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GE Nuclear Energy

ABWR

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Subject ABWR Review

Message Info. pertaining to RSW, MUWP, HECW, TCW and TSW

9.2.8 Makeup Water (MWP) System (Preparation)

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 200 gpm of demineralized water each.

(2) Storage of demineralized water shall be at least 200,000 gallons.

(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 600 gpm at a temperature between 50 to 100°F.

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

(6) The MWP system provides 200 gpm of filtered water to meet maximum anticipated peak demand periods for the Potable and Sanitary Water System.

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. Pumps are provided to keep the makeup water distribution system (MUWP) pressurized at all times. All components except storage tanks are arranged in two independent divisions. 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, well water storage tank and two well water forwarding pumps are provided which can produce sufficient water to meet the concurrent needs of the makeup water preparation system and the potable and sanitary water 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 50°F at all times. Water may be sent from the filtered water storage tank to the Potable and Sanitary Water 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 440 psig. 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 are sent to the cooling tower blowdown by gravity. 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 50°F 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 50°F 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 25 feet by 40 feet 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 cooling tower blowdown by gravity.

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 200 to 250 psig. Sodium hydroxide is added to the first pass perm ate 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 40 cubic feet 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. When no longer required they will be removed.

9.2.8.5 Evaluation of Makeup Water Preparation Performance (Interface Requirements)

The applicant referencing the ABWR design 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)

There are no safety requirements.

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 applicant referencing the ABWR design shall prepare and perform a preoperational test program and tests in accordance with the requirements of Chapter 14.

Table 9.2-15

MAKEUP WATER PREPARATION SYSTEM COMPONENTS

(Interface Requirements)

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.

