1.2 General Plant Description

1.2.1 Principal Design Criteria

The principal design criteria are presented in two ways. First, they are classified as either a power generation function or a safety function. Second, they are grouped according to system. Although the distinctions between power generation or safety functions are not always clear-cut and are sometimes overlapping, the functional classification facilitates safety analyses, while the grouping by system facilitates the understanding of both the system function and design.

1.2.1.1 General Design Criteria

1.2.1.1.1 Power Generation Design Criteria

(1) The plant is designed to produce steam for direct use in a turbine-generator unit.

(2) Heat removal systems are provided with sufficient capacity and operational adequacy to remove heat generated in the reactor core for the full range of normal operational conditions and abnormal operational transients.

(3) Backup heat removal systems are provided to remove decay heat generated in the core under circumstances wherein the normal operational heat removal systems become inoperative. The capacity of such systems is adequate to prevent fuel cladding damage.

(4) The fuel cladding, in conjunction with other plant systems, is designed to retain integrity so that the consequences of any failures are within acceptable limits throughout the range of normal operational conditions and abnormal operational transients for the design life of the fuel.

(5) Control equipment is provided to allow the reactor to respond automatically to load changes and abnormal operational transients.

(6) Reactor power level is manually controllable.

(7) Control of the reactor is possible from a single location.

(8) Reactor controls, including alarms, are arranged to allow the operator to rapidly assess the condition of the reactor system and locate system malfunctions.

(9) Interlocks or other automatic equipment are provided as backup to procedural control to avoid conditions requiring the functioning of nuclear safety systems or engineered safety features.

(10) The station is designed for routine continuous operation whereby steam activation products, fission products, corrosion products, and coolant dissociation products are processed to remain within acceptable limits.

1.2.1.1.2 Safety Design Criteria

(1) The station design conforms to applicable codes and standards as described in Subsection 1.8.2.

(2) The station is designed, fabricated, erected, and operated in such a way that the release of radioactive material to the environment does not exceed the limits and guideline values of applicable government regulations pertaining to the release of radioactive materials for normal operations, abnormal transients, and accidents.

(3) The reactor core is designed so its nuclear characteristics do not contribute to a divergent power transient.

(4) The reactor is designed so there is no tendency for divergent oscillation of any operating characteristic considering the interaction of the reactor with other appropriate plant systems.

(5) The design provides means by which plant operators are alerted when limits on the release of radioactive material are approached.

(6) Sufficient indications are provided to allow determination that the reactor is operating within the envelope of conditions considered safe by plant analysis.

(7) Radiation shielding is provided and access control patterns are established to allow a properly trained operating staff to control radiation doses within the limits of applicable regulations in any mode of normal plant operations.

(8) Those portions of the nuclear system that form part of the reactor coolant pressure boundary (RCPB) are designed to retain integrity as a radioactive material containment barrier following abnormal operational transients and accidents.

(9) Nuclear safety systems and engineered safety features function to assure that no damage to the RCPB results from internal pressures caused by abnormal operational transients and accidents.

(10) Where positive, precise action is immediately required in response to abnormal operational transients and accidents, such action is automatic and requires no decision or manipulation of controls by plant operations personnel.

(11) Safety-related actions are provided by equipment of sufficient redundance and independence so that no single failure of active components, or of passive components in certain cases in the long term, will prevent the required actions.

(12) Provisions are made for control of active components of safety-related systems from the control room.

(13) Safety-related systems are designed to permit demonstration of their functional performance requirements.

(14) The design of safety-related systems, components and structures includes allowances for natural environmental disturbances such as earthquakes, floods, and storms at the station site.

(15) Standby electrical power sources have sufficient capacity to power all safety-related systems requiring electrical power concurrently.

(16) Standby electrical power sources are provided to allow prompt reactor shutdown and removal of decay heat under circumstances where normal auxiliary power is not available.

(17) A containment is provided that completely encloses the reactor systems, drywell, and suppression chambers. The containment employs the pressure suppression concept.

(18) It is possible to test primary containment integrity and leaktightness at periodic intervals.

(19) A secondary containment is provided that completely encloses the primary containment above the Reactor Building basemat. This secondary containment provides for a controlled, monitored release of any potential radioactive leakage from the primary containment.

(20) The primary containment and secondary containment, in conjunction with other safety-related features, limit radiological effects of accidents resulting in the release of radioactive material to the containment volumes to less than the prescribed acceptable limits.

(21) Provisions are made for removing energy from the primary containment as necessary to maintain the integrity of the containment system following accidents that release energy to the containment.

(22) Piping that penetrates the primary containment and could serve as a path for the uncontrolled release of radioactive material to the environs is automatically isolated when necessary to limit the radiological impact from an uncontrolled release to less than acceptable limits.

(23) Emergency core cooling systems (ECCS) are provided to limit fuel cladding temperature to less than the limits of 10CFR50.46 in the event of a loss-of-coolant accident (LOCA).

(24) The ECCS provide for continuity of core cooling over the complete range of postulated break sizes in the RCPB.

(25) Operation of the ECCS is initiated automatically when required regardless of the availability of offsite power supplies and the normal generating system of the station.

(26) The control room is shielded against radiation so that continued occupancy under design basis accident conditions is possible.

(27) In the event that the control room becomes inaccessible, it is possible to bring the reactor from power range operation to cold shutdown conditions by utilizing alternative controls and equipment that are available outside the control room.

(28) Backup reactor shutdown capability independent of normal reactivity control is provided. This backup system has the capability to shut down the reactor from any normal operating condition and subsequently to maintain the shutdown condition.

(29) Fuel handling and storage facilities are designed to prevent inadvertent criticality and to maintain shielding and cooling of spent fuel as necessary to meet operating and offsite dose constraints.

(30) Systems that have redundant or backup safety functions are physically separated, and arranged so that credible events causing damage to one region of the Reactor Island complex has minimum prospect for compromising the functional capability of the redundant system.

1.2.1.2 System Criteria

The principal design criteria for particular systems are listed in the following subsections.

1.2.1.2.1 Nuclear System Criteria

(1) The fuel cladding is a radioactive material barrier designed to retain integrity so that failures do not result in dose consequences that exceed acceptable limits throughout the design power range.

(2) The fuel cladding, in conjunction with other plant systems, is designed to retain integrity so that the consequences of any failures are within acceptable limits throughout any abnormal operational transient.

(3) Those portions of the nuclear system that form part of the RCPB are designed to retain integrity as a radioactive material barrier during normal operation and following abnormal operational transients and accidents.

(4) The capacity of the heat removal systems provided to remove heat generated in the reactor core for the full range of normal operational transients as well as for abnormal operational transients is adequate to prevent fuel cladding damage that results in dose consequences exceeding acceptable limits.

(5) The reactor is capable of being shut down automatically in sufficient time to permit decay heat removal systems to become effective following loss of operation of normal heat removal systems. The capacity of such systems is adequate to prevent fuel cladding damage.

(6) The reactor core and reactivity control system are designed such that control rod action is capable of making the core subcritical and maintaining it even with the rod of highest reactivity worth fully withdrawn and unavailable for insertion.

(7) Backup reactor shutdown capability is provided independent of normal reactivity control provisions. This backup system has the capability to shut down the reactor from any operating condition and subsequently to maintain the shutdown condition.

(8) The nuclear system is designed so there is no tendency for divergent oscillation of any operating characteristic, considering the interaction of the nuclear system with other appropriate plant systems.

1.2.1.2.2 Electrical Power Systems Criteria

Sufficient normal auxiliary and standby sources of electrical power are provided to attain prompt shutdown and continued maintenance of the station in a safe condition under all credible circumstances. The power sources are adequate to accomplish all required essential safety actions under all postulated accident conditions.

1.2.1.2.3 Auxiliary Systems Criteria

(1) Fuel handling and storage facilities are designed to prevent inadvertent criticality and to maintain adequate shielding and cooling for spent fuel.

(2) Other auxiliary systems, such as service water, cooling water, fire protection, heating and ventilating, communications, and lighting, are designed to function as needed, during normal and/or accident conditions.

(3) Auxiliary systems that are not required to effect safe shutdown of the reactor or maintain it in a safe condition are designed so that a failure of these systems shall not prevent the essential auxiliary systems from performing their design functions.

1.2.1.2.4 Shielding and Access Control Criteria

Radiation shielding is provided and access control patterns are established to allow a properly trained operating staff to control radiation doses within the limits of applicable regulations in any normal mode of plant operation.

1.2.1.2.5 Process Control Systems Criteria

The principal design criteria for the process control systems are listed in the following subsections.

1.2.1.2.5.1 Nuclear System Process Control Criteria

(1) Control equipment is provided to allow the reactor to respond automatically to load changes within design limits.

(2) It is possible to control the reactor power level manually.

(3) Nuclear systems process displays, controls and alarms are arranged to allow the operator to rapidly assess the condition of the nuclear system and to locate process system malfunctions.

1.2.1.2.5.2 Electrical Power System Process Control Criteria

(1) The Class 1E power systems are designed with three divisions with any two divisions being adequate to safely place the unit in the hot shutdown condition.

(2) Protective relaying is used to detect and isolate faulted equipment from the system with a minimum of disturbance in the event of equipment failure.

(3) Voltage relays are used on the emergency equipment buses to disconnect the normal source in the event of loss of offsite power and to initiate starting of the standby emergency power system diesel generators.

(4) The standby emergency power diesel generators are started and loaded automatically.

(5) Safety-related electrically operated breakers are controllable from the control room.

(6) Monitoring of essential generators, transformers, and circuits is provided in the main control room.

