Chapter 10 Steam and Power Conversion System

10.1 Summary Description

This section of the referenced DCD is incorporated by reference with no departures and/or supplements.

10.2 Turbine Generator

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

10.2.3.4 **Turbine Design**

Add the following at the beginning of this section.

STD SUP 10.2-1

The General Electric Company manufactures the turbine and generator. The model N3R-6F52 turbine is from General Electric's N series nuclear steam turbines.

10.2.3.6 **Inservice Maintenance and Inspection of Turbine Rotors**

Replace the last paragraph with the following.

STD COL 10.2-1-A

The turbine maintenance and inspection program that supports the Original Equipment Manufacturer's turbine missile generation probability calculation is described in DCD Sections 10.2.2.7, 10.2.3.5, 10.2.3.6, and 10.2.3.7. The associated turbine maintenance and inspection frequencies are established in the bounding missile probability analysis in GE-ST, "ESBWR Steam Turbine - Low Pressure Rotor Missile Generator Probability Analysis," ST-56834/P, Revision 1, submitted in Reference 10.2-201.

10.2.3.8 **Turbine Missile Probability Analysis**

Replace the last paragraph with the following.

STD COL 10.2-2-A

The probability of turbine missile generation has been calculated based on bounding material property values in GE-ST, "ESBWR Steam Turbine - Low Pressure Rotor Missile Generator Probability Analysis," ST-56834/P, Revision 1, submitted in Reference 10.2-201.

10.2.5 COL Information

10.2-1-A Turbine Maintenance and Inspection Program

STD COL 10.2-1-A This COL item is addressed in Subsection 10.2.3.6

10.2-2-A Turbine Missile Probability Analysis

STD COL 10.2-2-A This COL item is addressed in Subsection 10.2.3.8.

10.2.6 References

10.2-201 GEH Letter, MFN 09-484, "Transmittal of GE-Energy Steam Turbines (GE-ST) "ESBWR Steam Turbine - Low Pressure Rotor Missile Generation Probability Analysis" ST-56834/P and ST-56834/N-P, Revision 1," dated July 28, 2009

10.3 Turbine Main Steam System

This section of the referenced DCD is incorporated by reference with no departures or supplements.

10.4 Other Features of Steam and Power Conversion System

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

10.4.5.2.1 General Description

Replace the text with the following.

EF3 CDI The CIRC is depicted in Figure 10.4-201 and Figure 10.4-202. The CIRC consists of the following components:

- Condenser water boxes, piping, and valves
- Condenser tube cleaning equipment
- Water box drain subsystem
- Four 25 percent capacity pumps and pump discharge valves
- A removable assembly of coarse and fine screens that separate the pump forebay (suction) from the cooling tower basin
- One hyperbolic natural draft cooling tower (NDCT)

Table 10.4-3R includes the temperature range of the water delivered by the CIRC pumps to the main condenser.

The CIRC water is normally circulated by four motor-driven pumps through the condenser and back to the cooling tower. Depending on ambient conditions, system configuration, and heat load, one CIRC pump may be taken out of operation with the flow of the remaining three CIRC pumps providing sufficient water for condenser heat removal.

The four pumps are arranged in parallel. Discharge lines combine into two parallel main circulating water supply lines to the main condenser. Each main circulating water supply line connects to a low pressure condenser inlet water box.

Two interconnecting lines are provided between the two main circulating water supply lines. The first interconnecting line is located near the discharge of the circulating water pumps and is used for flow balancing. The second interconnecting line is located between the first interconnecting line and the Turbine Building and functions as a flow path for both blowdown water and return water to the Plant Service Water System. Two motor operated valves are located on the blowdown cross-connect line, one on either side of the blowdown line. These valves allow operation of the CIRC with one main circulating water supply line out of service.

The discharge of each pump is fitted with a remotely operated valve. This arrangement permits isolation and maintenance of any one pump while the others remain in operation and minimizes the backward flow through an out-of-service pump.

The CIRC and condenser are designed to permit isolation of half of the three series connected tube bundles to permit repair of leaks and cleaning of water boxes while operating at reduced power.

The CIRC includes water box vents to help fill the condenser water boxes during startup and remove accumulated air and other gases from the water boxes during normal operation.

The CIRC system incorporates design provisions that minimize the effect of hydraulic transients upon the functional capability and the integrity of the system components. These design features include slow-stroke motor-operated valves (MOVs), air release valves to fill and keep the system full, vacuum release valves that minimize pressure transients, valve control and interlock features that ensure correct valve line-up prior to pump start, and discharge isolation valves that open and close with pump start and stop signals.