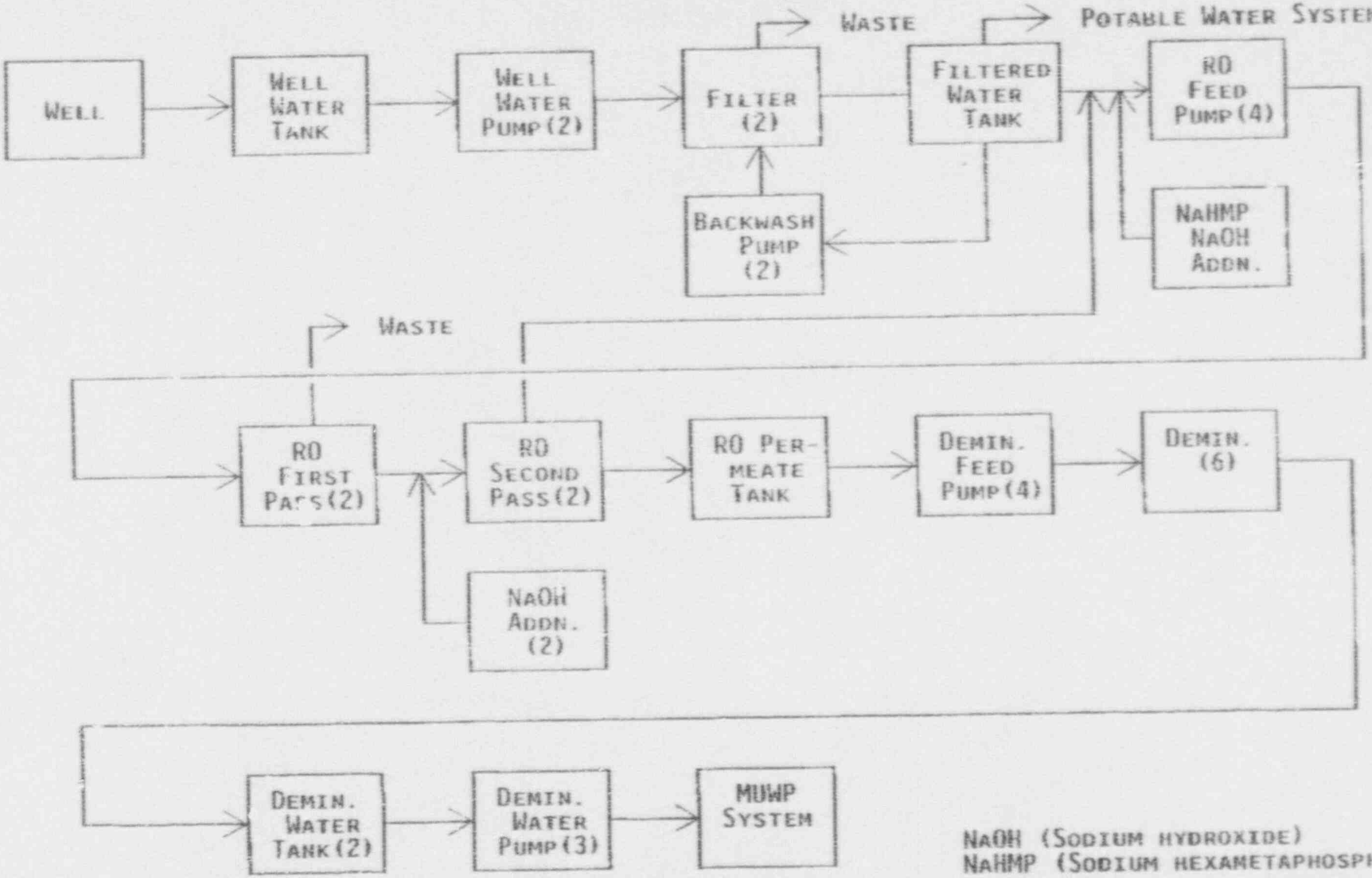
Component	Major Design Features
Well	
Capacity	at least 2,000 gpm
Well Water Tank	
Capacity	10,000 gallons
Well Water Pumps	
Quantity	two
Capacity	1,000 gpm each
Filters	
Quantity	two
Capacity	1,000 gpm each
Type	Pressure type, dual media
Filtered Water Storage Tank	
Capacity	40,000 gallons
Backwash Pumps	
Quantity	two
Capacity	2,000 gpm each
Head	90 feet
RO Feed Pumps	
Quantity	four
Type	Horizontal, multistage
Capacity	200 gpm each
Head	400 to 500 psig
RO First Pass	
Quantity	two
Type	2 to 1 array of thin film composite membranes
Capacity	300 gpm permeate each with 25 % rejection

Component	Major Design Features
RO Seco:.d Pass	
Quantity	two
Type	1 to 1 array of thin film composita membranes
Capacity	200 gpm permeate each with 33 % rejection
RO Permeate Storage Tank	
Capacity	5,000 gallons
Demineralizer Feed Pumps	
Quantity	four
Capacity	100 gpm each
Head	230 feet
Demineralizers	
Quantity	six
Capacity	100 gpm each
Resin	40 cubic feet of 1:2 cation/anion resin each
Demineralized Water Storage Tanks	
Quantity	two
Capacity	100,000 gallons each
Demineralized Water Forwarding Pumps	
Quantity	three
Capacity	200 gpm each
Chemical Feed Tank (NaHMP)	
Capacity	200 gallons
Chemical Feed Pump (NaHMP)	
Quantity	two
Capacity	10 gph each
Chemical Feed Tank (NaOH)	
Capacity	400 gallons
Chemical Feed Pump (NaOH)	
Quantity	four (three normally operating with one spare)
Capacity	10 gph each

FIGURE 9.2-10

MAKEUP WATER PREPARATION SYSTEM

BLOCK FLOW DIAGRAM
(INTERFACE REQUIREMENTS)



NaOH (SODIUM HYDROXIDE)
NaHMP (SODIUM HEXAMETAPHOSPHATE)

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 turbine building cooling water TCW expansion tank by water level controls, and the chiller units are con- trolled 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 turbine building cooling water system. The three way valve on the chilled water circuit controls the temperature of the chilled water to the cooling coils from the areas thermocouple controller. The thermocouples are located in each area being cooled. The control room operato ... e position during ... led water return t ... alarmed. Alterna ... valves, a flow co