1.2.1.2.5.3 Power Conversion Systems Process Control Criteria

(1) Control equipment is provided to control the reactor pressure throughout its operating range.

(2) The turbine is able to respond automatically to minor changes in load.

(3) Control equipment in the feedwater system maintains the water level in the reactor vessel at the optimum level required by steam separators.

(4) Control of the power conversion equipment is possible from a central location.

1.2.1.2.6 Power Conversion Systems Criteria

Components of the power conversion systems shall be designed to perform the following basic objectives:

(1) Produce electrical power from the steam coming from the reactor, condense the steam into water, and return the water to the reactor as heated feedwater with a major portion of its gases and particulate impurities removed.

(2) Assure that any fission products or radioactivity associated with the steam and condensate during normal operation are safely contained inside the system or are released under controlled conditions in accordance with waste disposal procedures.

1.2.1.3 Plant Design and Aging Management

The COL applicant shall initiate the life cycle management program early enough in the design process to aid in the application, selection and procurement of components with optimum design life characteristics, and to develop an aging management plan capable of assuring the plant's original design basis throughout its life.

The aging management plan shall cover containment structures, liner plates, embedded or buried structural components, piping and components. The plan shall consider the potential causes of corrosion which ultimately may be present at the site, including the potential corrosion from copper ground mats. The plan should be initiated early in the design process so that adequate provisions for mitigation measures can be made.

In developing the life cycle management program, the COL applicant shall consider the design life requirements prescribed in the EPRI Utility Requirements Document (URD) and the insights gained from the USNRC Nuclear Plant Aging Research (NPAR) Program. (e.g. NUREG/CRs - 4731 and - 5314)

See Subsection 1.2.3.1 for COL license information.

1.2.2 Plant Description

1.2.2.1 Site Characteristics

1.2.2.1.1 Site Location

The plant is located on a site adjacent or close to a body of water with sufficient capacity for either once-through or recirculated cooling or a combination of both methods.

1.2.2.1.2 Description of Plant Environs

1.2.2.1.2.1 Meteorology

The safety-related structures and equipment are designed to retain required functions for the loads resulting from any tornado with characteristics not exceeding the values provided in Table 2.0-1.

Tornado missiles are discussed in Section 3.5.

1.2.2.1.2.2 Hydrology

The safety design basis of the plant provides that structures of safety significance will be unaffected by the hydrologic parameter envelope defined in Chapter 2.

1.2.2.1.2.3 Geology and Seismology

The structures of safety significance for the plant are designed to withstand a safe shutdown earthquake (SSE) which results in a freefield peak acceleration of 0.3g.

1.2.2.1.2.4 Shielding

Shielding is provided throughout the plant, as required, to maintain radiation levels to operating personnel and to general public within the applicable limits set forth in 10CFR20 and 10CFR100. It is also designed to protect certain plant components from radiation exposure resulting in unacceptable alterations of material properties or activation.

1.2.2.1.3 Site Arrangements

The containment and building arrangements, including equipment locations, are shown in Figures 1.2-2 through 1.2-33. The arrangement of these structures on the plant site is shown in Figure 1.2-1.

1.2.2.2 Nuclear Steam Supply Systems

The Nuclear Steam Supply System (NSSS) includes a direct-cycle forced-circulation BWR that produces steam for direct use in the steam turbine. A heat balance showing the major parameters of the NSSS for the rated power conditions is shown in Figure 1.1-2.

1.2.2.2.1 Reactor Pressure Vessel System

The Reactor Pressure Vessel (RPV) System contains the reactor pressure vessel with the reactor internal pump (RIP) casings; core and supporting structures; the steam separators and dryers; the control rod guide tubes; the spargers for the feedwater, RHR and core flooder system; the control rod drive (CRD) housings; the incore instrumentation guide tubes and housings; and other components. The main connections to the vessel include steamlines, feedwater lines, RIPs, CRDs and incore nuclear instrument detectors, core flooder lines, RHR lines, head spray and vent lines, core plate differential pressure lines, internal pump differential pressure lines, and water level instrumentation.

A venturi-type flow restrictor is a part of the RPV nozzle configuration for each steamline. These restrictors limit the flow of steam from the reactor vessel before the main steamline isolation valves (MSIVs) are closed in case of a main steamline break outside the containment.

The RPV System provides guidance and support for the CRDs. It also distributes boron (sodium pentaborate) solution when injected from the Standby Liquid Control (SLC) System.

The RPV System restrains the CRD to prevent ejection of the control rod connected with the CRD in the event of a failure of the RCPB associated with the CRD housing weld.

CRD blowout restraints are located internal to the reactor vessel and the control rod drive. A restraint system is also provided for each RIP in order to prevent the RIP from becoming a missile in the event of a failure of the RCPB associated with the RIP casing weld.

The reactor vessel is designed and fabricated in accordance with applicable codes for a pressure of 8620 kPaG. The nominal operating pressure in the steam space above the separators is 7170 kPaA. The vessel is fabricated of low alloy steel and is clad internally with stainless steel or Ni-Cr-Fe Alloy (except for the top head, RIP motor casing, nozzles other than the steam outlet nozzle, and nozzle weld zones which are unclad).

The reactor core is cooled by demineralized water that enters the lower portion of the core and boils as it flows upward around the fuel rods. The steam leaving the core is dried by steam separators and dryers located in the upper portion of the reactor vessel. The steam is then directed to the turbine through the main steamlines. Each steamline is provided with two isolation valves in series, one on each side of the containment barrier.

1.2.2.2.2 Nuclear Boiler System

1.2.2.2.2.1 Main Steamline Isolation Valves

All pipelines that both penetrate the containment and offer a potential release path for radioactive material are provided with redundant isolation capabilities. Isolation valves are provided in each main steamline to isolate primary containment upon receiving an automatic or manual closure signal. Each is powered by both pneumatic pressure and spring force. These valves prevent excessive damage to the fuel barrier by limiting the loss of reactor coolant from the reactor vessel resulting from either a major leak from the steam piping outside the containment or a malfunction of the pressure control system resulting in excessive steam flow from the reactor vessel.

1.2.2.2.2.2 Main Steamline Flow Instrumentation

The steam flow instrumentation is connected to the venturi type steam nozzle of the RPV. The instrumentation provides high nozzle flow isolation signals in case of a main steamline break, flow signals for the feedwater flow control system and indication in the control room.

1.2.2.2.2.3 Nuclear System Pressure Relief System

A pressure relief system consisting of safety/relief valves (SRVs) mounted on the main steamlines is provided to prevent excessive pressure inside the nuclear system as a result of operational transients or accidents.

1.2.2.2.2.4 Automatic Depressurization System

The ADS rapidly reduces reactor vessel pressure in a loss-of-coolant accident, enabling the low-pressure RHR to deliver cooling water to the reactor vessel.

The ADS uses some of the SRVs that are part of the nuclear system pressure relief system. The SRVs used for ADS are set to open on detection of appropriate low reactor water level and high drywell pressure signals. The ADS will not be activated unless either an HPCF or RHR/low-pressure flooder loop pump is operating. This is to ensure that adequate coolant will be available to maintain reactor water level after depressurization.

1.2.2.2.2.5 Reactor Vessel Instrumentation

In addition to instrumentation for the nuclear safety systems and engineered safety features, instrumentation is provided to monitor and transmit information that can be used to assess conditions existing inside the reactor vessel and the physical condition of the vessel itself. This instrumentation monitors reactor vessel pressure, water level, coolant temperature, reactor core differential pressure, coolant flow rates, and reactor vessel head inner seal ring leakage.

1.2.2.2.3 Reactor Recirculation System

The reactor internal pumps (RIPs) are internal pumps which provide a continuous internal circulation path for the core coolant flow. The RIPs are located at the bottom of the vessel. The pump motors are enclosed in casings which are a part of the vessel. A break in the casing as described in Subsection 15B.3.4.3 will result in a leak flow that is less than the ECCS capacity, thus allowing full core coverage. The internal pumps are a wet motor design with no shaft seals, thereby providing increased reliability, reduced maintenance requirements and decreased operational radiation exposure. The RIP has a low rotating inertia. Coupled with the solid-state adjustable speed drives, the RIP can respond quickly to load transients and operator demands.

1.2.2.3 Control and Instrument Systems

1.2.2.3.1 Rod Control and Information System

The Rod Control and Information System (RCIS) provides the means by which control rods are positioned from the control room for power control. The system operates the rod drive motors to change control rod position. For operation in the normal gang movement mode, one gang of control rods can be manipulated at a time. The system includes the logic that restricts control rod movement (rod block) under certain conditions as a backup to procedural controls.

1.2.2.3.2 Control Rod Drive System

When scram is initiated by the RPS, the Control Rod Drive (CRD) System inserts the negative reactivity necessary to shut down the reactor. Each control rod is normally controlled by an electric motor unit. When a scram signal is received, high-pressure water stored in nitrogen charged accumulators forces the control rods into the core and the electric motor drives are signalled to drive the rods into the core. Thus, the hydraulic scram action is backed up by an electrically energized insertion of the control rods.

1.2.2.3.2.1 Control Rod Braking Mechanism

An electromechanical braking mechanism is incorporated in each control rod drive to prevent ejection of the attached control rod in the event of a hydraulic line break. This action limits the rate of reactivity insertion resulting from a rod ejection accident.

1.2.2.3.2.2 Control Rod Ejection

A nuclear excursion is prevented in case of a housing failure and thus the fuel barrier is protected because, as discussed in Subsection 1.2.2.2.1, the housing and the drive are restrained internally to the vessel to prevent the control rod ejection.

