controls to allow the CTG to be synchronized from the local CTG control room. The synchronizing system will control turbine speed/generator frequency, generator voltage, and breaker closure (factoring in breaker historical closure time). No remote manual synchronizing capability is required. Synchronizing breaker selection will be performed

through the turbine control system.

4.18.2 Automatic Generation Control

Automatic Generation Control and Monitoring will be provided. The control will be by the plant DCS system via a CAISO Remote Intelligent Gateway (RIG) installed in the PDC or from NCPA dispatch load balancing.

4.18.3 Medium Voltage Breaker Control

All medium voltage breakers and contactors when in the "in service" position will be controlled through the DCS. Local closing will only be allowed when the breaker or contactor is in the test position. Local opening will be allowed in either the "in service" or "test" position.

Control schemes for all medium voltage switchgear and motor controllers will be submitted for Owner's review prior to release for manufacturing.

4.18.4 480V Control

All 480V electrically operated switchgear breakers when in the "in service" position will be controlled through the DCS. Local closing will only be allowed when the breaker is in the test position. Local opening will be allowed in either the "connected" or "test" position.

480V starters that control process loads will be controlled from the control room through the DCS. Equipment such as HVAC, air compressors, small sump pumps, CEM, etc., will be locally controlled only, with no remote control.

Non-reversing motor control from the DCS will be via a maintained start/stop contact. Reversing motor control from the DCS will be via open/close contacts.

Control schemes for all low voltage switchgear and motor controllers will be submitted for Owner's review prior to release for manufacturing.

4.19 Communications and Security Systems

The telephone system and security system will be provided as discussed in the following subsections.

4.19.1 Telephone Communication System

The in plant telephone system will consist of a dedicated telephone exchange with an integrated voice mail system. The main switching termination and isolation equipment will be located in an administration building .

4.19.2 Computer Network System

The in plant computer system will consist of a local area network with the main switching, termination and isolation equipment located in the electronics room adjacent to the control room as described in the Instrument/Control Design Criteria.

4.19.3 Security System

The plant security system will consist of a surveillance camera at the main gate and one monitor in the plant control room. Additional cameras may be located at other places in the facility, e.g. water treatment, top of boiler, etc.

The main gate will be controlled from a programmable keypad at the gate and from the main control room. An intercom system will be provided from the main gate to the control room. Automatic opening/closing features of the gate will be provided for vehicles exiting the plant.

4.20 Cable and Raceway

In general, equipment at grade not located near overhead pipe or cable tray racks will be fed from underground ducts with other equipment generally connected using above grade cable tray and conduit systems. Where cable tray is routed in pipe rack with piping, the cable tray will be routed at the top elevation of the pipe rack above all piping. Covers will be provided if considered necessary for protection against welding slag or other debris.
Unless otherwise noted, all cables routed underground will be installed in marked concrete or cement slurry encased duct bank. Above ground circuits will be installed in conduit or tray. Grouped electrical cables should be routed away from exposure hazards or protected as required by the Fire Design Mitigation Plan. In particular, care should be taken to avoid routing cable trays near sources of ignition or flammable and combustible liquids. Where such routing is unavoidable, cable trays should be designed and arranged to prevent the spread of fire.

The final design will provide a minimum of 10 percent spare conduits in each duct bank. In no case will there be less than one spare conduit provided for each application utilized in that duct bank, (power, control, instrumentation).

Cable trays will be designed for 35% fill. Cable tray will be aluminum unless otherwise required due to environmental or corrosion issues.

Separation of voltage levels in all raceways will be maintained to meet the CTG manufacturers cable separation requirements or industry codes and standards whichever is more conservative. Rigid galvanized steel conduit will be used in duct banks when required for signal separation. Otherwise, conduit in ductbank will be PVC. All above ground conduit will be RGS (rigid galvanized steel).

Manholes will be provided as required for cable installation. Each manhole will be provided with a sloped floor to a 2'X2'x2' deep sump for pumping out water with a portable submersible pump. Duct banks will be sloped toward manholes where possible. The slope determination will be made to suit site conditions.

Hazardous area classifications and fire rated barrier requirements will be identified by the design engineer.

4.21 Grounding

The facility grounding grid system will consist of buried stranded copper conductors and ground rods, and ground wells as required. The buried grounding conductors will be sized on actual maximum available fault current in the switchyard. Exothermal welded type connectors that meet the requirements of IEEE 837 will be used for the buried ground grid connections. Exothermal welded connectors will be used above ground for connection of the ground grid to building steel. NEMA approved crimp on cable lugs will be used for connection of the ground grid to equipment.

