Mechanical Engineering Design Criteria
APPENDIX 10C
Mechanical Engineering Design Criteria

10C1 Introduction

Control of the design, engineering, procurement, and construction activities on the project will be completed in accordance with various predetermined standard practices and project specific programs/practices. An orderly sequence of events for the implementation of the project is planned consisting of the following major activities:

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

The purpose of this appendix is to summarize the codes and standards and standard design criteria and practices that will be used during the project. The general mechanical design criteria defined herein form the basis of the design for the mechanical components and systems of the project. More specific design information is developed during detailed design to support equipment and erection specifications. It is not the intent of this appendix to present the detailed design information for each component and system, but rather to summarize the codes, standards, and general criteria that will be used.

Section 10C2 summarizes the applicable codes and standards, and Section 10C3 includes the general design criteria for piping, valves, insulation, lagging, and freeze protection.

10C2 Design Codes and Standards

The design and specification of all work will be in accordance with all applicable laws and regulations of the federal government, the State of California, and the applicable local codes and ordinances. A summary of the codes and industry standards to be used in design and construction is listed below.

A California Professional Engineer stamp is required on design documents.

10C2.1 State and Local Building Codes, Standards and Ordinances

- Code, Rules and Regulations of the State of California
- California Building Standards Code (CBSC)
- Uniform Building Code (UBC)
- California Electrical Code
- California OSHA (CALOSHA)
- Local ordinances, regulations, and requirements
10C2.2 U.S. Government Codes, Ordinances, and Standards

- Occupational Safety and Health Act (OSHA) — 29 CFR 1910, 1926
- Federal Aviation Agency (FAA) — Obstruction Marking and Lighting AC No. 70/7460-IJ
- Environmental Protection Agency (EPA) — 40 CFR 423, 40 CFR 60, 40 CFR 72, 40 CFR 75, 40 CFR 112
- Appendix A to Part 36, “American Disability Act Accessibility Guidelines for Buildings and Facilities (applicable only to administrative and control room areas).

10C2.3 American Society of Mechanical Engineers

The following standards of the American Society of Mechanical Engineers (ASME) will be followed:

- ASME Boiler and Pressure Vessel Code Sections:
  - I  Power Boilers
  - II  Material Specifications
    - Part A: Ferrous Materials
    - Part B: Nonferrous Materials
    - Part C: Welding Rods, Electrodes, and Filler Metals
  - V  Nondestructive Examination
  - VIII Pressure Vessel Division 1
  - IX  Welding and Brazing Qualifications
- ASME B31.1 - Power Piping
- ASME Performance Test Codes:
  The following performance test code may be used as guidance in conducting the performance for the overall Project:
  - PTC 46  Overall Plant Performance
  - PTC 17  Internal Combustion Reciprocating Engines
  - PTC 1  General Instructions
  - PTC -19.1 Measurement Uncertainty

The following performance test codes may be used as guidance in conducting performance tests if a shortfall in overall Project performance requires individual component testing:

- PTC -19.2 Pressure Measurement
- PTC -19.3 Temperature Measurement

If comparable international standards to ASME standards are proposed by Contractor, the Contractor has full responsibility to confirm the international standards are equal or better than ASME standards, and that the deliverables are acceptable per the codes, standards, and permits of the site.
10C2.4 American National Standards Institute

The following standards of the American National Standards Institute (ANSI) will be followed:

- B16.1 Cast Iron Pipe Flanges and Flanged Fittings
- B16.5 Steel Pipe, Flanges, and Fittings
- B16.34 Steel Valves
- B30.17 Overhead and Gantry Cranes

If comparable international standards to ANSI standards are proposed by Contractor, the Contractor has full responsibility to confirm the international standards are equal or better than ANSI standards, and that the deliverables are acceptable per the codes, standards, and permits of the site.

10C2.5 Industry Standards

Applicable standards issued by the following industry organizations:

- American Boiler Manufacturers Association (ABMA)
- American Gas Association (AGA)
- American Gear Manufacturers Association (AGMA)
- Air Moving and Conditioning Association (AMCA)
- American Petroleum Institute (API)
- American Society for Nondestructive Testing (ASNT)
- American Society for Testing and Materials (ASTM)
- American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)
- American Water Works Association (AWWA)
- American Welding Society (AWS)
- Anti-Friction Bearing Manufacturers Association (AFBMA)
- Crane Equipment Manufacturer’s Association of America (CMMA)
- Expansion Joint Manufacturers Association (EJMA)
- Fluid Control Institute (FCI)
- Heat Exchange Institute (HEI)
- Hydraulic Institute (HI) - Standard for Pumps
- Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry
- National Association of Corrosion Engineers (NACE)
- National Electrical Manufacturers Association (NEMA)
- National Fire Protection Association (NFPA) National Fire Codes
- Pipe Fabrication Institute (PFI)
- Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
- Thermal Insulation Manufacturers Association (TIMA)
- Tubular Exchanger Manufacturers Association (TEMA)
- Underwriters Laboratories, Inc. (UL) - fire protection equipment and office building only
- Welding Research Council (WRC)
- Equipment sourced from Europe will be constructed according to functionally comparable DIN and ISO standards.
If comparable international standards to above U.S. industry standards are proposed by Contractor, the Contractor has full responsibility to confirm the international standards are equal or better than the U.S. industry standards, and that the deliverables are acceptable per the codes, standards, and permits of the site. Codes, Standards and Recommendations

10C2.6 Fire Protection System Codes and Standards

The fire protection systems will be designed in accordance with the specified codes, standards and recommendations, all applicable statutory requirements and amendments, and the EPC Specifications. Conflicts between applicable codes and the contract will be resolved to the parties’ mutual satisfaction. Codes in effect at the time of contract execution will govern.

The specified codes, standards and recommendations will include:

- Local Adopted Codes, Standards and Amendments, and requirements of local jurisdictional authority.

CBSC and the local building and fire codes, standards, recommendations and amendments to be used will be determined during the Contractors Building and Fire Codes, and Life Safety Compliance Review.

- National Fire Protection Association (NFPA) Codes, Standards and Recommendations
  a. NFPA 10, Standard for Portable Fire Extinguishers.
  b. NFPA 12, Standard on Carbon Dioxide Extinguishing Systems.
  d. NFPA 14, Standard for the Installation of Standpipe, Private Hydrants, and Hose Systems.
  g. NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection.
  h. NFPA 22, Standard for Water Tanks for Private Fire Protection.
  i. NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
  l. NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
  m. NFPA 50A, Standard for Gaseous Hydrogen Systems at Consumer Sites.
p. NFPA 70, National Electrical Code.
q. NFPA 72, National Fire Alarm Code.
r. NFPA 85, Boiler and Combustion Systems Hazard Code
t. NFPA 92B, Standard for Smoke Management Systems in Malls, Atria, and Large Spaces
v. NFPA 204, Standard for Smoke and Heat Venting.
w. NFPA 214, Standard on Water Cooling Towers
x. NFPA 221, Standard for Fire Walls and Fire Barrier Walls.
z. NFPA 497, Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.
aa. NFPA 780, Standard for the Installation of Lightning Protection Systems.

**10C.6.1 Other Codes and Standards**

American Petroleum Institute (API) 500, Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class 1, Division 1 and Division 2 will be used for the hazardous classification of equipment and systems.

The following referenced document(s) provide recommendations for fire protection of electric generating plants based on good industry practice and the applicable for the project sections will be used and implemented (should recommendations will be changed to “will”).


The specified standards define minimum requirements only. They do not necessarily include all requirements necessary to satisfy the applicable local statutes, as interpreted by the Local Statutory Authorities, or the EPC Specifications.

Unless otherwise indicated, the issue of the specific code, standard or recommendations in effect at the time of the “construction plan submittal to the Local Statutory Authorities” will apply.
In the event of differences between the requirements of the applicable codes, referenced standards and the EPC Specifications, the more stringent requirement(s) will apply.

If there are conflicts between the applicable codes and standards and the EPC Specification, it is the Contractor’s responsibility to immediately bring those conflicts to the attention of the Owner.

10C2.7 HVAC Standards

The following standards or other international standards as approved by the Owner will be used in the design of the HVAC system.

- **ASHRAE Handbooks:**
  - Fundamentals
  - HVAC Systems and Equipment
  - HVAC Applications
  - Refrigeration

- **ASHRAE Standards:**
  - 52.1, Method of Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter
  - 15, Safety Code for Mechanical Refrigeration
  - 62, Ventilation for Indoor Air Quality
  - 90.1, Energy Efficient Design of Buildings

- **ANSI/ASME Standards:**
  - ANSI/ASME B31.5, Refrigeration Piping

- **SMACNA Standards:**

- **NFPA Standards:**
  - 90A - Installation of Air Conditioning and Ventilating Systems
  - 90B - Installation of Warm Air Heating and Air Condition Systems
  - 204 - Smoke and Heat Venting

- **IEC Standards:**
  - 529 - Degree of Protectors for Electrical Equipment

- **ARI Standards:**
  - 410 - Forced Circulation Air-Cooling and Air Heating Coils
  - 430 - Central Station Air Handling Units
• AMCA Standards:
  – 210-85 - Laboratory Methods of Testing Fans for Rating
  – 500-89 - Test Method for Louvers, Dampers, and Shutters

10C3 Mechanical Engineering Design Criteria

10C3.1 Reciprocating Engines
The engines will be a four stroke, lean burn, turbocharged and intercooled designed to burn natural gas and liquid fuel.

Engines will be designed for dual fuel operation on either natural gas fuel or liquid fuel (diesel oil).

Engines will be provided with engine preheating and prelubrication equipment supplied for startups to full load within 10 minutes.

Engines will have common base frame mounted on the foundation by steel springs for engine and generator and flexible coupling between engine and generator.

Two independent interconnected compressed air systems for starting air and control and instrumentation air will be provided.

On-line wash system of turbocharger will be provided. The online water wash and drain system will be installed with all valves easily accessible for routine maintenance.

Engine cooling and oil cooling will be two independent separate cooling systems. It is acceptable to cool lube oil circuit and engine jacket water and radiators in one circuit.

Generator and controls will meet all WECC operating requirements.

CEMS sample and monitoring equipment will be provided for each engine and the equipment will be easily accessible for maintenance.

Engines will be factory tested to full load.

The parts on all engines will be interchangeable.

Engine service platforms will be provided for access to the top of engines and between engines.

Electric turning gear will be provided.

10C3.1.1 Starting Air System
Starting air system and starting air storage will be sized for rapid starting of all engines.

As a precaution, the engine will not be started when the turning gear is engaged.

A starting air system will be independent of shop compressed air system. Compressed air from the starting air unit will be stored in starting air tanks until it is used for starting the engines.
Starting air system will be capable of starting all engines in a rapid sequence with sufficient capacity to have all engines up and running in 10 minutes.

The total compressor capacity will be capable to recharge the starting air system within 90 minutes from the low pressure alarm, with 3 starts of all engines without recharging. The air systems will be interconnected and any engine can be started from any receiver.

10C3.1.2 Intake Air

Intake air is extracted from outside the building. The location of the inlet air filters will be located taking advantage of prevailing wind direction to mitigate recirculation of exhaust gases and radiator exhausts. The engine exhaust stacks and radiators will be downstream inlet air filters (prevailing wind).

The intake air filter elements will be designed for the current Project Site conditions to meet the manufacturer’s requirement.

