9.2 Water Systems

9.2.1 Station Service Water System

The functions normally performed by the Station Service Water (SSW) System are performed by the systems discussed in Subsection 9.2.15.

9.2.2 Closed Cooling Water System

The functions normally performed by the Closed Cooling Water (CCW) System are performed by the systems discussed in Subsections 9.2.11, 9.2.12, 9.2.13, and 9.2.14.

9.2.3 Demineralized Water Makeup System

The functions normally performed by the Demineralized Water Makeup (DWM) System are performed by the systems discussed in Subsections 9.2.8, 9.2.9 and 9.2.10.

9.2.4 Potable and Sanitary Water System

9.2.4.1 Portions Within Scope of ABWR Standard Plant

Those portions of the Potable and Sanitary Water (PSW) System that are within the Standard Plant buildings (Subsection 1.1.2) are in the scope of the ABWR Standard Plant and are described in Subsections 9.2.4.1.1 and 9.2.4.1.6.

All portions of the PSW System which are outside the ABWR Standard Plant buildings are not in the scope of the ABWR Standard Plant.

A separate portion of the PSW, the non-radioactive drains, is described in Subsection 9.3.3.

9.2.4.1.1 Safety Design Bases

The PSW System has no safety-related function. Failure of the system does not compromise any safety-related system or component, nor does it prevent a safe shutdown of the plant.

9.2.4.1.2 Power Generation Design Bases

The PSW System shall be designed with no interconnections with systems having the potential for containing radioactive materials. Protection shall be provided through the use of air gaps, where necessary.

9.2.4.1.3 System Description

Part of the PSW System is a hot and cold potable water distribution system. It includes piping, valves, instrumentation, sinks, toilets and other facilities.

The PSW System includes a sanitary drainage system, which is designed to collect liquid wastes and entrained solids discharged by all plumbing fixtures located in the Standard Plant buildings, from areas with no sources of potentially radioactive wastes and conveys them to a sewage treatment facility.

Potable water is provided to flush the service water sides of the RSW and TSW heat exchangers whenever they are put into a wet standby condition.

9.2.4.1.4 Safety Evaluation

The PSW System has no interconnections with systems having the potential for containing radioactive materials.

9.2.4.1.5 Instrumentation and Alarms

The subsystems of the PSW System are provided with control panels located in the control building which are designed for remote manual and automatic control of the processes.

9.2.4.1.6 Tests and Inspections

An integrity test is performed on the PSW System upon completion of construction and before putting the system into operation.

The operability of the PSW System is demonstrated by use during normal system operation.

9.2.4.2 Portions Outside the Scope of ABWR Standard Plant

All portions of the PSW System which are outside the Standard Plant buildings are not in the scope of the ABWR Standard Plant. Subsections 9.2.4.2.1 through 9.2.4.2.8 provide conceptual design of these portions of the PSW as required by 10 CFR 52. The interface requirements for this system are part of the design certification.

The portions of the PSW System which are not in the scope of the ABWR Standard Plant shall meet all requirements in Subsections 9.2.4.1.1 through 9.2.4.1.6 and all following requirements. The following subsection provides a conceptual design and interface requirements for these portions of the PSW System and are a part of the design certification.

9.2.4.2.1 Safety Design Bases (Interface Requirements)

The PSW System has no safety-related function. Failure of the system does not compromise any safety-related system or component, nor does it prevent a safe shutdown of the plant.

9.2.4.2.2 Power Generation Design Bases (Interface Requirements)

(1) The PSW System is designed to provide to all buildings a minimum of 45 m^3/h of potable water during peak demand periods.

(2) Potable water is filtered and treated to prevent harmful physiological effects on plant personnel.

(3) The PSW System includes a sanitary drainage system which is designed to collect liquid wastes and entrained solids discharged by all plumbing fixtures located in areas with no sources of potentially radioactive wastes and conveys them to a sewage treatment facility.

(4) The PSW System includes a sewage treatment system which treats sanitary waste using the activated sludge biological treatment process. The aeration tanks are capable of receiving waste at a rate between 45 m^3/d and 185 m^3/d.

(5) The PSW System shall be designed with no interconnections with systems having the potential for containing radioactive materials. Protection shall be provided through the use of air gaps, where necessary.

9.2.4.2.3 System Description (Conceptual Design)

The PSW System includes a potable water system, a sanitary drainage system and a sewage treatment system.

9.2.4.2.3.1 Potable Water System

Filtered water flows by gravity from the filtered water storage tank of the Makeup Water Preparation (MWP) System into a potable water storage tank. A hypochlorite addition pump and tank are provided which adds sodium hypochlorite to the water entering the potable water storage tank. Two potable water pumps send water from the potable water storage tank to a hydropneumatic pressure tank. A hydropneumatic pressure tank and air compressor are provided to maintain adequate pressure within a potable water distribution piping system. Potable water is sent to a heater where it is heated and distributed throughout the plant.

9.2.4.2.3.2 Sanitary Drainage System

The sanitary drainage system collects liquid wastes and conveys them to the Sewage Treatment System. This system is installed in accordance with ANSI A40.8, National Plumbing Code, and applicable local or state codes.

9.2.4.2.3.3 Sewage Treatment System

The Sewage Treatment System (STS) is a concrete structure containing several compartments. The STS uses the activated sludge biological treatment process. The STS includes a comminutor with a bypass screen channel, two aeration tanks, three final clarifiers, one chlorine contact tank, two aerobic digesters, three air blowers, a froth spray pump, a hypochlorite pump and related equipment. The system can be operated in two modes: extended aeration and contact stabilization.

9.2.4.2.4 System Operation (Conceptual Design)

9.2.4.2.4.1 Normal Operation

The potable water pumps take water from the potable water storage tank and discharges it into the potable water hydropneumatic pressure tank. Under automatic control, a low pressure switch starts one of the two potable water pumps when the hydropneumatic pressure tank water pressure falls below a specified limit. A pressure switch automatically starts the second potable water pump when a single pump is unable to maintain the tank pressure above a specified limit. When water level reaches a specified high level in the hydropneumatic pressure tank, a level switch automatically stops the potable water pumps. If high water level in the pressure tank is reached and the tank pressure is low, the air compressor is automatically started and is stopped at a specified pressure by a high pressure switch.

The air compressor controls are interlocked with the potable water pump controls so that the air compressor may operate only when the pumps are stopped and the hydropneumatic pressure tank water level is at the specified high limit.

Downstream of the hydropneumatic pressure tank, a branch sends potable water to a heater and a hot water distribution system.

Normally, the STS is operated in the extended aeration mode. The sanitary wastes enter the STS via the comminutor, in which any solids are shredded, and flows into the aeration tanks. In the aeration tanks, the waste liquids are continuously aerated. Occasionally, foaming occurs in the aeration tanks. A froth spray system is provided which uses processed sewage to control any froth which is present. The aeration tank contents are then transferred to the clarifiers where the sludge is allowed to settle. The clarified sewage passes into the chlorine contact tank for chlorination prior to being discharged to the plant wastewater treatment system (outside the ABWR Standard Plant scope). The settled sludge is sent to the aerobic digesters and disposed of offsite.

9.2.4.2.4.2 Abnormal Operation

The components of the PSW System are designed to meet the increased needs during refueling operations when additional people are onsite.

The STS may be operated in the contact stabilization mode to process the substantially higher waste water flow rates during outages. In this mode, a portion of the settled sludge from the final clarifiers is aerated, sent to the aeration tanks and mixed with incoming sewage.

9.2.4.2.5 Evaluation of Potable and Sanitary Water System Performance (Interface Requirements)

The COL applicant shall analyze the PSW System to assure that the system meets all applicable regulatory requirements and is compatible with site conditions.

9.2.4.2.6 Safety Evaluation (Interface Requirements)

The PSW System has no interconnection with systems having the potential for containing radioactive materials. Protection includes, where necessary, the use of air gaps.

9.2.4.2.7 Instrumentation and Alarms (Interface Requirements)

The subsystems of the PSW System are provided with control panels located in the Control Building which are designed for remote manual and automatic control of the processes.

A flow proportioning controller is used to operate the hypochlorinator pump as water enters the PSW System. Pressure and level switches are provided to start and stop the potable water pumps and the air compressor. Low hydropneumatic tank pressure is alarmed. Low level in the hypochlorite feed tank is alarmed.

The minimum instrumentation requirements for the STS are a treated effluent sewage flow meter and a common air blower discharge pressure gauge.

9.2.4.2.8 Tests and Inspections (Interface Requirements)

Drainage piping is hydrostatically tested to the equivalent of a 3-meter head of water for a minimum of 15 minutes.

The operability of all other parts of the PSW System is demonstrated by use during normal system operation.

9.2.5 Ultimate Heat Sink

This subsection provides a conceptual design of the ultimate heat sink (UHS) as required by 10CFR52. The interface requirements for the UHS are part of the design certification.

9.2.5.1 Safety Design Bases (Interface Requirements)

(1) The UHS is designed to provide sufficient cooling water to the Reactor Service Water (RSW) System to permit safe shutdown and cooldown of the unit and maintain the unit in a safe shutdown condition. The RSW water temperature at the inlet to the RCW/RSW heat exchangers is not to exceed 35°C during a LOCA. (GDC 44)

(2) In the event of an accident, the UHS is designed to provide sufficient cooling water to the RSW System to safely dissipate the heat for that accident. The amount of heat to be removed is provided in Tables 9.2-4a,9.2-4b and 9.2-4c. (GDC 44)

(3) The UHS is sized so that makeup water is not required for at least 30 days following an accident and design basis temperature and chemistry limits for safety-related equipment are not exceeded.

(4) The UHS is designed to perform its safety function during periods of adverse site conditions, resulting in maximum water consumption and minimum cooling capability.

(5) The UHS is designed to withstand the most severe natural phenomenon or site-related event (e. g., SSE, tornado, hurricane, flood, freezing, spraying, pipe whip, jet forces, missiles, fire, failure of non-Seismic Category I equipment, flooding as a result of pipe failures or transportation accident), and reasonably probable combinations of less severe phenomena and/or events, without impairing its safety function. (GDC 2 and 4)

(6) The safety-related portion of the UHS shall be designed to perform its required cooling function assuming a single active failure in any mechanical or electrical system.

(7) The UHS is designed to withstand any credible single failure of man-made structural features without impairing its safety function.

(8) All safety-related heat rejection systems shall be redundant so that the essential cooling function can be performed even with the complete loss of one division. Single failures of passive components in electrical systems may lead to the loss of the affected pump, valve or other components and the partial or complete loss of cooling capability of that division but not of other divisions.

(9) The UHS and any pumps, valves, structures or other components that remove heat from safety systems shall be designed to Seismic Category I and ASME Code, Section III, Class 3, Quality Assurance B, Quality Group C, IEEE-603, and IEEE-308 requirements.

(10) The safety-related portions of the UHS shall be mechanically and electrically separated. The UHS is arranged in three divisions. Active components within each division are powered by their respective Class 1E division. Each division is physically separated and electrically independent of the other divisions.

(11) The UHS is designed to include the capability for full operational inspection and testing.

(12) In the event of loss of preferred power source, the UHS is designed to be powered by the onsite emergency power system.

(13) UHS System Divisions A and B components have control interfaces with the Remote Shutdown System (RSS) as required to support UHS operation during RSS design basis conditions.

9.2.5.2 Power Generation Design Bases (Interface Requirements)

The UHS is designed to remove the heat load of the RSW System during all phases of normal plant operation. These heat loads are provided in Tables 9.2-4a, 9.2-4b and 9.2-4c. However, it is not a requirement that the UHS temperature be assumed to be the maximum temperature for all operating modes during normal plant operations.

9.2.5.3 System Description (Conceptual Design)

The UHS is comprised of a water basin and induced draft cooling towers. Above the basin is a counterflow mechanically induced draft cooling tower with six cooling tower cells, of which two cells are dedicated to each of the three RSW divisions to remove heat from their respective RCW/RSW division.

9.2.5.3.1 General Description

The UHS is a highly reliable, Seismic Category I structure that provides an adequate source of cooling water that is available at all times for reactor operation, shutdown cooling, and accident mitigation. The RSW is pumped from the UHS water storage basin to the RCW heat exchangers for removal of heat. The heated water is returned to the mechanical-induced draft cooling tower where the heat is dissipated to the atmosphere by evaporation and conduction.

The design of the RSW pump house, cooling tower, and UHS basin allows periodic inspections of components (pumps, fans, cooling tower cells, strainers, valves, and piping) to ensure system integrity and capability as required by GDC 45.

The design of the UHS system meets the requirements of GDC 46 by allowing appropriate periodic pressure and functional testing of structural and leak-tight integrity of its components, the operability and the performance of the system active components, and the operability of the system as a whole. It also allows testing, under conditions as close to the design as practical, the performance of the full operational sequence that brings the system into operation for reactor shutdown and for LOCAs, including operation of portions of the protection system and transfer between normal and emergency power sources.

9.2.5.3.2 UHS Water Storage Basin

The UHS water storage basin is a Seismic Category I concrete structure built partially below grade and sized for a water volume sufficient to meet the cooling requirements for 30 days following a design basis accident (DBA) with no makeup water and without exceeding the design basis temperature and chemistry limits. The UHS basin holds a sufficient amount of water to meet the unit cooling needs for 30 days following a postulated LOCA with no makeup.

9.2.5.3.3 RSW Pump House

The RSW pump house is contiguous with the UHS water storage basin and houses the RSW pumps and associated piping and valves (Subsection 9.2.15). The RSW pump house is integral with the UHS water storage basin structure. Each division's RSW pumps are located in a separate pump room.

The electrical equipment room of each division is located in the RSW pump house above the respective RSW pump room.

HVAC equipment maintains suitable room conditions for proper operation of the RSW pumps and electrical equipment as described below:

- Ventilation of the RSW pump rooms is provided by a dedicated, thermostatically controlled ventilation system that removes the heat generated by the RSW pump motor and other equipment in the RSW pump rooms. The system for each pump room is comprised of a supply fan, ductwork, intake damper, and return air damper. A space thermostat controls the dampers to maintain the room temperature. The ventilation inlet/exhaust openings in the RSW pump house structure are protected against tornado-generated missiles.
- The RSW pump rooms are heated by thermostatically controlled electric unit heaters sized to maintain the minimum design winter temperature.
- The air temperature in the electrical equipment rooms associated with the RSW pump house is controlled by the HVAC packaged air conditioning unit in each room. RSW is used to cool the water-cooled condenser of each air conditioning unit (see Subsection 9.2.15). The RSW used for cooling is returned to the UHS basin.

9.2.5.3.4 System Components

The RSW supply and return lines are routed through a divisionally separated tunnel.

The cooling tower is contiguous with the UHS structure. Each cooling tower is a counterflow mechanically induced draft cooling tower with six cooling tower cells, of which two cells are dedicated to each of the three RSW divisions. During normal plant operation, all three divisions are in operation with one cooling tower cell per division. When the heat load is increased during cooldown, shutdown, or accident, all cooling tower cells are in operation.

The cooling tower internals are protected from effects of tornado generated missiles. The cooling tower riser and distribution system sprays the heated water over the area of the tower fill. The cooling tower spray nozzles are of corrosion-resistant materials and designed to provide the required thermal performance while minimizing drift loss. The system is designed so that the pressure drop across the nozzles for proper spray performance is achieved for all anticipated modes of RSW system operation. The nozzles are designed to be resistant to clogging.

Mechanical-induced draft fans provide airflow to cool the water droplets as they fall through the tower fill, rejecting heat from the reactor service water to the air. The induced draft fans draw air through the openings on the sides of the cell and the heated air exits from the top of cooling tower cell. Drift eliminators are located between the water distribution system and the fan.