Remo ... lation of any dry ... nt of the coil de

9.2.13 HVAC Emergency Cooling Water System

9.2.13.1 Design Basis

9.2.13.1.1 Power Generation Design Bases

The HVAC emergency cooling water system (HECW) (safety-related) shall provide chilled water under normal plant operating conditions to the cooling coils of the main control room air conditioning units, to the diesel generator zone coolers, and to the control building essential electrical equipment room cooling coils. See Table 9.2-9. The supply temperature is 44.6°F the return temperature is 62.6°F.

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 control building essential electrical equipment room coolers, the diesel generator zone coolers, and the main control room coolers 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.

(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; and

(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.

9.2.13.2 System Description

The HVAC emergency cooling water system consists of redundant subsystems in three divisions. ~~Each division consists of~~ two 50% refrigerator ~~chiller~~ units, two 50% 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 ~~chiller~~ capacity is designed to cool ~~all heat loads with two chillers, but also cool the heat load of the main control room with one chiller.~~

Equipment is listed in Table 9.2-9. Each cooling coil has a three-way valve controlled by a room thermostat. Alternately, flow may be controlled by a temperature control valve. ~~The subsystems are designated Division I and Division II power, respectively. One compressor is the operating unit, while the other is on standby.~~ Condenser cooling is from the corresponding division of RCW.

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 not 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 refrige ~~chiller~~ 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.

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. 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. Each chiller is isolated in a separate room. in what

*** in divisions?

9.2.13.4 Tests and Inspection

Initial testing of the system includes performance testing of the refrig ~~chillers~~, 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 to permit periodic in-service inspection of all system components to assure the integrity and capability of the system.

where, fig 9.2-?

* Division A has one refrigerator (100%?) and pump and divisions B and C have ? why the difference

** the diesel generator zone and electrical equipment room

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(A) → 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.

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 ~~chillers~~ 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 Application

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 ~~chiller is~~ refrigerator equipped with an interlock which automatically starts the standby ~~chiller~~ and pump upon failure of the operating unit in divisions B and C.

The ~~chiller~~ 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 three-way valve to provide constant inlet condensate water temperature.

A temperature controller and flow switch continuously monitor the discharge of each

TABLE 9.2-8

HECW SYSTEM COMPONENT DESCRIPTION

HECW Chillers

Type		Centrifugal hermetic
Quantity		5 ~~6~~ ~~(50% capacity units)~~
Capacity (refrigeration)	five ~~four~~	2.3 ~~2.03~~ x 10^6 BTU/h each
	~~two~~	~~1.23 x 10^6 BTU/h each~~
Chilled water pump flow	five ~~four~~	256 ~~220~~ gpm each
	~~two~~	~~120 gpm each~~
Supply temperature	44.6°F	
Condenser water flow	five ~~four~~	564 gpm each
	~~two~~	~~341 gpm each~~
Supply temperature (max.)		95°F
Condenser	Shell and tube	
Evaporator	Shell and tube	

HECW Water Pumps

Quantity	5 ~~4~~ - 256 ~~220~~ gpm each ~~2 - 120 gpm each~~
Type	Centrifugal, horizontal