Air inlet filters sized and located to allow extended operation of the engines without replacement.

10C3.1.3 Exhaust Gas System

The exhaust gas system directs exhaust gas from the engine out of the powerhouse to the atmosphere. Exhaust system will be separate for each engine with height and location to prevent recirculation into the air inlets.

The exhaust gas system will be equipped with explosion rupture disks to relieve the excess pressure in case of explosion due to unburned gas in the ducting. The diameter of the disk is of the same size as the duct. If diameter is smaller than duct, Contractor will provide documentation that rupture disk diameter can handle applicable flow. The outlets of the rupture disks will be ducted out from the powerhouse to the atmosphere.

Expansion bellows will be provided between the engine and the exhaust silencer.

The engine exhaust gas system and ducts will be fully insulated and protected inside the powerhouse. Outside the powerhouse, exhaust ducts will be insulated up to the SCR units and beyond as necessary for personnel protection.

SCR/CO units will be provided to control NOx and CO emissions. Reactor housing to be sized with extra space for additional future layers of catalyst.

The engine exhausts will be grouped together in groups of five with a common steel support frame. Adequate access with ladders and platforms will be provided for maintenance of the SCRs and emission monitoring equipment.

10C3.1.4 Common Base Frame

A common base frame will be provided for the reciprocating engine and generator to provide the necessary stiffness and resonance attenuation.

10C3.1.5 Flexible Coupling and Connections

Flexible coupling and flywheel cover between engine and generator shaft will be provided.
Flexible hoses and bellows for connections of the engine to external piping such as water, fuel, and starting air will be provided.

All exposed moving parts will have shrouds or covers.

**10C3.1.6 Lubricating Oil System**

The engine should be automatically pre-lubricated during the starting sequence. Sample points will be provided to enable oil sampling when the engines are operating.

Separate storage tanks will be provided for clean and dirty oil with sufficient capacity for one oil change for up to four engines on the clean oil storage tank and up to four engines on the dirty oil storage tank on site. The system will include transfer pumps to transfer oil to and from the clean oil storage tanks for changing oil in 40 minutes or less each way.

New and used lube oil will be loaded and off loaded with onsite unloading pumps and with the capability to accommodate truck mounted transfer pumps.

**10C3.1.7 Engine Cooling Systems**

Cooling is vital part to enable reliable and continuous Project operation. Each circuit is connected to a radiator (or heat exchanger) located outdoors. The engine cooling water system includes one engine driven pump for the high temperature circuit, and one pump for the low temperature circuit (two pumps per engine). Lubricating oil heat exchanger—one per engine (plate type)—is provided for each engine. The lubricating oil is cooled with LT water.

Corrosion inhibiting additives must be used in the engine coolant water. The manufacturer's dosage, pH, and testing recommendations will be followed.

An elevated water surge tank will be provided for surge capability, system water level checking, venting, and adequate net positive suction head (NPSH) for supplying adequate pressure for the coolant water pumps. Vent valves will be provided to remove air from the system. Connections will be provided to add chemicals to the system and to take samples for testing chemistry.

**10C3.1.7.1 Radiator (or heat exchanger) Cooler Package**

The coolant water will be cooled in a closed circuit by radiators, remote mounted type, with electric fans, where the radiator elements are cooled by air (copper (or copper/nickel) tubes and aluminum fins) will be used.

**10C3.1.7.2 Preheating Units For Jacket Water**

Pre-heating will be provided to pre-heat the jacket water circuit before the engine is started. The system will consist of an electric heating unit and an electrically driven circulating pump. The preheating circuit will be provided with a non-return valve to force water to flow in the right direction.

**10C3.1.7.3 Maintenance water tank**

The drainage of treated engine coolant water will be to the maintenance water tank and will be designed to enable quick drainage. This is to facilitate maintenance. The treated engine coolant water will be pumped back into the engine and reused after maintenance.
One maintenance water tank with a pump may serve up to 5 engines.

The maintenance water tanks will be equipped with secondary containment in case of tank leaks or rupture.

**10C3.1.8 Closed Cooling Water System**

The closed cooling water system will be designed for removing the maximum heat rejected from all the auxiliary equipment identified and rejecting it to the atmosphere. Cooling water pumps, and cooling water heat exchangers (each isolatable for routine cleaning and tube plugging without plant curtailment), will be provided. For each engine, one 100 percent engine driven cooling pump for each circuit (HT and LT) will be provided.

The cooling water heat exchangers and pumps will be sized to supply adequate cooling water to the closed loop system. The system will be designed to provide adequate cooling for the site conditions. The system design will permit shutdown and maintenance of the individual items of equipment without interruption of the cooling function of the rest of the system.

Isolation valves will be provided at each engine for engine maintenance during Project operation.

**10C3.2 Selective Catalytic Reduction**

A selective catalytic reduction (SCR) system will be provided to control the emissions of NO\textsubscript{x} and CO for natural gas or liquid fuel operation. The system may be a separate module for each engine or several engines may exhaust to a single module. The system may use 19 percent aqueous ammonia.

The systems will be full automatic and will include:

- Ammonia storage tank with a minimum 10 day storage in gas mode and sufficient capacity to accept delivery of all contents of one delivery truck with a 2 day margin at full operation of existing tank contents
- Containment berm around the storage tank
- Truck unloading station
- Injection / forwarding pumps
- Mixing chamber
- Controls

Systems using urea must include insulation and heat tracing of the tanks, piping, and pumps as defined in other sections of this specification.

**10C3.3 Pumps**

This section is not applicable to pumps that are on the engines, engine auxiliary modules, pre-engineered pipe racks or engine exhaust gas modules as shipped from the factory. Pumps that are shipped as part of the engines will be vendor’s standard.
All pumps will be designed for continuous operation unless otherwise specified.

All pumps will be installed in positions convenient for operation and servicing. Where multiple pump installations are required, each pump and its associated equipment will be arranged in such a manner as to permit easy access for operation, maintenance, and pump removal without affecting plant operation. Lifting lugs, eye bolts, and other special tackle will be provided to permit easy handling and removal of the pump and its components, if weighing over 40 lbs.

Standard types of pumps will be used wherever possible. Only proven products and models are to be supplied.

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 with OSHA coupling guard.

Pumping systems with variable flow requirement will have a recirculation line for pump protection. As a minimum, pumps with motors rated for 25 hp and above will be supplied with a recirculation line for protection. The recirculation line will normally be routed to the source from which the system takes suction. Modulating or two-position automatic recirculation valves or restriction orifices will be used as applicable.

Lube pump circuits will be provided with a minimum one hour fire rated barrier enclosure and/or fire wrap. All fire barriers and/or fire wraps will be UL Listed and identifiable the latest edition of the UL fire directory.

Vent and drain plugs will be fitted, where necessary. Oil system pump vents and drains will be provided with valves. Horizontal split-case pumps will allow the removable half casing 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 from the motor end without disturbing the motor or discharge piping.

Where part-load (e.g., two 50 percent) duplicate pumps for the same service are provided, they will be capable of operating in parallel.

10C3.3.1 Pump Types
Centrifugal pumps will be used wherever possible. Positive displacement screw pumps may be used when handling fuel and lubricate oils, and reciprocating pumps will be accepted for chemical dosing and metering purposes.

10C3.3.2 General Design and Construction
All pumps will be designed to withstand 1.5 times the pump shut-off pressure, under maximum suction pressure conditions, unless otherwise specified. All pump shafts will be of ample size to transmit the full output from their drivers. Impellers will be fitted to the shaft in a suitable manner that will permit the transmission of the maximum torque developed under any operating condition and removal without damage to either impeller or shaft.

All pumps will be selected such that they do not cavitate under the expected range of operating conditions.
Renewable wear rings will be fitted to the casing and impeller.

All pumps will be constructed of materials specifically designed for the conditions and nature of the pumped fluid and to resist cavitation, erosion, and corrosion.

Where the pumps are operated intermittently, special care will be taken to prevent brining of the recess while the pumps are not in operation. Seals will be provided and must meet the working conditions. For centrifugal pumps, mechanic seals will be adopted.

Centrifugal pumps will preferably be of the horizontal-shaft type unless specified otherwise. Each horizontal pump will be mounted with its driving motor on a common baseplate of rigid construction. The baseplate will be provided with a drip tray fitted with a drain line and valve.

The construction of the pump casing will be two parts, an upper part and a lower part, for easy maintenance. For small process pumps, in lieu of split case construction, back pullout of impeller arrangement can be provided.

Vertical-shaft centrifugal pumps may be employed when pumped liquids are at or near their boiling point. Pumps for such duties must be carefully sited to ensure that the Net Positive Suction Head Available (NPSHA) under all operating conditions will be adequate for the type of pump employed. The NPSHA values represent the worst operating conditions, i.e., the lowest atmospheric pressure, lowest suction pressure of the pump, and highest temperature of the pumped fluid.

Horizontal shaft, 3,600 rpm pumps of the centrifugal type will have balanced impellers and at least two bearings. The driver will be mounted on an extension of the pump bedplate and will drive the pump through a flexible coupling.

Centrifugal pumps will be of rigid-shaft design and will be designed such that the first critical speed of the pump, when coupled to its driver is at least 10 percent higher than the maximum operating speed. The entire rotor assembly will be statically balanced, and dynamic balancing is required in one of the following cases:

- Pump speed exceeds 1,500 rpm, capacity exceeds 250 gpm (56 m³/h) and impeller diameter exceeds 6 inches (150 mm).
- Pump speed exceeds 1,500 rpm for pumps of two or more stages.

Pumps will operate smoothly throughout the speed range in reaching their operating speed. Where necessary the pumps are to be fitted with devices to ensure a minimum throughput.

The piping upstream of a pump will be at least as large as the pump suction connection. Velocity will be limited to 3 fps if there is a suction lift (negative pressure).

**10C3.3.3 Pump Characteristics**

Where a number of pumps are used for the same purpose, they will be suitable for parallel operation and will be interchangeable.
The pump head characteristics will be such that the head will continuously increase with decreasing flow quantity with a maximum head reached at zero flow. Generally, a head increase of 15 percent above the duty point at zero flow will be acceptable.

Full pump characteristic curves giving head/capacity, efficiency/capacity, power absorbed/capacity, and net positive suction head required/capacity will be provided for all pumps.

Unless otherwise specified, the capacity of all pumps will be so determined that under normal operation, their total rated running output is 110 percent of the process flow, if the suction level is controlled, and 115 percent of the process flow, if the suction is uncontrolled (i.e., free suction pump).

10C3.3.4 Fittings

Pumps will be installed with isolating valves, a discharge non-return valve, and suction and discharge pressure gauges, where applicable. All positive displacement pumps will be fitted with a discharge relief valve. Provisions for temperature measurement will be made in pump suction and discharge pipe sections adjacent to the pump flanges, where applicable.

All couplings and any intermediate shafting will be supplied with removable type coupling guards that will cover the rotating parts and comply with the stipulations on guards in the relevant section of this Specification.

Coupling halves will be so matched as to ensure accurate alignment. Horizontal shaft pumps will be driven by the motor through an approved type of flexible coupling. Pin-type flexible couplings will not be used. Vertical shaft and in-line pumps may be driven directly by the motor through a rigid coupling provided the motor thrust bearing has adequate margin to take care of the pump’s maximum thrust.