Circulating water chemistry is maintained by the circulating water chemical feed system and with blowdown. Circulating water chemical injection equipment injects the required chemicals into the Station Water System, the cooling tower basin before entering the CIRC pumps or the CIRC before the condenser.

10.4.5.2.2 Component Description

Replace the last paragraph with the following.

EF3 CDI

Table 10.4-3R provides reference parameters for the major components of the CIRC.

10.4.5.2.2.1 CIRC Chemical Injection

Circulating water chemistry is maintained by the circulating water chemical feed system. Circulating water chemical injection equipment injects the required chemicals into the Station Water System, the cooling tower basin before entering the CIRC pumps or the CIRC before the condenser.

Chemical injection maintains a non-corrosive, non-scale-forming condition and limits the biological film formation that reduces the heat transfer rate in the condenser and cooling tower fill.

Plant chemistry specifies the required chemicals used within the system. The chemicals can be divided into five categories based upon function: biocide, algaecide, pH adjuster, corrosion inhibitor, and scale inhibitor. The pH adjuster, corrosion inhibitor, and scale inhibitor are metered into the system continuously or as required to maintain proper concentrations. Biocide application frequency may vary with seasons. Algaecide is applied, as necessary, to control algae formation in the cooling tower. Chemicals that are injected in the CIRC include sodium hypochlorite, sulfuric acid, zinc chloride, and dispersants.

Circulating water chemistry is also controlled as required with blowdown.

Chemicals selected are compatible with selected materials or components used in the CIRC.

10.4.5.2.3 **System Operation**

Add the following at the end of this section.

EF3 CDI

The four circulating water pumps take suction from the circulating water pump pit and circulate the water through the main condenser. Circulating water returns through the condenser discharge to the cooling tower. The operating configuration of the cooling tower and CIRC is modified depending on desired configuration, heat load, and ambient conditions. The discharge is routed such that a small portion of the total flow can be directed to the traveling screens to prevent the formation of ice.

During normal operation, the NDCT distributes circulating water through nozzles in the cooling tower distribution headers. The water then falls through fill material to the basin beneath the tower and, in the process, rejects heat to the atmosphere. Circulating water flow may also be returned directly to the NDCT basin.

The SWS supplies makeup water to the NDCT basin to replace water losses due to evaporation, drift, and blowdown. Blowdown from the CIRC is taken from the second interconnecting line located between the first interconnecting line and the Turbine building, and is discharged to the plant outfall.

A condenser tube cleaning subsystem cleans the circulating water side of the main condenser tubes.

Leakage of condensate from the main condenser into the CIRC via a condenser tube leak is not likely during power operation, since the CIRC normally operates at a greater pressure than the shell (condensate) side of the condenser. Analysis of routine CIRC cooling tower grab samples will detect events that could lead to unmonitored, uncontrolled radioactive releases to the environment. This provides the action required by NRC Inspection and Enforcement Bulletin No. 80-10.

10.4.5.5 **Instrumentation Applications**

Insert the following between the fourth and fifth paragraphs.

EF3 CDI

Level instrumentation provided in the circulating water pump pit controls makeup flow from the SWS to the NDCT basin. Level instrumentation in the pump pit initiates alarms in the main control room on abnormally low or high water level.

Pressure indication is provided on the circulating water pump discharge. Differential pressure instrumentation is provided across the inlet and outlet to the condenser and is used to determine the frequency of operating the condenser tube cleaning system.

Local grab samples are used to periodically test the circulating water quality.

Replace the last paragraph with the following.

The temperature in each condenser cooling water supply line is indicated in the MCR. Based on these indications, warm water recirculation is controlled to maintain a minimum inlet temperature of approximately 0°C (32°F).

10.4.5.6 Flood Protection

Add the following to the end of this section.

EF3 CDI

Failure of a pipe or other component in the CIRC, including the NDCT cooling tower basin, in the yard would not have an adverse impact on the intended design functions of safety related SSCs.

The NDCT is located at an elevation lower than the power block structures. The relative location of the NDCT with respect to the power block structures is shown on Figure 2.1-204. As discussed in Subsection 2.5.5.1.1, grade elevation at the power block area where the Category I structures are located is approximately 179.6 m (589.3 ft) NAVD 88; which is raised to more than seven feet above the current elevation in this area of the site. Figure 2.4-215 shows the extent of the area that is raised. Comparing Figure 2.4-215 with Figure 2.1-204 shows that the NDCT is not in the area that is being raised. Thus, the NDCT is located lower than the power block structures. Therefore, failure of a pipe or component in the CIRC, including the NDCT basin, would not adversely impact the intended design functions of safety related SSCs.