Cold weather bypass lines are provided for each RSW return line to allow bypassing the cooling tower dedicated cells when the outside temperature is low and cooling tower operation is not required. The heated water from the RSW return line is discharged directly into the UHS water storage basin above the water surface.

The UHS must have a reliable source of makeup water. A makeup water valve controlled by level instrumentation in the UHS water storage basin is provided to maintain proper water level. The makeup water valve can also be operated remotely to maintain the desired water level or quality.

Blowdown from the UHS water storage basin is used to remove excess water from precipitation and maintain water storage basin water quality. Blowdown is taken from each RSW pump discharge line (see Subsection 9.2.15).

9.2.5.4 System Operation

9.2.5.4.1 Normal Operation

Normally, the RSW system has one pump per division in operation. Return water from each RSW division is sent to the UHS basin where it is routed to the respective RSW division cooling tower cell. The operators may alternate the operating RSW pump and the UHS cooling tower cell when desired. During normal shutdown and emergency cooling modes, the second RSW pump and the second cooling tower cell in each division are placed into service. Each RSW pump is provided with a self-cleaning strainer. The self-cleaning strainer operation is controlled by the pressure drop across the strainer inlet/discharge. The strainer discharge line is connected to the blowdown line when makeup water is available or to the UHS basin when no makeup water is available.

The UHS design is based on three cycles of concentration of the water composition in the UHS basin during normal operation. Chemicals are added to the UHS water storage basin as needed based on sampling and analysis.

Operation of the UHS water storage basin without blowdown would increase the concentration of scale-forming constituents in the water because of evaporation. Also, biofouling may occur under some conditions. However, sufficient water inventory is provided in the UHS water storage basin to prevent scale-producing agents, such as calcium sulfate, from reaching elevated concentrations that could cause significant scaling during the 30-day post-accident period when makeup and blowdown are assumed to be unavailable.

9.2.5.4.2 Cold Weather Operation

The cooling tower is designed to perform its cooling function during cold weather operation using the cooling tower bypass. Ice formation in the basin is not expected to occur because the system is in service during all operating modes. During cold weather conditions, the RSW system return flow to the cooling tower is isolated and the lines downstream of the isolation valves are drained. The cold weather bypass lines direct the warm water to the basin and discharge above the water surface to circulate and mix with the water in the basin. Any ice layer present on the basin surface will melt.

9.2.5.5 UHS Thermal Performance (Conceptual Design)

9.2.5.5.1 Design Meteorology

The COL applicant shall obtain and use conservative site-specific design meteorological data in the detailed design of the UHS.

9.2.5.5.2 UHS Basin Water Storage Requirements

The COL applicant shall determine the water requirements used in selecting UHS Basin design volume and used in the UHS thermal performance analysis. These requirements include:

(1) Evaporation Due to Plant Heat Load

(2) Natural Evaporation

(3) Drift Loss

(4) Seepage

(5) Sedimentation

(6) Water Quality

(7) Minimum Basin Water Level for Operation

(8) Pipe Crack

9.2.5.6 Evaluation of UHS Performance (Interface Requirements)

The COL applicant shall analyze the UHS performance to assure that UHS is adequate for 30 days of cooling without makeup or blowdown and that the cooling water temperature does not exceed the design limit for design basis heat input and site conditions.

9.2.5.7 Safety Evaluation (Interface Requirements)

9.2.5.7.1 Thermal Performance

The COL applicant shall demonstrate by analysis that the UHS is capable of providing cooling water within the design temperature limit for at least 30 days for the design basis event using conservative meteorology and assumptions.

9.2.5.7.2 Effects of Severe Natural Events or Site-Related Events

The COL applicant shall demonstrate by analysis that the UHS is capable of fulfilling its safety function concurrent with any of the following events: SSE, tornado, flood, drought, transportation accident, or fire.

9.2.5.7.3 Freezing Considerations

The COL applicant shall demonstrate by analysis that the UHS is designed for operations under any freezing conditions that may occur.

9.2.5.8 Conformance to Regulatory Guide 1.27 and 1.72 (Interface Requirement)

The COL applicant shall demonstrate that the UHS meets all applicable requirements of Regulatory Guide 1.27.

If any piping is made from fiberglass-reinforced thermosetting resin, the COL applicant shall provide information to show that all applicable requirements of Regulatory Guide 1.72 are met.

9.2.5.9 Instrumentation and Alarms (Interface Requirement)

UHS low water level (if applicable) and high water temperature are provided and alarmed in the control room. UHS surface water temperature indication is provided (if it can differ appreciably from the bulk temperature) in the control room.

UHS makeup and blowdown volumes (if applicable) are indicated by flow totalizers located in the makeup and blowdown lines.

Any components required for UHS system operation in Divisions A and B shall be operated from the Remote Shutdown System.

9.2.5.10 Tests and Inspections (Interface Requirements)

The COL applicant shall prepare and perform a preoperational test program in accordance with the requirements of Chapter 14. During normal operation the system shall have capability for full operational testing and inspection.

9.2.6 Condensate Storage Facilities and Distribution System

The functions of the storing and distribution of condensate are described in Subsection 9.2.9.

9.2.7 Plant Chilled Water System

The functions of the Plant Chilled Water (PCW) System are performed by the systems described in Subsections 9.2.12 and 9.2.13.

9.2.8 Makeup Water (MWP) Preparation System

This subsection provides a conceptual design of the Makeup Water Preparation System as required by 10CFR52. The interface requirements for this system are part of the design certification.

9.2.8.1 Safety Design Bases (Interface Requirements)

The MWP System has no safety-related function. Failure of the system does not compromise any safety-related system or component, nor does it prevent a safe shutdown of the plant.

9.2.8.2 Power Generation Design Bases (Interface Requirements)

(1) The MWP System consists of two divisions capable of producing at least 45 m^3/h of demineralized water each.

(2) Storage of demineralized water shall be at least 760 m^3.

(3) The quality of the demineralized water shall meet the requirements in Table 9.2-2a.

(4) Demineralized water shall be provided at a minimum flow rate of approximately 135 m^3/h at a temperature between 10° to 38°C.

(5) The MWP System is not connected to any system having the potential for containing radioactive material.

(6) The MWP System provides 45 m^3/h of filtered water to meet maximum anticipated peak demand periods for the PSW System.

(7) Any purified water storage tank located outdoors shall be provided with adequate freeze protection and adequate diking and other means to control spill and leakage.

9.2.8.3 System Description (Conceptual Design)

The MWP System consists of both mobile and permanently installed water treatment systems.

The permanently installed system consists of a well, filters, reverse osmosis modules and demineralizers which prepare demineralized water from well water. The demineralized water is sent to storage tanks until it is needed. The components of the MWP System are listed in Table 9.2-15 and the system block flow diagram is in Figure 9.2-10.

While it is planned to install both permanent divisions, only one division may be installed if plant water requirements and economic conditions indicate that the second division will not be needed.

Mobile water treatment systems will be used before the permanent system is installed and later if water requirements exceed the capacity of the permanent system or if economic condition make use of mobile equipment attractive compared to operating and maintaining the permanent system.

9.2.8.3.1 Well System

A well, water storage tank and two well water forwarding pumps are provided which can produce sufficient water to meet the concurrent needs of the MWP System and the PSW System.

9.2.8.3.2 Pretreatment System

Two dual media filters are provided in parallel which are backwashed when needed using one of two backwash pumps and water from a filtered water storage tank. This tank is provided with a heater to maintain a water temperature of at least 10°C at all times. Water may be sent from the filtered water storage tank to the PSW System or to the next components of the MWP System.

9.2.8.3.3 Reverse Osmosis Modules

Chemical addition tanks, pumps and controls are provided to add sodium hexametaphosphate and sodium hydroxide to the filtered water.

Four high pressure, horizontal multistage reverse osmosis (RO) feed pumps provide a feed pressure of approximately 3.14 MPaG. Reverse osmosis membranes are arranged in two parallel divisions of two passes each with the permeate of the first passes going to the inlet of the second passes. The reject or brine from the first passes is sent to the plant wastewater treatment system (outside the ABWR Standard Plant scope). A chemical addition tank, two pumps and controls are provided to add sodium hydroxide to the permeate of the first pass. The reject from the second passes is recycled to the RO feed pump suction line. The permeate from the second pass is sent to a RO permeate storage tank.

9.2.8.3.4 Demineralizer System

Two demineralizer feed pumps are provided in each parallel division. Three mixed bed demineralizers are provided in parallel in each division with two normally in operation with the third in standby. The demineralized water is monitored and sent to the demineralized water storage tanks.

9.2.8.3.5 Demineralized Water Storage System

Two demineralized water storage tanks are provided with a heater to maintain a water temperature of at least 10°C at all times. Three demineralized water forwarding pumps are provided to send water to the MUWP System.

9.2.8.3.6 Makeup Water Preparation Building

A building is provided for all of the subsystems listed above except for the well water storage tank and the demineralized water storage tanks which are located outdoors. The building is provided with a heating system capable of maintaining a temperature of at least 10^{o}C at all times.

The building does not contain any safety-related structures, systems or components. The MWP System shall be designed so that any failure in the system, including any that cause flooding, shall not result in the failure of any safety-related structure, system or component.

The building has a large open area about 7.6m by 12m with truck access doors and services for mobile water processing systems. These services include electric power, service air, connections to the water storage tanks and a waste connection. This area will be used for mobile water treatment systems or storage.

9.2.8.4 System Operation (Conceptual Design)

9.2.8.4.1 Normal Operation

During normal operation, the well pump is controlled by a water level controller to keep the well water storage tank full. The well water forwarding pumps are controlled by a water level controller to keep the filtered water storage tank full. Normally, one filter will be operating with the other filter in standby. The second filter is started from the Control Building or is automatically started by a low water level in the filtered water storage tank. When any filter develops a high pressure drop, it is isolated and any standby filter is put into operation. One of the two backwash pumps is operated to backwash the filter. The backwash is sent to the plant wastewater treatment system (outside the ABWR Standard Plant scope).

Sodium hexametaphosphate is added to control calcium sulfate or other fouling in the RO membranes and sodium hydroxide is added to adjust the pH for RO treatment.

The RO feed pumps are controlled by a water level controller which keeps the RO permeate storage tank full. These pumps feed the water through both RO passes. The RO membranes are of the thin film composite type. The first pass permeate, which becomes feed for the second pass, has a pressure of about 1.37 to 1.77 kPaG. Sodium hydroxide is added to the first pass permeate to adjust the pH to improve dissolved solids rejection in the second pass.

The demineralizer feed pumps are controlled by a water level controller in the demineralized water storage tanks. Each demineralizer contains 1.1 m^3 of ion exchange resin in a cation/anion ratio of 1 to 2. When the effluent quality of a demineralizer becomes unsatisfactory, it is automatically removed from operation and the standby demineralizer is automatically put into operation. The exhausted resins are regenerated offsite.

The demineralized water forwarding pumps are controlled by a pressure switch in their discharge piping. Normally, one pump is operated to maintain a specified system pressure. When the pressure drops below a specified pressure, the second pump is automatically put into operation until system pressure returns to the normal range. If this does not occur, the third pump is automatically put into operation.

9.2.8.4.2 Abnormal Operation

During the early construction period and at certain times later, the Makeup Water Preparation System may either not be installed or may not be in operation. Also, there may be times when demineralized water requirements exceed the production capacity. During these periods, mobile water treating systems will be used. They will be transported to the site by truck and will enter the Makeup Water Preparation Building through large doors. When no longer required, they will be removed.

9.2.8.5 Evaluation of Makeup Water System Preparation Performance (Interface Requirements)

The COL applicant shall analyze the raw water quality and availability and the required makeup water quality and amounts to assure that these requirements can be met. Any deficiencies in either quality or production capability shall be met with mobile water treating systems.

9.2.8.6 Safety Evaluation (Interface Requirements)

The MWP System is not connected to any systems having the potential for containing radioactive material.

9.2.8.7 Instrumentation and Alarms (Interface Requirements)

One division of MWP components is normally in operation. The components of the standby division are automatically placed into operation upon receiving a low level signal from their downstream water storage tank.

The following shall be displayed and alarmed locally and in the control building:

- Water level in all water storage tanks
- Running status of all pumps
- System pressures and differential pressures associated with the filters and RO modules
- Water quality monitors, including conductivity, pH, turbidity and silica analyzers

All water storage tanks are provided with low-low water level switches which stop the forwarding pumps for that tank.

9.2.8.8 Tests and Inspections (Interface Requirements)

The COL applicant shall prepare and perform a preoperational test program and tests in accordance with the requirements of Chapter 14.

9.2.9 Makeup Water Condensate System

9.2.9.1 Design Bases

(1) The Makeup Water-Condensate (MUWC) System shall provide condensate quality water for both normal and emergency operations when required.

(2) The MUWC System shall provide a required water quality as follows:

Conductivity (μS/cm)≤ 0.5 at 25°C

Chlorides, as Cl (ppm)≤ 0.02

pH 5.9 to 8.3 at 25°C

Conductivity and pH limits shall be applied after correction for dissolved CO_2. (The above limits shall be met at least 90% of the time.)

(3) The MUWC System shall supply water for the uses shown in Table 9.2-1.

(4) The MUWC System is not safety-related except as noted in items (7) and (8) below.

(5) The condensate storage tank shall have a capacity of 2110 m^3. This capacity was determined by the capacity required as shown in Table 9.2-3.

In accordance with guidelines of Regulatory Guide 1.155, “Station Blackout”, Position C3.2 through C3.5 as applicable, and 10CFR50.63, the condensate storage tank (CST) is designed to provide approximately (570,000 L) of water for use during station blackout. This volume of water is located in the lower portion of the CST and is sufficient for operation of the RCIC System to remove decay heat during the first eight hours of station blackout.

(6) All tanks, piping and other equipment shall be made of corrosion-resistant materials.

(7) The HPCF and RCIC instrumentation, which initiates the automatic switchover of HPCF and RCIC suction from the CST header to the suppression pool, shall be designed to safety-grade requirements (including installation with necessary seismic support).

(8) The instrumentation is mounted in a safety-grade standpipe located in the Reactor Building secondary containment. With no condensate flowing, the water level is the same in both the CST and the standpipe. A suitable correction will be made for the effect of flow upon water level in the standpipe.

(9) High water level shall be alarmed both in the Radwaste Building control room and in the main control room (Subsection 11.2.1.2.1).

9.2.9.2 System Description

The MUWC P&ID is shown in Figure 9.2-4. This system includes the following:

(1) A condensate storage tank (CST) is provided. The volume is shown in Table 9.2-3.

(2) The following pumps take suction from the CST:

  (a) RCIC pumps

  (b) CRD pumps

  (c) HPCF pumps

  (d) SPCU pumps

  (e) MUWC transfer pumps (three 149 m^3/h at 0.971 MPa head)

(3) Water can be sent to the CST from the following sources:

  (a) MWP pumps

  (b) CRD system

  (c) Radwaste disposal system

  (d) Condensate demineralizer system effluent (main condenser high level relief)

(4) Associated receiving and distribution piping valves, instruments, and controls shall be provided.

(5) Overflow and drain from the CST shall be sent to the radwaste system for treatment.

(6) Any outdoor piping shall be protected from freezing.

(7) All surfaces coming in contact with the condensate shall be made of corrosion-resistant materials.

(8) All of the pumps mentioned in (2) above shall be located at an elevation such that adequate suction head is present at all water levels in the CST.

(9) Instrumentation shall be provided to indicate CST water level in the main control room, Radwaste Building control room and Remote Shutdown System. High water level shall be alarmed both in the Radwaste Building control room and in the main control room (Subsection 11.2.1.2). Low water level shall be alarmed in the main control room.

(10) Potential flooding is discussed in Subsection 3.4. Potential flooding from lines within the Reactor Building and the Control Building are evaluated in Subsection 3.4.1.1.1.