All pumps other than submersible pumps and the coolant pumps will have temporary strainers fitted in the suction pipe-work during initial start-up and commissioning. All critical pumps will be provided with permanent strainers together with differential pressure gauges and alarm facilities.

Air release valves will be fitted to all pumps that are not self-venting pumps. Drainage facilities will be provided on the pump casing or adjacent pipe-work to facilitate the dismantling of pumps.

10C3.3.5 Bearings

If automated oil-lubricated sleeve bearings are not provided, Contractor will submit design for Owner’s review. Bearings will not be lubricated by the process fluid if the process fluid is other than clean oil.

On pumps utilizing ball or roller bearings, the inner race will be fitted directly onto the shaft and reliably fixed by a shoulder on the shaft. Bearings on vertical-shaft pumps will be so spaced as to prevent shaft whipping or vibration under any mode of operation.

Bearing housing on horizontal shaft pumps will be effectively protected against the ingress of water, pumped fluid, and dust with suitable non-ferrous deflectors.
10C3.4 Piping

This section is not applicable to piping systems that are on the engines, engine auxiliary modules, pre-engineered pipe racks, or engine exhaust gas modules as shipped from the factory. Piping that is shipped as part of the engines will be vendors standard.

Piping materials, fabrication, and erection will be in accordance with ANSI B31.1 “Power Piping” except as noted otherwise herein. Reference to ANSI B31.1 is equivalent to ASME B31.1. All piping in services with design temperatures 750°F or above will be seamless. Electric Fusion Welded Pipe (EFW) may be used, as long as all requirements of ANSI B31.1 are met.

Extra strong or schedule 80 will be used for all piping 2 inch and smaller except for stainless steel construction where schedule 40S may be used. Socket weld construction will be used for all piping 2 inch and smaller. All threaded piping will be schedule 40 minimum. Maximum line size for threaded connection will be 2”. Threaded connections at equipment will be provided with unions. All threaded piping will be schedule 40 minimum. Maximum line size for threaded connection will be 2 inches.

Minimum corrosion allowances for all piping systems will be per ANSI B31.1 requirements and standard industry practices for facilities with a 30-year design life. Natural gas systems will use butt weld construction for all sizes 2.5 inches and larger. Water and water-based systems using steel pipe may be either butt weld or flange construction for sizes 2.5 inches and larger.

All critical above ground pressure piping, including, as a minimum, the cycle makeup water supply line and all underground pressure piping will be hydrostatically tested at pressures required by ANSI B31.1.

Note: All non-skid mounted piping will be supplied in accordance with ANSI B31.1 in instances where B31.1 differs from the European code. In ALL instances, documentation will be in accordance with B31.1. This note applies to all piping in the Project.

Potable water piping will be schedule 80 PVC pipe or HDPE and fittings with bronze valves except for exterior piping in rack will be schedule 80 A53 galvanized with 3000# cadmium plated A105 threaded fittings. Potable water will supply safety showers/eye washes, which will be furnished for the following locations:

- Chemical feed storage and metering area

Any shower/eyewash located outside will be freeze protected with electric heating tracing with suitable controls to prevent overheating of water. Underground piping systems may use PVC or HDPE pipe where appropriate based on design conditions. Buried steel pipe will be coated and wrapped and cathodic protection should be considered as required by the soil conditions. Carbon steel bolts for mechanical joints will be wrapped. Cast iron valves may be used for wastewater, potable water, and fire protection only.

All piping furnished with the equipment regardless of size and service will be provided with all necessary rigid and spring hangers, supports, braces, and anchors required to properly support the piping systems and will include necessary expansion loops to provide flexibility. Piping support steel length will be limited to a maximum of 15 feet. All welding
of piping systems will be performed by welding operators who have been qualified in accordance with the applicable requirements of Section IX of the ASME BP&V code.

All materials for piping, valves, fittings, pressure vessels, and associated piping components will conform to the applicable ANSI Codes. Valves will be appropriate for the pressures and temperatures of each specific application. Gate valves will not be used for throttling. ANSI Class 125 valves are not acceptable, except for potable water plumbing and circulating water system. Contractor will provide adequate pipe support systems to allow pipe expansion, contraction, and appropriate seismic loads, if any.

Supporting straps around pipe flanges or valves are not acceptable. Anchors will be attached to pipes by approved means.

Where pipe runs pass through open penetrations, floors, or walls, either individually or collectively, floor or wall collars or other approved curbing will be provided. Floor collars will extend to an approved height.

Each pipe will be fitted at the ends to prevent the ingress of dirt during transportation and storage.

Care will be taken during final assembly and commissioning that pipes are cleaned and free of grit, scale, jointing material, and/or tools.

Instrument air branches will be taken from the top of the mains. Service air branch pipe to points of use will terminate in positive locking Schrader-type hose coupling.

Piping may be routed on overhead pipeways or sleeperways; it may be supported from the building structure using pipe supports or rod hangers; or it may be buried. Space for electrical and instrument conduit runs will be provided on the pipeways and sleeperways as required. Underground piping will be provided with adequate corrosion protection, if required. Fire water loop piping and potable water piping will normally be routed underground.

Carbon steel lines 2 inches and smaller will be Schedule 40 minimum. For the 2-inch and smaller alloy steel lines, the minimum pipe wall thickness will be calculated based on design conditions.

Minimum pipe size will be ½ inch, except for connections to equipment. Pipe sizes 1-1/4 inches and 5 inches will not be used except for connections to equipment.

Pipe wall thickness calculations will be based on the lowest strength component in the system, considering all factors, including the possibility of pipe and fittings having different maximum allowable stress values, and/or manufacturer’s minus tolerance.

Individual pipeline material classifications will be developed for each class of service. These material classifications will define the valves, pipe, fittings, flanges, gaskets, and bolting to be used.

Piping systems and components will be stress analyzed, if required, for thermal flexibility, support, pressure, vibration, seismic, fluid or gas flow reactions, and environmental factors, including effects on equipment.
The piping flexibility analysis will consider the most severe operating temperature condition sustained during startup, normal operation, upsets, or shutdown. The analysis will be for the maximum temperature differential. The effect of installation temperature and solar temperatures will be considered in determining the maximum temperature differential. Analysis will include relief valve opening and stop valve closure.

As a minimum, computer analysis will be performed on all piping over 250°F or piping subject to dynamic transients.

Piping flexibility will be obtained through pipe routing or expansion loops unless limitations of space or economics dictate the use of flexible connectors.

Expansion loops, when installed in a horizontal plane, may be offset vertically to clear adjacent piping. Flexible connectors are to be used only when it is not feasible to provide flexibility by other means.

Contractor’s pipe stress engineer will verify proper installation and setting for all pipe supports (1) before initial heat up, and (2) during initial operation at full plant load or other maximum operating conditions (where possible).

10C3.4.1 Piping Materials

All pipe-work will be designed, fabricated and tested according to the requirements of the approved standard as required by this Technical Specification.

The material of the piping will be equal to or better than the following technical requirements:

- For design metal temperature up to and including 420°C, carbon steel (including plate material) will be used.
- For design metal temperature between 420°C and 530°C, approved low alloy steel will be used.
- For design metal temperature above 530°C, 2.25 percent Cr, 1 percent Mo steel will be used.

The outside of the embedded pipes will be protected by coatings.

Underground piping systems may use PVC or HDPE pipe where appropriate based on design conditions. Buried steel pipe will be coated and wrapped and cathodic protection should be considered as required by the soil conditions. Carbon steel bolts for mechanical joints will be wrapped. Cast iron valves may be used for wastewater, potable water, and fire protection only.

Lubricating oil piping will be made of A53 (ASME) or equivalent material, with Schedule 40 minimum pipe thickness or equivalent standard thickness. Pressure piping will be of seamless pipe. The pipeline from last filter on the generator oil supply manifold to the generator group connecting point will be made of stainless steel. The control oil pipeline will be stainless steel seamless pipe.

The cooling water and fire protection water piping will be made of carbon steel.
The pipes used for acids or caustic solutions will be made of anti-corrosive material. The chlorine piping will also be of anti-corrosive material.

Instrument compressed air piping will be made of stainless steel. The joints of piping will be welded and, for thread-type joints, sealed weld will be applied.

Demineralized water pipe will be made of stainless steel.

Piping materials under special conditions will be as follows:

- Sodium hydroxide — Stainless steel or semi transparent FRP
- Hydrochloric acid — Polyvinyl chloride pipe or FRP
- Other chemicals — Polyvinyl chloride pipe or FRP

The materials of the piping leading from drains, vents, and so on to the shutoff valve on the main pipe will be made of the same material as the main pipe.

Potable water piping material will be in accordance with applicable plumbing code and suitable for the well or utility interconnect water chemistry.

Potable water piping will be schedule 80 PVC pipe or HDPE and fittings with bronze valves except for exterior piping in rack will be schedule 80 A53 galvanized with 3000# cadmium plated A105 threaded fittings. Potable water will supply safety showers and eye washes, which will be furnished for the following locations:

- Acid and caustic, ammonia or urea storage tank area(s)
- Chemical feed storage and metering area.

Compressed air piping between air compressors and air dryers will be galvanized carbon steel, copper, or stainless steel. Compressed air piping downstream of air dryers (instrument air) will be copper or stainless steel. Other compressed air piping downstream of the receiver(s) (service air) will be stainless steel, galvanized carbon steel, or copper.

All pipes which are subject to corrosion, in addition to the normal design wall thickness, will have an additional corrosion allowance that is sufficient to ensure a minimum service life of 30 years and is, in any case, no less than 0.08 in (2 mm).

Piping will be so arranged as to provide clearance for the removal of any piece of equipment requiring maintenance with a minimum dismantling of piping and for easy access to valves and other piping accessories required for operation.

Overhead piping will have a minimum vertical clearance of 7 feet 2 inches above walkways and working areas and be of sufficient height above roadways to enable removal of the largest/heaviest equipment from the Project.

All pipe-work will be fabricated with appropriate connections used for pressure gauges, thermometers and any other corollary device as required by the plant design. Appropriate connections for Performance Test instrumentation will also be provided.

No pipe-work will be run in trenches carrying electrical cables.

Maximum design velocity of fluids through piping will take into account water hammer, erosion, and pressure drop of fluid in the lines.
Double-wall piping with leak detection will be provided for underground piping containing hazardous chemicals. In lieu of double wall pipe, contained coated pipe ways are acceptable, with leak detection.

**10C3.4.2 Pipe Velocities**

The velocity of flow in pipes is not to exceed the values in Table 10C-1 unless otherwise specifically mentioned:

**TABLE 10C-1**

<table>
<thead>
<tr>
<th>Piping</th>
<th>Flow Rate (feet per second)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water Lines</strong></td>
<td></td>
</tr>
<tr>
<td>Closed cooling and cooling water</td>
<td>12</td>
</tr>
<tr>
<td>General service piping including drinking,</td>
<td>10</td>
</tr>
<tr>
<td>fire fighting, raw and demineralized water</td>
<td></td>
</tr>
<tr>
<td>lines</td>
<td></td>
</tr>
<tr>
<td>City service piping</td>
<td>7</td>
</tr>
<tr>
<td>General pump suction lines</td>
<td>3</td>
</tr>
<tr>
<td><strong>Air Lines</strong></td>
<td></td>
</tr>
<tr>
<td>Compressed air pipelines</td>
<td>80</td>
</tr>
<tr>
<td><strong>Natural Gas Lines</strong></td>
<td></td>
</tr>
<tr>
<td>Fuel gas supply lines (with insulation</td>
<td>170</td>
</tr>
<tr>
<td>to reduce noise levels)</td>
<td></td>
</tr>
</tbody>
</table>

Maximum design velocity of fluids through piping will take into account water hammer, erosion, and pressure drop of fluid in the lines.