1.2.2.3.3 Feedwater Control System

The Feedwater Control System (FCS) automatically controls the flow of feedwater into the reactor pressure vessel to maintain the water within the vessel at predetermined levels. A fault-tolerant triplicated, digital controller using a conventional three-element control scheme is used to accomplish this function.

1.2.2.3.4 Standby Liquid Control System

The Standby Liquid Control System (SLCS) provides an alternate method to bring the nuclear fission reaction to subcriticality and to maintain subcriticality as the reactor cools. The system makes possible an orderly and safe shutdown in the event that not enough control rods can be inserted into the reactor core to accomplish shutdown in the normal manner. The system is sized to counteract the positive reactivity effect from rated power to the cold shutdown condition.

1.2.2.3.5 Neutron Monitoring System

The Neutron Monitoring System (NMS) consists of incore neutron detectors and out-of-core electronic monitoring equipment. The NMS provides indication of neutron flux, which can be correlated to thermal power level for the entire range of flux conditions that can exist in the core. There are fixed incore sensors, the startup range neutron monitors (SRNM), which provide level indications during reactor startup and low power operation. The local power range monitors (LPRM) and average power range monitors (APRM) allow assessment of local and overall flux conditions during power range operation. The automatic traversing incore probe (ATIP) system provides a means to calibrate the local power range monitors. The NMS provides inputs to the RCIS to initiate rod blocks if preset flux limits or period limits for rod block are exceeded, as well as inputs to the RPS if other limits for scram are exceeded.

Those portions of the NMS that input signals to the RPS qualify as a safety-related system. The SRNM and the APRM which monitor neutron flux via incore detectors provide scram logic inputs to the RPS to initiate a scram in time to prevent excessive fuel clad damage as a result of over-power transients. The APRM system also generates a simulated thermal power signal. Both upscale neutron flux and upscale simulated thermal power are conditions which provide scram logic signals.

1.2.2.3.6 Remote Shutdown System

In the event that the control room becomes inaccessible, the reactor can be brought from power range operation to cold shutdown conditions by use of controls and equipment that are available outside the control room.

1.2.2.3.7 Reactor Protection System

The Reactor Protection System (RPS) initiates a rapid, automatic shutdown (scram) of the reactor. It acts in time to prevent fuel cladding damage and any nuclear system process barrier damage following abnormal operational transients. The RPS overrides all operator actions and process controls and is based on a failsafe design philosophy that allows appropriate protective action even if a single failure occurs.

1.2.2.3.8 Recirculation Flow Control System

During normal power operation, the speed of the reactor internal pumps (RIP) is adjusted to control flow. Adjusting RIP speed changes the coolant flow rate through the core and thereby changes the core power level. The system can automatically adjust the reactor power output to the load demand. The solid-state adjustable speed drives (ASD) provide variable-voltage/variable-frequency electrical power to the RIP motors. In response to plant needs, the recirculation flow control system adjusts the ASD power supply output to vary RIP speed, core flow, and core power.

1.2.2.3.9 Automatic Power Regulator System

The Automatic Power Regulator System is summarized in Subsection 7.7.1.7(1).

1.2.2.3.10 Steam Bypass and Pressure Control System

A turbine bypass system is provided which passes steam directly to the main condenser under the control of the pressure regulator. Steam is bypassed to the condenser whenever the reactor steaming rate exceeds the load permitted to pass to the turbine generator. The turbine bypass system has the capability to shed 33% of the turbine-generator rated load without reactor trip or operation of safety/relief valves. The pressure regulation system provides main turbine control valve and bypass valve flow demands so as to maintain a nearly constant reactor pressure during normal plant operation. It also provides demands to the recirculation system to adjust power level by changing reactor recirculation flow rate.

1.2.2.3.11 Plant Computer Functions (Includes PGCS)

Online plant computer functions are provided to monitor and log process variables and make certain analytical computations. The performance and power generation control systems are included.

1.2.2.3.12 Refueling Platform Control Computer

The refueling platform control computer provides (1) memory of all the fuel and platform positions, (2) directions for the traversable area and traveling paths, (3) directions for the speed functions for all modes of travel, and (4) control of the fuel load. The computer controls automatic or manual refueling between fuel storage and the reactor from the remote control room.

1.2.2.3.13 CRD Removal Machine Control Computer

The CRD handling equipment local operation panel provides automatic positioning, continuous operation and prevention of erroneous operation in the stepwise removal and installation of CRDs from the remote control room.

1.2.2.4 Radiation Monitoring Systems

1.2.2.4.1 Process Radiation Monitoring System

The process radiation monitoring system measures and controls radioactivity in process and effluent streams and activate appropriate alarms and controls.

The process radiation monitoring system measures and records radiation levels associated with selected plant process streams and effluent paths leading to the environment. All effluents from the plant which are potentially radioactive are monitored.

1.2.2.4.2 Area Radiation Monitoring System

The area radiation monitoring system alerts local occupants and the control room personnel of excessive gamma radiation levels at selected locations within the plant.

1.2.2.4.3 Containment Atmospheric Monitoring System

The Containment Atmospheric Monitoring System (CAMS) measures, records and alarms the radiation levels and the oxygen and hydrogen concentration levels in the primary containment under post-accident conditions. Hydrogen and oxygen monitors are not required to mitigate design basis accidents.

1.2.2.5 Core Cooling System

In the event of a breach in the RCPB that results in a loss of reactor coolant, three independent divisions of ECCS are provided to maintain fuel cladding below the temperature limit as defined by 10CFR50.46. Each division contains one high pressure and one low pressure inventory makeup system.

1.2.2.5.1 Residual Heat Removal System

The Residual Heat Removal (RHR) System is a system of pumps, heat exchangers, and piping that fulfills the following functions:

(1) Removes decay and sensible heat during and after plant shutdown.

(2) Injects water into the reactor vessel following a LOCA to reflood the core in conjunction with other core cooling systems (Subsection 5.5.1).

(3) Removes heat from the containment following a LOCA to limit the increase in containment pressure. This is accomplished by cooling and recirculating the suppression pool water by containment sprays.

1.2.2.5.1.1 Low Pressure Flooder

Low pressure flooding is an operating mode of each RHR system, but is discussed here because the low pressure flooder (LPFL) mode acts in conjunction with other injection systems. LPFL uses the RHR pump loops to inject cooling water into the pressure vessel. LPFL operation provides the capability of core flooding at low vessel pressure following a LOCA in time to maintain the fuel cladding below the prescribed temperature limit.

1.2.2.5.1.2 Residual Heat Removal System Containment Cooling

The RHR System is placed in operation to: (1) limit the temperature of the water in the suppression pool and the atmospheres in the drywell and suppression chamber following a design basis LOCA; (2) control the pool temperature during normal operation of the safety/relief valves and the RCIC System; and (3) reduce the pool temperature following an isolation transient. In the containment cooling mode of operation, the RHR main system pumps take suction from the suppression pool and pump the water through the RHR heat exchangers, where cooling takes place by transferring heat to the service water. The fluid is then discharged back either to the suppression pool, the drywell spray header, the suppression chamber spray header, or the RPV.

1.2.2.5.1.3 Wetwell/Drywell Spray

A spray system is provided for wetwell/drywell cooling in the suppression chamber and drywell air space. The wetwell/drywell spray can be initiated manually if a high containment pressure signal is received. Each subsystem is supplied from a separate redundant RHR subsystem.

1.2.2.5.2 High Pressure Core Flooder System

High pressure core flooder (HPCF) systems are provided in two divisions to maintain an adequate coolant inventory inside the reactor vessel to limit fuel cladding temperatures in the event of breaks in the reactor coolant pressure boundary. The systems are initiated by either high pressure in the drywell or low water level in the vessel. They operate independently of all other systems over the entire range of system operating pressures. The HPCF System pump motors are powered by a diesel generator if auxiliary power is not available. The systems may also be used as a backup for the RCIC System.

1.2.2.5.3 Leak Detection and Isolation System

The leak detection and isolation system (LDS) detects and monitors leakage from the reactor coolant pressure boundary and initiates isolation of the leakage source. The system initiates isolation of the process lines that penetrate the containment by closing the appropriate inboard and outboard isolation valves. LDS monitors leakage inside and outside of the drywell and annunciates excessive leakages in the control room. The following control and isolation functions are automatically performed by LDS:

(1) Isolates the main steamlines

(2) Isolates the reactor water cleanup process lines

(3) Initiates the standby gas treatment system

(4) Isolates the Reactor Building HVAC system

(5) Isolates the containment purge and vent lines

(6) Isolates the cooling water lines in the Reactor Building

(7) Isolates the RHR shutdown cooling system lines

(8) Isolates the steamline to the RCIC turbine

(9) Isolates the suppression pool cleanup system lines

(10) Not Used

(11) Isolates the drywell sumps drain lines

(12) Isolates the fission products monitor sampling and return lines

(13) Initiates withdrawal of the automated traversing incore probe

In addition to the above functions, LDS monitors leakage inside the drywell from the following sources and annunciates the abnormal leakage levels in the control room:

(1) Fission products releases

(2) Condensate flow from the drywell air coolers

(3) Drywell sump level changes

(4) Leakages from valve stems equipped with leak-off lines

Other leakages from the FMCRDs, the SRVs and from the reactor vessel head seal flange are monitored by their respective systems.

1.2.2.5.4 Reactor Core Isolation Cooling System

The RCIC System provides makeup water to the reactor vessel when the vessel is isolated and is also part of the emergency core cooling network. The RCIC System uses a steam-driven turbine-pump unit and operates automatically in time and with sufficient coolant flow to maintain adequate water level in the reactor vessel for events defined in Section 5.4.