The ground resistivity will be measured in accordance with IEEE 81 or ASTM G57. The ground grid will be designed so that the step, touch, and mesh potentials are within acceptable levels per IEEE 80 and IEEE 695. The calculated ground grid resistance will be verified by measuring final grounding resistance by Fall-of-Potential method per IEEE 81. The ground grid design will take into account the nearby substation and will be tied into the grid of the substation in at least 2 places.

Equipment and electrical systems in the plant power block area will be grounded in accordance with the Owner's standard grounding details, the National Electrical Code (NEC) and IEEE 142. All major electrical equipment will be grounded directly to the ground grid. The communication, instruments, and control cable shields will be grounded per the Owner's standard grounding details, IEEE 789, the turbine supplier's requirements, and the DCS supplier requirements as applicable.

4.22 Cathodic Protection

Because of the potential hazard in case of a leak, cathodic protection will be provided for all buried, coated-carbon-steel pipe including natural gas pipes. The cathodic protection system for buried pipes will be sacrificial galvanic anode system unless soil conditions or pipe size require the use of an impressed current system. Cathodic protection will be designed to meet NACE RP-01-69.

All underground piping systems, tanks, large heat exchangers, condensers will be reviewed for cathodic protection by the Owner prior for release for manufacturing on installation.

Field-erected storage tank bottoms will be set on a concrete ring-wall or slab foundation.

Cathodic protection will be provided if required.

4.23 Lightning Protection

It is not expected that lightning protection will be required for any plant site or structure located at any plant site. However, lightning protection will be provided as required by the Owner in specialized locations such as near the high voltage side of the GSUT.

4.24 Lighting Systems

As a minimum, lighting will be provided in the following areas:

- Building interiors.
- Building exterior entrances.
- Outdoor equipment within the power block and tank area.
- Power transformers.
- Power plant roadways.
- Parking areas within the power block area.
- Entrance gate.

Lighting levels will be as recommended in IES standards.

Suitable fixtures will be specified and installed according to the hazardous area classification.

Emergency lighting will be provided by integral battery packs and will not be connected to UPS system or 125 VDC station battery. Emergency lighting will be provided for safe egress from all plant areas. Emergency lighting will be provided with battery packs as well as connected to the plant 120V system.

If specified in Section 1, Stack aviation warning lighting will be installed per FAA advisory circular AC 70/7460-1.

The lighting circuits will consist of minimum #12 AWG stranded copper conductor. Cables used for lighting circuits will be XHHW-2. In outdoor areas, the circuits will be provided with rigid steel galvanized conduits with weatherproof fittings.

Outdoor lighting will be switched and photocell controlled through contactor's that feeds/controls the outdoor lighting. Light poles will be galvanized steel or aluminum. To reduce the visual impact created by outdoor lighting, the following mitigation measures will be adopted:

Lighting on the project site will be limited to areas required for safety and will be shielded from public view to the extent possible.

Lights will be directed on site so that significant light or glare will not be created. Highly directional, high-pressure sodium vapor fixtures will be used.

Nighttime backscatter illumination will be avoided by directional shielding of lights and providing on/off switch at the bottom of the ladders and stairways. All light switches will be clearly identified.

LV distribution panelboards for lighting and receptacles will be sized to distribute the capacity of the supplying transformer and will be located near the loads connected to each panel. Such panels will include a minimum of 20 percent spare breakers and all spaces will be equipped. Panels will include a main breaker as required by the NEC. All plant lighting panelboards will be located indoors, to the extent practical.

Distribution transformers will be sized to supply the expected continuous load, with approximately 20 percent margin for future load growth. The transformers will be air-cooled, dry type, with a 150° C rise. When it is required that the panelboard and/or transformer are located outdoors, the panelboard will have a minimum NEMA 3R rating and the transformer will be equipped with drip shields.

4.25 Freeze Protection / Electric Heat Tracing

The following paragraphs are intended to serve only as a guideline for defining freeze protection, heat tracing and insulation of systems that could potentially be damaged by freezing. Freeze protection methods will consist of the use of self limiting, insulated electric heating cables for low temperature lines and mineral-insulated (MI) for high temperature lines, heated “doghouses,” insulation, sparging with heated water, etc. Although pipe or equipment insulation is referenced in Section 3, it will be considered an integral part of the freeze protection system.

