5.4 Components and Subsystem Design

The information in this section of the reference ABWR DCD, including all subsections, tables and figures, is incorporated by reference with the following departures and supplements.

STD DEP T1 2.4-1

STD DEP T1 2.4-3 (Table 5.4-2)

STD DEP T1 2.14-1

STD DEP 5B-1 (Table 5.4-4)

STD DEP 5.4-1 (Table 5.4-6)

STD DEP Admin (Table 5.4-3)

5.4.6.2.1.3 Interlocks

STD DEP T1 2.4-3

GE Licensing Topical Report (LTR) NEDE-33299P, titled “Advanced Boiling Water Reactor (ABWR) With Alternate RCIC Turbine-Pump Design,” addresses the deletion of valve F045 in Appendix C. Pages C-25 and C-26 of the LTR are incorporated by reference.

5.4.6.2.2.1 Design Conditions

STD DEP T1 2.4-3

LTR NEDE-33299P addresses the operating parameters for the components of the RCIC system in Appendix C. Page C-26 of this LTR is incorporated by reference.

5.4.6.2.5.2 Emergency Mode (Transient Events and LOCA Events)

STD DEP T1 2.4-3

LTR NEDE-33299P addresses the deletion of valve F045 for RCIC System startup in Appendix C. Page C-27 of this LTR is incorporated by reference.

5.4.7.1 Design Basis

STD DEP T1 2.4-1

Connections are provided to the upper pools on ~~two~~three *loops to return shutdown cooling flow to the upper pools during normal refueling activities if necessary. These connections also allow the RHR System to provide additional fuel pool cooling capacity as required by the Fuel Pool Cooling System during the initial stages of the refueling outage.*

5.4.7.1.1.8 Fuel Pool Cooling

STD DEP T1 2.4-1

~~*Two*~~ Three *of the RHR loops* can *provide supplemental fuel pool cooling during normal refueling activities and any time the fuel pool heat load exceeds the cooling capacity of the fuel pool heat exchangers. For normal refueling activities where the reactor well is flooded and the fuel pool gates are open, water is drawn from the reactor shutdown suction lines, pumped through the RHR heat exchangers and discharged through the reactor well distribution spargers. For 100% core removal, if necessary, water is drawn from the Fuel Pool Cooling (FPC) System skimmer surge tanks, pumped through the RHR heat exchangers and returned to the fuel via the FPC System cooling lines. These operations are initiated and shut down by operator action.*

5.4.7.2.2 Equipment and Component Description

STD DEP 5B-1

(2) Heat Exchangers

(c) Safe Shutdown—The RHR System brings the reactor to a cold shutdown condition of less than 100°C within 36 hours of control rod insertion with two out of the three divisions in operation. The RHR System is manually activated into the shutdown cooling mode below a nominal vessel pressure of 0.93 MPaG.

The RHR heat exchanger capacity is required to be sufficient to meet each of these functional requirements. The limiting function for the RHR heat exchanger capacity is reactor shutdown. ~~*post-LOCA containment cooling.*~~ *The heat exchanger capacity, K, is* 4.27×10^{5} W/°C ~~*370.5kJ/°C-s*~~ *per heat exchanger.*

The performance characteristics of the heat exchangers are shown in Table 5.4-4.

5.4.7.2.6 Manual Action

STD DEP T1 2.4-1

(6) Fuel Pool Cooling

Three~~*Two*~~ *of the RHR loops* can *provide supplemental fuel pool cooling during normal refueling activities and any time the fuel pool heat load exceeds the cooling capacity of the fuel pool heat exchangers. For normal refueling activities where the reactor well is flooded and the fuel pool gates are open, water is drawn from the reactor shutdown suction lines, pumped through the RHR heat exchangers and discharged through the reactor well distribution spargers. For 100% core removal, if necessary, water is drawn from the Fuel Pool Cooling (FPC) System skimmer surge tanks, pumped through the RHR heat exchangers and returned to the fuel pool via the FPC System cooling lines. These operations are initiated and shut down by operator action.*

5.4.8.2 System Description

STD DEP 5.4-1

The total capacity of the system, as shown on the process flow diagram in Figure 5.4-13, is equivalent to 2% of rated feedwater flow. ~~*Each pump, NRHX, and F/D is capable of 50% system capacity operation, with the one RHX capable of 100% system capacity operation.*~~ Each pump and F/D is capable of 100% system capacity operation. Each of two NRHX is capable of 50% system capacity operation, with the one RHX capable of 100% system capacity operation.