One division contains the RCIC System, which consists of a steam-driven turbine pump assembly and the turbine pump accessories. The system also includes piping, valves, and instrumentation necessary to implement several flow paths. The RCIC steam supply line branches off one of the main steamlines (leaving the RPV) and goes to the RCIC turbine with drainage provision to the main condenser. The turbine exhausts to the suppression pool with vacuum breaking protection. Makeup water is supplied from the condensate storage tank (CST) or the suppression pool with preferred source being the CST. RCIC pump discharge lines include the main discharge line to the feedwater line, a test return line to the suppression pool, and a minimum flow bypass line to the suppression pool.

Following a reactor scram, steam generation in the reactor core continues at a reduced rate due to the core fission product delay heat. The turbine condenser and the feedwater system supply the makeup water required to maintain reactor vessel inventory.

In the event the reactor vessel is isolated, and the feedwater supply is unavailable, relief valves are provided to automatically (or remote manually) maintain vessel pressure within desirable limits. The water level in the reactor vessel drops due to continued steam generation by decay heat. Upon reaching a predetermined low level, the RCIC System is initiated automatically. The turbine-driven pump supplies water from the suppression pool or from the CST to the reactor vessel. The turbine is driven with a portion of the decay heat steam from the reactor vessel, and exhausts to the suppression pool.

In the event of a LOCA, the RCIC System, in conjunction with the two HPCF systems, is designed to pump water into the vessel from approximately 1.0 MPaG to full operating pressure. These high pressure systems, combined with the RHR low pressure flooders and ADS, make up the ECCS network which can accommodate any single failure and still shut down the reactor (see Subsection 6.3.1.1 for a detailed description of ECCS redundancy and reliability).

During RCIC operation, the wetwell suppression pool acts as the heat sink for steam generated by reactor decay heat. This results in a rise in pool water temperature. Heat exchangers in the RHR System are used to maintain pool water temperature within acceptable limits by cooling the pool water directly.

1.2.2.6 Reactor Servicing Equipment

1.2.2.6.1 Fuel Servicing Equipment

Fuel servicing equipment is summarized in Subsection 9.1.4.2.3.

1.2.2.6.2 Miscellaneous Servicing Equipment

The servicing aids equipment includes general handling fuel pool tools such as actuating poles with various end configurations. General area underwater lights and support brackets are provided to allow the lights to be positioned over the area being serviced independent of the platform. A general-purpose, plastic viewing aid is provided to float on the water surface to provide better visibility. A portable underwater closed circuit television camera may be lowered into the reactor vessel pool and/or the fuel storage pool to assist in the inspection and/or maintenance of these areas. An underwater vacuum with submersible pump and filter for cleaning.

1.2.2.6.3 Reactor Pressure Vessel Servicing Equipment

Equipment associated with servicing the reactor pressure vessel is used when the reactor is shutdown and the reactor vessel head is being removed or installed. Tools used consist of strongbacks, nut racks, stud tensioners, protectors, wrenches, etc. Lifting tools are designed for a 60-year life and for a safety factor of 10 or better with respect to the ultimate strength of the material used.

1.2.2.6.4 RPV Internal Servicing Equipment

The majority of internal servicing equipment was designed to be attached to the refueling platform auxiliary hoist and used when the reactor is open. A variety of equipment (e.g., grapples, guides, plugs, holders, caps, strongbacks and sampling stations) is used for internal servicing. In addition to these are the RIP handling devices for repair and/or installation. Lifting tools are designed for a safety factor of 10 or better with respect to the ultimate strength of the material used.

1.2.2.6.5 Refueling Equipment

The fuel servicing equipment includes a 1.471 MN Reactor Building crane, refueling machine, and other related tools for reactor servicing.

The Reactor Building crane handles the spent fuel cask from the transport device to the cask loading pit. The refueling machine transfers the fuel assemblies between the storage area and the reactor core. New fuel bundles are handled by the Reactor Building crane.

The handling of the reactor head, removable internals, reactor insulation, and drywell head during refueling is accomplished using the Reactor Building crane.

1.2.2.6.5.1 Refueling Interlocks

A system of interlocks that restricts movement of refueling equipment and control rods when the reactor is in the refueling and startup modes is provided to prevent an inadvertent criticality during refueling operation. The interlocks backup procedural controls that have the same objective. The interlocks affect movement of the refueling machine, refueling machine hoists, fuel grapple, and control rods.

1.2.2.6.6 Fuel Storage Facility

Spent fuel storage racks are designed to prevent inadvertent criticality and load buckling. Sufficient cooling and shielding are provided to prevent excessive pool heatup and personnel exposure, respectively. The design of the fuel pool provides for corrosion resistance, adherence to Seismic Category I requirements, and prevention of k_{eff} from reaching 0.95 under dry or flooded conditions.

1.2.2.6.7 Undervessel Servicing Equipment

This equipment is used for the installation and removal work associated with the fine motion control rod drive (FMCRD), RIP, incore monitoring (ICM) and so on. A handling platform provides a working surface for equipment and personnel performing work in the undervessel area. The polar platform is capable of rotating 360 degrees, and has an FMCRD handling trolley with full traverse capability across the vessel diameters. All equipment is designed to minimize radiation exposure, contamination of surrounding equipment and reduce the number of workers required.

1.2.2.6.8 CRD Maintenance Facility

The CRD maintenance facility is located close to the primary containment and is designed and equipped to accommodate maintenance of the FMCRD, provide decontamination of the FMCRD component, perform the acceptance tests and provide storage. The facility uses manual and/or remote operation to minimize radiation exposure to the personnel and to minimize the contamination of surrounding equipment during operation. The layout of the facility is designed so as to maximize the efficiency of the personnel, thereby minimizing the number of workers required.

1.2.2.6.9 Internal Pump Maintenance Facility

The reactor internal pump (RIP) maintenance facility is located in the Reactor Building and is designed for performing maintenance work on the motor assembly and related parts. The facility is designed for one motor assembly, including decontamination in assembled and disassembled states. The facility is equipped with all tools needed for inspection of motor parts and heat exchanger tube bundles. RIP handling tools are stored outside this area.

1.2.2.6.10 Fuel Cask Cleaning Facility

The fuel cask cleaning facility provides for empty casks to be checked for contamination and cleaned of road dirt, moved into the Reactor Building airlock, inspected for damage, and raised to the refueling floor cask pit. The closure head is removed and stored in the adjacent cask washdown pit, while the canal gates between the cask pit and spent fuel pool are removed and the spent fuel is transferred to fill the cask. The canal gates and closure head are replaced and the cask is lifted to the washdown pit. The cask is decontaminated with high pressure water sprays, chemicals and hand scrubbing to the level required for offsite transport. Smear tests are performed to verify cleaning before the filled cask is lowered to the airlock, mounted on the transport vehicle and moved out of the Reactor Building.

1.2.2.6.11 Plant Startup Test Equipment

Plant startup test equipment is a combination of strain gauges, accelerometers, temperature detectors, photo cells, pressure transducers and other associated instrumentation for conducting special startup and reactor internal vibration tests.

1.2.2.6.12 Inservice Inspection Equipment

Inservice inspection equipment are coordinated ultrasonic, eddy current and visual systems needed for incore housing, stub tube, feedwater nozzle, RPV inside and outside diameters, RPV internals and head studs, shroud head bolts, and piping inspections and examinations.

1.2.2.7 Reactor Auxiliary Systems

1.2.2.7.1 Reactor Water Cleanup System

The Reactor Water Cleanup System (CUW) recirculates a portion of reactor coolant through a filter-demineralizer to remove particulate and dissolved impurities from the reactor coolant. It also removes excess coolant from the reactor system under controlled conditions and provides clean water for the reactor head spray nozzle.

1.2.2.7.2 Fuel Pool Cooling and Cleanup System

The Fuel Pool Cleanup (FPC) System maintains acceptable levels of temperature and clarity and minimizes radioactivity levels of the water in the spent fuel pool, reactor well and dryer/separator pit on top of the containment. The FPC System also maintains the temperature and water level in the service pool and equipment pool. The system includes two heat exchangers, each capable of removing the decay heat generated from an average discharge of spent fuel, and two filter/demineralizers, each unit having the capacity to process the system flow or greater to maintain the desired purity level.

1.2.2.7.3 Suppression Pool Cleanup System

The Suppression Pool Cleanup (SPCU) System provides a continuous purification of the suppression pool water. The system removes impurities by filtration, adsorption, and ion exchange processes. The system consists of a recirculation loop with a pump and isolation valves. Suppression pool water is passed through the Fuel Pool Cooling and Cleanup (FPC) System filter/demineralizers for treatment. Treated water may be diverted to refill the reactor well and the upper pool during refueling outage or provide makeup water to the fuel pool and reactor cooling water (RCW) surge tanks following a seismic event.

1.2.2.8 Control Panels

1.2.2.8.1 Main Control Room Panels

The main control room panel arrangement is summarized in Appendix 18C.

1.2.2.8.2 Control Room Backpanels

The control room backpanels are located in an area adjacent to the main control panels and convenient to the control room crew.

1.2.2.8.3 Radioactive Waste Control Panel

The Radioactive Waste Control Panel System provides the operator interface to the consolidated automatic and remote manual controlling of radioactive waste system mechanical, electrical, and chemical process components. It consists of one or more control panels, including panel-mounted meters and displays, CRT displays, status indicating lights, mode and display selector switches, actuating mechanical and electrical components, controllers, and control logic elements and signal conditioning devices and processors. It does not include equipment or process sensors, local panels or equipment-mounted actuators or power controllers.