For items located outdoors, the heat tracing system will be provided for freeze protection at site minimum ambient temperature and weather conditions. Freeze protection will be provided for all piping systems indoors or outdoors which are subject to freezing during plant operation and shutdown. Sufficient cable will be provided for all flanges, valves and piping specialty items to permit maintenance of these items. The heat tracing system will provide a controlled amount of heat to maintain the temperature above the freezing point, or, in the case of process protection, maintain proper viscosity, temperature or other parameters required for process operation. Lines requiring freeze protection normally include (but will not be limited to) water lines, instrument lines, instrument transmitter housings, safety showers, eyewash stations, and condensate lines.

Where freeze protection is required on fire protection, the design will be in accordance with NFPA standards.

Freeze protection will be provided in accordance with the P&IDs for all piping systems,

equipment, tubing, gages and instrumentation that contain fluids subject to freezing. All tubing requiring heat trace will be thermostatically controlled to prevent boil off of the sensing fluid. Above grade, freeze protected piping that continues below grade will be insulated and heat traced below frost depth.

Space heaters or heated enclosures will be used for items where heating cables and insulation is not practical. Power for the heating cable circuits will be supplied from distribution panels similar to those used for the lighting circuits and will be controlled by locally mounted individual thermostats. The freeze protection system will provide local status and alarm indication for each circuit. Each circuit will be provided with electronic monitoring that indicates heat trace proper operation, failure or damage conditions.

Where required, instruments will be freeze protected by utilizing heated "soft-pack" type enclosures. Heaters will be centrally located within the enclosures and rated for extreme plant ambient temperature and wind speed. All process tubing will be continuously heat traced and insulated through the enclosure wall up to the base of the instrument.

4.26 Welding and Convenience Receptacles

Welding receptacles with local disconnects (480 V, 60 amp) will be provided in convenient locations throughout the plant. This includes two at the bottom of each HRSG on opposite sides, two near each CTG, one near the gas compressor area, and one near each PDC.

Convenience receptacles (120 V) will be provided around the plant as follows:

- PDC per the manufacturer's standard scope of supply, but no less than three (3).
- Mechanical and Electrical Enclosures. One duplex receptacle for each enclosure
- General Plant Area to allow a 100-foot extension cord to reach all areas that require power for maintenance.
- Inside the CEMS enclosure and near the gas compressor area.

Outdoor convenience receptacles will be the weather proof GFCI type.

4.27 Temporary Construction Power

Construction Power requirements will be arranged for by the construction contractor to meet construction needs including service to Construction Offices, Vendors, Engineers, and Sub-Contractors, plus 250 KW of start-up loads until back feed is available. The Contractor is responsible for the entire temporary power system design, supply, installation, safety inspection, maintenance, and removal.

Temporary power will be supplied by the construction contractor for space heaters, motor heaters, temporary heaters, and lighting as required for proper storage of material or equipment supplied by the Contractor, Owner or others.

5.0 CONTROL AND INSTRUMENT DESIGN CRITERIA

5.1 General

The complete plant will be monitored and controlled by a Distributed Control System (DCS).

Auxiliaries such as small sump pumps that need not be in continuous operation for electric power production will be monitored, controlled, and protected locally, with limited DCS monitoring and control.

5.2 Automatic Generation Control (AGC)

The plant will be capable of set point remote block Automatic Generation Control (AGC) from CAISO or NCPA dispatch. The reference point for the AGC will be the net plant revenue meter(s) on the generator step-up transformer(s).

Plant data will be communicated to Pacific Gas & Electric (PG&E) and CAISO. The inputs required must be provided by PG&E/CAISO and an example is indicated in the table below:

INPUTS REQUIRED						
ITEM	**STATUS/UNITS**	**MW**	**MVAR**	**MW-HR**	**MVAR-HR**	**COMMENTS**
T-Line Revenue Metering Point (each)	Ok/trouble	X	X	X	X	
GSUT High Side voltage	kV					
GSUT High Side Frequency	Hz					
High Voltage Circuit Breaker(s)	Open/close/trip					
AGC Set Point	MW					Feed back
AGC High and Low Limits	MW					
Generator Circuit Breaker (CTG)	Open/Close/Trip					
Generating Unit (each)	On/Off, AGC enabled	X	X	X	X	
High Temperature Control Limit	Deg F					
Gas Turbine Inlet Air Temperature	Deg F					
Ambient Air Temperature	Deg F					
Net Plant Fuel Flow	MMBTU/Hr and Standard Cu-Ft/HR					
Auxiliary Power		X	X	X	X	