**10C3.4.3 Pipe Hangers and Supports**

When located outdoors, corrosion-resistant variable and constant springs will be furnished that consist of all galvanized components except for the spring or coil, which will be neoprene coated. Rods, clevises, weldless eyenuts, and turnbuckles will be galvanized. All other hanger components may be painted per the requirements of section on painting.

Piping that normally does not contain liquid and requiring hydro testing will be pneumatically tested.

**10C3.5 Valves**

This section is not applicable to valves that are on the engines, engine auxiliary modules, pre-engineered pipe racks or engine exhaust gas modules as shipped from the factory. Valves that are shipped as part of the engines will be vendor’s standard.

Valves will be installed to meet valve manufacture’s recommendation. For example, valve with vertical actuator will not be installed with actuator in any other way but vertical.

Valves may comply with European standards that are comparable with U.S. standards. Contractor is responsible for ensuring proper interconnections between items built to...
European standards and items built to U.S. standards. Contractor will include a set of maintenance tools for items built to European standards.

Nameplates on safety and relief valves will indicate manufacturer’s name, model number, size, set pressure, capacity, orifice size, materials, and approving authority stamp symbol. Each safety and relief valve will be supplied with a test certificate.

All valves and valve actuators will be accessible for operation and maintenance.

Block valves will be provided at all equipment, except the air-side of rotor air coolers.

Valving and other accessories will be positioned and physically spaced relative to other equipment so as to allow convenient access for operation and maintenance. Crowding of piping, components, and accessories will be avoided.

Valves will be arranged for convenient operation from an appropriate floor level or platform and will be provided with extension spindles or gearing, as required. Deviations from this design criterion require Owner approval before design finalization. Where extension spindles are fitted, all the thrust when opening or closing the valves will be taken directly on the valve body and all pedestals will be mounted directly on floor girders or other stationary members. Chain operators are not acceptable. Valves, valve handwheels, and/or valve actuators will not infringe on Owner-reserved spaces or walkways. Valve pedestals will be of approved design and be fitted with an indicator to show whether the valve is open or closed.

All valves will be arranged to close when the handwheel is rotated in a clockwise direction when looking at the handwheel from the operating position. The direction of rotation to close the valve will be clearly marked on the face of each handwheel.

All steam and water valves operating at less than atmospheric pressure will have inverted Teflon stem packing.

Hand-actuated valves will be operable by one person. Gear operators will be provided on manual valves when the rim pull required to open or close the valve is greater than 100 pounds.

Valve materials will be suitable for operation at the maximum working pressure and temperature of the piping to which they are connected. Steel valves will have cast or forged steel spindles. Seats and faces will be of low friction, wear-resistant materials.

Valves in throttling service will be selected with design characteristics and of materials that will resist erosion of the valve seats when the valves are operated partly closed.

Valves with position stops that limit the travel of each valve in the open or closed position will have the stops located on the exterior of the valve body to provide clear indication of full open and close positions.

In general, the valves specified will be standardized to use the same valve type and manufacturer to the extent possible.

Except where otherwise specified or approved, gate valves greater than 3 inches in diameter in high pressure classes will be of the parallel slide type or flexible wedge type, and, when
in the fully open position, the bore will not be obstructed by any part of the gate. The internal diameter of valve ends will be the same as the internal diameter of the pipe. Gate valves in pressure classes 1500 and above, standard port size, will be used whenever suitable. Gate valves in high pressure classes will have butt-welded joints except where otherwise specified or approved.

Valves will not be installed in an inverted position.

10C3.5.1 Valve Types
10C3.5.1.1 Drain and Vent Valves and Traps
Double valving will be provided for drains and vents in Class 900 or higher piping service. Drain and vent valves can be ball, needle, globe, or gate valves.

Drain traps will be complete with air cock and easing mechanism. Internal parts will be constructed from corrosion-resistant materials and be renewable. Trap bodies and covers will be cast or forged steel and be suitable for operating at the maximum working pressure and temperature of the piping to which they are connected. Traps will be piped to the drain collection tank or to sumps, and condensate will be returned to the cycle if convenient.

Drain valves will have cast or forged steel bodies with covers and glands of approved construction. Spindles will be of stainless steel, and materials will be suitable for operation at the maximum working pressure and temperature of the piping to which they are connected.

Where valve seats are shrouded, the design of the shroud will be such as to prevent foreign matter from lodging in the valve seat.

10C3.5.1.2 Low-Pressure Water Valves
Low-pressure water valves will be butterfly type of steel or cast iron construction. Cast iron valves will have cast iron bodies, covers, gates (discs), and bridges; the spindles, seats, and faces will be bronze or stainless steel. For butterfly valves the seats and faces may be of soft seal material.

Low-pressure valves carrying liquids or gases at sub-atmospheric temperatures (e.g., carbon dioxide storage) will be designed to meet ASHRAE and applicable industry requirements for refrigeration piping.

10C3.5.1.3 Instrument Air Valves
Instrument air valves will be ball type of bronze or stainless steel construction, with valve face and seat of approved wear-resistant alloy. An isolation valve will be provided at each branch point from main headers.

10C3.5.1.4 Non-Return Valves
Non-return valves will be provided on the discharge of all centrifugal pumps (and other pumps that allow backflow) to minimize manual operator actions during system filling, to prevent system backflow/drainage following pump trip or shutdown, and to prevent backflow from desuperheaters (where applicable). Check valves are not required for the closed cooling water pumps.
10C3.5.1.5 Control Valves

Control valves in throttling service will generally be the globe-body cage type with body materials, pressure rating, and valve trims suitable for the service involved. Other style valve bodies (e.g., butterfly, eccentric disk) may also be used. Block valves will be provided upstream and downstream of all modulating control valves except for the main steam bypass. Bypass valves will be provided except where bypass valve use is impractical or presents a potential safety hazard, as approved by Owner.

Control valve actuators will be the pneumatic-spring diaphragm or piston type. The actuator will be sized to shut off against at least 110 percent of the maximum shutoff pressure. Actuators will be designed to function with instrument air pressure ranging from 60 to 125 psig.

Valves will be designed to fail in a safe position.

Control valve body size will not be more than two sizes smaller than line size, unless the smaller size is specifically reviewed for stresses in the piping and calculations are provided to Owner for record purposes.

Where flanged valves are used, minimum flange rating will be ANSI 150 class. Control valves in 600 class service and below will be flanged where economical.

Critical service valves will be defined as ANSI 900 class and higher valves in sizes over 2 inches.

Severe service valves will be defined as valves requiring anti-cavitation trim, low noise trim, or flashing service, with differential pressures greater than 100 psig.

In general, control valves will be specified for a noise level no greater than 90 dBA when measured 3 feet downstream and 3 feet away from the pipe surface.

Valve actuators will use positioners that are manufacturer’s standard.

Handwheels will be furnished only on those valves that can be manually set and controlled during system operation (to maintain Project operation) and do not have manual bypasses.

Control valve accessories, excluding controllers, will be mounted on the valve actuator unless severe vibration is expected.

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

The DCS/PLC will monitor both “Open” and “Closed” position switches for motor-operated valves and pneumatic-operated control valves used for “On-Off” service. Position switches will not typically be provided for control valves used for “throttling” service. Where required, automatic combined recirculation flow control and check valves or orifices (provided by the pump manufacturer) will be used for pump minimum flow recirculation control. Modulating or two-position automatic recirculation valves or restriction orifices will be used as applicable.

Body material and rating will conform to piping specifications as a minimum.
In no case will the valve body minimum rating be less than that permitted by piping specifications.

Control valve body size will be 1-inch minimum. Sizes such as 5-inch body will not be used. Body sizes smaller than 1 inch may be used for special applications with 3/4-inch-and-under line size, and for pressure regulator services. Reduced ports will be used as required. Body size will not be more than two pipe sizes smaller than the line. Valves for on-off service will normally be line size.

Valve type and size will be selected taking into account such factors as cost, operating and design conditions, fluid being handled, rangeability-required allowable leakage, noise, and any other special requirements. For general services, the following types will be considered:

- Cage Guided Globe Valves with balanced or unbalanced type trim.
- Single seated globe valves may be either top and bottom or top guided.
- Eccentric Rotating Plug Valves of the throttling type.
- Ball Valves of the throttling type.
- Butterfly Valves with either conventional or shaped discs.
- Special Body Types may be considered for special applications such as slurry handling, highly erosive or viscous streams, and noise control.

Characteristics of the inner valve will be determined by the following system characteristics:

- Equal Percentage Characteristics will normally be used on loops that have large variations in valve pressure drops, fast pressure control loops, and most flow control loops. In processes where no guidelines are available, equal percentages will be used.
- Linear Characteristics will normally be used for most level control, slow pressure control loops, and loops where the measurement is linear and the variation in the pressure drop across the control valve is small. Linear characteristics will be used for three-way valves and for two-way valves used in three-way service.
- Quick Opening Characteristics will normally be used for off-on service and for direct connected regulators using low lift.

Valve trim will be stainless steel minimum, hardened as required for maximum service requirements. Severe service conditions may dictate consideration of other materials.

Guide bushings will be of corrosion-resistant material. It is preferred that the guide material be a minimum of 125 Brinell harder than the trim.

Packing glands will be equipped with flange-style gland followers, secured by two bolts. A lubricator with steel isolating valve will be provided where packing lubrication is required. Packing will be Teflon below 450°F and Graphoil for temperatures of 450°F and higher. No asbestos is permissible.

Extension bonnets will be provided on throttling services above 450°F and below 0°F, or in accordance with the manufacturer’s recommendation. On-off control valves will use high temperature packing in lieu of extension bonnets when practicable.
Piston actuators will be furnished with pneumatic trip valve, volume tank, piping, and necessary components to lock-in supply air pressure on loss of supply air pressure to actuator to ensure proper failure position.

Split ranging of control valves will be done electronically using independent DCS/PLC outputs. Pneumatic split ranging is not allowed.

Positioners will be the manufacturer’s standard.

Valve leakage class will conform to ANSI B16.104, “Control Valve Seat Leakage”, Class II.

10C3.5.1.6 Safety and Relief Valves
Safety valves and relief valves will be provided as required by Code. Safety and relief valves will be flanged and installed vertically. Piping systems that can be overpressurized by a higher pressure source will also be protected by pressure relief valves. Equipment or parts of equipment that can be overpressurized by thermal expansion of the contained liquid will be provided with thermal relief valves.

10C3.5.1.7 Instrument Root Valves
Instrument root valves and condensate pots will be specified for operation at the working pressure and temperature of the piping to which they are connected. Double valving will be provided for instrument taps in Class 900 or higher service. Root valves for Class 600 and lower may be 1/2 inch. All other systems will have ¾-inch root valves.

10C3.5.1.8 Float-Operated Valves
Float-operated valves will be provided with small-bore float-operated pilot valves connected into each system, where necessary, to eliminate water hammer. Floats will be arranged to operate in a baffle tank, designed to prevent a turbulent water surface around the float.