It is expected that most of the panels of this system will be located in the radioactive waste control room; panels performing the above functions which are located in the main control room shall also belong to this system.

1.2.2.8.4 Local Control Panels

The local control panels provide facilities for the installation and operation of electrical equipment and interconnecting wiring which supports no primary man-machine interface during normal plant operations. Included within the scope of the local control panels shall be the physical panel structure and the wiring associated with the components installed within the panels. The local control panels do not include the major electrical components installed within the panels, which are instead defined and provided as part of the interfacing plant systems.

1.2.2.8.5 Instrument Racks

The instrument racks provide facilities for the installation and operation of locally mounted instrumentation. Included within the scope of the instrument racks shall be the physical structure upon which the instrumentation is mounted and the wiring associated with the instrument installations. The instrument racks do not include the locally mounted instrumentation, which is instead defined and provided as part of the interfacing plant systems.

1.2.2.8.6 Data Communication

Data communication is accomplished through multiple control and instrumentation data communications functions that support the monitoring and control of interfacing plant systems. The equipment includes electrical devices and circuitry that connect sensors, display devices, controllers, and actuators which are part of these plant systems. The data communication function also includes the associated data acquisition and communication software required to support its function of plant-wide data and control distribution.

1.2.2.8.7 Local Control Boxes

Local control boxes are uniquely identified to provide operational control of an individual piece of electrical equipment.

1.2.2.9 Nuclear Fuel

The nuclear fuel assembly contains fissionable material which produces thermal power while maintaining structural integrity. The configuration of the fuel bundle consists of fuel rods, spacers, springs, upper and lower tie plates, and nuts. Four fuel sub-bundles along with the channel and a handle with spring, are assembled into a transportable, interchangeable assembly. The outer envelope of the fuel assembly is square with distinguishing features which provide support, identification, orientation and handling capabilities. The fuel design interface is described in Subsection 4.2.2.1.

The fuel channel encloses the four sub-bundles and provides: a barrier between two parallel coolant flow paths, one for flow inside the fuel bundle and the other for flow in the bypass region between channels; a bearing surface for the control rod; and rigidity for the fuel bundle. The sub-bundles are inserted into the channel, supported at the bottom end by an inlet piece bolted to the channel. The handle is connected to the top end of the channel, and equipped with a double leaf spring, maintaining contact with corresponding springs on adjacent assemblies, thus assuring channel-to-channel spacing.

1.2.2.10 Radioactive Waste System

1.2.2.10.1 Radwaste System

1.2.2.10.1.1 Liquid Waste Management System

The Liquid Waste Management System collects, monitors, and treats liquid radioactive wastes for return to the primary system whenever practicable. The radwaste processing equipment is located in the Radwaste Building. Processed waste volumes discharged to the environs are expected to be small. Any discharge is such that concentrations and quantities of radioactive material and other contaminants are in accord with applicable local, state, and federal regulations.

All potentially radioactive liquid wastes are collected in sumps or drain tanks at various locations in the plant. These wastes are transferred to collection tanks in the radwaste facility.

Waste processing is done on a batch basis. Each batch is sampled as necessary in the collection tanks to determine concentrations of radioactivity and other contamination. Equipment drains and other low-conductivity wastes are treated by filtration and demineralization and are transferred to the condensate storage tank for reuse. Laundry drain wastes and other detergent wastes of low activity are treated by filtration, sampled and released via the liquid discharge pathway and demineralization and may be released from the plant on a batch basis. Protection against inadvertent release of liquid radioactive waste is provided by design redundancy, instrumentation for the detection and alarm of abnormal conditions, automatic isolation, and administrative controls.

Equipment is selected, arranged, and shielded to permit operation, inspection, and maintenance with minimum radiation exposure to personnel.

1.2.2.10.1.2 Gaseous Waste Management System

The objective of the Gaseous Waste Management System is to process and control the release of gaseous radioactive effluents to the site environs so as to maintain the exposure of persons in unrestricted areas to radioactive gaseous effluents as low as reasonably achievable

(10CFR50, Appendix I). This shall be accomplished while maintaining occupational exposure as low as reasonably achievable and without limiting plant operation or availability.

The offgas system provides for holdup and decay of radioactive gases in the offgas from the air ejector system of a nuclear reactor and consists of process equipment along with monitoring instrumentation and control equipment (Section 11.3).

1.2.2.10.1.3 Solid Waste Management System

The Solid Waste Management System provides for the safe handling, packaging, and short-term storage of radioactive solid and concentrated liquid wastes that are produced. Dry active waste is surveyed and disposed of whenever possible via the provisions of applicable Federal and State regulations. Refer to Section 11.4 for a complete description of the solid waste management system.

1.2.2.11 Power Cycle Systems

1.2.2.11.1 Turbine Main Steam System

The Main Steam (MS) System delivers steam from the reactor to the turbine generator, the reheaters, and the steam jet air ejectors (SJAE) from warmup to full-load operation. The MS System also provides steam for the steam seal system and the auxiliary steam system when other steam sources are not available.

1.2.2.11.2 Condensate, Feedwater and Condensate Air Extraction System

The Condensate and Feedwater System provides a dependable supply of high-quality feedwater to the reactor at the required flow, pressure, and temperature. The condensate pumps take the deaerated condensate from the condenser hotwell and deliver it through the SJAE condenser, gland steam condenser, condensate filters and demineralizer, and through three parallel strings of four low pressure feedwater heaters to the reactor feed pumps' suction. The reactor feed pumps discharge through two stages of two parallel high pressure feedwater heaters to the reactor. The drains from the high pressure heaters are pumped backward to the suction of the reactors feed pumps.

1.2.2.11.2.1 Main Condenser Evacuation System

The Main Condenser Evacuation System removes the noncondensible gases from the main condenser and discharges them to the offgas system. This system consists of two 100% capacity, multiple-element, multi-stage steam jet air ejectors (SJAE) with intercondensers, for normal station operation, and mechanical vacuum pumps for use during startup.

1.2.2.11.3 Heater, Drain and Vent System

The Heater, Drain and Vent System permits efficient and dependable operation of the heat cycle balance-of-plant equipment and, particularly, the condensate and feedwater regenerative heaters. All process equipment drains and vents are collected and routed to the appropriate points in the cycle and flows are controlled for equipment protection.

1.2.2.11.4 Condensate Purification System

Each unit is served by a 100% capacity condensate cleanup system, consisting of high efficiency filters followed by deep-bed demineralizer vessels designed for parallel operation. One demineralizer vessel is a spare. The condensate cleanup system with instrumentation and automatic controls is designed to ensure a constant supply of high-quality water to the reactor.

1.2.2.11.5 Condensate Filter Facility

The condensate filter facility continuously removes suspended solids by processing the full-flow condensate through high efficiency filters. A fast acting full-flow bypass valve opens on high pressure differential across the filter to protect against sudden loss of condensate flow.

1.2.2.11.6 Condensate Demineralizer

The condensate demineralizers continuously process condensate to remove dissolved solids to reactor feedwater quality through demineralizers and an additional unit in manual standby. An emergency bypass line protects the equipment, and a demineralizer resin handling and cleaning system is included.

1.2.2.11.7 Main Turbine

The main turbine is a 188.5 rad/s, tandem compound six-flow, reheat steam turbine with 132.08 cm last-stage blades. The turbine generator is equipped with an electro-hydraulic control system and supervisory instruments to monitor performance. The gross electrical output of the turbine generator is approximately 1400 MW.

1.2.2.11.8 Turbine Control System

The Turbine Control System is summarized in Subsection 10.2.2.3.

1.2.2.11.9 Turbine Gland Steam System

The Turbine Gland Steam System provides steam to the turbine shaft glands and the turbine valve stems. The system prevents leakage of air into or radioactive steam out of the turbine shaft and turbine valves. The gland steam condenser collects air and steam mixture, condenses the steam, and discharges the air leakage to the atmosphere via the main vent by a motor-driven blower.

1.2.2.11.10 Turbine Lubricating Oil System

The Turbine Lubricating Oil System supplies oil to turbine-generator bearing lubrication lines and mainly consists of lube oil tank, oil pumps, oil coolers, and oil purifier equipment.

1.2.2.11.11 Moisture Separator Reheater

The moisture separator reheater is summarized in Subsection 10.2.2.2 (Subtopic Moisture Separator Reheater).

1.2.2.11.12 Extraction System

Extraction steam from the high pressure turbine supplies the last stage of feedwater heating and extraction steam from the low pressure turbines supplies the first four stages. An additional low pressure extraction drained directly to the condenser protects the last-stage bucket from erosion induced by water droplets.

1.2.2.11.13 Turbine Bypass System

The turbine bypass system is summarized in Subsection 10.4.4.2.1

1.2.2.11.14 Reactor Feedwater Pump Driver

Each reactor feedwater pump is driven by an electrical motor driven adjustable speed drive.

1.2.2.11.15 Turbine Auxiliary Steam System

The Turbine Auxiliary Steam System is used when required to supply steam to the steam jet air injectors for condenser deaeration and to the Turbine Gland Seal System, which prevents radioactive steam leakage out of the turbine casings and atmospheric air leakage into the casing at specific operating conditions.

The house boiler steam is a backup to the reactor generated steam during operation and would be used only when reactor steam is unavailable or too radioactive.

1.2.2.11.16 Generator

The generator is a direct-driven, three-phase, 60 Hz, approximately 26 kV, 1800 rpm, conductor cooled, synchronous generator rated at approximately 1610 MVA, at 0.90 power factor, 520 kPaG hydrogen pressure, and approximately 0.5 short circuit ratio.