9.2.9.3 Safety Evaluation

Operation of the MUWC System is not required to assure any of the following conditions:

(1) Integrity of the reactor coolant pressure boundary.

(2) Capability to shut down the reactor and maintain it in a safe shutdown condition.

(3) Ability to prevent or mitigate the consequences of events that could result in potential offsite exposures.

The MUWC System is not safety-related. However, the system incorporates features that assure reliable operation over the full range of normal plant operations.

9.2.9.4 Tests and Inspections

The MUWC System is proved operable by its use during normal plant operation. Portions of the system normally closed to flow can be tested to ensure operability and the integrity of the system.

9.2.10 Makeup Water Purified System

9.2.10.1 Design Bases

(1) The Makeup Water Purified (MUWP) System shall provide makeup water purified for makeup to the reactor coolant system and plant auxiliary systems.

(2) The MUWP System shall provide purified water to the uses shown in Table 9.2-2.

(3) The MUWP System shall provide water of the quality shown in Table 9.2-2a. If these water quality requirements are not met, the water shall not be used in any safety-related system. The out-of-spec water shall be reprocessed or discharged.

(4) The MUWP System is not safety-related.

(5) All piping and other equipment shall be made of corrosion-resistant materials.

(6) The system shall be designed to prevent any radioactive contamination of the purified water.

(7) The interfaces between the MUWP System and all safety-related systems are located either in the Control Building or Reactor Building, which are Seismic Category I, tornado-missile resistant and flood protected structures. The interfaces with safety-related systems are safety-related valves which are part of the safety-related systems. The portions of the MUWP System, which upon their failure during a seismic event can adversely impact structures, systems, or components important to safety, shall be designed to assure their integrity under seismic loading resulting from a safe shutdown earthquake.

(8) Safety-related equipment located by portions of the MUWP System are in Seismic Category I structures and protected from all system impact.

9.2.10.2 System Description

The MUWP System P&ID is shown in Figure 9.2-5. This system includes the following:

(1) Distribution piping, valves, instruments and controls shall be provided.

(2) Any outdoor piping shall be protected from freezing.

(3) All surfaces coming in contact with the purified water shall be made of corrosion-resistant materials.

(4) Continuous analyzers are located at the MUWP System. These are supplemented as needed by grab samples. Allowance is made in the water quality specifications for some pickup of carbon dioxide and air in any demineralized water storage tank. The pickup of corrosion products should be minimal because the MUWP piping is stainless steel.

(5) Intrusion of radioactivity into the MUWP System from other potentially radioactive systems are prevented by one or more of the following:

   (a) Check valves in the MUWP lines.

   (b) Air (or siphon) breaks in the MUWP lines.

   (c) The MUWP System lines are pressurized while the receiving system is at essentially atmospheric pressure.

   (d) Piping to the user is dead ended.

(6) There are no automatic valves in the MUWP System. During a LOCA, the safety-related systems are isolated from the MUWP System by automatic valves in the safety-related system.

(7) The outboard primary containment isolation valve is locked closed during standby, hot standby and power operation.

9.2.10.3 Safety Evaluation

Operation of the MUWP System is not required to assure any of the following conditions:

(1) Integrity of the reactor coolant pressure boundary.

(2) Capability to shut down the reactor and maintain it in a safe shutdown condition.

(3) Ability to prevent or mitigate the consequences of events which could result in potential offsite exposures.

The MUWP System is not safety-related. However, the systems incorporate features that assure reliable operation over the full range of normal plant operations.

9.2.10.4 Tests and Inspections

The MUWP System is proved operable by its use during normal plant operation. Portions of the system normally closed to flow can be tested to ensure operability and integrity of the system.

Flow to the various systems is balanced by means of manual valves at the individual takeoff points.

9.2.11 Reactor Building Cooling Water System

9.2.11.1 Design Bases

9.2.11.1.1 Safety Design Bases

(1) The Reactor Building Cooling Water (RCW) System shall be designed to remove heat from plant auxiliaries which are required for a safe reactor shutdown, as well as those auxiliaries whose operation is desired following a LOCA, but not essential to safe shutdown.

The heat removal capacity is based on the heat removal requirement during a LOCA with the maximum RSW water temperature at the inlet to the RCW/RSW heat exchangers of 35°C. As shown in Table 9.2-4a, the heat removal requirement is higher during other plant operation modes, such as shutdown at 4 hours. However, the RCW System is designed to remove this larger amount of heat to meet the requirements in Subsection 5.4.7.1.1.7.

(2) The RCW System shall be designed to perform its required cooling functions following a LOCA, assuming a single active or passive failure.

(3) The safety-related portions and valves isolating the non-safety-related portions of the RCW System shall be designed to Seismic Category I and the ASME Code, Section III, Class 3, Quality Assurance B, Quality Group C, IEEE-603 and IEEE-308 requirements.

(4) The RCW System shall be designed to limit leakage to the environment of radioactive contamination that may enter the RCW System from the RHR System.

(5) Safety-related portions of the RCW System shall be protected from flooding, spraying, steam impingement, pipe whip, jet forces, missiles, fire, and the effect of failure of any non-Seismic Category I equipment, as required.

(6) The safety-related portion of the RCW System shall be designed to meet the foregoing design bases during a loss of preferred power (LOPP).

(7) The safety-related electric modules and safety-related cables for the RCW System are in the Control Building and Reactor Building, which are Seismic Category I, tornado-missile resistant and flood protected structures.

(8) Protection from being impacted adversely by missiles generated by any non-safety-related component shall be provided as discussed in Subsection 3.5.1.

(9) Protection against high-energy and moderate-energy line failures will be provided in accordance with Section 3.6.

(10) Piping within the Control Building shall be fabricated and installed as all welded piping. Major components may have flange bolted or welded connections to the piping system. No expansion joints or bellows assemblies shall be used within the Control Building.

9.2.11.1.2 Power Generation Design Bases

The RCW System shall be designed to cool various plant auxiliaries as required during: (a) normal operation; (b) emergency shutdown; (c) normal shutdown; (d) testing; and (e) loss of preferred power (LOPP).

9.2.11.2 System Description

The RCW System distributes cooling water during various operating modes, during shutdown, and during post-LOCA operation. The system removes heat from plant auxiliaries and transfers it to the Reactor Service Water System (Subsection 9.2.15). Figures 9.2-1, sheets 1 through 9, show the piping and instrumentation diagram. Design characteristics for RCW System components are given in Table 9.2-4d.

The Control and Service Building general arrangement drawings, Figures 1.2-14 through 1.2-17 (and companion Fire Protection drawings, Figure 9A.4-11 through 9A.4-13, and Radiation Protection drawings Figures 12.3-42, 43, 48 and 64) show the location of the RCW pumps and heat exchangers. (Note: the heat exchangers are depicted as shell-and-tube type; however, the alternate plate-type can be accomodated in the same area of the Control Building in a horizontal arrangement at elevation -8200mm, the same elevation as the pumps).

The RCW system serves the auxiliary equipment listed in Tables 9.2-4a, 9.2-4b, and 9.2-4c.

Some of the cooling loads are serviced by only one or two RCW divisions. These components may be reassigned to other RCW divisions if redundancy and divisional alignment of supported and supporting systems is maintained and the design basis cooling capacity of the RCW divisions is assured.

The reactor decay heat at four hours after shutdown is approximately 133.1 GJ/h. Each division of the RCW System has the design heat removal capability of 108.02 GJ/h from the RHR System in addition to other cooling loads. If three divisions of RHR/RCW/RSW are used for heat removal, each division must remove one third of the decay heat, or 44.4 GJ/h. This means that each division will remove 108.02 minus 44.4, or 63.62 GJ/h of sensible heat, primarily by cooling the reactor water. If only two divisions of RHR/RCW/RSW are used for heat removal, each division must remove one half of the decay heat, or 66.6 GJ/h. This means the sensible heat removal will be 108.02 minus 66.6 or 41.42 GJ/h of sensible heat primarily from the reactor water. Of course the decay heat will decrease with time.

The above analysis shows that there is sufficient heat removal capability to remove not only the decay heat but also sensible heat primarily from the reactor water. If a division of RHR/RCW/RSW is not available or if heat removal capability has been lost in any of the heat exchangers, only the rate of heat removal will decrease, but heat will still be removed.

Shutdown cooling times are discussed in Subsection 5.4.7.1.1.7.

The RCW System is designed to perform its required safe reactor shutdown cooling function following a postulated LOCA, assuming a single active failure in any mechanical or electrical system. In order to meet this requirement, the RCW System provides three complete trains, which are mechanically and electrically separated. In case of a failure which disables any of the three divisions, the other two division meet plant safe shutdown requirements, including a LOCA or a loss of offsite power, or both. Each RCW division is supplied electrical power from a different division of the ESF power system.

During normal operation, RCW cooling water flows through all the equipment shown in Tables 9.2-4a, 9.2-4b, and 9.2-4c.

During all plant operating modes, a RCW water pump and two heat exchangers are normally operating in each division. Therefore, if a LOCA occurs, the RCW System required to shut down the plant safely are already in operation. The second pump and the third heat exchanger in each division are put in service if a LOCA occurs.

The non-safety-related parts of the RCW System are not required for safe shutdown and, hence, are not safety systems. Isolation valves separate the essential subsystems from the non-safety-related subsystems during a LOCA, in order to assure the integrity and safety functions of the safety-related parts of the system. Some non-safety-related parts of the system are operated during all other modes, including the emergency shutdown following an LOPP or LOCA, as shown in Tables 9.2-4a, 9.2-4b, and 9.2-4c.

Surge tank water level instrument is provided. Low water level signal in the surge tank opens the MUWP makeup water valve and low-low water level signal isolates the non-essential subsystems, thus assuring continued operability of the safety-related services.

Instruments, controls, and isolation valves are located in the safety-related part of the RCW System and designed to safety-grade requirements, as stated in design basis (3) of Subsection 9.2.11.1.1.

Makeup water is automatically added to the surge tanks from the MUWP System. If needed, the operator shall manually add makeup water from the suppression pool (Figure 7.3-7). The surge tanks have an upper part connected to both RCW and HECW Systems and containing 7,000 liters of waters (Figure 9.2-1). Periodically, the average steady-state (no RCW or HECW temperature changes or draining and filling of components) daily surge tank makeup rate shall be determined. When the average daily steady-state makeup exceed 70 liters per day continuously, the operators shall inspect the RCW and HECW Systems in that division and repair leaks until the average daily steady-state makeup rate is below 70 liters per day in that division.

A dedicated sump and sump pump are provided for each RCW division. Any system leakage or drainage may be collected, sampled and analyzed, and either returned to the RCW System or sent to the Liquid Radwaste System for treatment or to the HSD sample tank for discharge depending upon the radioactivity and impurities in the water.

There are cross connections between the divisions, shown in Figure 9.2-1, sheets 2, 5 and 8, which will be used to isolate portions of the RCW System during maintenance shutdowns.

Piping within the control building shall be fabricated and installed as all welded piping. Major components may have flange bolted or welded connections to the piping system. No expansion joints or bellows assemblies shall be used within the Control Building.

9.2.11.3 Safety Evaluation

9.2.11.3.1 Failure Analysis

A system failure analysis of active and passive components of the RCW System is presented in Tables 9.2-5a and 9.2-5b. Any of the assumed failures of the RCW System are detected in the control room by variations of process variables and/or alarms from the various system instruments and also from the leak detection system sensing leakage in the ECCS pump and heat exchanger areas.

9.2.11.3.2 Safety Evaluation of Equipment

Equipment served by the RCW System is listed in Tables 9.2-4a, 9.2-4b, and 9.2-4c. The tables contain five operating modes:

(1) Normal operation

(2) Shutdown at 4 h

(3) Shutdown at 20 h

(4) Hot standby (No LOPP)

(5) Hot standby (LOPP)

(6) Post-LOCA

The flow rates and heat loads are given for each equipment in each operating mode.

In the event of a LOCA, most of the nonessential cooling water uses are isolated by proper isolation valves. The fuel pool coolers, instrument air system, service air system, control rod drive pump oil cooler and the Reactor Water Cleanup (CUW) System pump coolers remain in service until the operator removes them from service. The non-safety-related portion of the system is automatically isolated in the event of a rupture in the non-safety-related subsystem. The surge tank water level is monitored. A level switch is activated by a significant leak, sending an isolation signal to close two valves. One valve on the supply line and one valve on the discharge line are used, with suitable power and controls from divisional sources to assure isolation in the event of any single active failure. Single isolation valves are used on the basis that an active failure of one isolation valve disables only that system of which it was a part.

Water level sensors are located in the RCW surge tank standpipes. Low water level signals from both the surge tank and the standpipe stop any operating pumps in that division. A signal from LOCA, high suppression pool temperature or high RCW water temperature overrides the low water levels signals and puts all pumps in that division in operation.

The RCW System is designed to withstand a single active failure without losing its capability to participate in the safe shutdown of the reactor following a LOCA or DBA. Tables 9.2-5a and 9.2-5b gives the result of a system failure analysis of active and passive components.

Redundant trains of the RCW System are separated and protected to the extent necessary to assure that sufficient equipment remains operating to permit shutdown of the unit in the event of any of the following (separation is applied to electrical equipment and instrumentation and controls as well as to mechanical equipment and piping):

(1) Flooding, spraying, or steam release due to pipe rupture or equipment failure

(2) Pipe whip and jet forces resulting from postulated pipe rupture of nearby high energy pipes

(3) Missiles which may result from equipment failure

(4) Fire

(5) Failures of any non-seismic Category I equipment (pertains to Seismic Category I equipment)

Radiation monitors are provided to sample the RCW cooling water. Upon detection of radiation leakage in one of the systems, that system is isolated by operator action from the control room, and the total cooling load can be met by the other two systems. Consequently, radioactive contamination released by the RCW System to the environment does not exceed allowable limits defined by 10CFR100.

The safety-related parts of the RCW System are designed to Seismic Category I and ASME Code, Section III, Class 3, Quality Assurance B and Quality Group C requirements. The design also meets IEEE-603 and IEEE-308 requirements.

The non-essential portion of the RCW System is designed to the ANSI B31.1 Power Piping Code and the requirements of Quality Group D. The piping between the fuel pool coolers and the separation valves is Seismic Category I and non-safety-grade.

The design pressure and temperature of the RCW System and piping are 1.37 MPaG and 70°C maximum.

System low point drains and high point vents are provided as required.

All divisions are maintained full of water when not in service except when undergoing maintenance.

System components and piping materials are selected where required to be compatible with the available site cooling water in order to minimize corrosion. Cathodic protection of the heat exchanger shall be provided. Adequate corrosion safety factors are used to assure the integrity of the system during the life of the plant.

During all plant operating modes, all divisions have at least one RCW cooling water pump operating. Therefore, if a LOCA occurs, the RCW cooling water system required to shut down the plant safely is already in operation. If a loss of offsite power occurs during a LOCA, the pumps momentarily stop until transfer to standby diesel generator power is completed. The pumps are restarted automatically according to the diesel loading sequence. If a LOCA occurs, most non-safety-related components are automatically isolated from the RCW System. Consequently, no operator action is required, following a LOCA, to start the RCW System in its LOCA operating mode.

All heat exchangers and pumps are normally placed in operation during the following plant operating conditions, in addition to LOCA: shutdown at 4 hours, shutdown at 20 hours and hot standby with loss of AC power.

Loss of either RCW Division A or B will result in loss of RCW cooling to every other RIP (five total) as shown on RRS P&ID (Figure 5.4-4) and will cause those five RIPs to runback to minimum speed and trip. The RIP M-G set in the same electrical division, which is cooled by the same RCW division which failed and powers three of the same five RIPS, would stop by M-G set cooling water protection. Assuming that the event began at full power on the 100%

Control Rod Line, the resulting temporary reactor power would be approximately 60% power. Assuming the RCW division loss did not cause a reactor scram or shutdown for other reasons, the five RIP runback and trip at full power would initiate runback of the other five RIPs to minimum speed and a SCRRI that further reduces reactor power from the 100% power rod line to the 80% power rod line. The operator would then correct the RCW problem or initiate a normal plant shutdown.