10C3.5.1.9 High-Pressure Valves
Steel valves will have cast or forged steel spindles. Seats and faces will be of low friction and wear resistant.

Valves used for throttling service will be designated to prevent erosion of the valve seats when the valves are operated in a partly open condition.

Valves over NPS 2 inches in size and rated in pressure Class 900 and above will be provided with pressure seal bonnets. Systems with pressure ratings of Class 900 or greater will use double valve for vents and drains to the atmosphere. Valves over NPS 2 inches in size and rated in pressure Class 600 and below will be provided with bolted or welded bonnets “T” pattern, or “Y” pattern bonnetless style design.

Valves under NPS 2 inches in size will be provided as follows:

- For Class 600 and under, use bolted bonnet.
- For Class 900 and over, use welded bonnet “T” pattern, or “Y” pattern bonnetless style.

ANSI pressure Classes 900 and 1500 flexible wedge gate valves will be specified with pressure seal bonnet/cover joint, stellited integral or welded-in seat rings, lubricated
bearing yoke sleeve (NPS 6 and larger), bolted gland, and the disc provided with stellited seating surfaces.

ANSI pressure Class 600 flexible wedge gate valves will be provided with bolted gland arrangement, integral or welded-in seat rings, provision for back seating, bolted-ring type body/bonnet joint, and yoke drive sleeve with ball or needle bearings and booster station as described above, except they will not include the bolted ring type body/bonnet joint.

10C3.5.2 Insulation and Freeze Protection
All piping subject to freezing will be freeze protected with electric heat tracing cable as described in the Electrical section. Piping will be insulated with mineral fiber per ASTM C547, Class 2 for operating temperatures up to 500°F and calcium silicate per ASTM C533, Type 1 for higher operating temperatures. (Except that insulation on European sourced equipment will use equivalent international standards. The manufacturer will provide specifications in the final documents.) Insulation will be covered with a “stucco” embossed aluminum lagging per ASTM B209, Alloy 3003, Temper H14 (half-hard) with a thickness of 0.016 ±0.003 inches. The insulation and lagging system will provide a cold face temperature of 140°F at an ambient air temperature of 95°F in still air.

Anti-sweat insulation will be flexible elastomeric cellular insulation conforming to ASTM C534.

10C3.5.3 Tanks
Large outdoor storage tanks will be welded or seamless construction. Drains and other design features will be provided as required to prevent damage to the tank wall during extended outages in subfreezing weather. Tanks will be sized to provide the required storage volume that accounts for freeze losses.

Demineralized water tanks will be shop-coated internally with a fused-glass coating. Coated tank material surface profiles will be suitable for coating application, Coatings will extend completely under all gaskets, and special provisions will be made at all plate ends to prevent corrosion (e.g., use of stainless steel edge coat).

Nozzles on water tanks subject to freezing will project into the tank by a distance sufficient to permit continued operation with an ice layer on the inside of the tank wall.

Maintenance drains near the tank bottom will be provided for complete tank drainage.

Containment systems will be provided for all tanks containing potentially hazardous liquids, including ammonia. Leak detection systems will be provided, as required by regulations or permits. All tank containment areas will be furnished with drains and low-point sumps.

Special requirements for aqueous ammonia tanks: The ammonia storage facility will be designed to either the ASME Pressure Vessel Code and ANSI K61.6 or to API 620. In either case, the storage tank will be protected by a secondary containment basin capable of holding 150 percent of the storage volume of the largest tank in the basin, plus the volume associated with 24 hours of rain assuming the 25-year storm.
Manholes, where provided, will be at least 24 inches in diameter. Ladders and cleanout doors will be provided on storage tanks as required to facilitate access/maintenance. Provisions will be included to allow proper tank ventilation during internal maintenance.

Unless otherwise specified or approved, tanks used for the storage of oil, raw water, treated fresh water, and condensate will be carbon-steel-plate stiffened and stayed in an approved manner where necessary.

Pipe connections for tanks will be made to welded pads or reinforced nozzles, the thickness of which will not be less than 1-1/2 times the diameter of the joint studs. Joint stud holes will not be drilled through the pads. Pipe connections will be made with studs and not cap bolts.

Tanks that are to be insulated and lagged will be provided with external lugs where necessary.

A corrosion allowance of 1/16 inch for carbon steel and low chrome alloys will be used, except for lined or internally coated tanks.

Overflow connections and lines will be provided and be at least one pipe size larger than the largest input line or combination of inputs that can discharge simultaneously.

Liquid fuel will be stored in vertical cylindrical oil storage tanks which will be designed as per API-650. The storage tanks will be located within a dyked/contained area as per applicable rules and regulations; however, the Contractor will coordinate with Owner regarding the location of existing Humboldt Bay Power Plant fuel storage tanks while determining the new location in order to comply with Owner requirements.

The fuel oil storage tanks will be provided with necessary local indication. Oil pipe lines will be all welded except for the flanges at the pumps.

**10C3.5.4 Heat Exchangers**

Heat exchangers will be provided as components of mechanical equipment packages and may be shell-and-tube or plate type. Heat exchangers will be designed in accordance with Tubular Exchanger Manufacturers Association (TEMA) or manufacturer's standards. Fouling factors will be specified in accordance with TEMA or HEI.

Thermal relief valves will be provided for heat exchangers as required.

**10C3.5.5 Pressure Vessels**

Pressure vessels will be designed to ASME VIII standards and in accordance with state and local requirements.

Pressure vessels will include the following features and appurtenances:

- Process, vent, and drain connections for startup, operation, and maintenance
- Materials compatible with the fluid being handled
- A minimum of one handhole and one air ventilation opening (e.g., handhole) where required for maintenance or cleaning access
• Shop-installed insulation clips spaced not greater than 18 inches on center for vessels requiring insulation

• Relief valves in accordance with the applicable codes

• Vessel capacity consistent with design requirements of the system and not less than required to absorb the maximum anticipated system transients.

Carbon steel tanks will have a minimum corrosion allowance of 0.06250 inch. Where practical, coated pressure vessels will be avoided.

10C3.6 Fuel Supply System

The Contractor will design, furnish, and install the fuel (natural gas and liquid) filtering equipment, and pipeline to accommodate the complete operating range of the engines without affecting the stable operation of the Project. The fuel conditioning equipment will process the fuel to meet the OEM requirements for the fuel to the equipment. The Contractor will supply individual fuel regulators and associated relief valves for the fuel consuming components if necessary to prevent exceeding the manufacturer’s maximum allowable supply pressure to such components. The systems will allow the ability to change out filters and dryers on line with no supply restrictions.

If required by the manufacturer, the Contractor will furnish and install equipment necessary to heat the fuel to a temperature acceptable to the engine manufacture with suitable means within the restriction of the Project’s environmental consents (including the Environmental Permit).

The fuel system will be designed to supply the total engine load demands under all ambient conditions.

10C3.6.1 Natural Gas

Fuel conditioning system will include the following equipment:

• Natural gas compressor(s) – electric driven (if required)

• Scrubber, coalescent gas filter, and gas heaters (if applicable) which use waste heat or cycle heat source to ensure that natural gas quality meets the requirements of the engine supplier while improving overall cycle efficiency

• One fuel gas drain tank, with level switch alarmed to the control room

• Pressure regulating station

• Natural gas metering station

• Natural gas heater (if needed)

• Fuel metering (at the plant and at each engine – metering will report to the plant DCS/PLC system)

• Cathodic protection on the gas pipeline to meet PG&E gas interconnection requirements or AGA as applicable.
The minimum fuel processing standards will be as follows:

- **Dry scrubber upstream of the engines:**
  - Filtration will be 100 percent effective for particles 3 microns or larger at design flow rate.
  - Outlet gas will contain no more than 0.10 gallon of entrained liquid per million standard cubic feet of gas.

- **Clean up (coalescing filter) requirements and sizing**
  - Two coalescing filters will be 100 percent effective for particles 0.3 microns or larger.
  - The two filters will operate in parallel so that there is no need to shut down the engines while performing maintenance on one of the filters.
  - The coalescing filters can handle small slugs of liquids up to about 10 gallons.
  - Each filter will be sized to handle the flow associated with all the engines operating at full load.
  - Piping will be carbon steel upstream of the filters and stainless steel downstream of the filters.

Contractor will supply individual fuel gas regulators and associated relief valves for the gas consuming components if necessary to prevent exceeding the manufacturer's maximum allowable supply pressure to such components.

The fuel gas system will be designed to supply the total engine load demands demand under all ambient conditions. The design will allow the ability to change out filters and dryers online with no supply restrictions.

Cathodic protection will be provided on the gas pipeline to meet PG&E gas interconnection requirements and AGA as applicable.

**10C3.6.2 Liquid Fuel System**

The fuel oil system will receive, store and transport diesel fuel for the engines, and black start power generator. The fuel oil will be delivered to the site by truck. The mass flow meter will measure all fuel supplied and will be located close to the Humboldt Bay Power Plant truck delivery point as practically possible. The mass flow meter will be integrated into the Plant DCS/PLC system and, set up to continuously record any fuel quantity delivered.

The tank-truck unloading point for fuel with oil resistant concrete hard-standing, adequate turning and maneuvering areas will also be provided. The truck unloading will be sized to enable unloading two 6,000 gallon trucks with trailer per hour.

Fuel tank truck unloading unit will include fuel feeder pump, fuel pump strainer, flow meter, local control panel, and local selector switch for run / stop / stand-by operation. Two 100 percent strainers (0.5 mm mesh) with differential pressure alarms will be provided (with local annunciation and in MCR).
The fuel storage tanks will have a total capacity to provide 4 days continuous operation of the Project at 100 MW. Each tank will include high and low level alarm switches, locally mounted level indicator, remote indication to DCS/PLC, local fuel temperature indicator, and fuel oil heater (if required). The tank will have a low level alarm that is a mechanical float type. The tanks will be provided with a containment dike to contain any oil spills with drain lines with valves to direct the flow from the containment area to the appropriate rain water or oily/water collection location.

The fuel storage tanks will be provided with a fixed roof. The fuel tank will be provided with piping and drain valves to bleed off any water and sediment at the bottom of the tank, to be tied into waste oil drain system. A low point drain will be provided for bleeding water and sampling. A mixing method will be provided to prevent stratification during storage. A submerged inlet will be provided to avoid splashing and increasing the vapor pressure during filling.

The tank will be provided with external biocide and fuel stabilizer tanks. These will be provided for biocide and fuel stabilizer addition if the fuel will be stored for extended periods.

The fuel truck unloading system will be designed to enable emptying the fuel storage tank to trucks. A higher suction point for fuel system transfer pump will be provided to minimize entrainment of tank bottoms.

The FO day tanks for the engines will be elevated as necessary to provide for a suction head for the FO booster pumps feeding the engines. FO day tanks will have low point drains and with provision to return oil to the fuel storage tank.

The accuracy of all fuel mass flow meters will be equal to or better than ± 0.2 percent of scale reading between at least 50 percent and 100 percent of meter scale, and equal to or better than 0.5 percent at all other scale positions. Mass flow meter accuracy will be based on ISO/DIS 11631, and the temperature range in Attachment 5 to this Exhibit E.