INPUTS REQUIRED						
ITEM	**STATUS/UNITS**	**MW**	**MVAR**	**MW-HR**	**MVAR-HR**	**COMMENTS**
Transformers						

5.3 Distributed Control System (DCS)

The DCS will provide control of the balance of plant equipment. The balance of plant control system will interface with the CTG Turbine Control Panel (TCP), Steam Turbine Control Panel, Duct Burner Management System PLC, Gas Compressor PLC, CEMS PLC, Ammonia System PLC, Air Compressor PLC, water treatment system PLC, auxiliary boiler PLC and HRSG PLC to provide routine operator control including start-up, shut down, synchronizing, and set point load control from the balance of plant console.

In addition to the control interface provided by the balance of plant control system, the primary equipment to produce electric power, the CTG and related auxiliaries, will also be monitored, controlled, and protected via the Turbine Control Panel provided by the turbine supplier.

The DCS processors will be centrally located in one of Power Distribution Centers located in the new plant. The DCS I/O racks will be distributed around the site in the Power Distribution Centers and water treatment area. The DCS communication network will be a redundant Ethernet, with dual data links to equipment PLCs and dual connected workstations in the Control Room.

Packaged systems (where applicable), except as noted herein, will be programmed into, and controlled by the DCS. Control of the continuous emissions monitoring system (CEMS), HRSG, gas compressor, auxiliary boiler, water treatment system, ammonia delivery system, and air compressor will be by stand-alone programmable logic controller (PLC) systems. These PLCs will include an RS-485 link to the DCS, unless approved otherwise by the Owner, for transfer of process monitoring and status information. Air compressor and dryer packages will utilize their manufacturers' standard stand-alone control system(s) with a data link to the plant DCS. Signals for start/stop, lead/lag, and status (running, trouble, etc.) will be hard wired to/from the DCS unless otherwise provided by the OEM.

A consistent control and instrumentation philosophy will apply throughout the plant to minimize diversity of equipment type and manufacturer.

There will be no hardwired discrete control and monitoring operator stations to back up the LCD's and keyboards. However, individual emergency pushbuttons or switches will be provided for hardwired shutdown of major equipment (CTG, HRSG, STG and fuel gas shut off). These push buttons will be mounted in the Plant Main Control Room.

5.3.1 DCS Equipment

5.3.1.1 Operator Workstation

The balance of plant DCS will include one operator workstation. The workstation will be equipped with one keyboard and one 19" LCD Flat Panel Monitor. The monitor will be located on the work desk provided in the Plant Main Control Room.

5.3.1.2 Printers

One color inkjet printer will be provided and will be located on the work desk in the Plant Main Control Room.

5.3.2 DCS Processors, I/O Cabinets and Hardware

Processors, power supplies, communication modules, input and output modules will be mounted in a freestanding cabinet with front access. Redundant circuits in separate raceways will provide 125 VDC power to the DCS processors. The operator workstation and printer will be powered from the plant UPS system.

The system will be provided with 10 percent spare wired I/O and 10 percent spare slots in each cabinet at system shipment.

Equipment and termination blocks will be identified either with laminated phenolic nameplates or stamped metal tags.

5.3.3 DCS Functionality

The control system will show an overview and grouped or detailed information to assist the operator in required control actions. Functional logic diagrams or ladder logic diagrams will be provided to the DCS supplier.

Motor control logic will be coordinated to offer consistent functionality for all balance of plant equipment. Likewise, the operator interface for such logic will also be consistent. Permissive displays will be provided for applicable motors and valves identifying all system interlocks. Permissive displays will be developed either as a paged display associated with a given graphic or a pop-up display.

All alarm annunciation will be done in the balance of plant DCS. The sequence of events (SOE) function will have a resolution of not more than 1 millisecond and will be an integral part of the DCS. The CTG sequence of events will be synchronized with the same time stamp as the BOP or hard wired points to the BOP DCS to allow comprehensive SOE reports to be generated by the BOP DCS.

5.3.4 Graphics

A maximum of ten process graphics with an ISA-based symbol set, 10 trend displays, and 10 permissive displays that show the status of system interlocks will be included in the

BOP portions of the DCS. Graphic and trend displays associated with the OEM-supplied equipment will be provided. Faceplates will be included as pop-up windows on the process graphic displays. SOE trip logs will be included.