1.2.2.11.17 Hydrogen Gas Cooling System

The Hydrogen Gas Cooling System is summarized in Subsection 10.2.2.2 (Subtopic Bulk Hydrogen System).

1.2.2.11.18 Generator Cooling System

The Generator Cooling System includes the hydrogen cooled rotor portion of the Hydrogen Gas Cooling System and the water cooled stator portion of the Turbine Building Cooling Water System.

1.2.2.11.19 Generator Sealing Oil System

The Generator Sealing Oil System prevents hydrogen gas from leaking from the generator. The sealing oil is vacuum-treated to maintain the hydrogen gas purity.

1.2.2.11.20 Exciter

The generator exciter is a static excitation system and will have a response ratio that meets the plant voltage regulation requirements and the site specific grid requirements.

Excitation power is provided by the output of a dedicated transformer. This output is rectified by thyristor rectifiers. The DC output of the rectifier banks then is applied to the main generator field through the generator collectors.

1.2.2.11.21 Main Condenser

The main condenser is a single-pressure, three-shell deaerating type condenser or multi-pressure design as dictated by the site specific circulating water system and power cycle heat sink. During plant operation, steam expanding through the low pressure turbines is directed downward into the main condenser and is condensed. The main condenser also serves as a heat sink for the turbine bypass system, emergency and high level feedwater heater and drain tank dumps, and various other startup drains and relief valve discharges.

1.2.2.11.22 Offgas System

The Offgas System is summarized in Subsection 11.3.

1.2.2.11.23 Circulating Water System

The Circulating Water System provides a continuous supply of cooling water to the condenser to remove the heat rejected by the steam cycle and transfers it to the power cycle heat sink.

1.2.2.11.24 Condenser Cleanup Facility

The condenser cleanup facility removes slime and sludge to prevent vacuum decline of the condenser and to suppress corrosion on the inner surface of the condenser tubes.

1.2.2.12 Station Auxiliary Systems

1.2.2.12.1 Makeup Water System (Preparation)

The Makeup Water System (preparation) is summarized in Subsection 9.2.8.3.

1.2.2.12.1.1 Makeup Water System (Purified)

The Makeup Water System (purified) is summarized in Subsection 9.2.10.2.

1.2.2.12.2 Makeup Water System (Condensate)

The Makeup Water System maintains the required capacity and flow of the condensate for the RCIC and HPCF Systems and maintains the required level in the condenser hotwell. The system also (1) stores and transfers water during refueling and cask storage pool water during fuel shipping cask loading, (2) receives and stores the process effluent from the liquid radwaste system, (3) provides makeup to other plant systems where required, and (4) provides condensate to the Control Rod Drive (CRD) Hydraulic System.

The system consists of a condensate storage tank, three condensate transfer pumps, and the necessary controls and instrumentation.

1.2.2.12.2.1 Condensate Storage Facilities and Distribution System

The condensate storage tank receives demineralized water from the purified water makeup system and may also receive low conductivity water from the condensate return of the primary loop, from the radwaste disposal system and the condensate system in the Turbine Building.

1.2.2.12.3 Reactor Building Cooling Water System

The Reactor Building Cooling Water (RCW) System provides cooling water to certain designated equipment located in the Reactor Building. Capacity and redundancy is provided in heat exchangers and pumps to ensure adequate performance of the cooling system under all postulated conditions. During loss of offsite power, emergency power for the system is available from the onsite emergency diesel generators. The closed loop design provides a barrier between radioactive systems and the reactor service water discharged to the environment. Heat is removed from the closed loop by the Reactor Service Water System. Radiation monitors are provided to detect contaminated leakage into the closed systems.

1.2.2.12.4 Turbine Building Cooling Water System

The Turbine Building Cooling Water System is summarized in Subsection 9.2.14.2.1.

1.2.2.12.5 HVAC Normal Cooling Water System

The HVAC Normal Cooling Water System provides chilled water to the air supply cooling coils of the reactor building, to the heating/cooling coils in the drywell, and the control building electrical equipment room.

1.2.2.12.6 HVAC Emergency Cooling Water System

The HVAC emergency cooling water system provides chilled water to the cooling coils in the control building essential electrical equipment room, the main control room and the diesel generator electrical equipment areas. The safety-related chilled-water system is designed to meet the requirements of Criterion 19 of 10CFR50.

1.2.2.12.7 Oxygen Injection System

The Oxygen Injection System is summarized in Subsection 9.3.10.2.

1.2.2.12.8 Ultimate Heat Sink

The Ultimate Heat Sink System is summarized in Subsection 9.2.5.3.

1.2.2.12.9 Reactor Service Water System

The Reactor Service Water System is summarized in Subsection 9.2.15.1.3 and 9.2.15.2.3.

1.2.2.12.10 Turbine Service Water System

The Turbine Service Water System is summarized in Subsection 9.2.16.1.3 and 9.2.16.2.3.

1.2.2.12.11 Station Service Air System

The Station Service Air System provides a continuous supply of compressed air of suitable quality and pressure for general plant use. The service air compressor discharges into the air receivers and the air is then distributed throughout the plant.

1.2.2.12.12 Instrument Air System

The Instrument Air System is summarized in Subsection 9.3.6.2.

1.2.2.12.13 High Pressure Nitrogen Gas Supply System

Nitrogen gas is normally supplied by the Atmospheric Control System to meet the requirement of (1) the Main Steam System SRV automatic depressurization and relief function accumulators, (2) the main steam isolation valves, and (3) instruments and pneumatic valves using nitrogen in the Reactor Building. When this supply of pressurized nitrogen is not available, the High Pressure Nitrogen Gas Supply (HPIN) System automatically maintains nitrogen pressure to this equipment. The HPIN System consists of high pressure nitrogen storage bottles with piping, valves, instruments, controls and control panel.

1.2.2.12.14 Heating Steam and Condensate Water Return System

The Heating Steam and Condensate Water Return System supplies heating steam from the House Boiler for general plant use and recovers the condensate return to the boiler feedwater tanks. The system consists of piping, valves, condensate recovery set and associated controls and instrumentation.

1.2.2.12.15 House Boiler System

The House Boiler System consists of the house boilers, reboilers, feedwater components, boiler water treatment and control devices. The House Boiler System supplies turbine gland steam and heating steam, including the concentrating tanks and devices of the high conductivity waste equipment.

1.2.2.12.16 Hot Water Heating System

The Hot Water Heating System is a closed-loop hot water supply to the various heating coils of the HVAC systems. The system includes two heat exchangers, surge and chemical addition tanks and associated equipment, controls and instrumentation.

1.2.2.12.17 Hydrogen Water Chemistry System

The Hydrogen Water Chemistry System is summarized in Subsection 9.3.9.2.

1.2.2.12.18 Zinc Injection System

The Zinc Injection System is summarized in Subsection 9.3.11.1.

1.2.2.12.19 Breathing Air System

The Breathing Air System includes air compressors, dryers, purifiers and a distribution network. This network makes breathing air available in all plant areas where operations or maintenance must be performed and high radioactivity could occur in the ambient air. Special connections are provided to assure that this air is used only for breathing apparatus.

1.2.2.12.20 Sampling System (Includes PASS)

The Process Sampling System is furnished to provide process information that is required to monitor plant and equipment performance and changes to operating parameters. Representative liquid and gas samples are taken automatically and/or manually during plant operation for laboratory or online analyses.

1.2.2.12.21 Freeze Protection System

The Freeze Protection System provides insulation, steam and electrical heating for all external tanks and piping that may freeze during winter weather.

1.2.2.12.22 Iron Injection System

The Iron Injection System consists of an electrolytic iron ion solution generator and means to inject the iron solution into the feedwater system in controlled amounts.

1.2.2.12.23 Alternate Feedwater Injection System

The Alternate Feedwater Injection (AFI) System is summarized in Subsection 9.5.14.

1.2.2.13 Station Electrical Systems

1.2.2.13.1 Electrical Power Distribution System

The unit Class 1E AC power system supplies power to the unit Class 1E loads. The offsite power sources converge at the system. The system includes diesel generators that serve as standby power sources, independent of any onsite or offsite source. Therefore, the system has multiple sources. Furthermore, the system is divided into three divisions, each with its own independent distribution network, diesel generator, and redundant load group. A fourth division battery for the safety logic and control system bus receives charger power from the Division II source.

1.2.2.13.2 Unit Auxiliary Transformer

The unit auxiliary AC power system supplies power to unit loads that are non-safety-related and uses the main generator and/or offsite power as the normal power source with the reserve auxiliary transformer as a backup source. The unit auxiliary transformer steps down the AC power to the 13.8 kV and 4.16 kV station bus voltages.

1.2.2.13.3 Isolated Phase Bus

The isolated phase bus duct system provides electrical interconnection from the main generator output terminals to the generator breaker and from the generator breaker to the low voltage terminals of the main transformer, and the high voltage terminals of the unit auxiliary transformers. During the time the main generator is off line, the generator breaker is open and power is fed to the unit auxiliary transformers by backfeeding from the main transformer. During startup, the generator breaker is closed between 10% and 15% power to provide power to the main and the unit auxiliary transformers for normal operation of the plant.

A package cooling unit is supplied with the isolated bus duct system.

1.2.2.13.4 Non-Segregated Phase Bus

The non-segregated phase bus or cable provides the electrical interconnection between the unit auxiliary transformers and their associated medium-voltage switchgear, and between the reserve auxiliary transformers and their associated medium-voltage switchgear.