TABLE 9.2-9

HVAC EMERGENCY COOLING WATER SYSTEM HEAT LOADS

DIVISION	SYSTEM	NORMAL Heat Load ($x10^6$ BTU/h)	NORMAL Chilled Water Flow (gpm)	EMERGENCY Heat Load ($x10^6$ BTU/h)	EMERGENCY Chilled Water Flow (gpm)
A	main control room	1.35	~~125~~ 113	1.25	~~116~~ 104
	diesel generator zone (A)	0.83	62	0.83	62
	control building elect. eq. room (A)	1.19	88	1.19	88
	Total	~~2.37~~ 2.02	~~275~~ 150	~~3.27~~ 2.02	~~266~~ 150
B	diesel generator zone (B)	0.86	~~63~~ 64	0.86	~~63~~ 64
	control bldg. elect. eq. room (B)	1.19	88	1.19	88
	Total	~~2.05~~ 3.4	~~151~~ ~~276~~ 265	~~2.05~~ 3.3	~~151~~ ~~267~~ 256
C	main control room	1.35	~~125~~ 113	1.25	~~116~~ 104
	diesel generator zone (c)	0.86	~~63~~ 64	0.86	~~63~~ 64
	control bldg. elect. eq. room (C)	1.19	88	1.19	88
	Total	3.40	~~276~~ 265	3.30	~~267~~ 256

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 a division (B or C) would not permit sending chilled water to the main control room from the affected division. The other HVAC emergency cooling water (HECW) division would send chilled water to the main control room which would maintain adequate cooling.
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

In division A, loss of either the refrigerator or the pump would result in loss of cooling water flow to division A essential electrical equipment room and diesel generator zone A. Cooling of main control room not affected.

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 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 105°F, to the turbine island auxiliary equipment, with a service water inlet temperature not exceeding 95°F.

(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 illustrated on Figure 9.2-6. The system is a single loop system and consists of one surge tank, one chemical addition tank, two pumps with a capacity of 29,000 gpm each, two heat exchangers with heat removal capacity of 130 x 10^6 Btu/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 system (Subsection 9.2.16).

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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 ~~100%~~ 50 capacity each and are constant speed electric motor driven, horizontal centrifugal pumps. The two pumps are connected in parallel with common suction and discharge lines.

The TCW heat exchangers are ~~100%~~ 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

INSERT

(A) → three pumps wi a capacity of 15,000 gpm each, three heat exch gers with heat removal capacity of 65 x 10^6 Btu/h each, location away from any safety-related components. Failure of the surge tank will not affect any safety-related systems.

Those parts of the TCW system in the turbine building are located in areas that do not contain any safety-related systems. All safety-related systems in the turbine building are located in special areas to prevent any damage from non-safety-related systems during seismic events. Those parts of the TCW system outside the turbine building are located away from any safety-related systems.

9.2.14.2.3 System Operation

During normal power operation, ~~one~~ two of the ~~two 100%~~ three 50% capacity TCW system pumps circulate corrosion-inhibited demineralized water through the shell side of ~~one of the two 100%~~ two of the three 50% capacity TCW heat exchangers in service. The heat from the TCW system is rejected to the turbine service water 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 and aftercoolers, and generator exciter air cooler is regulated by control valves. Control valves in the cooling water outlet from 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 outlet from 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 inhibiter 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 set points to verify the system condition.

9.2.14.5 Instrumentation Application

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 ← (B)

9.2.15.1 Design Bases

9.2.15.1.1 Safety Design Bases

(1) The reactor service water (RSW) system shall be designed in three divisions to remove heat from the three divisions of the reactor cooling water 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.

(2) The RSW system shall be designed to

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(B) → 9.2.15.1 Portions Within Scope of ABWR Standard Plant

Those portions of the Reactor Service Water System (RSW) that are within the control building are in the scope of the ABWR Standard Plant and are described in Sections 9.2.15.1.1 through 9.2.15.1.5.

All portions of the RSW system which are outside the control building are not in the scope of the ABWR Standard Plant.

Seismic Category I and ASME Code, Section III, Class 3, Quality Assurance B, Quality Group C, IEEE-279 and IEEE-308 requirements.

(3) The RSW 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.

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

9.2.15.1.2 Power Generation Design Bases

The RSW system shall be designed to cool the reactor building cooling water (RCW) as required during: (a) normal operation; (b) emergency shutdown; (c) normal shutdown; and (d) testing.

9.2.15.2 System Description

The RSW system 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. Figure 9.2-7 shows the RSW system diagram. Component descriptions are provided in Table 9.2-13.

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 sea water sites where infestations of macrobial growth can occur.

See Subsection 9.2.17.4, items (1), (2) and (3) for interface requirements.