5.3.5 Input/Output

Discrete I/O in the form of analog input/outputs (AI/AO) and digital input/outputs (DI/DO) will be utilized. Pure alarms will open-to-alarm and fail in the open position. Alarms used for control will close-to-alarm and fail in the open position.

Field Wiring

Field wiring to the DCS will land on compression type terminal blocks in the processor or remote I/O cabinets. The DCS will accept both field powered and dry contact inputs. The normal wetting voltage for digital inputs will be 24 VDC supplied by the DCS from redundant power supplies. Motor run/stop status contacts will be 120 VAC powered from the motor control center. Solenoid-operated valves will generally be 120VAC powered from the DCS.

Sequence of Events

One millisecond resolution time stamped points (SOE) will be provided for the following:

Generator circuit breakers (52b contacts)

The 4.16kV volt main breakers to secondary unit substation transformers (4.16kV to 480 volt) (52b contacts)

The 480 volt secondary unit substation main breakers (52b contacts)

All lockout relays combined into a single “protection tripped” signal (normally-open contact)

No other points than those listed above will be connected as SOE

5.3.6 Foreign Device Interface (FDI)

The DCS will be capable of interfacing with other foreign devices through Ethernet, RS232, or RS485 interfaces using a MODBUS or TCP/IP protocol (where applicable). Data links to the DCS will be provided for switchgear relays, fuel gas metering station, ammonia delivery system, CEMS, HRSG, air compressor, and gas compressors. A Serial MODBUS link will be utilized for interfacing to the CT and STG TCP.

5.3.7 Factory Acceptance Test

The DCS will include a supplier-supported factory acceptance test, which will provide a thorough demonstration of all functional features of the DCS. The system will be

demonstrated using software simulation, but will include sufficient hardware testing to confirm proper system integration. A test procedure will be developed by the system supplier to support the factory acceptance test.

5.4 Local Controls

DCS start/stop functions will not be provided for self-contained components/equipment packages that do not require constant operator control or intervention (e.g., lubricating oil pumps, sump pumps, vent fans, etc).

Hard wired local controls for equipment will be limited to hand-off-auto switches in the MCC's for 480 volt motors and those provided by the equipment/skid manufacturer.

5.5 Analytical Equipment

5.5.1 Continuous Emissions Monitoring System

A continuous emissions monitoring system (CEMS) and data acquisition and reporting system (DARS) will be provided for the HRSG trains in accordance with the air permit. The CEMS will consist of sampling devices connected via sample lines to emissions rack mounted analytical measurement devices and CEMS control equipment located in the CEMS enclosure near the base of one of the stacks.

Adequate rack space will be provided to allow future analyzers if required.

The building containing the CEMS equipment will have an exterior weather shield to protect the bolted racks, gas cylinders and regulators for connection of the calibration gases.

The CEMS will be controlled by a PLC and will monitor NOx, CO, O_2, and NH_3.

Inputs for fuel flow, power generation, and all other required process conditions will be hard wired from the plant DCS. Emissions will be calculated based on plant fuel flows, analyzer readings, and surrogate calculations based on fuel analysis.

The primary operator interface with the CEMS will be through a personal computer workstation (PC) located in the CEMS building. The PC will provide operator access via a Windows environment to acknowledge alarms, retrieve data, and generate all required emissions reports and will include exceedance/fault codes as appropriate. System reports will be modifiable by site personnel, and emission alarms will be adjustable through the PC interface. All appropriate equations and coefficients used by the systems will be capable of being modified by authorized plant personnel (via password protection).

The CEMS hardware and reporting package software will meet the requirements of applicable permits. System reports will be able to include a daily summary of the average plant generation in megawatts, the average fuel flows, and any other plant data available to

the system.

All corrected emissions data and a common alarm will be hard wired to the DCS system.

UPS power will be provided for the CEMS analyzers, controller, and PC to ensure proper surge protection, power conditioning, and protection in the event of a momentary loss of power.

The local control unit located with the CEMS equipment will allow access to the operational status of the CEMS and provide the capability to initiate both automatic and manual calibrations.

5.6 Instrumentation Design Criteria/General Requirements

5.6.1 General

The instrumentation and control equipment/systems and materials and their installation will be designed in accordance with applicable codes, industry standards, this scope document, and material selection specified in this section. Instruments and valves will be pre-calibrated, tagged and/or programmed by the supplier.