10C3.7 Sump Pumps

Single sump pumps will be furnished as required. The pumps will be equipped with guide bars for removal and automatic discharge connections.

A control panel complete with auto/manual control, starters, level switches, etc., will be included. Pumps will operate at high-high level.

10C3.8 Potable Water

Permanent potable water for personnel use, service/fire water supply, and supply to the water treatment system will be provided. The source will be the Owner’s on-site existing line. The Contractor is to install all potable water supply piping and accessories. The Contractor’s scope includes all tie-ins, metering, and piping necessary to bring the potable water from the tie-in to the project users. All applicable construction permits are by the Contractor.

The Project potable water system will consist of potable water distribution system equipment, including valves and backflow preventors as required. The water distribution
system will be sized to deliver peak demand to each building at a normal pressure of 40 psi and a maximum pressure of 80 psi. Minimum pipe size for building service will be ¾ inch. System will be designed to utilize these pressures considering peak flow demand of the components.

10C3.9 Fire Protection System

10C3.9.1 General
The requirements for the design, manufacturing, testing, supply, and delivery of a complete stand-alone fire protection and fire detection alarm and notification systems, and related subsystems, sprinkler systems, fixed water spray systems, fire protection water supply systems, clean agent extinguishing system, standpipe and hose station connections, and hand held portable fire extinguisher, hereinafter referred to collectively as the fire protection system.

The fire protection system will be independent of the existing Humboldt Bay Power Plant Project but will report and annunciate in the existing Humboldt Bay Power Plant main control room.

Compliance with this Specification does not relieve the Contractor of the responsibility of designing, fabricating, and furnishing a system in accordance with National Fire Protection Association (NFPA) requirements and recommendations, applicable State of California Building and Fire Codes, Standards and Amendments, Federal and County Codes, and the local authorities having jurisdiction.

The fire protection systems and related subsystems are intended as a life safety system and equipment protection, and will be designed and supplied consistent with that objective.

The fire protection systems specified herein is intended for installation by Contractor(s) familiar with the design, manufacture, installation, testing and proper application of such systems.

It is not the intent to specify all details of design and construction. The Contractor will ensure that the equipment as been designed, fabricated, erected and tested in accordance with all building and fire codes, standards, recommendations and governmental regulations applicable to the specified services.

The fire protection system specified herein is intended to be operated by the power station operating staff. As such, it is required that the systems be designed and supplied so as to be “user-friendly.”

10C3.9.2 Contractor’s Responsibility
The Contractor will be responsible for the design and supply of fully operational fire protection systems. The Contractor will be responsible for all material, labor, logistical and technical resources, and coordination necessary for the complete execution of all particulars of this Specification.

All work performed pursuant to this Specification will be complete in every respect, resulting in fully operational fire protection systems supplied entirely in accordance with
the applicable codes, standards, manufacturer’s recommendations, product listings and this Specification.

The fire protection systems supplied will be designed in a consistent manner throughout the premises and all components will be able to operate to meet all requisite functions in a consistent manner. It will be the Contractor’s responsibility to interface and receive approval from the authorities having jurisdiction for the proposed fire protection system.

All design drawings and calculations will be signed and sealed by a State of California Registered Professional Engineer currently practicing engineering in the State of California. In addition to other submittals required by this Specification, the Contractor will provide submittal packages for transmittal to the Local Authorities having Jurisdiction for review, comments and approval of the various fire protection designs, equipment and installations.

**10C3.9.3 Fire Protection Master Plan and Design Basis**

The Contractor will be responsible for preparing a Fire Protection Master Plan and Design Basis. This plan will be integrated with the Owner’s existing Humboldt Bay Power Plant fire protection plan. Contractor will coordinate the new Humboldt Bay Power Plant fire protection master plan and design bases based on the existing Humboldt Bay Power Plant. This will consist of as a minimum the following documents:

- Building and Fire Codes, and Life Safety Compliance Review Report
- Fire Risk Evaluation Report
- Hazardous Area Classification Evaluation

Building and Fire Codes, and Life Safety Compliance Review – The report will identify and address for each building, pre-engineered and/or pre-fabricated building, equipment enclosure and/or structure at a minimum the following:

- Applicable building and fire codes, standards, recommendations and amendments.
- Building classification, occupancy and permitted construction types.
- Building height and area limitations.
- Fire resistance requirements for floors, exterior and interior walls and structural supports.
- Egress and exiting requirements.
- Detailed exit analysis and calculations. Prepare exit analysis drawings documenting occupant loads, required exit widths, occupant load distribution and travel distances.
- Combustible and flammable gases and liquids process equipment and storage fire protection, quantity limitations, and storage requirements.
- Accessibility requirements.
- Fire Department access and fire fighting facilities.
- Occupancy and area separation requirements.
- Fire alarm and detection systems.
APPENDIX 10C: MECHANICAL ENGINEERING DESIGN CRITERIA

1. Sprinkler/Standpipe and fire hose station requirements (duration, flows, pressures and densities).

m. Fire protection water supply requirements.

n. Emergency power and lighting requirements.

o. Smoke control and ventilation requirements.

p. Elevator Requirements

The Building and Fire Codes, and Life Safety Compliance Review will be performed by a State of California Fire Protection and Engineering (FPE) Firm experienced in the preparation of fire protection master plans, building code reviews and reports and exit/egress analysis calculations and diagrams.

Fire Risk Evaluation - A NFPA 850 fire risk evaluation will be initiated as early in the design process as practical to ensure that the fire prevention and fire protection recommendations as described in this document have been evaluated in view of the plant-specific considerations regarding design, layout, and anticipated operating requirements. The evaluation should result in a list of recommended fire prevention features to be provided based on acceptable means for separation or control of common and special hazards, the control or elimination of ignition sources, and the suppression of fires. The fire risk evaluation should be approved by the owner prior to final drawings and installation.

Hazardous Area Classification Evaluation - The basis for classification evaluation will be NFPA 70 (National Electrical Code [NEC]), NFPA 497, API 500, vendor information and other standards, as applicable.

All three documents will be submitted to the local statutory authorities and the Owner for review, comment and approval.

10C3.9.4 Materials, Equipment and System Components Listings and Approvals

All materials, equipment and system components furnished, will be new and approved by local statutory authorities (approved for use by the State of California Fire Marshal) and listed by Underwriters Laboratory (UL/ULI) and/or approved by Factory Mutual Research Corporation (FM) if required by Applicable Laws. The Contractor will provide evidence of listing and/or approvals (if required) of all equipment and combinations of equipment with his submittals.

All materials, equipment and system components for which UL listing categories exist will be ULI listed for the intended application.

All materials, equipment and system components for which UL listing and/or FM approval is required will be listed in the current edition of the UL or FM Fire Protection Equipment Directories and will be delivered to the project site with factory applied, UL and/or FM stickers. It is the Contractor’s responsibility to confirm which components require UL/ULI/FM approval and label per the applicable regulations, and provide all testing and certification required.
Components for which UL listing, FM approval, and the State of California Fire Marshal approval are "pending" are not acceptable.

**10C3.9.5 Fire Protection Water Supply and Water Storage**

The required fire protection water supply (fire flow and duration) will be designed in accordance with the applicable codes and standards.

The water supply for fire protection will be provided directly from a dedicated supply in a Factory Mutual Approved water storage tank. The fire water reserve will be based on the minimum required fire protection water flow and flow duration. The guaranteed fire water level will be based on the largest postulated fire flow per the Fire Protection Master Plan and Design Basis and if the guaranteed fire water quantity can be replaced in an 8-hour time interval as required by NFPA 22.

The tank will be provided with:

a. Fire protection water low level supervisory alarms and low temperature supervisory alarms both monitored by the plants fire detection and alarm system per NFPA 22 and 72, and the DCS/PLC system.

b. OSHA approved handrails, guardrails and ladders for inspection and maintenance of the tank.

c. A supplemental heating system to maintain the water temperature of the tank above the required NFPA 22 requirements.

d. A Factory Mutual (FM) Approval metal tag indicating that the tank is FM Approved affixed to the exterior of the tank by the tank manufacture.

e. Meeting the requirements as specified within other sections of the EPC Specification.

**10C3.9.6 Fire Pumps**

The site will be provided with two (2) Factory Mutual Approved fire pumps both located within a fire pump house enclosure constructed of masonry construction. The fire pumps will be sized to meet the applicable code requirements and the largest postulated fire(s) per the Risk Evaluation.

The types of fire pumps that will be provided are as follows:

a. One (1) 100 percent electric motor-driven centrifugal fire pump.

b. One (1) 100 percent diesel engine-driven centrifugal fire pump.

One (1) pressure maintenance pump (jockey pump) will be provided to maintain pressure in the underground fire protection water main system and also will be located in the fire pump house.

The fire pumps will be separated from each other by a two (2) hour rated fire barrier wall.

The diesel engine driven fire pump will be installed with a residential low noise type muffler.
Each fire pump area will be provided with:

a. An automatic wet pipe sprinkler system.
b. Low temperature supervisory device per NFPA 72.
c. Ventilation system.

All fire pump and sprinkler valves within each fire pump area will be provided with a valve supervisory (tamper) switch. The use of butterfly valves is prohibited.

The fuel oil storage tank for the diesel engine driven fire pump will be of double wall construction with tank leak detection system. The tank will be able to be refueled from both outside the pump house (external fuel connection with tank level gauge) as well as inside the pump house.

Terminals will be provided on the controller for remote monitoring and annunciation (individual) by the plant fire detection and alarm system for the following supervisory alarm conditions of the following conditions:

a. Engine running (separate signal).
b. Controller selector switch in off or manual positions (separate signal).
c. Trouble on the controller or engine (This includes critically low oil pressure, high engine jacket coolant temperature, failure of engine to start, overspeed shutdown, battery failure (Battery Set 1), battery failure (Battery Set 2), battery charger failure, and low engine oil or engine jacket coolant temperature).
d. Low fuel oil level in day tank.
e. Day tank leak.

Terminals will be provided on the controller for remote monitoring and annunciation (individual) by the plant fire detection and alarm system for the following supervisory alarm conditions of the following conditions:

a. Pump operating.
b. Power loss (all phases supervised).
c. Phase reversal.
d. Phase failure.

The fire pumps will be designed and installed such that either fire pump can be taken out of service without affecting the use and operability of the other fire pump and the pressure maintenance pump.

The design, installation, and testing of the fire pumps will be in compliance with the requirements of NFPA 20, 70 and 72.

**10C3.9.7 Fire Protection Water Main System and Hydrants**

Fire water piping may run both above and below ground. Piping materials and sizes will meet the requirements of the local jurisdictional authorities.

Underground piping will comply with the following:
The underground fire protection water main system and fire hydrants will be arranged around the structures, process areas including outdoor equipment throughout the power plant and switchyard. The size of the loop piping will be based on the calculated maximum demand and the requirements of NFPA 24 and per the Risk Evaluation.

The underground fire protection water piping will be constructed of a combination of cement lined ductile iron and Factory Mutual (FM) Approved high-density polyethylene pipe (HDPE-Class 200).

The minimum underground fire protection water main pipe sizes are as follow:

a. Underground loop – 8 inch for cement lined ductile iron and 10 inch for HDPE.

b. Laterals to fire hydrants less than 25 feet on a dead end main - 6 inch for cement lined ductile iron and 8 inch for HDPE.

c. Laterals to fire hydrants 25 feet and greater on a dead end main - 8 inch for cement lined ductile iron and 10 inch for HDPE.