9.2.15.3 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; and

(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.

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

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. 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.

See Subsection 9.2.17.4, items (4) and (5) for interface requirements.

9.2.15.4 Testing and Inspection Requirements

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 the 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.

9.2.15.1.5
~~9.2.15.5~~ Instrumentation and Control Requirements

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.

9.2.16 Turbine Service Water System

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.

9.2.16.1 Design Bases

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 turbine cooling water (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 100°F.

(3) The TSW system is designed to pe[illegible]it the maintenance of any single active component without inte[illegible] the cooling function.

9.2.16.1.2
~~9.2.16.2~~ System Description

9.2.16.1.2.1
~~9.2.16.2.1~~ General Description

The TSW system is illustrated on Figure 9.2-8.

The TSW pumps take suction from the power cycle heat sink and supply cooling water to the tube side of the TCW heat exchangers. The heat rejected to the TSW system is discharged to the power cycle heat sink.

Piping and valves in the TSW system are carbon or low alloy steel and are protected from interior and exterior corrosion with suitable corrosion resistant material as required by site specific soil and water conditions.

~~9.2.16.2.2~~ Component Description
9.2.16.1.2.2

The TSW system consists of two 100% capacity vertical wet pit pumps located at the intake structure. One pump is in operation during normal operation with one pump on standby.

Two 100% capacity duplex strainers are provided (one for each TSW pump). Each half of the duplex strainer is designed for the design flow of one TSW pump. Only one half of each duplex strainer is in operation when its associated pump is in operation. The duplex strainers are motor operated and automatically switch from the half in service to the clean half of the duplex strainer on detection of high differential pressure. Debris collected in the strainer is automatically sluiced to a disposal collection area.

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

A summary of the TCW heat exchangers is provided in Table 9.2-12.

9.2.16.1.2.3
~~9.2.16.2.3~~ System Operation

The system normally is started manually from

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C → 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. Sections 9.2.15.2.1 through 9.2.15.2.5 provide a 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.

9.2.15.2.1 Design Bases

The site dependent portions of the RSW system shall meet all requirements in Sections 9.2.15.1.1 through 9.2.15.1.5 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.

9.2.15.2.1.1 Safety Design Bases (Interface Requirements)

The 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 a pipeline break and a single active component failure shall show that flooding shall not affect the main control room or more than one division of the RSW system

9.2.15.2.1.2 Power Generation Design Bases (Interface Requirements)

There are none.

9.2.15.2.2 System Description (Conceptual Design)

The RSW pump house is located at the Ultimate Heat Sink (UHS) which is described in Section 9.2.5.

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 macrobial growth can occur.

9.2.15.2.3 Safety Evaluation (Interface Requirements)

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

An analysis shall show that the requirements in 9.2.15.6.1(4) and 9.2.15.6(5) are met.

9.2.15.2.4 Testing and Inspection Requirements (Interface Requirements)

There are none.

9.2.15.2.5 Instrumentation and Control Requirements (Interface Requirements)

There are none.

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9.2.16.1 Portions Within Scope of ABWR Standard Plant

Those portions of the Turbine Service Water System (TSW) that are within the turbine building are in the scope of the ABWR Standard Plant and are described in Sections 9.2.16.1.1 through 9.2.16.1.5.

All portions of the TSW system that are outside the turbine building are not in the scope of the ABWR Standard Plant.

the main control room and one pump is operated continuously during normal power operation conditions.

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

~~9.2.16.3~~ 9.2.16.1.3 Safety Evaluation

The TSW system does not serve or support any safety function and has no safety design bases. The TSW system is not interconnected with any safety-related systems. See Subsection 9.2.17.5 for interface requirements.

~~9.2.16.4~~ 9.2.16.1.4 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 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.

~~9.2.16.5~~ 9.2.16.1.5 Instrumentation Application

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

TSW system pump status is indicated in the main control room.

TSW system trip is alarmed and the automatic startup of the standby pump is annunciated in the main control room.