Pneumatic signal levels, where used, will be 3-15 psig for pneumatic transmitter outputs, controller outputs, electric-to-pneumatic converter outputs, valve positioner inputs, etc. Signal levels of electric to pneumatic converters may also be 6 to 30 psig, depending on application.

Electronic transmitters and controllers will be designed for proportional output of 4-20 mA DC with 24V DC power supply from the DCS into 600 OHM maximum loop resistance.

No primary sensor full-scale signal level, other than thermocouples, will be less than 10 mV or greater than 125 V. Transmitters requiring an external power supply will be connected to 115 VAC.

An identification tag showing the purchaser's identifying tag number as per the data sheets will be attached to each field instrument. The tag will be a minimum of 20 gage stainless steel wired to the transmitter with a minimum letter height of 0.25", 85 characters maximum or permanently stamped on the instrument with 65 characters maximum. As a minimum the tag should have the manufacturer name, model number and purchase order number. For safety, tag wired ends will be curled.

Each field instrument will be installed as per construction installation drawings. Interchanging instruments during construction is prohibited.

Field instruments, digital indicators, DCS, PLC, etc. will be configured for the following engineering units:

Temperature	Degrees F
Pressure	
Near Atmos.	In. of water
Above Atmos.	PSIG
Below Atmos.	In. of Hg Absolute
Absolute	PSIA
Level	Percent of range for process
Flow	
Liquids	GPM
Water	GPM
Gas or Vapor	SCFH*
Air & Nitrogen	SCFH*
Analyzers	Ph, %, us

* Defined at 60° F and 14.69 PSIA

5.6.2 Pressure Instruments

Where necessary for operation, either industrial-type 4-1/2-inch-diameter pressure gauges with white faces and black scale markings, or indicating pressure transmitters will be provided. Pneumatic receiver gauges will be 3-1/2 inch oval size. In general, pressure instruments will have linear scales with units of measurement in pounds per square inch gauge. Pressure gauge accuracy will be ±0.5 percent of full range per ANSI Specification B40.1, Grade 2A. Pressure instruments will generally have screwed connections. Pressure gauge stem connection will generally be ½" NPT.

Pressure gauges will have either a blowout disk or a blowout back and an acrylic or shatterproof glass face.

Pressure gauges on process piping will generally be visible 10 feet from an operator's normal stance at floor level and will be resistant to plant atmospheres.

Connections to piping or equipment will be in accordance with piping specification and instrument installation details.

Pressure test points will have isolation valves and caps or plugs. Pressure devices on pulsating services will have pulsation dampers.

Fire protection system pressure gauges will be designed in accordance with UL standards.

"Face" gauges in high vibration areas will be liquid filled and include a vibration snubber. "Face" gauges used for measuring high pressure or temperature process media will be fitted with an isolation diaphragm.

5.6.3 Temperature Instruments

In general, temperature instruments will have scales with temperature units in degrees Fahrenheit. Exceptions to this are electrical machinery RTDs and transformer winding temperatures, which are in degrees Celsius.

Dial thermometers will have 4-1/2 inch-diameter (minimum) dials and white faces with black scale markings and will be every-angle type and bimetal actuated. Dial thermometers will generally be visible 10 feet from an operator's normal stance at floor level (viewing area) and will be resistant to plant atmospheres.

Temperature elements and dial thermometers will be protected by thermowells except when measuring gas or air temperatures at atmospheric pressure. Temperature test points will have thermowells and caps or plugs.

Thermowells for dial thermometers and filled system instruments will be purchased with the instruments to assure proper fit. Thermowells will be constructed of stainless steel except where conditions warrant the use of main line class material.

All thermowells will be drilled barstock (not built-up type).

Threaded and socket weld thermowells will have lagging extensions when used with insulation for high temperature. Consideration will be given to thicker insulation in cold services.

In general, RTDs will be dual 100-ohm platinum three-wire circuits (R_{100}/R_0-1.385). The element will be spring-loaded, mounted in a thermowell, and connected to a cast iron head assembly. However, RTDs associated with multi-variable transmitters will be four-wire.

Thermocouples will be type K dual element, ungrounded, and spring-loaded. For general service, the materials of construction will be dictated by service temperatures. Thermocouple heads will be the cast type with an internal grounding screw. If a thermocouple is inaccessible, the leads will be brought to an accessible junction box.

"Face" gauges in high vibration areas will be liquid filled and include a vibration snubber.