Complete failure of any RCW division will reduce drywell cooling, but not enough to require plant shutdown or power level reduction. Failure of RCW Division A would have only one drywell cooler using RCW cooling and the normal HVAC Normal Cooling Water (HNCW) System cooling. Drywell temperatures would not increase enough to adversely affect any drywell components.

The drywell cooling system can perform its function after the loss of any RCW division. With only one RCW division and one drywell cooler operating, the drywell temperature will increase but not to a temperature that would damage equipment or require an immediate shutdown.

9.2.11.4 Testing and Inspection Requirements

The RCW System is designed to permit periodic inservice inspection of all system components to assure the integrity and capability of the system.

The RCW System is designed for periodic pressure and functional testing to assure:

(1) the structural and leaktight integrity by visible inspection of the components;

(2) the operability and the performance of the active components of the system; and

(3) the operability of the system as a whole.

The tests shall assure, under conditions as close to design as practical, the performance of the full operational sequence that brings the system into operation for reactor shutdown and for LOCA, including operating of applicable portions of the Reactor Protection System and the transfer between normal and standby power sources. These tests shall include periodic testing of the heat removal capability of each RCW heat exchanger. Each of these heat exchangers has been designed to provide 20% margin above the heat removal capability required for LOCA in Tables 9.2-4a, 9.2-4b and 9.2-4c. The revised heat removal capacity of the heat exchangers is shown in Table 9.2-4d. This 20% margin is provided to compensate for the combined effects of fouling and leakage. When this margin is no longer present (i.e., zero margin), the heat exchanger heat removal capacity will be increased by either cleaning or refurbishing.

The RCW System is supplied with a chemical addition tank to add chemicals to each division. The RCW System is initially filled with demineralized water. A corrosion inhibitor can be added if desired. These measures are adequate to protect the RCW System from the ill effects of corrosion or organic fouling.

The RCW System is designed to conform with the foregoing requirements. Initial tests shall be made as described in Subsection 14.2.12.

The heat removal capacities of the as-built RCW heat exchangers shall be estimated before sufficient heat is available for normal heat transfer tests using both test and analysis. The flow rates of RCW and RSW water through the RCW heat exchangers shall be measured using installed or test instruments. By analysis using heat transfer data, from tests performed under similar conditions, the heat removal capacities shall be estimated for the as-built RCW heat exchangers.

9.2.11.5 Instrumentation and Control Requirements

All equipment is provided with either globe or butterfly valves to give the capability for manual control. These valves are accessible downstream of the equipment for regulation of flow through the equipment or for balancing the circuits. The isolation valves to the non-essential RCW System are automatically and remote-manually operated.

Pressure taps or indicators at equipment are provided to enable the operator to adjust the differential pressure across each heat exchanger or cooler and also to allow leak checking.

Locally mounted temperature indicators or test wells are furnished on the equipment cooling water discharge lines to enable verification of specified heat removal during plant operation. The required heat removal and flow rates are shown in Tables 9.2-4a, 9.2-4b, and 9.2-4c.

The combination of pressure taps (or indicators) and temperature indicators allow correct system balancing with or without a system heat load. For purposes of system balancing, provisions for flow measurement are provided as required.

Connections to a radiation monitor are provided in each division to detect radioactive contamination resulting from leakage in one of the RHR exchangers, fuel pool exchangers, or other exchangers.

Isolation valves for RHR heat exchangers and non-essential cooling water subsystems are provided with remote manual switches and indication on the remote shutdown panel.

9.2.12 HVAC Normal Cooling Water System

9.2.12.1 Design Bases

9.2.12.1.1 Power Generation Design Bases

The non-safety-related HVAC Normal Cooling Water (HNCW) System shall provide chilled water to the cooling coils of the drywell coolers, of each building supply unit and of local air conditioners to maintain design thermal environments during normal and upset conditions. The supply temperature is 7°C. The return temperature is 14.7°C.

9.2.12.1.2 Safety Design Bases

The HNCW System does not perform any safety functions, except for the containment penetration and isolation valves.

9.2.12.2 System Description

The HNCW System components are listed in Table 9.2-6 and shown in Figure 9.2-2.

System components consist of five 25% chillers, each with pumps, serving a common chilled water distribution system connected to the chilled water cooling coils in the drywell coolers, the cooling coils of each building supply unit and cooling coils of local air conditioners. Condenser cooling is from the Turbine Building Cooling Water (TCW) System. Each chiller evaporator is designed, fabricated and certified in accordance with the ASME Code Section VIII, Division 1. A chemical feed tank is provided. Makeup water is from the surge tank, which is shared between the HNCW and TCW Systems, which receives water from the MUWP System. Isolation valves and piping for primary containment penetrations are designed to Seismic Category I, ASME Code, Section III, Class 2, Quality Group B, Quality Assurance B requirements. The supply line penetration has a Division 1 isolation valve outside containment and Class 2 piping into the drywell. The return line penetration has divisional isolation valves inside and outside containment. These valves are motor-operated.

No diesel-generator power is available to this system during a LOPP or a LOCA.

9.2.12.3 Safety Evaluation

Operation of the HNCW System is not required to assure the following conditions:

(1) Integrity of the reactor coolant pressure boundary

(2) Capability to shut down the reactor and maintain it in a safe shutdown condition

(3) Ability to prevent or mitigate the consequences of events which could result in potential offsite radiological exposures

The HNCW System is not safety-related. However, it does incorporate features that assume reliable operation over the full range of normal plant operations.

Portions of the chilled water system which penetrate the primary containment are provided with isolation valves and penetrations which are Seismic Category I, Safety Class 2. The valves may be manually-operated from the control room, except when a LOCA signal assumes control.

9.2.12.4 Tests and Inspections

Initial testing of the system includes performance testing of the chillers, pumps and coils for conformance with design heat loads, water flows, and heat transfer capabilities. An integrity test is performed on the system upon completion.

Provision is made for periodic inspection of major components to ensure the capability and integrity of the system. Local display devices are provided to indicate all vital parameters required in testing and inspections.

The chillers are tested in accordance with ASHRAE Standard 30 (Methods of Testing for Rating Liquid Chilling Packages). The pumps are tested in accordance with standards of the Hydraulic Institute. ASME Section VIII and TEMA C standards apply to the ASHRAE Standard 33 (Methods of Testing for Rating Forced Circulation Air-Cooling and Heating Coils).

Samples of chilled water may be obtained for chemical analyses. Radioactivity is not expected to be in the chilled water.

9.2.12.5 Instrumentation Application

A regulated supply of demineralized makeup water adds water to the TCW expansion tank by water level controls, and the chiller units are controlled individually by remote manual switches.

A temperature controller and flow switch continuously monitor the discharge of the evaporator. If the temperature of the chilled water drops below a specified level, the control automatically adjusts the temperature control inlet guide vanes of the chiller compressor. Flow switches prohibit the chiller from operating unless there is water flow through both evaporator and condenser. (See Section 3.11 for temperature requirements.) In case of a chiller or pump trip, the standby units are automatically started.

Chilled water flow into and out of the containment is controlled by isolation valves which shall be automatically closed after a LOCA signal. Condenser water is provided from the TCW System. The thermocouples are located in each area being cooled. The control room operator can adjust the three-way valve position during startup and whenever high chilled water return temperatures are indicated and alarmed. Alternately, instead of the three-way valves, a flow control valve may be used.

Remote controlled valves permit isolation of any drywell cooling coil in the event of the coil developing a detectable leak.

9.2.13 HVAC Emergency Cooling Water System

9.2.13.1 Design Basis

9.2.13.1.1 Power Generation Design Bases

The safety-related HVAC Emergency Cooling Water (HECW) System shall provide chilled water under normal plant operating conditions to the Reactor Building safety-related electrical equipment HVAC system, Control Building safety-related equipment area HVAC System and the control room habitability area HVAC System (Table 9.2-9). The supply temperature is 7°C, the return temperature is 17°C.

9.2.13.1.2 Safety Design Bases

The HECW System performs a safety design function.

(1) The HECW System shall deliver chilled water to the Reactor Building safety-related electrical equipment HVAC System and Control Building safety-related equipment area HVAC System and the control room habitability area HVAC System during shutdown of the reactor, operating modes and abnormal reactor conditions including LOCA.

(2) Sufficient redundancy and electrical and mechanical separation shall be provided to ensure proper operations under all conditions.

(3) The system shall be designed and constructed in accordance with Seismic Category I, ASME Code, Section III, Class 3 requirements.

(4) The system shall be powered from Class 1E buses. Power shall be available from the Alternate AC (AAC) power source when required.

(5) The HECW System shall be protected from missiles in accordance with Subsection 3.5.1.

(6) Design features to preclude the adverse effects of water hammer are in accordance with the SRP section addressing the resolution of USI A-1 discussed in NUREG-0927.

These features shall include:

(a) An elevated surge tank to keep the system filled.

(b) Vents provided at all high points in the system.

(c) After any system drainage, venting is assured by personnel training and procedures.

(d) System valves are slow acting.

(7) The HECW System shall be protected from failures of high and medium energy lines as discussed in Section 3.6.

(8) The design operation of the HECW compressors will take into account power or operational perturbations which could result in a) frequent immediate or elongated restarts, b) in unacceptable compressor coolant and lubrication oil interactions, and c) compressor coolant leaks or releases.

(9) The system piping design will take into account unacceptable nil-ductility-temperature conditions associated with normal and transient operation.

9.2.13.2 System Description

The HECW System consists of subsystems in three divisions. Divisions A, B and C have two refrigerator units, two pumps, instrumentation and distribution piping and valves to corresponding cooling coils. A chemical addition tank is shared by all HECW divisions. Each HECW division shares a surge tank with the corresponding division of the RCW System. The refrigerator capacity is designed to cool the Reactor Building safety-related electrical equipment HVAC Systems and Control Building safety-related equipment area HVAC Systems.

The system is shown in Figure 9.2-3. The refrigerators are located in the Control Building as shown in Figures 1.2-20 and 1.2-21. Each refrigerator unit consists of a evaporator, a compressor, refrigerant, piping, and package chiller controls. This system shares the RCW surge tanks which are in the Reactor Building (Figure 1.2-12). Equipment is listed in Table 9.2-8. Each cooling coil is controlled by a room thermostat. Alternately, flow may be controlled by a temperature control valve. Condenser cooling is from the corresponding division of the RCW System.

Piping and valves for the HECW System, as well as the cooling water lines from the RCW System, designed entirely to ASME Code, Section III, Class 3, Quality Group C, Quality Assurance B requirements. The extent of this classification is up to and including drainage block valves. There are no primary or secondary containment penetrations within the system. The HECW System is not expected to contain radioactivity.

High temperature of the returned cooling water causes the standby refrigerator unit to start automatically. Makeup water is supplied from the MUWP System, at the surge tank. Each surge tank has the capacity to replace system water losses for more than 100 days during an emergency. The only non-safety-related portions of the HECW divisions are the chemical addition tank and the piping from the tank to the safety-related valves which isolate the safety-related portions of the system.

Also, see Subsection 9.2.17.1 for COL license information requirements.

9.2.13.3 Safety Evaluation

The HECW System is a Seismic Category I system, protected from flooding and tornado missiles. All components of the system are designed to be operable during a loss of normal power by connection to the ESF buses (Tables 8.3-1 and 8.3-2). Redundant components are provided to ensure that any single component failure does not preclude system operation. The system is designed to meet the requirements of Criterion 19 of 10CFR50. The refrigerators of each division are in separate rooms.

During a Station Blackout (SBO), the HECW refrigerators, pumps and instrumentation will be powered by the AAC System which will become available in ten minutes. Provisions will be made to ensure prompt and reliable restart of the chiller units. COL license information requirements are provided in Subsection 9.2.17.1.

The response to SBO is discussed in Chapter 1, Appendix 1C. During the SBO, little heat will be generated in the areas cooled by HECW because only battery powered equipment will be operating. These areas are the main control room, the Control Building essential electrical equipment rooms and the Reactor Building essential electrical equipment rooms. The HVAC fans in these areas are powered by Class 1E buses. When AAC power becomes available, these fans will be powered and will start supplying outside air and exhausting any hot air from these areas. When chilled water becomes available, cooled air will be circulated in these areas to restore normal temperature.

If a LOPP event occurs, there are provisions for a stop signal to the HECW pumps to trip the breakers or for sequencing the HECW pumps back onto the emergency bus during the allotted time frame (load block 3), which is 15 seconds after the emergency buses are picked up by the diesel generators. Once the pumps are reconnected to the emergency bus, they are prevented from cycling on and off until the remaining LOPP sequence loads are connected to the emergency bus. If a LOCA follows a LOPP, there are provisions for resetting the start timers and connecting the HECW pumps to the emergency busses at the proper time if they are not already connected when the LOCA appears.

Power is provided to the HECW refrigerators thirty seconds after it is provided to the HECW pumps. The HECW refrigerators will then begin a programmed startup process.

The HECW system air operated valves will upon loss of instrument air or power assume configurations or positions that assure continued system cooling service.

9.2.13.4 Tests and Inspection

Initial testing of the system includes performance testing of the refrigerators, pumps and coils for conformance with design capacity water flows and heat transfer capabilities. An integrity test is performed on the system upon completion.

The HECW System is designed for periodic pressure and functional testing to assure:

(1) the structural and leaktight integrity by visual inspection of the components;

(2) the operability and the performance of the active components of the system; and

(3) the operability of the system as a whole.

Local display devices are provided to indicate all vital parameters required in testing and inspections. Standby features are periodically tested by initiating the transfer sequence during normal operation.

The refrigerators are tested in accordance with ASHRAE Standard 30. The pumps are tested in accordance with standards of the Hydraulic Institute. ASME Section VIII and TEMA C standards apply to the heat exchangers. The cooling coils are tested in accordance with ASHRAE Standard 33.

9.2.13.5 Instrumentation and Alarms

A regulated supply of makeup water is provided to add purified water to the surge tanks by water level controls.

The chilled water pumps are controlled from the main control panel. The standby refrigerator has an interlock which automatically starts the standby refrigerator and pump upon failure of the operating unit.

The refrigerator units can be controlled individually from the main control room by a remote manual switch. Chilled water temperature is controlled by inlet guide vanes on each chiller refrigerant circuit. Condenser water flow is controlled by a two-way valve based on refrigerant compressor discharge pressure.

A temperature controller and flow switch continuously monitor the discharge of each evaporator. If the temperature of the chilled water drops below a specified level, the controller automatically adjusts the position of the compressor inlet guide vanes. Flow switches prohibit the chiller from operating unless there is water flow through both evaporator and condenser.

9.2.14 Turbine Building Cooling Water System

9.2.14.1 Design Bases

9.2.14.1.1 Safety Design Bases

The Turbine Building Cooling Water (TCW) System (Figure 9.2-6) serves no safety function and has no safety design basis.

There are no connections between the TCW System and any other safety-related systems.

9.2.14.1.2 Power Generation Design Bases

(1) The TCW System provides corrosion-inhibited, demineralized cooling water to all Turbine Island auxiliary equipment listed in Table 9.2-11.

(2) During power operation, the TCW System operates to provide a continuous supply of cooling water, at a maximum temperature of 41°C, to the Turbine Island auxiliary equipment, with a service water inlet temperature not exceeding 37.8°C.

(3) The TCW System is designed to permit the maintenance of any single active component without interruption of the cooling function.

(4) Makeup to the TCW System is designed to permit continuous system operation with design failure leakage and to permit expeditious post-maintenance system refill.

(5) The TCW System is designed to have an atmospheric surge tank located at the highest point in the system.