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

(E) →

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(E) → 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. Sections 9.2.16.2.1 through 9.2.16.2.5 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.

9.2.16.2.1 Design Bases

The site dependent portions of the TSW system shall meet all requirements in Sections 9.2.16.1.1 through 9.2.16.1.5 and all 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.

9.2.16.2.1.1 Safety Design Bases (Interface Requirements)

There are none.

9.2.16.2.1.2 Power Generation Design Bases (Interface Requirements)

The 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

9.2.16.2.2 System Description

9.2.16.2.2.1 General Description (Conceptual Design)

Piping and valves in the TSW system are carbon or low alloy steel and are protected from interior and exterior corrosion with suitable corrosion resistant material as required by site specific soil and water conditions.

9.2.16.2.2.2 Component Description (Conceptual Design)

Two 100 % capacity duplex strainers are provided (one for each TSW pump). Each half of the duplex strainer is designed for the design flow of one TSW pump. Only one half of each duplex strainer is in operation when its associated pump is in operation. The duplex strainers are motor operated and automatically switch from the half in service to at the clean half of the duplex strainer on detection of high differential pressure. Debris collected in the strainer is automatically sluiced to a disposal collection area.

9.2.16.2.3 Safety Evaluation (Interface Requirements)

The 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.

9.2.16.2.4 Tests and Inspections (Interface Requirements)

There are none.

9.2.16.2.5 Instrumentation Application (Interface Requirements)

There are none.

TABLE 9.2-6

HVAC NORMAL COOLING WATER SYSTEM COMPONENT DESCRIPTION

HNCW Chillers

Type	Centrifugal hermetic
Quantity	5 (including one standby unit)
Cooling Capacity	8.93 x 10^6 BTU/h each
Chilled water flow per unit	~~1,695~~ 1,980 g/m
Supply temperature	44.6°F
Condenser water flow per unit	~~1,673~~ 1,840 g/m
Supply temperature	95°F
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 (gpm) each	~~1,695~~ 1,980
Total discharge head	71 psi

TABLE 9.2-7

HVAC NORMAL COOLING WATER LOADS

Name of Area or Unit	During Normal Operation		During Refueling Shutdown	
	Capacity BTU/h x 10^{-6}	Flow gpm	Capacity BTU/h x 10^{-6}	Flow gpm
Reactor Building				
Drywell Coolers (2 of 3)	0.92	306	0.75	306
RIP Coolers	1.66	92	2.90	459
Others (Note 1)	10.40	577	17.69	2,801
Turbine Building (Note 2)	~~1.77~~ 2.14	~~151~~ 192	1.08	172
Radwaste Building (Note 4)	5.42	358	6.45	1,023
Service Building	3.47	770	3.47	770
Others (Note 5)	4.37	633	3.38	633
Total	~~28.0~~ 29.4	~~2,887~~ 2,928	35.7 (Note 6)	6,164

NOTES:

(1) Loads include reactor/turbine building supply units.

~~*(2) Load is 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 8.93 x 10^6 BTU/h each and the pumps ~~1,695~~ 1,980 gpm each. Thus, four HNCW pumps have total capacity in excess of the amount required as shown in the last column of the table

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

Table 9.2-13

REACTOR SERVICE WATER SYSTEM

RSW Pumps (Two per division)	
Discharge Flow Rate, per pump	7,920 gpm
Pump Total Head	50 psi
Design Pressure	115 psi
Design Temperature	122° F
RSW Piping and Valves	
Design Pressure	155 psi
Design Temperature	122° F

Table 9.2-17

TURBINE SERVICE WATER SYSTEM

(Out of Scope)

TSW Pumps (Three 50 % pumps)	
Discharge Flow Rate	15,000 gpm per pump
Pump Total Head	28 psig
Design Pressure	85 psig
Design Temperature	104°F
TSW Piping and Valves	
Design Pressure	85 psig
Design Temperature	104°F