5.6.4 Level Instruments

Reflex-glass or magnetic level gauges will be used. Level indication for corrosive service (if required) will use devices other than reflex-glass gauges. Level gauges for high-pressure service will have suitable personnel protection. Transparent type gauge glasses will be used up to 600 PSIG.

Gauge glasses used in conjunction with level instruments will cover a range that includes the highest and lowest trip/alarm set points.

Level transmitters for measuring the level in storage tanks vented to atmosphere (e.g., condensate storage tank) will generally be the flanged differential pressure type and will

have local and main control room indication. Differential pressure type level instruments will normally be furnished for pressure vessels in level ranges which exceed 48 inches. External displacer type level transmitters and controllers will be normally furnished for all pressure vessels in level ranges equal to or less than 48 inches. Guided wave, internal displacer or ball float level instruments will be furnished for open sumps and tanks and for services where draining of the tank for maintenance can be easily accomplished.

5.6.5 Flow Instruments

Primary Elements

Concentric type orifice plates will be used as the primary elements for flow measurement. In general, 316 SS orifice plates will be provided. For clean fluids the square edge orifice will be used. The orifice plates will be in accordance with API 2530, Chapter 14, Section 3, orifice metering of natural gas and other related hydrocarbon fluids. Each orifice plate will be stamped with the tag number. For clean fluids use square edge orifices.

The feedwater flow will be measured with a flow nozzle or venturi tube and differential pressure transmitters. The flow signal will be temperature compensated.. The steam flow will be measured with a flow nozzle or venturi tube and will be pressure and temperature compensated.

Meter Runs

Flow nozzle and venturi tubes will be installed in a horizontal line. Orifice runs will utilize orifice flange taps and will be installed in a horizontal line if possible. Integral orifice meters, variable area meters (armored rotameters) should be installed in lines less than 2 inches.

Flow transmitters will be the differential pressure type with the range matching (as closely as practical) the primary element. All flow differential pressure transmitters will be furnished and shipped with integral three or five valve manifolds. In general, flow transmitters will be Rosemount 3095 MV or acceptable equal with external RTDs.

5.6.6 Control Valves

Control valves in throttling service will be the globe-body cage type with body materials, pressure rating, and valve trim suitable for the service involved. Other style valve bodies may also be used when suitable for the intended service. No split-body valves or separable flange styles will be used without specific approval. Butterfly valves will be of the lug body type.

Each control valve will be sized using the methods and equations described in the standard ISA-75.01. Each control valve will be sized and selected, including trim and plug design, actuators, valve materials, and valve accessories to properly satisfy all operating and design

conditions of each application as listed in the Data Sheets.

The valve body size will not be less than two pipe sizes smaller than the nominal inlet pipeline size, unless otherwise specified.

Bellow seal bonnets will be used for highly toxic or volatile fluids. Teflon or approved non-asbestos alternate packing material may be used for temperatures between -40°F and 450°F. Grafoil packing will be used as a minimum for temperatures 450°F and above.

Solenoid valves supplied with the control valves will have Class H coils 120 VAC UPS powered. The coil enclosure will normally be a minimum of NEMA 4 but will be suitable for the area of installation. Terminations will typically be by pigtail wires.

5.6.6.1 End Connections

Steel valves with flanged ends will be in accordance with ASME B16.5. End to end dimension of each valve will be in accordance with the appropriate ISA Standards (i.e. ISA S75.03 and S75.04).

All welding connections for valves 2-1/2 inches and larger in nominal size will be butt-welded. All welding connections for valves 2 inches and smaller in nominal size will be socket welded. All welding ends will be in accordance with ASME B16.34 and B16.25.

Control valves in 300# class service and below will be flanged, except for Hydrogen, Natural Gas, Ammonia, steam and vacuum service. Where flanged valves are used the flange rating will match the pipe class specifications.

All control valves 600# and greater will be furnished with weld end connections.

For butterfly, ball, and similar body types, lugged or flanged bodies to permit dead end service will be provided unless otherwise specified. Wafer types that cannot be independently fastened to the field piping at both ends of the valve body will not be provided.

5.6.6.2 End extensions and Reducers:

If the size of a welded end valve is different than the field pipe size, the valve will be furnished with shop welded concentric reducers matching the upstream and downstream pipe size, material and wall thickness. Shop welded end extensions will be provided for valves with body material that is different than the field piping material (such as alloy valve bodies to be welded into carbon steel pipelines or vice versa). End extensions will be a pipe section at least 6 inches (150 mm) long. End extensions and reducers will be factory installed on the valve body and stress relieved in accordance with ASME B31.1. End extensions and reducers will be shown on the valve drawing and included in the shop end-to-end or center-to-face dimensions.