(6) The TCW System is designed to have a higher pressure than the power cycle heat sink water to ensure leakage is from the TCW System to the power cycle heat sink in the event a tube leak occurs in the TCW System heat exchanger.

9.2.14.2 System Description

9.2.14.2.1 General Description

The TCW System is a single-loop system and consists of one surge tank, one chemical addition tank, three pumps with a capacity of 4550 m^3/h each, three heat exchangers with heat removal capacity of 114.5 GJ/h each (connected in parallel), and associated coolers, piping, valves, controls, and instrumentation. Heat is removed from the TCW System and transferred to the non-safety-related Turbine Service Water (TSW) System (Subsection 9.2.16).

A TCW System sample is periodically taken for analysis to assure that the water quality meets the chemical specifications.

9.2.14.2.2 Component Description

Codes and standards applicable to the TCW System are listed in Table 3.2-1. The system is designed in accordance with quality Group D specifications.

The chemical addition tank is located in the Turbine Building in close proximity to the TCW System surge tank.

The TCW pumps are 50% capacity each and are constant speed electric motor-driven, horizontal centrifugal pumps. The three pumps are connected in parallel with common suction and discharge lines. One 50% TCW pump is on standby.

The TCW heat exchangers are 50% capacity each and are designed to have the TCW water circulated on the shell side and the power cycle heat sink water circulated on the tube side. The surface area is based on normal heat load.

The surge tank, which is shared between the HNCW and TCW Systems, is an atmospheric carbon steel tank located at the highest point in the TCW System. The surge tank is provided with a level control valve that controls makeup water addition.

The surge tank is located above the TCW pumps and heat exchangers in the Turbine Building in a location away from any safety-related components. Failure of the surge tank will not affect any safety-related system.

Those parts of the TCW System in the Turbine Building are located in areas that do not contain any safety-related systems. Those parts of the TCW System outside the turbine building are located away from any safety-related system.

9.2.14.2.3 System Operation

During normal operation, two of the three 50% capacity TCW System pumps circulate corrosion-inhibited demineralized water through the shell side of two of the three 50% capacity TCW heat exchangers in service. The heat from the TCW System is rejected to the TSW System, which circulates water on the tube side of the TCW System heat exchangers.

The standby TCW System pump is automatically started on detection of low TCW System pump discharge pressure. The standby TCW System heat exchanger is placed in service manually.

The cooling water flow rate to the electro-hydraulic control (EHC) coolers, the turbine lube oil coolers the generator H_2 cooler is regulated by control valves. Control valves in the cooling water inlet or outlet of these units are throttled in response to temperature signals from the fluid being cooled.

The flow rate of cooling water to all of the other coolers is manually regulated by individual throttling valves located on the cooling water inlet or outlet of each unit.

The minimum system cooling water temperature is maintained by adjusting the TCW System heat exchanger bypass valve.

The surge tank provides a reservoir for small amounts of leakage from the system and for the expansion and contraction of the cooling fluid with changes in the system temperature and is connected to the pump suction.

Demineralized makeup water to the TCW System is controlled automatically by a level control valve which is actuated by sensing surge tank level. A corrosion inhibitor is manually added to the system.

9.2.14.3 Safety Evaluation

The TCW System has no safety design bases and serves no safety function.

9.2.14.4 Tests and Inspections

All major components are tested and inspected as separate components prior to installation, and as an integrated system after installation to ensure design performance. The systems are preoperationally tested in accordance with the requirements of Chapter 14.

The components of the TCW System and associated instrumentation are accessible during plant operation for visual examination. Periodic inspections during normal operation are made to ensure operability and integrity of the system. Inspections include measurements of cooling water flows, temperatures, pressures, water quality, corrosion-erosion rate, control positions, and setpoints to verify the system condition.

9.2.14.5 Instrumentation and Alarms

Pressure and temperature indicators are provided where required for testing and balancing the system. Flow indicator taps are provided at strategic points in the system for initial balancing of the flows and verifying flows during plant operation.

Surge tank high and low level and TCW pump discharge pressure alarms are retransmitted to the main control room from the TCW local control panels.

Makeup flow to the TCW System surge tank is initiated automatically by low surge tank water level and is continued until the normal level is reestablished.

Provisions for taking TCW System water samples are included.

9.2.15 Reactor Service Water System

9.2.15.1 Portions Within Scope of ABWR Standard Plant

Those portions of the Reactor Service Water (RSW) System that are within the Control Building are in the scope of the ABWR Standard Plant and are described in Subsections 9.2.15.1.1 through 9.2.15.1.6.

All portions of the RSW System which are outside the Control Building are not in the scope of the ABWR Standard Plant.

9.2.15.1.1 Safety Design Bases

(1) The RSW System shall be designed in three mechanically and electrically separated divisions to remove heat from the three divisions of the Reactor Cooling Water (RCW) System which is required for safe reactor shutdown, and which also cools those auxiliaries whose operation is desired following a LOCA, but not essential to safe shutdown.

    The heat removal requirements from the RCW System and the UHS temperature are in Subsection 9.2.11.1.

(2) The RSW System shall be designed to Seismic Category I and ASME Code, Section III, Class 3, Quality Assurance B, Quality Group C, IEEE-603 and IEEE-308 requirements.

(3) Each RSW System division shall be mechanically and electrically separated from the other divisions. For any structures housing RSW System components, there shall be inter-divisional boundaries (including walls, floors, doors and penetrations) that have a three hour fire rating. In addition, each division shall be protected from flooding, spraying, steam impingement, pipe whip, jet forces, missiles, fire from the other divisions and the effect of failure of any non-Seismic Category I equipment, as required.

(4) The RSW System shall be designed to meet the foregoing design bases during a loss of preferred power.

(5) System low point drains and high point vents are provided as required. All divisions are maintained full of water (to prevent waterhammer) when not in service except when undergoing maintenance.

(6) Piping within the Control Building shall be fabricated and installed as all welded piping. Major components may have flange bolted or welded connections to the piping system. No expansion joints or bellows assemblies shall be used within the Control Building.

9.2.15.1.2 Power Generation Design Bases

The RSW System (Figure 9.2-7) shall be designed to cool the Reactor Building Cooling Water (RCW) as required during: (a) normal operation; (b) emergency shutdown; (c) normal shutdown; (d) testing; and (e) loss of preferred power.

9.2.15.1.3 System Description

The RSW System (Figure 9.2-7) provides cooling water during various operating modes, during shutdown and post-LOCA operations. The system removes heat from the RCW System and transfers it to the ultimate heat sink. Component descriptions of the RSW System are provided in Table 9.2-13.

The RSW System response to high water level in the RCW/RSW heat exchanger room in the Control Building is discussed in Subsection 3.4.1.1.2.2 and Figure 7.3-7. The isolation valves shall close upon receipt of a high water level signal in the RCW/RSW heat exchanger room in that division.

9.2.15.1.4 Safety Evaluation

The components of the RSW System are separated and protected to the extent necessary to assure that sufficient equipment remains operating to permit shutdown of the unit in the event of any of the following (separation is applied to electrical equipment and instrumentation and controls as well as to mechanical equipment and piping):

(1) Flooding, spraying or steam release due to pipe rupture or equipment failure

(2) Pipe whip and jet forces resulting from postulated pipe rupture of nearby high energy pipes

(3) Missiles which result from equipment failure

(4) Fire

Liquid radiation monitors are provided in the RCW System. Upon detection of radiation leakage in a division of the RCW System, that system is isolated by operator action from the control room, and the cooling load is met by another division of the RCW System. Consequently, radioactive contamination released by the RSW System to the environment does not exceed allowable limits defined by 10CFR100.

System low point drains and high point vents are provided as required.

During all plant operating modes, each division shall have at least one service water pump operating. Therefore, if a LOCA occurs, the system is already in operation and all standby pumps start and all standby valves open. If a loss of offsite power occurs during a LOCA, the pumps momentarily stop until transfer to standby diesel-generator power is completed. The pumps are restarted automatically according to the diesel loading sequence. No operator action is required, following a LOCA, to start the RSW System in its LOCA operating mode.

9.2.15.1.5 Instrumentation and Alarms

Locally mounted temperature indicators or test wells are furnished on the equipment cooling water discharge lines to enable verification of specified heat removal during plant operation.

The Control Building basement has potential flooding from several sources with the RSW being the largest. Safety-related pipe break detection is required to take automatic protective action for breaks within the Control Building RCW individual areas.

Each RCW equipment divisional area will be provided with water level detection instrumentation. The instrumentation will be composed of two sets of water level detection devices. A set of four water detection devices will provide alarms locally and in the MCR. This set will detect initial abnormal water level. The second set of four diverse seafety-related water level devices will provide alarm, valve closure and pump trip actions. For further discussion see Subsection 3.4.1. The devices are shown in Figure 11.2-2a (Sheet 36). The four sensors in each set will be arranged in a 2/4 logic to provide redundant trip actuation signals. The instrumentation will utilize the Essential Communication Function (ECF).

9.2.15.1.6 Tests and Inspections

The RSW System is designed for periodic pressure and functional testing to assure:

(1) The structural and leaktight integrity by visible inspection of the components

(2) The operability and the performance of active components of the system

(3) The operability of the system as a whole

9.2.15.2 Portions Outside the Scope of ABWR Standard Plant

All portions of the RSW System which are outside the Control Building are not in the scope of the ABWR Standard Plant. Subsections 9.2.15.2.1 through 9.2.15.2.6 provide conceptual design of these portions of the RSW System as required by 10CFR52. The interface requirements for this system are part of the design certification.

The site-dependent portions of the RSW System shall meet all requirements in Subsections 9.2.15.1.1 through 9.2.15.1.6 and all following requirements. This subsection provides a conceptual design and interface requirements for those portions of the RSW System which are site-dependent and are a part of the design certification.

9.2.15.2.1 Safety Design Bases (Interface Requirements)

The COL applicant shall provide the following system design features and additional information which are site dependent:

(1) The temperature increase and pressure drop across the heat exchangers.

(2) The required and available net positive suction head for the RSW pumps at pump suction locations considering anticipated low water levels.

(3) The location of the RSW pump house.

(4) The design features to assure that the requirements in Subsection 9.2.15.1.1(3) are met.

(5) An analysis of an RSW pipeline break and a single active component failure shall show that maximum flooding will not exceed 5.0m in an individual RCW heat exchanger room.

(6) System low point drains and high point vents are provided as required. All divisions are maintained full of water (to prevent waterhammer) when not in service except when undergoing maintenance.

(7) The following interface requirements from Tier 1 Section 2.11.9 are provided:

– Each RSW division is powered by its respective Class 1E division. In the RSW system, independence is provided between Class 1E divisions, and between Class 1E divisions and non-Class 1E equipment.

– RSW System Divisions A and B components have control interfaces with the RSS as required to support RSW operation during RSS design basis conditions.

– Any portions of the RSW system located outside of the Control Building, including tunnel structure used to route RSW System Piping to/from the Control Building, will be designed for extreme natural phenomena such as earthquakes, tornados, and flooding.

9.2.15.2.2 Power Generation Design Bases (Interface Requirements)

(1) The RSW system shall be able to function during abnormally high or low water levels and steps are taken to prevent organic fouling that may degrade system performance. These steps include trash racks and provisions for biocide treatment (where discharge is allowed). Where discharge of biocide is not allowed, non-biocide treatment shall be provided. Thermal backwashing capability shall be provided at any site where infestations of macrobial growth can occur.

(2) System components and piping materials shall be provided to be compatible with the site cooling water to minimize corrosion. Adequate corrosion and erosion safety factors shall be used to assure the integrity of the system during the life of the plant.

(3) The heat removal requirements from the RCW system are in Table 9.2-4d.

(4) Potable water shall be provided to flush the service water side of the RSW/RCW heat exchangers whenever they are put into a wet standby condition (Subsection 9.2.4.1.3).

9.2.15.2.3 System Description (Conceptual Design)

The RSW System is shown on Figure 9.2-7. components of the RSW System are provided as shown in Table 9.2-13.

The RSW pump house is located at the ultimate heat sink (UHS) which is described in Subsection 9.2.5.

The RSW pump house shall be located so that the main service water piping between it and the Control Building shall not exceed 2 km in length. The piping is the choice of the COL applicant.

The RSW System is able to function during abnormally high or low water levels, and steps are taken to prevent organic fouling that may degrade system performance. These steps include trash racks and provisions for biocide treatment (where discharge is allowed). Where discharge of biocide is not allowed, non-biocide treatment will be provided. Thermal backwashing capability will be provided at any site where infestations of microbial growth can occur.

9.2.15.2.4 Safety Evaluation (Interface Requirement)

An analysis shall show that the requirements in Subsections 9.2.15.1.1(3) and 9.2.15.2.1(5) are met.

9.2.15.2.5 Instrumentation and Alarms (Interface Requirement)

All pumps shall stop and all automatic isolation valves outside the Control Building shall close upon receipt of a high water level signal in the RCW heat exchanger room in that division.

Normally the operators will periodically clean the strainers to maintain low differential pressure. High pressure difference across the service water strainers shall alarm in the control room.

9.2.15.2.6 Tests and Inspections (Interface Requirements)

The tests shall assure, under conditions as close to design as practical, the performance of the full operational sequence that brings the system into operation for reactor shutdown and for LOCA, including operating of applicable portions of the reactor protection system and the transfer between normal and standby power sources.

9.2.16 Turbine Service Water System

9.2.16.1 Portions Within Scope of ABWR Standard Plant

Those portions of the Turbine Service Water (TSW) System that are within the Turbine Building are in the scope of the ABWR Standard Plant and are described in Subsections 9.2.16.1.1 through 9.2.16.1.6.

All portions of the TSW System that are outside the Turbine Building are not in the scope of the ABWR Standard Plant.

9.2.16.1.1 Safety Design Bases

The TSW System does not serve or support any safety function and has no safety design basis.

9.2.16.1.2 Power Generation Design Bases

(1) The TSW System is designed to remove heat from the TCW System heat exchangers and reject this heat to the power cycle heat sink during normal and shutdown conditions.

(2) During normal power operation, the TSW System supplies cooling water to the TCW System heat exchangers at a temperature not exceeding 37.8°C.

(3) The TSW System is designed to permit the maintenance of any single active component without interruption of the cooling function.

9.2.16.1.3 System Description

9.2.16.1.3.1 General Description

The Turbine Service Water (TSW) System supplies cooling water to the Turbine Cooling Water (TCW) System heat exchangers to transfer heat from the TCW System to the power cycle heat sink.

The TSW system is illustrated on Figure 9.2-8.

9.2.16.1.3.2 Component Description

The TSW heat exchangers are shown on Figure 9.2-6a and are described in Subsection 9.2.14.2.

9.2.16.1.3.3 System Operation

The system is operated from the main control room.

9.2.16.1.4 Safety Evaluation

The TSW System is not interconnected with any safety-related system.

9.2.16.1.5 Instrumentation Application

Pressure and temperature indicators are provided where required for testing the system.

9.2.16.1.6 Tests and Inspections

All major components are tested and inspected as separate components prior to installation, and as an integrated system after installation to ensure design performance. The systems are preoperationally tested in accordance with the requirements of Chapter 14.

The components of the TSW System and associated instrumentation are accessible during plant operation for visual examination. Periodic inspections during normal operation are made to ensure operability and integrity of the system. Inspections include measurement of the TSW System flow, temperatures, pressures, differential pressures and valve positions to verify the system condition.

9.2.16.2 Portions Outside Scope of ABWR Standard Plant

All portions of the TSW System that are outside the Turbine Building are not in the scope of the ABWR Standard Plant. Subsections 9.2.16.2.1 and 9.2.16.2.2 provide a conceptual design of these portions of the TSW System as required by 10CFR52. The interface requirements for this system are part of the design certification.