1.2.2.13.5 Metal-clad Switchgear

The metal-clad switchgear distributes the 13.8 kV or 4.16 kV power. Circuit breakers are drawout type, stored energy vacuum breakers. The switchgear interrupting rating shall be determined in accordance with requirements of IEEE C37.010.

1.2.2.13.6 Power Center

The power center is summarized in Subsection 8.3.1.1.2.1.

1.2.2.13.7 Motor Control Center

The motor control center is summarized in Subsection 8.3.1.1.2.2.

1.2.2.13.8 Raceway System

The Raceway System is a plant-wide network comprised of metallic cable trays, metallic conduits and supports. Raceways are classified for carrying medium voltage power cables, low voltage power cables, control cables and low level signal/instrumentation cables. Divisional cables are routed in separate cable raceways for each division.

Fiber optic dataways are not restricted to raceway classifications, but would generally be run with control cables due to their common destinations.

1.2.2.13.9 Grounding Wire

Station grounding and surge protection are discussed in Section 8A.1.

1.2.2.13.10 Electrical Wiring Penetration

Electrical wiring penetrations are described in Subsection 8.3.3.6.1.2 (7).

1.2.2.13.11 Combustion Turbine Generator

The primary function of the Combustion Turbine Generator (CTG) is to act as a standby onsite non-safety power source to feed Plant Investment Protection (PIP) non-safety loads during Loss of Preferred Power (LOPP) events.

The unit also provides an alternate AC power source in case of a station blackout event, as defined by Appendix B of Regulatory Guide 1.155 (Appendix 1C).

1.2.2.13.12 Direct Current Power Supply

The plant has four independent Class 1E and three non-Class 1E 125 VDC power systems.

1.2.2.13.12.1 Unit Auxiliary DC Power System

The Unit Auxiliary DC Power System supplies power to unit DC loads that are non-safety-related. The system consists of three battery chargers, three batteries, and three distribution panels.

1.2.2.13.12.2 Unit Class 1E DC Power System

The Unit Class 1E DC Power System supplies 125 VDC power to the unit Class 1E loads. Battery chargers are the primary power sources. The system, which includes storage batteries that serve as standby power sources, is divided into four divisions, each with its own independent distribution network, battery, and charger.

1.2.2.13.13 Emergency Diesel Generator System

The Emergency Diesel Generator System is supplied by three diesel generators. Each Class 1E division is supplied by a separate diesel generator. There are no provisions for automatic transfer of Class 1E buses between standby AC power supplies or supplying more than one division of engineered safety features (ESF) from one diesel generator. This one-to-one relationship ensures that a failure of one diesel generator can affect only one ESF division. The diesel generators are housed in the Reactor Building which is a Seismic Category I structure, to comply with applicable NRC and IEEE design guides and criteria.

1.2.2.13.14 Vital AC Power Supply

1.2.2.13.14.1 Safety System Logic and Control Power System

Four divisions of the Safety System Logic and Control (SSLC) Power System provide an uninterruptible Class 1E source of 120-VAC single-phase control power. The primary power source for the SSLC Power System is the Class 1E AC power system. On loss of AC power, the appropriate divisional battery immediately assumes load without interruption. When AC power is restored, it resumes the load without interruption.

1.2.2.13.14.2 Uninterruptible Power System

The Uninterruptible Power System (UPS) supplies regulated 120 VAC single-phase power to non-Class 1E instrument and control loads which require an uninterruptible source of power. The power sources for the UPS are similar to those for the SSLC, but are non-Class 1E.

1.2.2.13.14.3 Reactor Protection System Alternate Current Power Supply

The Reactor Protection System alternate current power supply is described in Subsection 8.3.1.1.4.2.1.

1.2.2.13.15 Instrument and Control Power Supply

The instrument and control (I&C) power supply provides 120 VAC single-phase power to I&C loads which do not require an uninterruptible power source.

1.2.2.13.16 Communication System

The communication system is summarized in Subsection 9.5.2.

1.2.2.13.17 Lighting and Servicing Power Supply

The design basis for the lighting facilities is the standard for the Illuminating Engineering Society. Special attention is given to areas where proper lighting is imperative during normal and emergency operations. The system design precludes the use of mercury vapor fixtures in the containment and the fuel handling areas. The normal lighting systems are fed from the non-Class 1E Plant Investment Protection (PIP) buses that are backed up by the combustion turbine generator. Emergency power is supplied by engineered safety buses backed-up by diesel generators. Normal operation and regular simulated offsite power loss tests verify system integrity.

1.2.2.14 Power Transmission Systems

1.2.2.14.1 Reserve Auxiliary Transformer

Each reserve auxiliary transformer provides alternate preferred feeds to two power generation buses and can feed any of the three plant investment protection buses and any of the three Class 1E 4.16 kV buses.

1.2.2.15 Containment and Environmental Control Systems

1.2.2.15.1 Primary Containment System

The ABWR primary containment system design incorporates the drywell/pressure suppression feature of previous BWR containment designs. In fulfilling its design basis as a fission product barrier, the primary containment is a low leakage structure even at the increased pressures that could follow a main steamline rupture or a fluid system line break.

1.2.2.15.1.1 Primary Containment Vessel

The main features of the primary containment design include:

(1) The drywell, a cylindrical steel-lined reinforced concrete structure surrounding the reactor pressure vessel (RPV).

(2) A suppression pool filled with water, which serves as a heat sink during normal operation and accident conditions.

(3) The air space above the suppression pool.

1.2.2.15.2 Containment Internal Structures

The containment internal structures are summarized in Subsections 3.8.3.1 and 6.2.1.1.2.3.

1.2.2.15.3 Reactor Pressure Vessel Pedestal

The reactor pressure vessel (RPV) pedestal is a prefabricated cylindrical steel structure filled with concrete which supports the RPV and is maintained below design temperature by cooling. The pedestal provides drywell connecting vents which lead to the horizontal vent pipes to the suppression pool.

1.2.2.15.4 Standby Gas Treatment System

The Standby Gas Treatment System (SGTS) minimizes exfiltration of contaminated air from the secondary containment to the environment following an accident or abnormal condition which could result in abnormally high airborne radiation in the Reactor Building. Because the fuel storage area is also in the secondary containment, it also can be exhausted to the SGTS.

All safety-related components of the SGTS are operable during loss of offsite power.

1.2.2.15.5 PCV Pressure and Leak Testing Facility

The PCV pressure and leak testing facility is a special area just outside the containment. It provides instrumentation for conducting the PCV pressure and integrated leak rate tests.

1.2.2.15.6 Atmospheric Control System

The Atmospheric Control System is designed to establish and maintain an inert atmosphere within the primary containment during all plant operating modes except during plant shutdown for refueling or maintenance.

The Atmospheric Control System is summarized in Subsection 6.2.5.2.1.

1.2.2.15.7 Drywell Cooling System

The Drywell Cooling System is summarized in Subsection 9.4.9.2.

1.2.2.15.8 Not Used

1.2.2.15.9 Suppression Pool Temperature Monitoring System

The Suppression Pool Temperature Monitoring (SPTM) System is summarized in Subsection 7.6.1.7.1.

1.2.2.16 Structures and Servicing Systems

1.2.2.16.1 Foundation Work

The analytical design and evaluation methods for the containment and Reactor Building walls, slabs and foundation mat and foundation soil are summarized in Subsection 3.8.1.4.1.1.

1.2.2.16.2 Turbine Pedestal

The description for the turbine pedestal is the same as that for foundation work in Subsection 3.8.1.4.1.1.

1.2.2.16.3 Cranes and Hoists

The cranes and hoists are summarized in Subsection 9.1.

1.2.2.16.4 Elevator

The controlled elevators service the Reactor Building radiation controlled zones from the basemat to the refueling floor. Two additional clean elevators service all elevations of the clean zone.

1.2.2.16.5 Heating, Ventilating and Air Conditioning

The plant environmental control systems control temperature, pressure, humidity, and airborne contamination to ensure the integrity of plant equipment, provide acceptable working conditions for plant personnel, and limit offsite releases of airborne contaminants.

The following environmental systems are provided:

(1) The Control Room Habitability Area HVAC System, consisting of supply, recirculation/exhaust and makeup air cleanup units to ensure the habitability of the control room under normal and abnormal conditions of plant operation.

(2) The Reactor Building Secondary Containment HVAC System maintains a negative pressure in the secondary containment under normal and abnormal operating conditions, thereby isolating the environs from potential leak sources. This system removes heat generated during normal plant operation, shutdown, and refueling periods.

(3) The Drywell Cooling System to remove heat from the drywell generated during normal plant operations including startup, reactor scrams, hot standby, shutdown, and refueling periods.

(4) The R/B Safety-Related Equipment HVAC System to distribute air so that a negative pressure is maintained in the emergency core cooling equipment rooms, thereby isolating the potential airborne contamination in these rooms.

(5) The C/B Safety-Related Equipment Area HVAC System to pressurize the electrical rooms, thus allowing exfiltration of air to the battery rooms for exhaust to the outside atmosphere.

(6) The Spent Fuel Pool Area HVAC System to maintain the refueling floor at a negative pressure with respect to the outside atmosphere to prevent the potential release of airborne contamination.

(7) The R/B Satey-Related Diesel Generator HVAC System to provide cooling during operation of the diesel generators. A tempered air supply system controls the thermal environment when the diesel generators are not operating.

(8) Coolers in the steam tunnel and ECCS rooms to remove heat generated during operation of the equipment in these rooms.

(9) The Turbine Island HVAC System maintains environmental conditions in the Turbine Building and the Electrical Equipment areas.