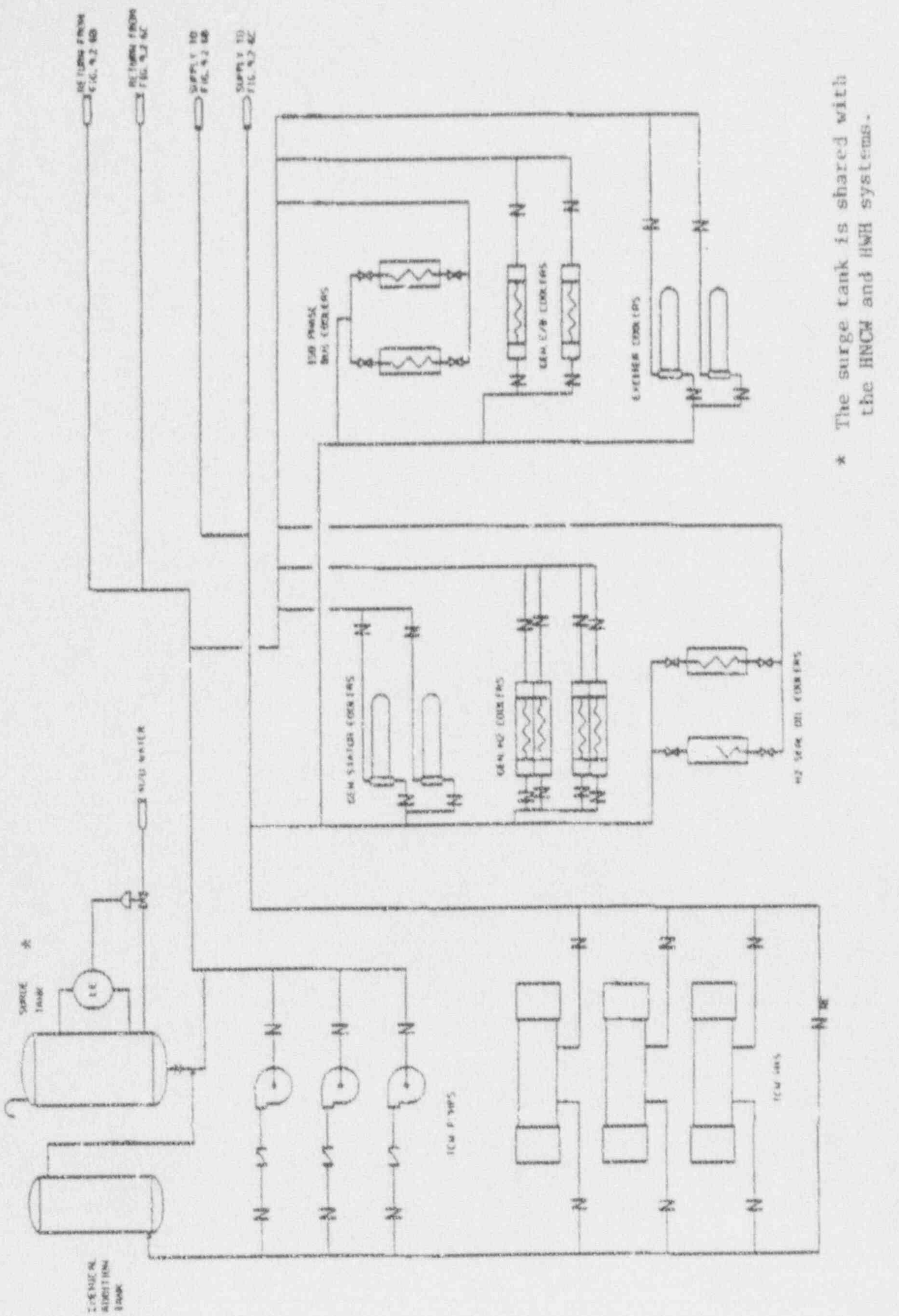

Figure 9.2-6a TURBINE COOLING WATER SYSTEM DIAGRAM