The site-dependent portions of the TSW System shall meet all requirements in Subsections 9.2.16.1.1 through 9.2.16.1.5 and following requirements. This subsection provides a conceptual design and interface requirements for those portions of the TSW System which are site dependent and are a part of the design certification.

9.2.16.2.1 Safety Design Bases (Interface Requirement)

There are none.

9.2.16.2.2 Power Generation Design Bases (Interface Requirements)

The COL applicant shall provide the following system design features and additional information which are site dependent:

(1) The temperature increase and pressure drop across the heat exchangers.

(2) The required and available net positive suction head for the TSW pumps at pump suction locations considering anticipated low water levels.

(3) The location of the TSW pump house.

(4) The heat removal requirements from the TCW System are in Subsection 9.2.14.2.

(5) System low point drains and high point vents are provided as required. All components are maintained full of water (to prevent waterhammer) when not in service except when undergoing maintenance.

9.2.16.2.3 System Description

9.2.16.2.3.1 General Description (Conceptual Design)

The TSW System consists of three 50% capacity vertical wet pit pumps located at the intake structure. Two pumps are in operation during normal operation with one pump in standby.

The TSW pumps supply cooling water to the three TCW heat exchangers (two are normally in service and one is on standby).

9.2.16.2.3.2 Component Description (Conceptual Design)

Three strainers are provided (one for each TSW pump). Debris collected in the strainer is sluiced to a disposal collection area.

Piping and valves in the TSW System are protected from interior corrosion with suitable corrosion resistant material as required by site specific soil and water conditions.

9.2.16.2.3.3 System Operation (Conceptual Design)

The system is operated from the main control room.

The standby pump is started automatically in the event the normally operating pump trips or the discharge header pressure drops below a preset limit.

9.2.16.2.4 Safety Evaluation (Interface Requirements)

The COL applicant shall demonstrate that all safety-related components, systems and structures are protected from flooding in the event of a pipeline break in the TSW System.

9.2.16.2.5 Instrumentation and Alarms (Interface Requirements)

TSW System pump status shall be indicated in the main control room.

TSW System trip shall be alarmed and the automatic startup of the standby pump shall be annunciated in the main control room.

High differential pressure across the duplex filters shall be alarmed in the main control room.

9.2.16.2.6 Tests and Inspections (Interface Requirements)

All major components are tested and inspected as separate components prior to installation, and as an integrated system after installation to ensure design performance. The systems are preoperationally tested in accordance with the requirements of Chapter 14.

The components of the TSW System and associated instrumentation are accessible during plant operation for visual examination. Periodic inspections during normal operation are made to ensure operability and integrity of the system. Inspections include measurements of cooling water flows, temperatures, pressures, water quality, corrosion-erosion rate, control positions, and setpoints to verify the system condition.

9.2.17 COL License Information

9.2.17.1 HECW System Refrigerator Requirements

The COL applicant shall provide for the following after refrigerators have been procured:

(1) Means shall be provided for adjusting refrigerator capacity to chilled water outlet temperature.

(2) Means shall be provided for starting and stopping the pump and refrigerator on proper sequence.

(3) Means shall be provided for reacting to a loss of electrical power for periods up to two (2) hours and for automatic restarting of pumps and refrigerators, under the expected environmental conditions during station blackout when electrical power is restored.

(4) Means shall be provided to minimize the potential for coolant leakage or release into system or surrounding equipment environs.

(5) An evaluation of transient effects on starting and stopping or prolonged stoppage of the refrigeration/chiller units. Effects like high restart circuit draw downs on safety buses, coolant-oil interactions, degassing needs, coolant gas leakage or release in equipment areas along with flammability threats, synchronized refrigeration swapping.

9.2.17.2 Reactor Service Water System Requirements

The COL applicant shall provide the following which apply on a plant specific basis:

(1) Provisions for periodic analyses of samples of water and substrate and/or periodic visual inspection of intake structure for biofouling and removal of any fouling accumulations detected during such inspections.

(2) Provisions for periodic full flow testing of redundant and infrequently used cooling loops.

(3) Provisions for continuous biocide treatment of the RSW System for sites with a potential for macroscopic biofouling.

(4) Provisions for filling RSW System cooling loops with biocide treated water before layup.

(5) Provisions for biocide treatment before layup for other systems such as some fire protection system which use raw service water as a source for the systems.

(6) Provisions for a EPG that backup the RSW System leak detection instrumentation automatice protective actions by manual operator actions including local and manual valve closure actions.

Table 9.2-1 Users of Makeup Water-Condensate

The MUWC transfer pumps provide condensate to the following systems and uses:

- Main condenser hotwell
- Liquid Radwaste System
- Residual Heat Removal System flushing
- High Pressure Core Flooder System charging and flushing
- Reactor Core Isolation Cooling System charging and flushing
- Fuel pool skimmer surge tanks
- Cleanup system phase separators and cleanup system filter demineralizer
- Condensate filter and demineralizer
- Other miscellaneous uses.

Table 9.2-2 Users of Makeup Water-Purified

The MUWP transfer pumps provide purified water to the following systems and uses:

- Condensate storage tank makeup
- Reactor Building Cooling Water System makeup
- Turbine Building Cooling Water System makeup
- Diesel Generator Cooling Water System makeup
- Liquid radwaste system
- Standby liquid control tank
- Decontamination station
- Plant chilled water systems
- Plant laboratories
- Other miscellaneous uses

Table 9.2-2a Water Quality Characteristics for the Makeup Water Purified System

Water Quality Parameter		Operating Target	System Design	Maximum Value
Chloride (ppb)		10.0	20.0	100.0
Sulfate (ppb)		10.0	20.0	100.0
Conductivity* at 25°C (μS/cm)		0.2	0.3	1.0
Silica (ppb as SiO_2)		10.0	20.0	100.0
pH at 25°C	Min	6.4	6.2	5.6
	Max	7.8	8.0	8.6
Corrosion Product Metals (ppb)				
Fe insoluble				
soluble				
Cu total		10.0	20.0	100.0
all other metals				
	sum	10.0	20.0	100.0
Organic Impurities†				
Equivalent K (μS/cm)		0.2	0.4	2.0

* Does not include an incremental conductivity value of 0.8 uS/cm at 25°C due to carbon dioxide from air in water stored in tanks open to the atmosphere.

† Organic impurity values apply to fresh makeup water stored in any Demineralized Water Storage Tank.

Table 9.2-3 Capacity Requirements for Condensate Storage Tank

Dead space—top of pool	29,901L*
Normal operation variation and receiving volume for plant startup return water	999,240L
Minimum storage volume	247,500L
Dead space—middle of pool	129,901L*
Water source for station blackout	569,567L†
Dead space—bottom of pool	129,901L*
Total	2,108,321L

* These values are based on a bottom area of $130m^3$.

† Water for operation of RCIC is taken from the condensate storage tank and the suppression pool as described in the EPGs of Appendix 18A.

Table 9.2-4a Reactor Building Cooling Water Division A

Operating Mode/Components	Normal Operating Conditions		Shutdown at 4 Hours		Shutdown at 20 Hours		Hot Standby (No Loss of AC)		Hot Standby (Loss of AC)		Emergency (LOCA) (Suppression Pool at 97°C	
	Heat*	Flow*	Heat	Flow	Heat	Flow	Heat	Flow	Heat	Flow	Heat	Flow
Essential												
Emergency Diesel Generator A	—	—	—	—	—	—	—	—	13.40	229	13.40	229
RHR Heat Exchanger A	—	—	108.02	1,199	34.75	1,199	—	—	25.54	1,199	89.18	1,199
Others (essential)†	3.18	205	3.60	205	3.81	205	3.39	205	4.10	205	4.19	205
Non-Essential												
CUW Heat Exchanger‡	20.10	159	—	159	—	159	20.10	159	20.93	159	—	—
FPC Heat Exchanger Aƒ	7.12	279	7.12	279	7.12	279	7.12	279	7.12	279	9.63	279
Inside Drywell**	5.86	320	5.86	320	5.86	320	5.86	320	3.39	320	—	—
Others (non-essential)††	2.64	160	2.64	160	2.64	160	2.64	160	0.84	59	0.75	59
Total Load	38.94	1,123	127.24	2,322	54.01	2,322	38.94	1,123	75.36	2,450	117.23	1,971

* Heat in GJ/h; flow in m^3/h, sums may not be equal due to rounding.

† HECW refrigerator, CAMS coolers, room coolers (RHR, RCIC, CAMS), RHR motor and seal coolers.

‡ The heat transferred from the CUW heat exchanger at the start of cooldown is appreciable, but during the critical last part of a cooldown, the heat removed is very little because the temperature difference between the reactor water and the RCW System is small. Sometimes, the operators may remove the CUW heat exchangers from service during cooldown. Thus, the heat removed varies from about that during normal operation at the start of cooldown to very little at the end of cooldown.

ƒ Includes FPC room cooler.

** Drywell (A & C) and RIP coolers.

†† Instruments and service air coolers; CUW pump cooler, CRD pump oil, and RIP MG sets.

Table 9.2-4b Reactor Building Cooling Water Division B

Operating Mode/Components	Normal Operating Conditions		Shutdown at 4 Hours		Shutdown at 20 Hours		Hot Standby (No Loss of AC)		Hot Standby (Loss of AC)		Emergency (LOCA) (Suppression Pool at 97°C	
	Heat*	Flow*	Heat	Flow	Heat	Flow	Heat	Flow	Heat	Flow	Heat	Flow
Essential												
Emergency Diesel Generator B	—	—	—	—	—	—	—	—	13.40	229	13.40	229
RHR Heat Exchanger B	—	—	108.02	1,199	34.75	1,199	—	—	25.54	1,199	89.18	1,199
Others (essential)†	6.28	360	6.70	360	6.70	360	6.28	360	7.12	360	7.95	360
Non-Essential												
CUW Heat Exchanger‡	20.10	159	—	159	—	159	20.10	159	20.93	159	—	—
FPC Heat Exchanger B*ƒ*	7.12	279	7.12	279	7.12	279	7.12	279	7.12	279	9.63	279
Inside Drywell**	5.44	279	6.28	279	5.40	279	5.40	279	2.51	279	—	—
Others (non-essential)††	2.93	159	1.47	159	1.47	159	1.47	159	0.33	9.1	—	9.1
Total Load	41.87	1,236	129.79	2,435	55.27	2,435	40.19	1,236	77.04	2,514	120.16	2,076

* Heat in GJ/h; flow in m^3/h, sums may not be equal due to rounding.

† HECW refrigerator, room coolers (RHR, HPCF, SGTS, CAMS), CAMS cooler, HPCF and RHR motor and mechanical seal coolers.

‡ The heat transferred from the CUW heat exchanger at the start of cooldown is appreciable, but during the critical last part of a cooldown, the heat removed is very little because the temperature difference between the reactor water and the RCW System is small. Sometimes, the operators may remove the CUW heat exchangers from service during cooldown. Thus, the heat removed varies from about that during normal operation at the start of cooldown to very little at the end of cooldown.

ƒ Includes FPC room cooler.

** Drywell (B) and RIP coolers.

†† Reactor Building sampling coolers; LCW sump coolers (in drywell and reactor building), RIP MG sets and CUW pump coolers.

Table 9.2-4c Reactor Building Cooling Water Division C

Operating Mode/Components	Normal Operating Conditions		Shutdown at 4 Hours		Shutdown at 20 Hours		Hot Standby (No Loss of AC)		Hot Standby (Loss of AC)		Emergency (LOCA) (Suppression Pool at 97°C	
	Heat*	Flow*	Heat	Flow	Heat	Flow	Heat	Flow	Heat	Flow	Heat	Flow
Essential												
Emergency Diesel Generator C	—	—	—	—	—	—	—	—	13.40	229	13.40	229
RHR Heat Exchanger C	—	—	108.02	1,199	34.75	1,199	—	—	25.54	1,199	89.18	1199
Others (essential)†	6.28	360	6.70	360	6.70	360	6.28	360	6.70	360	7.12	360
Non-Essential												
Others (non-essential)‡	20.51	422	19.26	422	7.54	422	20.51	422	0.54	50	0.75	50
Total Load	26.80	782	133.98	1,981	48.57	1,981	26.80	782	46.05	1838	110.53	1838

* Heat in GJ/h; flow in m^3/h, sums may not be equal due to rounding.

† HECW refrigerator, room coolers, motor coolers, and mechanical seal coolers for RHR and HPCF, FCS room cooler, SGTS room cooler.

‡ Instrument and service air coolers, CRD pump oil cooler, radwaste components, HSCR condenser, and turbine building sampling coolers.

Table 9.2-4d Design Characteristics for Reactor Building Cooling Water System Components

RCW Pumps (Two per division)		
	RCW (A)/(B)	**RCW (C)**
Discharge Flow Rate	1420 m^3/h/pump	1,237 m^3/h/pump
Pump Total Head	0.57 MPa	0.52 MPa
Design Pressure	1.37 MPa	1.37 MPa
Design Temperature	71°C	71°C
RCW Heat Exchangers (Three per division)		
	RCW (A)/(B)	**RCW (C)**
Capacity (for each heat exchanger)	47.73 GJ/h	44.38 GJ/h
RCW Surge Tanks		
Capacity	16 m^3 (total, each)	
Design Pressure	Static Head	
Design Temperature	71°C	
RCW Chemical Addition Tanks		
Design Pressure	1.37 MPaG	
Design Temperature	71°C	
RCW Piping		
Design Pressure	1.37 MPaG	
Design Temperature	71°C	

Table 9.2-5a Reactor Building Cooling Water Active Failure Analysis

Single Active Failure	Analysis
Failure of diesel generator to start or failure of all power to a single Class 1E power system bus	The other RCW pumps are powered and controlled from other buses which are energized from other independent diesel generators and DC buses and, therefore, provide sufficient cooling for the essential equipment. The independent RCW Systems are mechanically and electrically separated to prevent damage to one system from other systems.
Failure of pump auto start signal	Same analysis as above.
Failure of ECCS pump area air cooler	Essential plant cooling requirements are met by the redundant ECCS, which have their own independently cooled pump areas.
Failure of a single RCW pump during normal plant operation	Essential plant cooling requirements are met by the remaining operable, redundant RCW pumps.

Table 9.2-5b Reactor Building Cooling Water System Passive Failure Analysis

Single Active Failure	Analysis
Failure of any RCW System supply or return piping	Essential plant cooling requirements are met by the remaining intact RCW System, which includes their own independent supply and return service water headers. The redundant systems are mechanically and electrically separated to prevent damage to one system from the other systems.
Failure of RCW to RHR heat exchanger	Essential plant cooling requirements are met by the remaining intact redundant RHR System, which includes its own 100% capacity heat exchanger.
Failure of RCW piping to or from the air cooler for an ECCS pump area	Essential plant cooling requirements are met by the redundant ECCS which have their own independently cooled pump areas.
Failure of a single RCW heat exchanger during normal operation	Essential plant cooling requirements are met by the remaining operable, redundant heat exchanger.

Table 9.2-6 HVAC Normal Cooling Water System Component Description

HNCW Chillers	
Quantity	5 (including one standby unit)
Cooling Capacity	9.42 GJ/h each
Chilled water flow per unit	450 m^3/h
Supply temperature	7°C
Condenser water flow per unit	420 m^3/h
Supply temperature (max)	45°C
Control	Inlet guide vane
Condenser	Shell and tube
Evaporator	Shell and tube
HNCW Water Pumps	
Quantity	5 (including one standby unit)
Type	Centrifugal, horizontal
Capacity m^3/hr each	450
Total discharge head	0.49 MPa

Table 9.2-7 HVAC Normal Cooling Water Loads

Name of Area or Unit	During Normal Operation Capacity GJ/h	During Normal Operation Flow m^3/h	During Refueling Shutdown Capacity GJ/h	During Refueling Shutdown Flow m^3/h
Reactor Building				
Drywell Coolers	0.96	69.5	0.80	69.5
RIP Coolers	1.59	20.9	3.06	104
Others (Note 1)	10.05	131	18.84	636
Turbine Building (Note 2)	2.26	43.5	1.13	39
Radwaste Building (Note 4)	5.69	81.2	6.70	232
Service Building	3.64	175	3.64	175
Others (Note 5)	4.61	151	3.56	151
Total	28.89	672	37.68 (Note 6)	1,407

NOTES:

(1) Loads include reactor/turbine building supply units, HVH, FCU and room coolers.