(10) The Service Building HVAC System maintains environmental conditions in the Service Building, including clean areas such as the Technical Support Center and Operations Support Center during emergency conditions.

(11) The Radwaste Building HVAC System is engineered and designed to provide proper environmental conditions within all areas of the Radwaste Building during normal plant operation.

1.2.2.16.5.1 Potable and Sanitary Water System

The potable and sanitary water includes site specific designs of a potable water system, a sanitary water system, a sewage treatment system, and a separate non-radioactive drain system. These systems are summarized in Subsections 9.2.4.1.3, 9.2.4.3.2, and 9.3.3.2.3 respectively.

1.2.2.16.6 Fire Protection System

The Fire Protection System is designed to provide an adequate supply of water or chemicals to points throughout the plant where fire protection is required. Diversified fire-alarm and fire-suppression types are selected to suit the particular areas or hazards being protected. Chemical fire-fighting systems are also provided as additions to or in lieu of the water fire-fighting systems. Appropriate instrumentation and controls are provided for the proper operation of the fire detection, annunciation and fire-fighting systems.

1.2.2.16.7 Floor Leakage Detection System

The drainage system is also used to detect abnormal leakage in safety-related equipment rooms and the fuel transfer area.

1.2.2.16.8 Vacuum Sweep System

A portable, submersible-type, underwater vacuum cleaner is provided to assist in removing crud and miscellaneous particulate matter from the pool floors or reactor vessel. The pump and the filter unit are completely submersible for extended periods. The filter “package” is capable of being remotely changed, and the filters will fit into a standard shipping container for offsite burial.

1.2.2.16.9 Decontamination System

The Decontamination System provides areas, equipment and services to support low radiation level decontamination activities. The services may include electrical power, service air, demineralized water, condensate water, radioactive and nonradioactive drains, HVAC and portable shielding.

1.2.2.16.10 Reactor Building

The Reactor Building includes the containment, drywell, and major portions of the nuclear steam supply system, steam tunnel, refueling area, diesel generators, essential power, non-essential power, emergency core cooling systems, HVAC and supporting systems. The secondary containment is a reinforced concrete building that forms the secondary containment boundary which surrounds the primary containment above the basemat. It permits monitoring and treating all potential radioactive leakage from the primary containment. Treatment consists of HEPA and activated charcoal filtration.

1.2.2.16.11 Turbine Building

The Turbine Building houses all equipment associated with the main turbine generator. Other auxiliary equipment is also located in this building.

1.2.2.16.12 Control Building

The Control Building includes the control room, the computer facility, the cable tunnels, some of the plant essential switchgear, some of the essential power, reactor building water system and the essential HVAC system.

1.2.2.16.13 Radwaste Building

The Radwaste Building houses all equipment associated with the collection and processing of solid and liquid radioactive waste generated by the plant.

1.2.2.16.14 Service Building

The Service Building houses the personnel facilities and portions of the non-essential HVAC System.

1.2.2.16.15 Control Building Annex

The Control Building Annex is a nonsafety-related structure located adjacent to the Control Building. It houses the two nonsafety-related Reactor Internal Pump Motor Generator sets, control panels, and the cooling water lines, HVAC system, and electrical lines that support the MG sets. The reactor internal pump motor-generator set equipment performs no safety-related function.

1.2.2.16.16 Alternate Feedwater Injection (AFI) Pump House

The Alternate Feedwater Injection Pump House, which is located remotely from the Reactor Building, contains the additional equipment, such as the AFI pump, piping and valves which support the AFI function.

1.2.2.17 Yard Structures and Equipment

1.2.2.17.1 Stack

The plant stack is located on the Reactor Building and rises to an elevation of 76 meters above grade level. The stack is a steel shell construction supported by an external steel tubular frame work. The stack vents the Reactor Building, Turbine Building, Radwaste Building, and a small portion of the Control and Service buildings.

1.2.2.17.2 Oil Storage and Transfer System

The major components of this system are the fuel-oil storage tanks, pumps, and day tanks. Each diesel generator has its own individual supply components. Each storage tank is designed to supply the diesel needs during the post-LOCA period, and each day tank has capacity for 8 hours of diesel generator operation at maximum LOCA load demand. Each fuel oil pump is controlled automatically by day-tank level and feeds its day tank from the storage tank. Additional fuel oil pumps supply fuel to each diesel fuel manifold from the day tank.

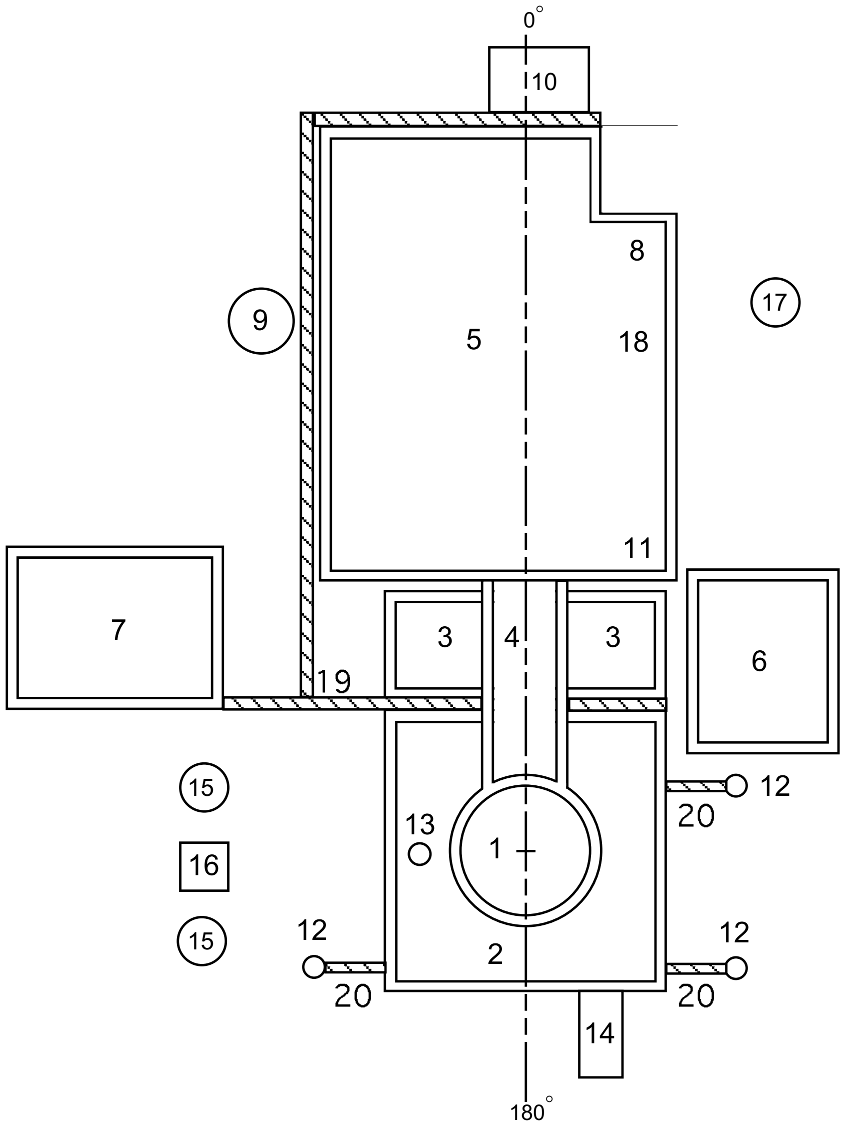
1.2.2.17.3 Site Security

Site Security is summarized in Subsection 13.6.3.1.

1.2.3 COL License Information

1.2.3.1 Plant Design and Aging Management

The COL applicant shall initiate the life cycle management program early in the design process and shall consider the design life requirements as outlined in Subsection 1.2.1.3. In addition, the aging management plan shall cover the structures and components, and the plan shall consider the potential causes of corrosion as outlined in Subsection 1.2.1.3.



No.	FACILITY
1	REACTOR CONTAINMENT
2	REACTOR BUILDING
3	CONTROL BUILDING
4	MAIN STEAM/FEEDWATER TUNNEL
5	TURBINE BUILDING
6	SERVICE BUILDING
7	RADWASTE BUILDING
8	HOUSE BOILER
9	CONDENSATE STORAGE TANK
10	UNIT AUXILIARY TRANSFORMERS
11	NORMAL SWITCHGEAR
12	DIESEL OIL STORAGE TANK (3)
13	STACK
14	EQUIPMENT ENTRY LOCK
15	FIRE PROTECTION WATER STORAGE TANK (2)
16	FIRE PROTECTION PUMPHOUSE
17	BUNKER FUEL TANK
18	COMBUSTION TURBINE GENERATOR
19	RADWASTE TUNNELS RB, CB, TB
20	DG OIL TRANSFER TUNNEL (3)

Figure 1.2-1 Site Plan

The following figures are located in Chapter 21 :

Figure 1.2-25 Turbine Building, General Arrangement at Elevation 6300 mm

Figure 1.2-26 Turbine Building, General Arrangement at Elevation 12300 mm

Figure 1.2-27 Turbine Building, General Arrangement at Elevation 19700 mm

Figure 1.2-28 Turbine Building, General Arrangement at Elevation 24400 mm

Figure 1.2-29 Turbine Building, General Arrangement at Elevation 27800 mm

Figure 1.2-30 Turbine Building, General Arrangement at Elevation 38300 mm

Figure 1.2-31 Turbine Building, General Arrangement at Elevation 47200 mm

Figure 1.2-32 Turbine Building, General Arrangement at Section A-A

Figure 1.2-33 Turbine Building, General Arrangement at Section B-B