Thrust blocks will be provided for all underground fire protection pipes.

Exception: – Thrust blocks for HDPE pipe can be eliminated with written approval submitted to the Owner for review by all the following:

a. Factory Mutual Engineering and Research (FMRE). This document will include all special requirements by FMRE that need to be provided so that the thrust blocks can be eliminated.

b. Local Statutory Authorities.

c. HDPE manufacturer and supplier.

The underground loop will be connected to the stations fire pumps using two parallel lateral underground water mains (primary and back up) with post indicator valves located on both sides of the lateral and between both of them.

Gate (curb box) valves are provided for each yard hydrant to isolate it from the underground loop for maintenance purposes, in the event of mechanical damage, and/or line rupture. The underground loop will be provided with post indicator valves (PIV’s) to isolate sections so that not more than four (4) fire protection users (i.e. fire hydrants, fixed fire suppression systems, stand pipes, etc.) are out of service due to a single line break. The Contractor will verify if additional isolations controls are required per local code.

Laterals to buildings and outside equipment that have water based fire suppression system will be provided with outside isolation water control supply valves using PIV’s (with valve supervisory (tamper) switches) to isolate the water supply.

**10C3.9.8 Fire Hydrants**

The distance between fire hydrants around the Power Island fire loop will be a maximum of 250 feet and hydrants will not located within 40 feet of building structures as required by NFPA 24. Additional hydrants will be provided so that no exposure is more than 250 feet.
from the nearest hydrant so that a fire hose can be used. The number and placement of fire hydrants will meet the requirements of the local jurisdictional authority.

The fire hydrants will be provided with two hose connections and one fire pumper suction connection.

The entire design and installation of the underground fire protection water supply main system will be in compliance with the requirements of NFPA 24 and 291, and the local Statuary Authorities.

10C3.9.9 Fire Protection and Detection System

Table 10C-2 shows the fire protection and detection that will be provided:

<table>
<thead>
<tr>
<th>Equipment, Area, and/or Building</th>
<th>Fire Protection Suppression System Type</th>
<th>Detection or Actuation Devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power House-at the gas regulation unit along side each engine</td>
<td>None</td>
<td>Gas Detectors</td>
</tr>
<tr>
<td>Power House</td>
<td>Automatic wet pipe sprinkler system provided throughout the entire building. Class II hose stations located throughout the entire building</td>
<td>Manual pull stations located at each exterior exit door.</td>
</tr>
<tr>
<td>Power House Control Room</td>
<td>Double Interlock pre-action sprinkler system</td>
<td>Smoke detectors at the ceiling level and beneath all raised floors</td>
</tr>
<tr>
<td>Maintenance Shop (includes Tools / Storage Room and beneath all Mezzanine)</td>
<td>Automatic Wet Pipe Sprinkler System</td>
<td></td>
</tr>
<tr>
<td>Warehouse (includes Storage Room and above Interior Roof)</td>
<td>Automatic Wet Pipe Sprinkler System</td>
<td></td>
</tr>
<tr>
<td>I &amp; C Shop</td>
<td>Automatic Wet Pipe Sprinkler System</td>
<td></td>
</tr>
<tr>
<td>General Office Areas, Corridors, File &amp; Copy Room(s), Conference Room, Janitor and Storage Room and Lunch Room</td>
<td>Automatic Wet Pipe Sprinkler System</td>
<td></td>
</tr>
<tr>
<td>Both Women’s and Men’s Combination Wash Rooms and Locker Rooms</td>
<td>Automatic Wet Pipe Sprinkler System</td>
<td></td>
</tr>
<tr>
<td>Telephone and Communication Room</td>
<td>Pre-action sprinkler System – Electric Release</td>
<td>Spot type smoke detectors, including beneath raised floors.</td>
</tr>
<tr>
<td>Operator Equipment and Storage Room</td>
<td>Automatic Wet Pipe Sprinkler System</td>
<td></td>
</tr>
<tr>
<td>Electrical Equipment Rooms</td>
<td>Pre-action sprinkler System – Electric Release</td>
<td>Spot type smoke detectors</td>
</tr>
</tbody>
</table>
### TABLE 10C-2
Fire Protection and Detection Systems

<table>
<thead>
<tr>
<th>Equipment, Area, and/or Building</th>
<th>Fire Protection Suppression System Type</th>
<th>Detection or Actuation Devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery Rooms</td>
<td>Pre-action sprinkler System – Electric Release</td>
<td>Smoke detectors at the ceiling. Note: If the room is classified per the Fire Protection Master Plan and Design Basis, explosion proof smoke detectors are required.</td>
</tr>
<tr>
<td>Electronics Rooms</td>
<td>Pre-action sprinkler System – Electric Release</td>
<td>Spot type smoke detectors, including beneath raised floors.</td>
</tr>
<tr>
<td>Gas Processing and Control Equipment</td>
<td>Automatic wet pipe sprinkler system</td>
<td>Gas Detectors</td>
</tr>
<tr>
<td><strong>Transformers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Each Main Transformer</td>
<td>Automatic Water Spray (Deluge) System. Dry Pilot Sprinklers (Head) looped around each Unit, maximum of 10 ft on center, and in accordance with NFPA 72.</td>
<td></td>
</tr>
<tr>
<td>Each Reserve Aux Transformer</td>
<td>Automatic Water Spray (Deluge) System. Dry Pilot Sprinklers (Head) looped around each Unit, maximum of 10 ft on center, and in accordance with NFPA 72.</td>
<td></td>
</tr>
<tr>
<td>Chem Feed Equipment Enclosure</td>
<td></td>
<td>Manual pull stations at each exit door. Spot type smoke detectors.</td>
</tr>
<tr>
<td>Demineralized water pump enclosure</td>
<td></td>
<td>Manual pull stations at each exit door. Spot type smoke detectors.</td>
</tr>
<tr>
<td>Warehouse and Storage Buildings</td>
<td>Automatic wet pipe sprinkler system. Class II hose station located throughout the entire building.</td>
<td>Manual pull stations at each exit door.</td>
</tr>
<tr>
<td>Water Treatment Building</td>
<td></td>
<td>Manual pull stations at each exit door.</td>
</tr>
</tbody>
</table>

The specified required fire protection and fire detection outlined in the table above defines minimum requirements only. The table may not include all requirements necessary to satisfy the applicable local statutes, as required by the Local Statutory Authorities, or the EPC Specifications. The Contractor will be responsible for providing all additional fire protection and fire detection as per Applicable Laws. Fire protection and detection equipment will comply with the NFPA code and the local jurisdictional authority.

All outdoor sprinkler system releasing valves subject to freezing will be installed in a heated weatherproof insulated enclosure. Each enclosure will be provided with a low temperature enclosure monitoring device monitored and annunciating by the fire alarm control panel in the control room. Heats tracing and/or insulating sprinkler isolation and control valves, releasing valves and sprinkler piping is prohibited.
All valves controlling and/or isolating water for fire protection use will be provided with valve supervisory (tamper) switches.

All sprinkler system releasing valves will be externally re-settable without having to remove the front inspection cover. Acceptable sprinkler equipment manufactures are Viking and Grinnell.

All above ground sprinkler piping located outside will be hot dipped galvanized steel. All sprinkler hangers and rolled grooved fittings and couplings will be galvanized. Sprinkler pipe hangers for cooling tower sprinkler systems will be stainless steel including for dry – pilot piping.

The use of butterfly valves to control and/or isolation fire protection water is prohibited.

All valves controlling and/or isolating CO2 will be provided with valve supervisory (tamper) switches.

Each Class II and Class III fire hose station will be provided with the following.

a. One 1-1/2 inch adjustable pressure restricting angle valve.

b. One heavy duty FM approved hose reel, suitable for the specified fire hose.

c. One hundred feet of FM approved 1-1/2 inch single polyester jacket, synthetic rubber lined fire hose, with couplings and connections.

d. One 1-1/2 inch fully adjustable hose nozzle rated for Class A or B fires. Hose stations located near electrical equipment will be provided with nozzle rated for use on electrical fires.

e. One 2-1/2 inch Fire Department Valve Connection

f. Fire hose reel cover

A complement of 20-pound type, portable fire extinguishers rated for Class A, B, and C fires will be installed in accordance with local building code and NFPA 10. In addition, portable CO2 extinguishers will be located in areas containing sensitive electrical and telecommunication equipment, such as the control room and the switchgear rooms. One portable wheeled dry-chemical extinguisher will be located in the engine area to provide extended manual suppression capability. Fire Extinguishers containing water or water-based agent and Listed for Class C will not be used.

10C3.10 Fire Detection System

The Main Fire Protection Panel (MFPP), located in plant main control room, will be integrated fire detection, evacuation signaling and auxiliary function control system. Remote panels may be included, but a central Main Fire Protection Panel located in the plant main control room is required. The system will be of the multiplex type.

The system will be capable of providing point identification addressable for each individual fire and supervisory alarm-initiating device.
The system Central Processing Unit (CPU) will have sufficient system expansion capability to monitor a minimum 200 initiating device circuits/zones.

The sensors of the Fire Alarm Systems will be addressable.

The system will be designed and equipped to receive, monitor and annunciate all signals from fire and supervisory alarm initiating devices and circuits installed throughout the site including combustion turbine and associated ancillary equipment fire suppression and fire detection systems and equipment. The Contractor will provide remote stand alone fire alarm panels throughout the site networked to the MFPP such that failure of the MFPP will not inhibit the operability of any fire protection system from automatically operating. A separate fire alarm control panel will be provided in the control room to monitor and annunciate all gas detectors.

The fire alarm system will monitor and annunciate three distinct types of signals:

a. Fire alarms, including signals initiated by manual fire alarm stations, smoke detectors (confirmed signals only), heat detectors, and water flow discharge pressure switches, induct smoke detectors, combustion turbine. Fire alarms will be audibly and visually annunciated at the Control Room MFPP and will initiate automatic evacuation signaling, remote signaling and auxiliary control functions as specified.

b. Supervisory signals, including signals initiated by sprinkler valve supervisory switches, supervisory pressure switches, high system air pressure and low system air pressure, low air, supervisory contacts associated with monitored fire pump controllers, fire water storage tank level, temperature, common trouble contacts of monitored subsystems, manual control switches for auxiliary functions and status annunciation contacts for devices controlled by the fire alarm system as auxiliary functions. Supervisory signals will not initiate automatic evacuation signaling or auxiliary control functions.

c. Trouble conditions, including signals initiated by the system in response to fault conditions detected in supervised circuits and/or components. Trouble conditions will be audibly and visually annunciated at the Control Room MFPP. They will not initiate automatic evacuation signaling or auxiliary control functions.

Fire alarm and supervisory alarm initiation circuits will be Style "A" or "B", as described in NFPA.

Signaling line circuits will be style "1" or "2" as described in NFPA.

Indicating device circuits will be "Class B", supervised with end-of-line supervisory components, capable of operating during a single ground condition.

All wiring required for proper system operation, except as specifically allowed herein, will be electrically supervised for opens and shorts to ground. Wiring faults on supervised circuits will initiate trouble conditions.

Trouble signals will be indicated on the MFPP in the Control Room.