(2) Loads are the offgas cooler condenser (normal operation only) and the electrical equipment supply unit.

(3) Deleted

(4) Loads included are the radwaste building supply unit and the radwaste building electrical equipment room supply unit.

(5) Loads include HVH units not previously included.

(6) The HNCW chillers are 9.38 GJ/h each and the pumps $449 m^3/h$ each. Thus, four HNCW pumps have total capacity in excess of the amount required as shown in the last column of the table.

Table 9.2-8 HECW System Component Description*

HECW Chillers		
Quantity		6
Capacity (Refrigerator)	six	2.51 GJ/h
Chilled water pump flow	six	57 m^3/h
Supply temperature		7°C
Condenser water flow	six	128 m^3/h
Supply temperature (max.)		45°C
Condenser	Shell and tube	
Evaporator	Shell and tube	
HECW Water Pumps		
Quantity		6 (57 m^3/h each)
Type		Centrifugal, horizontal

* Each of Divisions A, B, and C have two parallel pump-refrigerator units.

Table 9.2-9 HVAC Emergency Cooling Water System Heat Loads

		Normal		Emergency	
Division	**System**	**Heat Load (GJ/h)**	**Chilled Water Flow (m^3/h)**	**Heat Load (GJ/h)**	**Chilled Water Flow (m^3/h)**
A	Reactor Building Electrical Equipment Room (A)	0.88	14.3	0.88	14.3
	Control Building Electrical Equipment Room (A)	1.26	20.2	1.26	20.2
	Total	2.14	34.5	2.14	34.5
B	Main Control Room	1.42	26	1.30	24
	Reactor Building Electrical Equipment Room (B)	0.92	15	0.92	15
	Control Building Electrical Equipment Room (B)	1.26	20.2	1.26	20.2
	Total	3.60	61.2	3.48	59.2
C	Main Control Room	1.42	26	1.30	24
	Reactor Building Electrical Equipment Room (C)	0.92	15	0.92	15
	Control Building Electrical Equipment Room (C)	1.26	20.2	1.26	20.2
	Total	3.6	61.2	3.48	59.2

Table 9.2-10 HVAC Emergency Cooling Water System Active Failure Analysis

Failure of diesel generator to start or failure of all power to a single Class 1E power system bus.	Loss of one refrigerator and pump in Division B or C would not permit sending chilled water to the Control Room Habitability Area HVAC System from the affected division. The other HECW division would send chilled water to the Control Room Habitability Area HVAC System which would maintain adequate cooling. In Division A, loss of both of the refrigerators or the pumps would result in loss of cooling water flow to Division A Control Building safety-related Equipment Area HVAC System and Reactor Building safety-related Electrical Equipment HVAC System. Cooling of Control Room Habitability Area HVAC System not affected.
Failure of auto pump or refrigerator signal.	Same analysis as above.
Failure of a single HECW refrigerator.	Same analysis as above.
Failure of a single HECW pump.	Same analysis as above.
Failure of HECW pump and refrigerator room cooling.	Same analysis as above.

Table 9.2-11 Turbine Island Auxiliary Equipment

The TCW System removes heat from the following components:

- HVAC normal cooling water chillers
- Generator stator coolers, hydrogen coolers, seal oil coolers, exciter coolers and breaker coolers
- Turbine lube coolers
- Mechanical vacuum pump coolers
- Isophase bus coolers
- Electro-hydraulic control coolers
- Reactor feed pump and auxiliary coolers
- Standby reactor feed pump motor coolers
- Condensate pump motor coolers
- Heater drain pump motor coolers

Table 9.2-12 Not Used

Table 9.2-13 Reactor Service Water System (Interface Requirements)

RSW Pumps (Two per division)	
Discharge flow rate, per pump	1,800 m^3/h
Pump total head	0.34 MPa
Design pressure	0.79 MPa
Design temperature	50°C
RSW Piping and Valves	
Design pressure	1.08 MPa
Design temperature	50°C

Table 9.2-14 Potable and Sanitary Water System Components (Interface Requirements)

Component	Major Design Features
All tanks are vertical, cylindrical type except where noted. All water pumps are horizontal, centrifugal and single stage. All chemical feed pumps are positive displacement diaphragm type.	
Potable Water Storage Tank	
Capacity	23 m^3
Potable Water Pump	
Quantity	2
Capacity	23 m^3/h
Head	18 m
Hypochlorinator Pump	
Capacity	0.6 m^3/h
Head	9m
Hypochlorite Tank	
Capacity	0.2 m^3
Hydropneumatic Pressure Tank	
Type	Horizontal, cylindrical
Capacity	15 m^3
Design pressure	1.03 MPaG
Air Compressor	
Type	Piston, single-stage
Capacity	5 m^3/min
Discharge pressure	0.8 MPaG
Comminutor	
Type	Revolving vertically-slotted drum
Aeration Tank	
Quantity	2
Volume	25 m^3 each
Clarifier	
Quantity	1 large, 2 small
Volume	19m^3, 7m^3
Hypochlorite Contact Tank	
Volume	4.25 m^3

Table 9.2-14 Potable and Sanitary Water System Components (Interface Requirements) (Continued)

Component	Major Design Features
Aerobic Digester	
Quantity	2
Volume	25 m^3 each
Air Blower	
Quantity	3
Capacity	0.34 m^3/min each
Froth Spray Pump	
Capacity	6 m^3/h
Head	30 m
Hypochlorite Feed Pump	
Capacity	1.5 m^3/h
Head	30 m
Hypochlorite Tank	
Capacity	0.4 m^3

Table 9.2-15 Makeup Water Preparation System Component (Interface Requirements)

Component	Major Design Features
All tanks are vertical, cylindrical type. All water pumps are horizontal, centrifugal and single-stage except the RO feed pumps. All chemical feed pumps are positive displacement, diaphragm type.	
Well	
Capacity	At least 450 m^3/h
Well Water Tank	
Capacity	38 m^3
Well Water Pumps	
Quantity	2
Capacity	230 m^3/h
Filters	
Quantity	2
Capacity	230 m^3/h each
Type	Pressure type, dual media
Filtered Water Storage Tank	
Capacity	150 m^3
Backwash Pumps	
Quantity	2
Capacity	450 m^3/h each
Head	27m
RO Feed Pumps	
Quantity	4
Type	Horizontal, multistage
Capacity	45 m^3/h
Head	2.75 to 3.43 MPaG
RO First Pass	
Quantity	2
Type	2-to-1 array of thin film composite membranes
Capacity	68 m^3/h permeate each with 25% rejection
RO Second Pass	
Quantity	2
Type	1-to-1 array of thin film composite membranes

Table 9.2-15 Makeup Water Preparation System Component (Interface Requirements) (Continued)

Component	Major Design Features
Capacity	45 m^3/h permeate each with 33% rejection
RO Permeate Storage Tank	
Capacity	20 m^3
Demineralizer Feed Pumps	
Quantity	4
Capacity	23 m^3/h each
Head	16m
Demineralizers	
Quantity	6
Capacity	23 m^3/h each
Resin	1.1m^3 of 1:2 cation/anion resin each
Demineralized Water Storage Tanks	
Quantity	2
Capacity	380 m^3, each
Demineralized Water Forwarding Pumps	
Quantity	3
Capacity	45 m^3/h
Chemical Feed Tank (NaHMP)	
Capacity	0.8 m^3
Chemical Feed Pump (NaHMP)	
Quantity	2
Capacity	0.04 m^3/h each
Chemical Feed Tank (NaOH)	
Capacity	1.5m^3
Chemical Feed Pump (NaOH)	
Quantity	4 (three normally operating with one spare)
Capacity	0.04 m^3/h

Table 9.2-16 Turbine Service Water System (Interface Requirement)

TSW Pumps (Three 50% pumps)	
Discharge Flow Rate	3400 m^3/h per pump
Pump Total Head	0.20 MPaG
Design Pressure	0.59 MPaG
Design Temperature	40°C
TSW Piping and Valves	
Design Pressure	0.59 MPaG
Design Temperature	40°C

The following figures are located in Chapter 21 :

Figure 9.2-1 Reactor Building Cooling Water System P&ID (Sheets 1–9)

Figure 9.2-1a Not Used

Figure 9.2-2 HVAC Normal Cooling Water System P&ID

Figure 9.2-3 HVAC Emergency Cooling Water System P&ID (Sheets 1–3)

Figure 9.2-4 Makeup Water (Condensate) System P&ID

Figure 9.2-5 Makeup Water (Purified) System P&ID (Sheets 1–3)