5.4.15 COL License Information

5.4.15.1 Testing of Main Steam Isolation Valves

The following site-specific supplement addresses COL License Information Item 5.7.

Testing of the Main Steam Isolation valves under operating conditions will be performed during the Initial Test Program as described in Subsections 14.2.12.2.26 and 14.2.12.2.34. ITAAC 6 from Table 2.1.2, Nuclear Boiler System, will ensure the MSIVs meet their design basis.

5.4.15.2 Analysis of Non-Design Basis Loss of AC Coping Capability

The following site-specific supplements listed in this section address COL License Information Item 5.8.

5.4.15.2.1 Analysis to Demonstrate the Facility has 8 Hour Non-Design SBO Capability

The capability of the RCIC System to operate for 8 hours as discussed in Subsection 5.4.6 and NUREG-1503 will be demonstrated during the Initial Test Program as described in section 14.2.12.1.9. A best estimate analysis will be available for NRC review by the end of preoperational testing demonstrating that the RCIC system can function for 8 hours in an SBO event. This analysis will reflect Class 1E loadings based on expected plant and operator response during this event. Additionally, an evaluation of room temperature response during the transient will ensure that equipment remains within its qualification envelope. Similar evaluations have been satisfactorily performed on other ABWRs. (COM 5.4-1)

5.4.15.2.2 Analysis to Demonstrate that the DC Batteries and SRV/ADS Pneumatics have Sufficient Capacity

A best estimate analysis demonstrating adequate DC battery and pneumatic supply capacity based on the as purchased equipment configuration will be completed and available for NRC review prior to the commencement of the Preoperational Test Program. This analysis will reflect Class 1E bus loadings based on expected plant response during the 8-hour SBO event. Additionally, an evaluation of room temperature response will ensure that the batteries remain within their qualification envelope. Similar evaluations have been satisfactorily performed on other ABWRs. (COM 5.4-2)

5.4.15.3 ACIWA Flow Reduction

The following site-specific supplement addresses COL License Information Item 5.9.

A hydraulic analysis will be performed to determine if a flow reduction device is needed based on the actual flow rate capacities, pressure, and hose size of the diesel driven pump. This analysis will be available for NRC review prior to the commencement of the Preoperational Test Program. (COM 5.4-3)

5.4.15.4 RIP Installation and Verification During Maintenance

The following site-specific supplement addresses COL License Information Item 5.10.

Procedures address RIP installation and verification for motor bottom cover, as well as visual monitoring of the potential leakage during impeller-shaft and plug removal. A contingency plan assures that core and spent fuel cooling can be provided in the event of loss of coolant during Reactor Internal Pump (RIP) maintenance.

Table 5.4-2 Design Parameters for RCIC System Components

Changes are shown for this table in Appendix C of LTR NEDE-33299P. Pages C-28, C-29 and C-30 of this LTR are incorporated by reference.

Table 5.4-3 RHR Pump/Valve Logic

Valve Number	Valve Function	Normal Position	Automatic Logic or Permissives		
			Condition	Automatic Action	
F017 B,C	Drywell Spray Valves	Closed	Note ~~D~~ **K**	Close	Permissive: To open requires high drywell pressure and F005 fully closed, or to open for test requires F018 fully closed.
F018 B,C	Drywell Spray Isolation Valves	Closed	Note ~~H~~ **K**	Close	Permissive: To open requires high drywell pressure and F005 fully closed, or to open fully requires F017 fully closed.
F019 B,C	Wetwell Spray Isolation Valves	Closed	Note ~~A~~ **K**	Close	Permissive: To open requires F012 fully closed and either the absence of LOCA or F005 fully closed.
C002	N/A	Run	Note ~~A~~ **L**	Stop	

NOTES:

G. High suppression pool temperature. **(when activated by suppression pool cooling mode)**

H. ~~*LOCA condition as indicated by a not fully closed injection valve F005.*~~ ***Not used.***

J. ~~*High loop flow signal.*~~ **Normal loop flow signal.**

K. F005 open will cause this valve to close.

L. Main RHR pump running.

Table 5.4-4 RHR Heat Exchanger Design and Performance Data

Design Point Function	~~*Post-LOCA Containment*~~ **Reactor Shutdown**

Table 5.4-6 Reactor Water Cleanup System Equipment Design Data

Pumps		
System Flow Rate (kg/h)	152,500	
Type	Vertical Sealless centrifugal pump	
Number Required	2 **(One Pump is required running at 100% capacity)**	
Capacity (% of CUW System flow each)	~~50~~ **100**	
Design Temperature (°C)	66	
Design pressure (MPaG)	~~10.20~~ **10.65**	
Discharge head at shutoff (m)	~~160~~ **182**	
Heat Exchangers	Regenerative	Nonregenerative
Number Required	1 (3 shells per unit)	2 (2 shells per unit)
Capacity (% CUW System flow each)	100	50
Shell design pressure (MPaG)	~~10.20~~ **10.65**	~~1.37~~ **1.4**
Shell design temperature (°C)	302	85
Tube design pressure (MPaG)	~~8.83~~ **8.865**	~~8.83~~ **8.865**
Tube design temperature (°C)	302	302
Type	Horizontal U-tube	Horizontal U-tube
Exchange Capacity (kJ/h) (per unit)	~~1.15×10^8~~ **1.269×10^8**	~~2.01×10^7~~ **2.342×10^7**
Filter-Demineralizers		
Type	pressure precoat	
Number Required	2 **(One F/D train is required running at 100% capacity)**	
Capacity (% of CUW System flow each)	~~50~~ **100**	
Flow rate per unit (kg/h)	~~76,250~~ **152,500**	
Design Temperature (°C)	66	
Design pressure (MPaG)	~~10.20~~ **10.65**	
Linear velocity (m/h)	~~~2.5~~ **~5.0**	
Differential Pressures (MPa)		
Clean	0.034	
Annunciate	0.17	
Backwash	0.21	
Containment Isolation Valves		
Closing time (s)	<30	
Maximum differential pressure (MPa)	8.62	

Figure 5.4-8 Reactor Core Isolation Cooling System P & ID (Sheet 1, 2, and 3)

STD DEP T1 2.4-3

LTR NEDE-33299P addresses the change from a separate pump and turbine to an integrated pump and turbine design in Appendix C. Page C-23 of this LTR is incorporated in these figures in Chapter 21.

Figure 5.4-9 Reactor Core Isolation Cooling System PFD (Sheet 1 & 2)

STD DEP T1 2.4-3

LTR NEDE-33299P addresses the change from a separate pump and turbine to an integrated pump and turbine design in Appendix C. Page C-24 of this LTR is incorporated in these figures in Chapter 21.

Figure 5.4-10 Residual Heat Removal System P&ID (Sheet 1, 4 and 6)

STD DEP T1 2.14-1

LTR NEDE-33330P, titled “Advanced Boiling Water Reactor (ABWR) Hydrogen Recombiner Requirements Elimination” addresses the deletion of Hydrogen Recombiner Flammability Control System in Appendix C. Page C-24 and C-25 of this are incorporated in these figures in Chapter 21.

Figure 5.4-10 Residual Heat Removal System P&ID (Sheet 2 and 3)

STD DEP T1 2.4-1

The capability to use RHR division A in the Fuel Pool Cooling Assist Mode is incorporated in these figures in Chapter 21.

Figure 5.4-11 Residual Heat Removal System PFD (Sheet 1)

STD DEP T1 2.4-1 and STD DEP 5B-1

The capability to use RHR division A in the Fuel Pool Cooling Assist Mode and increase in Heat Exchanger K value are incorporated in this figure in Chapter 21.

Figure 5.4-11 Residual Heat Removal System PFD (Sheet 2)

STD DEP T1 2.4-1

The capability to use RHR division A in the Fuel Pool Cooling Assist Mode is incorporated in this figure in Chapter 21.