Evacuation signaling circuit trouble signals will be indicated on the MFPP in the Control Room.
Any single open or single ground condition on any non-addressable initiating device circuit or non-addressable auxiliary function circuit, such as the circuits between addressable monitor/control modules and their associated monitored/controlled device(s) will cause a trouble signal on their associated addressable circuit.

All control components will be placement supervised such that removal of any module will cause a trouble signal on the MFPP in the Control Room.

All fire alarm control and releasing equipment, devices and wiring will be protected against electro-magnetic/radio frequency interference or induced voltages caused by AC power circuits, electrical transformers, motors or switchgear, electronic equipment, fluorescent lighting fixtures, hand held portable radios, cellular phones or other devices.

The system will be designed and installed so as to be unaffected (with all control cabinet face plates installed and in the open position) by the operation of hand held, portable radios of up to 5 watts, or portable cellular telephones of up to 1 watt, within 12 inches of any system component(s).

All circuits will be segregated and/or shielded as necessary to eliminate audio and/or electrical crosstalk between circuits. Where necessary, separate, isolated power supplies, shielded equipment cabinets, or other appropriate means of eliminating interference/crosstalk will be provided.

Combination fire alarm tone horns and stroke lights will be installed in pairs (one fire and one stroke light) above each manual fire alarm station with additional devices provided as necessary for optimum audibility and visibility.

Fire alarm bells, horns horn strobes, strobes, trouble horns, and chimes will be installed as determined by the Fire Protection Master Plan and Design Plan.

Horns and strobe lights will be on separate circuits.

Fire detection warning horns separate from the Project annunciator will be stationed in locations throughout the entire Project. The warning horns will be audible from any location within the Project boundary and will continue to sound until silenced at the central control panel.

Several rotating light or strobe beacons separate from those provided for the Project annunciator will be stationed to allow visible indication of a fire condition from any location within the Project boundary. These beacons will be clearly visible during daylight or sundown hours.

To allow manual initiation of a fire alarm, manual pull stations will be distributed throughout the Project. The manual pull stations will be equipped with a dual action releasing lever to reduce chances of accidental operation.

**10C3.11 Compressed Air System**

The compressed air system will consist of an instrument air and a station air system and will be separate and isolated from the air start system.
The instrument air system will have adequate dryers and filters to meet OEM quality specifications. Two 100 percent heatless dryers with two 100 percent filters will supply dry (-40°F dew point at 125 psig), oil free air for use by control systems and instrumentation.

Use of compressed air supplying the instrument air distribution header (via the instrument air dryer) for such auxiliary functions as purge air (except for instruments) is discouraged. Instrument air will be provided in the Project's instrument/maintenance shop.

The station air system will be a separate compressor and distribution system which provides air for maintenance tools and will have valved access points at convenient maintenance around the Project. The air will be dry and clean.

Adequate instrument compressed air storage will be provided to facilitate emergency shutdown of the plant. The instrument air receiver and piping will provide a minimum of 3 minutes of compressed instrument air (pressure above minimum instrument requirement) for plant shutdown without instrument air compressor operation.

The major components of each of the Project's compressed air system consist of the following:

- Two 100 percent or three 50 percent instrument air compressors and connection for portable compressor
- One service air compressor – identical to the instrument air compressor.
- One air receiver for each system. (One receiver for service air, one for instrument air).
- Two 100 percent instrument air dryer and filters for oil removal. Ability to change out compressed air dryer elements and filters on line with no plant curtailments
- Instrument air distribution header
- Station air distribution header

**10C3.12 Cranes, Hoists, and Trolleys**

A bridge crane or overhead cranes will be provided with sufficient capacity for all overhaul activities in the power house. The crane will have at least two speeds suitable for careful placement of equipment meeting engine manufacturer’s requirements during maintenance work. The bridge crane will be two speed, single hoist. The hoist will be operated from a single remote.

During the design phase of the project and before any site construction, the Contractor will provide written descriptions for all disassembly and reassembly lifts required for all major scheduled inspections and overhauls of the engines and generators. This will include descriptions of the use and sizing of fixed and mobile cranes. The Contractor will also provide models or drawings to demonstrate the ability to avoid all fixed interferences while completing all required movements and lifts and the ability of the specified mobile cranes to be driven to the required locations using only the road surfaces and maintenance pads designed for maintenance crane loadings.

All equipment in the plant will be provided with a convenient arrangement for slinging or handling during overhaul.
Fixed cranes and hoists will be designed, manufactured, erected, and tested in accordance with the specified standards and codes. All crane structures and associated lifting tackle will be tested at lifting loads 25 percent in excess of the rating of the crane. Lifting cables will have enough length to lift loads the entire height without intermediate stops to adjust lifting tackle. Cranes and lifting tackle over 5 tons lifting capacity will be electrically operated and controlled from floor level.

Each item of lifting equipment will comply with the minimum requirements of the applicable standards and codes with regard to:

- Identification markings
- Tests and inspection
- Quality/grade of material
- Dimensions

Brakes of an approved type will be fitted to the lift and hoist and to the hoisting, traversing, and dwelling motions of each crane. The brakes will be designed to operate automatically on interruption of the electrical supply to the motors and to arrest and hold, at any position, the greatest load carried by the motor. Brake design will minimize shock loading during application of the brakes. Crane hoists will be equipped with an independent manually operated brake, capable of holding the maximum load lifting capability of the hoist.

A separately mounted “stop” push button (“E-Stop”) will be provided in such a position as to be readily available for use by the operator. The emergency stop push button will trip the main contactor.

Electrically operated hoists will be fitted with automatic self-sustaining brakes. Electrical motors will be rated for at least 40 starts per hour.

10C3.13 Heating Ventilating and Air Conditioning

HVAC will be provided for all buildings. The HVAC System will heat, ventilate and/or air-condition plant buildings and enclosures for personnel comfort, equipment environment protection and/or freeze protection. HVAC System design generally will comply with ASHRAE Handbooks and Standards.

Electric heaters in air-conditioned areas and ventilated areas will provide any necessary space heating.

Regarding engine hall HVAC, Contractor’s design of the HVAC will meet the requirements of the equipment being housed, and not for personal comfort or high efficiency.

10C3.13.1 System Function

HVAC systems will maintain the environmental conditions in terms of space temperature and humidity, air quality, and building pressurization in order to provide efficient equipment operation and comfortable working conditions for personnel.

10C3.13.2 Buildings and Enclosures

The following discussion applies to buildings, rooms, areas, and enclosures.
Maintenance of indoor environmental conditions will be accomplished with air conditioning systems or ventilation systems, as appropriate. Areas such as electrical switchgear rooms and battery rooms will be maintained at temperatures above those typical for air conditioned environments, yet below temperatures equal to or in excess of the outdoor ambient design temperature. Pre-filter and final filters will be used for all areas that are either air-conditioned or ventilated. Pre-filter efficiency will be 30 percent and final filter efficiency will be 80 percent based on ASHRAE 52.1-1992 or approved equivalent international standard.

Explosion-resistant construction will be used in all battery rooms where hydrogen may be developed or released.

The fresh air intakes for the control room will be elevated and separated by at least 3 to 5 feet vertically and 10 to 15 feet horizontally. Also, fresh air intakes will not be located on the same wall as any ventilation discharge from the battery rooms.

All ductwork will be galvanized steel. The duct system will include fire dampers, balancing dampers, insulation, flexible connections, etc., needed for a complete system. Products will meet NFPA 90A or approved equivalent international standard, and fire dampers will meet UL 555 or approved equivalent international standard. No products used in the duct construction will exceed the maximum rating of 25 for flame-spread and the rating of 50 for smoke-developed and fuel-contributed obscuration.

**10C3.13.3 Air Conditioning System**

A split packaged air conditioning system(s) or ventilation system(s), as appropriate, will be installed for rooms requiring maintenance of indoor environmental conditions, including the main control room, offices, storage areas, and battery room. The system(s) will provide constant volume air supply with a variable outside air supply capability of 10 to 100 percent (economizer) to achieve energy conservation. When outdoor air temperature and humidity conditions permit, the system will utilize outside air in lieu of refrigerant for cooling. Each AC unit will be provided with a compressor, evaporator coil, detached air-cooled condenser, electric heating coil, and a pre-filter and final filter. The HVAC system will continuously operate the year round. For the control room, two 100 percent capacity HVAC systems will be provided, one operating and one as standby.

The HVAC split units for the air conditioning system or ventilation system will include a mixing section with fresh air, exhaust air, and return air dampers, filter section (including pre-filter and final filter), electric pre-heating coil section, cooling coil section, supply fan section and return/exhaust fan section. The air conditioning system final filter will meet the requirements of 80 percent atmospheric dust spot efficiency based on ASHRAE Standard 52.1 or approved equivalent international standard.

Duct-mounted electric reheat coils will be provided for zone temperature control as well as high humidity control.

Careful consideration will be taken for locating outdoor air intakes considering prevailing wind direction, airborne sand and dust, and thermal exhaust from equipment such as radiators.
10C3.13.4 Battery Room Exhaust System

The exhaust system in the battery room will be operated continuously to maintain negative pressure and to avoid accumulation of hydrogen gas or leakage to neighboring rooms. Ducted exhaust intake will be directed upward to remove hydrogen accumulated at ceiling and in beam pockets. Discharge air will exceed the air supply by 15 percent. The supply air for the battery room will come from the air conditioning system.

Indoor air temperature will be kept below 85°F. Exhaust air rate will meet the requirement of not less than ten volume air changes per hour. Two 50 percent capacity in-line exhaust fans will be provided.

Exhaust fans and motors will be of explosion proof design.

In lieu of lead acid batteries requiring battery room hydrogen exhaust system, Contractor may provide sealed batteries with the appropriate ventilation provisions.

10C3.13.5 Design Parameters

Control Building HVAC system indoor design temperatures are summarized in Table 10C-3:

<table>
<thead>
<tr>
<th>Room</th>
<th>System Type</th>
<th>Indoor Environmental Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control room/ Offices/ I&amp;C maintenance / CEMS Enclosure</td>
<td>HVAC</td>
<td>75 ± 4°F, 50% RH</td>
</tr>
<tr>
<td>Battery room</td>
<td>HVAC</td>
<td>75° ±5° -0° F</td>
</tr>
</tbody>
</table>

The indoor environmental conditions will be met based upon the internal heat gain in the room and outdoor ambient design conditions as listed in Table 10C-4.

<table>
<thead>
<tr>
<th>Service</th>
<th>Equipment Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control room/battery room</td>
<td>HVAC Split Packaged Unit 2 x 100%</td>
</tr>
<tr>
<td>Switchgear</td>
<td>HVAC split packaged Unit</td>
</tr>
<tr>
<td>Offices, I&amp;C maintenance room/ and CEMS Enclosure</td>
<td>HVAC Split Packaged Unit</td>
</tr>
<tr>
<td>Mechanical maintenance area</td>
<td>Wall/roof exhaust, louvers, dampers</td>
</tr>
<tr>
<td>Electrical building</td>
<td>Supply fans, dampers, louvers</td>
</tr>
<tr>
<td>Fire pump enclosure</td>
<td>Supply fans, dampers, louvers</td>
</tr>
<tr>
<td>Power House</td>
<td>Supply fans, dampers, louvers Temperature rise to be limited to not more than 20 degrees f measured 5 feet from the operating floor.</td>
</tr>
</tbody>
</table>