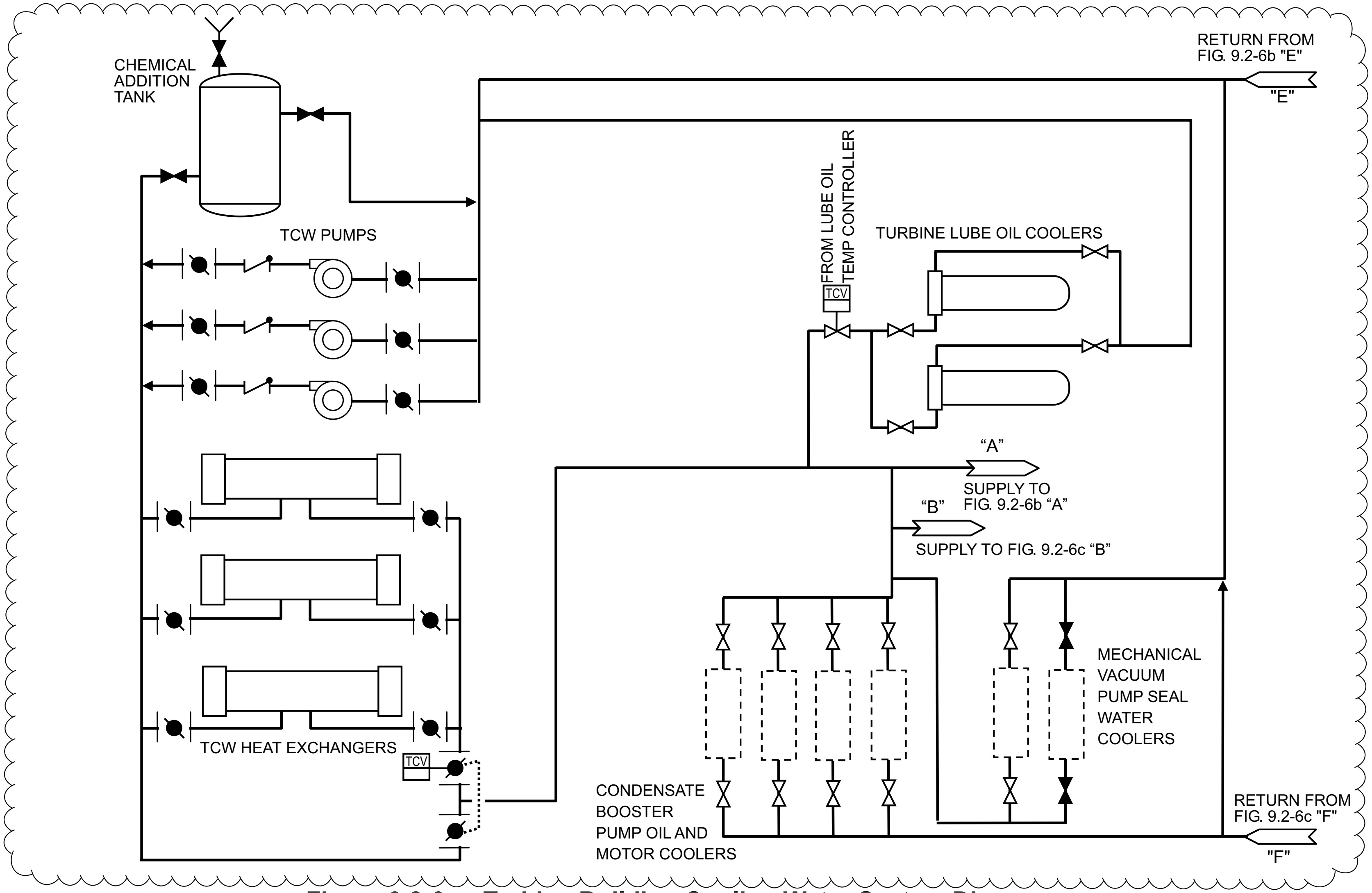


Figure 9.2-6a Turbine Building Cooling Water System Diagram

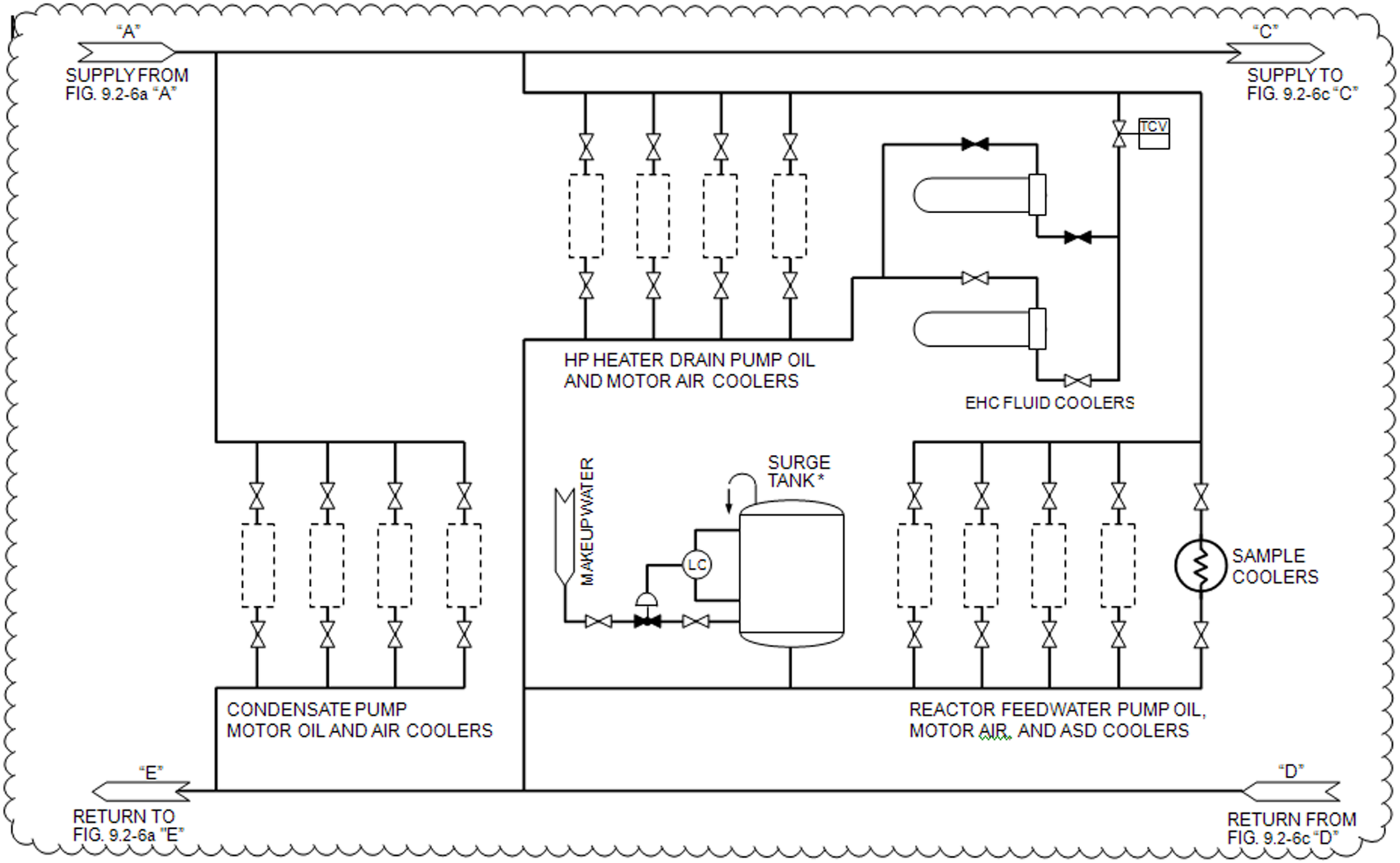


Figure 9.2-6b Turbine Building Cooling Water System Diagram

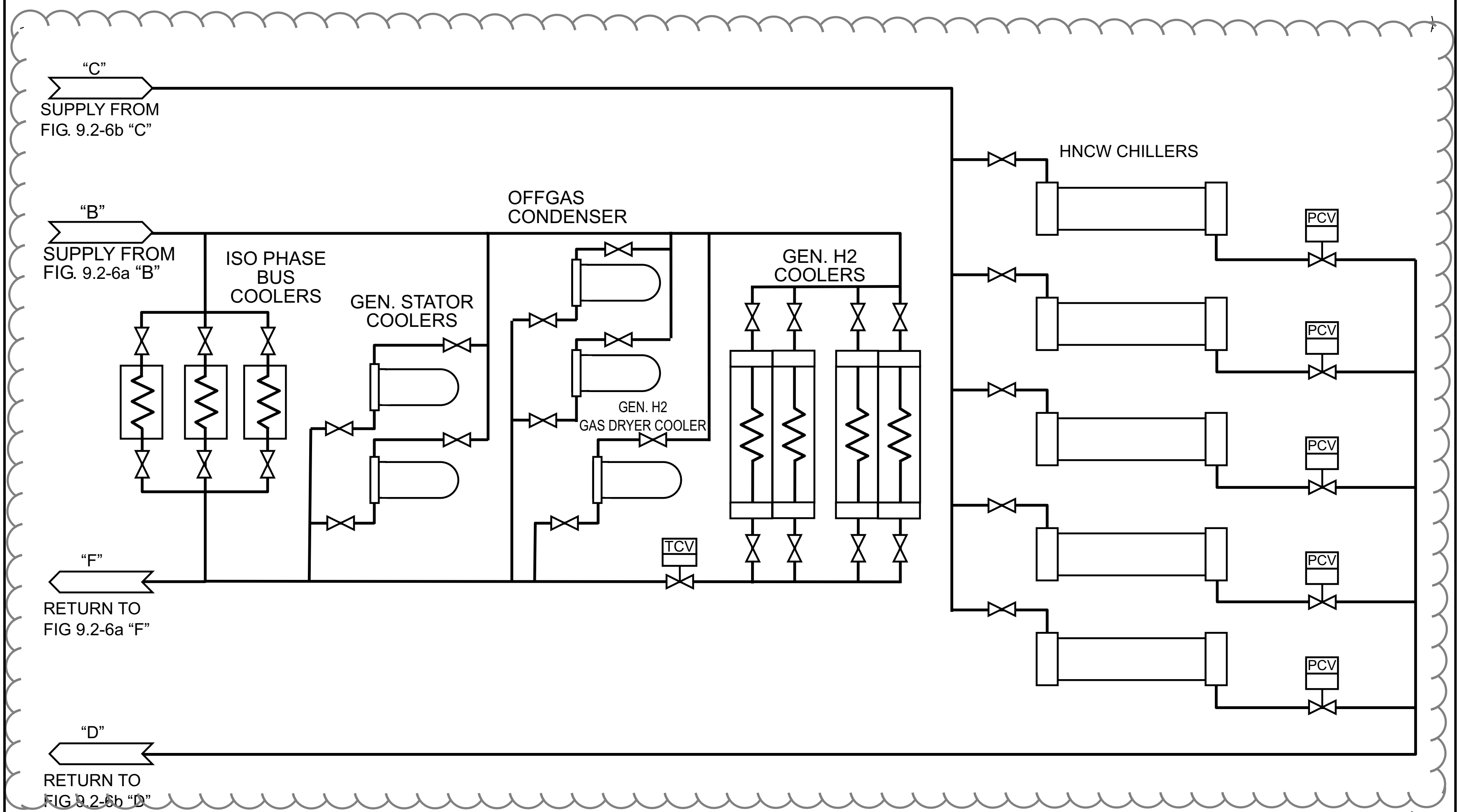


Figure 9.2-6c Turbine Building Cooling Water System Diagram

The following figure is located in Chapter 21:

Figure 9.2-7 Reactor Service Water System P&ID (Sheets 1–3)

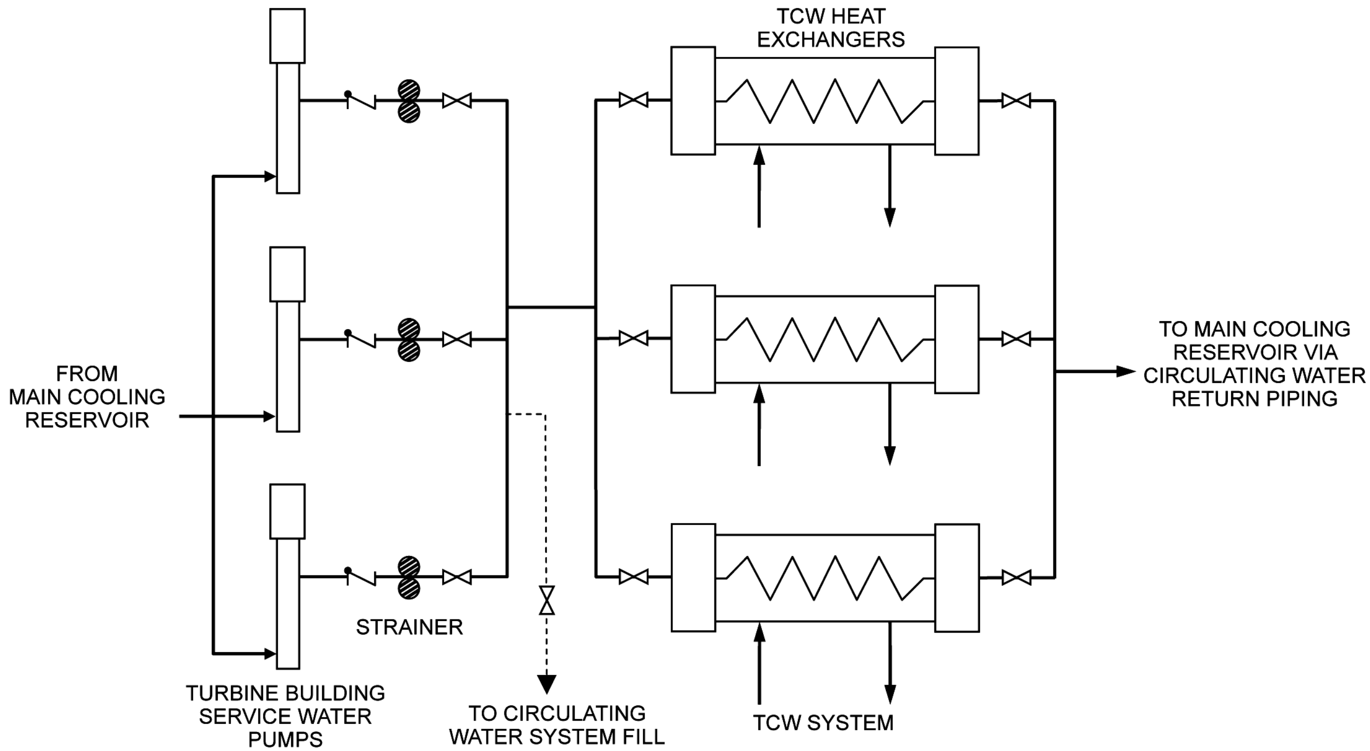
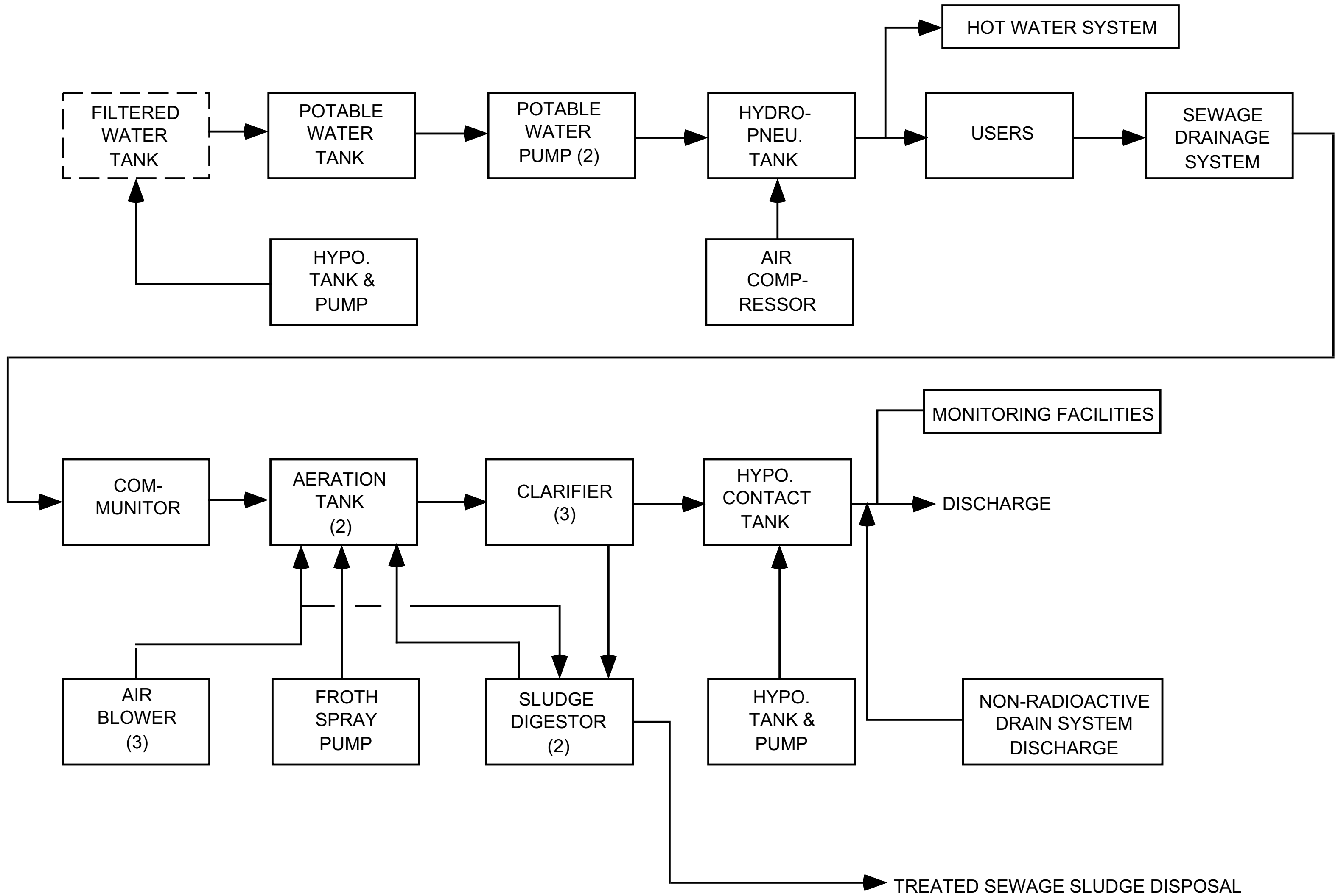


Figure 9.2-8 Turbine Building Service Water System



Block Flow Diagram
(Interface Requirements)

Figure 9.2-9 Potable and Sanitary Water System

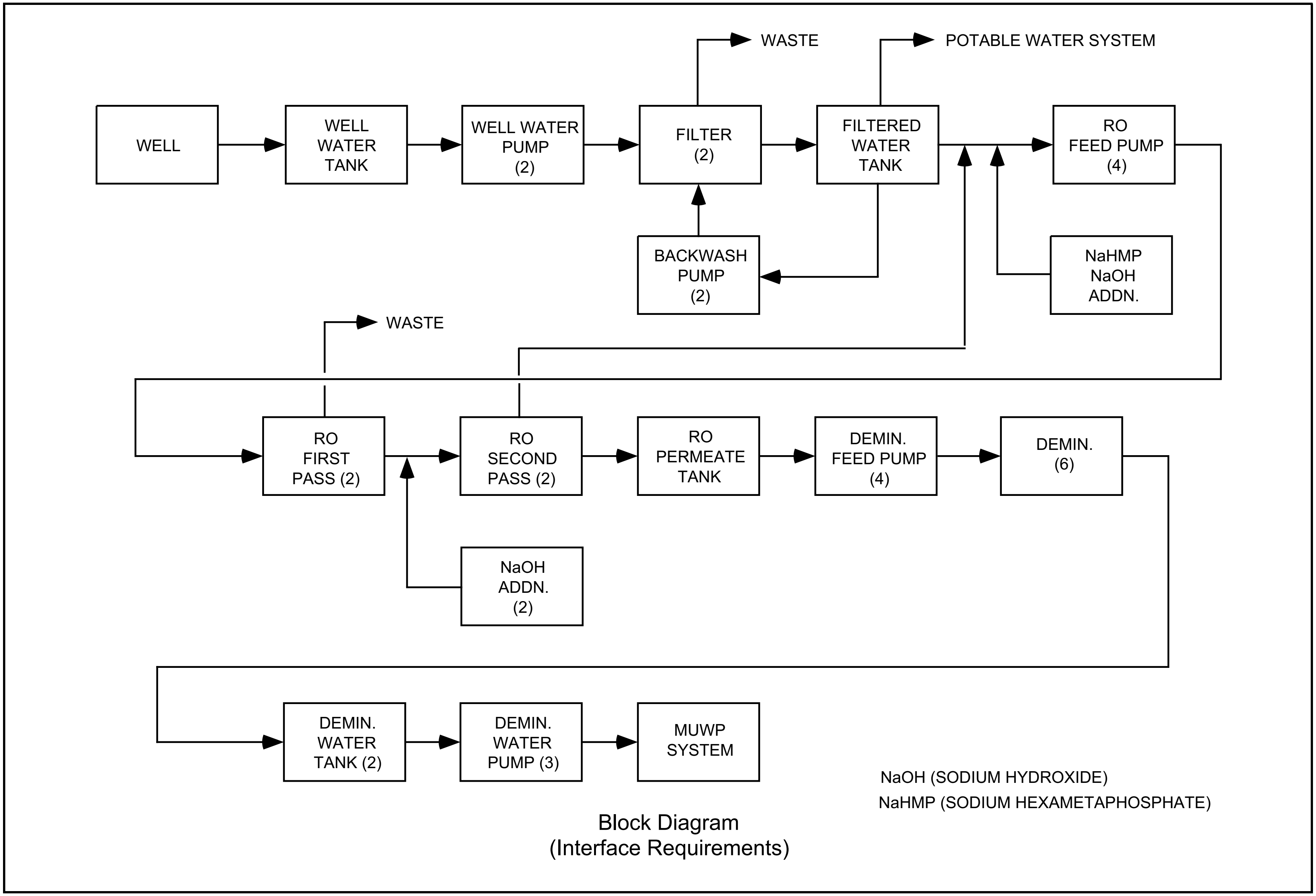


Figure 9.2-10 Makeup Water Preparation System