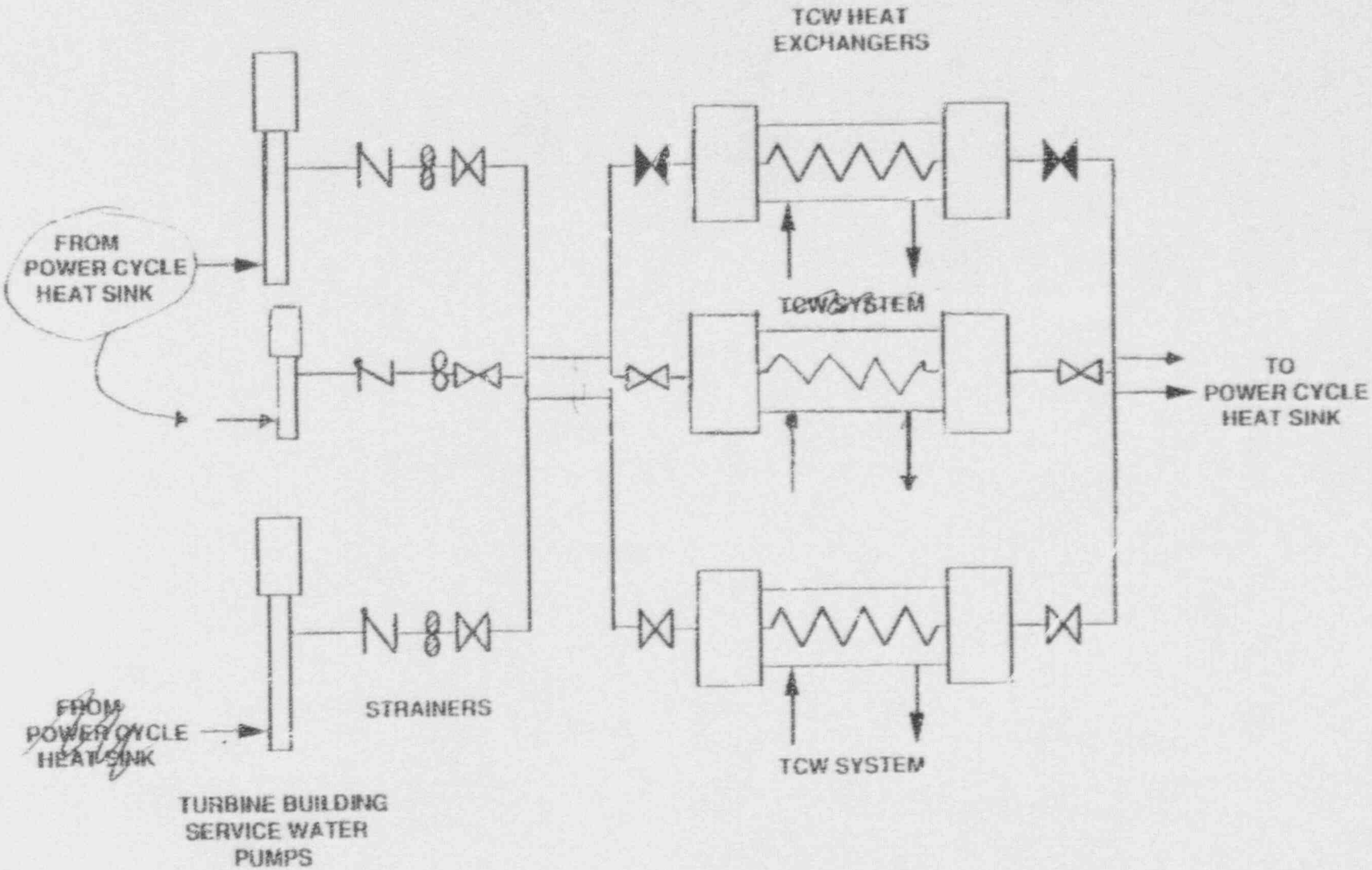

Figure 9.2-8 TURBINE SERVICE WATER SYSTEM