5.6.6.3 Valve Actuators

All control valves will be furnished with pneumatic spring opposed diaphragm actuators where possible. Pneumatic piston, electric or other actuators can be provided if better suited for the application or called out on the data sheets.

Valves will be designed to fail in a safe position.

Valve actuators with valve action "fail open" or "fail closed", will be provided with a mechanical spring or a trip valve and volume tank to fully open or close the valve as applicable on loss of air pressure. Valve actuators with valve action "fail in place" will be provided with a mechanism to hold the valve in position on loss of air pressure. Actuators will be sized sufficiently to achieve the desired “fail” position while the valve is operating at maximum differential pressure.

5.6.6.4 Volume Tanks

Volume tanks will be designed to withstand a minimum pressure of 125 psig.

All volume tanks will be constructed in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 (stamped UM).

5.6.6.5 Sound Control Requirements

For all valves, the equivalent "A" weighted sound level, measured three feet downstream of the valve outlet and one meter from the un-insulated pipe surface, will not exceed 85 dBA unless noted otherwise on the valve Data Sheets. Noise reduction will be accomplished by source treatment, utilizing trim specifically designed for the service. Calculations of noise will be done in accordance with the International Standard IEC 534-8-3 and submitted with valve specifications and sizing information.

5.6.6.6 Positioners

Positioners will be the Fisher DVC6000 Series, electro-pneumatic type utilizing the HART communication protocol and will be provided with pressure gauges for indicating the air supply, valve actuator, and control signal pressures. Input signal will be loop powered by the DCS. Positioners will be designed for a control signal input range of 4-20 mA. Positioners will provide an output signal from 0 psig to the full supply air pressure to the valve actuator. Positioners will not be provided with bypasses.

Control valve accessories will be mounted on the valve actuator unless severe vibration is expected. Control valves with a positioner will not be equipped with a pneumatic valves unloader.

When valve position feed back is required for DCS information (i.e. non-control use) only, Fisher digital valve controllers (DVC’s) will be utilized to provide a Hart signal back to the

DCS superimposed on the valve analog output. Valve position feed back for process control use will be hard wired.

5.6.7 Instrument Tubing and Installation

Tubing used to connect instruments to the process line will generally be 1/2 inch diameter, 0.049 inch wall (minimum) seamless 316 stainless steel for primary instruments and sampling systems.

Instrument tubing fittings will be the compression type. One manufacturer will be selected for use and will be standardized as much as practical throughout the plant.

Differential pressure (flow) instruments will be fitted with five-valve manifolds. Three-valve or two-valve manifolds will be specified for other instruments as appropriate.

Instrument installation will be designed to correctly sense the process variable. Taps on process lines will be located so that sensing lines do not trap air in liquid service or liquid in gas service. Taps on process lines will be fitted with a shutoff (root or gauge valve) close to the process line. Root and gauge valves will be main-line class valves.

Instrument tubing will be supported in both horizontal and vertical runs as necessary. Expansion loops will be provided in tubing runs subject to high temperatures. The instrument tubing support design will allow for movement of the main process line.

5.6.8 Field-Mounted Instruments

Field-mounting instruments will be of a design suitable for the area in which they are located. They will be mounted in areas accessible for maintenance and relatively free of vibration and will not block walkways or prevent maintenance of other equipment.

Field-mounted instruments will be grouped on racks. Supports for individual instruments will be a prefabricated, off-the-shelf, 2-inch pipe stand. Instrument racks and individual supports will be mounted to concrete floors, to platforms, or on support steel in locations not subject to excessive vibration.

Instruments will be freeze protected by utilizing heated “hard box” type enclosures as required.

Individual field instrument sensing lines will be sloped or pitched in such a manner and be of such length, routing, and configuration that signal response is not adversely affected.

Liquid level controllers will generally be the non-indicating, displacement type with external cages.

5.6.9 Instrument Air System

Branch headers will have a shutoff valve at the takeoff from the main header. The branch headers will be sized for the air usage of the instruments served, but will be no smaller than 3/8 inch. Each instrument air user will have a shutoff valve, filter, and regulator (where appropriate) at the instrument.