10.4.5.8 Normal Power Heat Sink

Replace the text with the following.

EF3 CDI

The cooling tower arrangement includes a single natural draft cooling tower. The NDCT supports a maximum cold water temperature of 35.6°C (96°F) for 100% turbine bypass capacity.

The NDCT design flow rate is 164,545 m^3/hr (724,000 gpm), including Plant Service Water System supply. The operating flow rate varies depending on ambient conditions and heat load.

The NDCT is located at least a distance equal to its height away from any seismic Category 1 or 2 structures. Thus, if there were any structural failure of the cooling tower, no seismic Category 1 or 2 structures or any safety-related systems or components would be affected or damaged. The NDCT is made of non-combustible material.

10.4.6.3 Evaluation

Replace the second sentence in the third paragraph with the following.

STD COL 10.4-1-A

A table summarizing the manufacturer's recommended threshold values of key chemistry parameters and associated operator actions is provided as Table 10.4-201.

10.4.10 COL Information

10.4-1-A Leakage (of Circulating Water Into the Condenser)

STD COL 10.4-1-A

This COL Item is addressed in Subsection 10.4.6.3

Table 10.4-201 Recommended Water Quality and Action Levels [STD COL 10.4-1-A]

Reactor Water Quality-Power Operation

Control Parameter	Action Levels 0	1	2	3
Conductivity, μS/cm at 25°C*	≤ 0.100	> 0.300	> 1	≥ 2
Chloride, ppb	≤ 0.3	> 5	> 50	≥ 200
Silica, ppb	≤ 200	> 500	N/A	N/A
Sulfate, ppb	≤ 2	> 5	> 50	≥ 200

Feedwater Quality – Power Operation***

Control Parameter	Action Levels 0	1	2
Conductivity, μS/cm at 25°C**	< 0.057	> 0.065	> 0.100
Dissolved Oxygen, ppb as O_2**	30-50	< 20 or > 200	N/A

* Value depends on Hydrogen Water Chemistry System Operation

** Applicable when Reactor Power >10%

*** Also Condensate Purification System Effluent

Action Level 0: Target Value. The parameter may be outside the Action Level 0 value and not in Action Level 1, 2, or 3. In this case, efforts should be made to return the parameter to the Action Level 0 value.

Action Level 1: Lowest Severity. The parameter should be brought below this value within 96 hours. A technical review should be performed to determine the appropriate response.

Action Level 2: Moderate Severity. If the parameter is not reduced below this level within 24 hours, an orderly shutdown should be initiated.

Action Level 3: Highest Severity. If the parameter is not reduced below this level within 6 hours, an orderly shutdown should be initiated.

Table 10.4-3R Circulating Water System [EF3 CDI]

Parameter	Value
Circulating Water Pumps	
Number of pumps	4
Pump Type	Vertical, wet pit
Unit flow capacity**, m^3/hr (gpm)	Approx. 42,000 (185,000)
Driver Type	Electric motor
Ball Cleaning System	
Ball recirculation pump	2 (one for each condenser train)
Ball discharge pump	2 (one for each condenser train)
Chemical injection pumps	Various metering pumps
System design pressure MPa (psi)	0.448 (65)
Natural Draft Cooling Tower	
Number of towers	1
Basin diameter* m (ft)	140 (460)
Height*, m (ft)	180 (600)
Operating Temperatures	
Temperature range of water delivered to the main condenser, °C (°F)	0*** to 37.8 (32 to 100)
CIRC temperature for rated turbine performance, °C (°F)	30 (86)
Maximum CIRC temperature to accommodate the bypass flow resulting from a turbine trip, 100% load reject, or island mode, in conjunction with the power reduction resulting from SRI/SCRRI function, ºC (ºF).	35.6 (96)

*Cooling tower dimensions and specifications are approximate.

**This capacity is for condenser cooling requirements, Plant Service Water System requirements, and blowdown flow from the NPHS.

***If the Normal Power Heat Sink does not maintain temperatures above the minimum temperature, then the minimum temperature is maintained by warm water recirculation.

Figure 10.4-201 CIRC Natural Cooling Tower and Pump

[EF3 CDI]

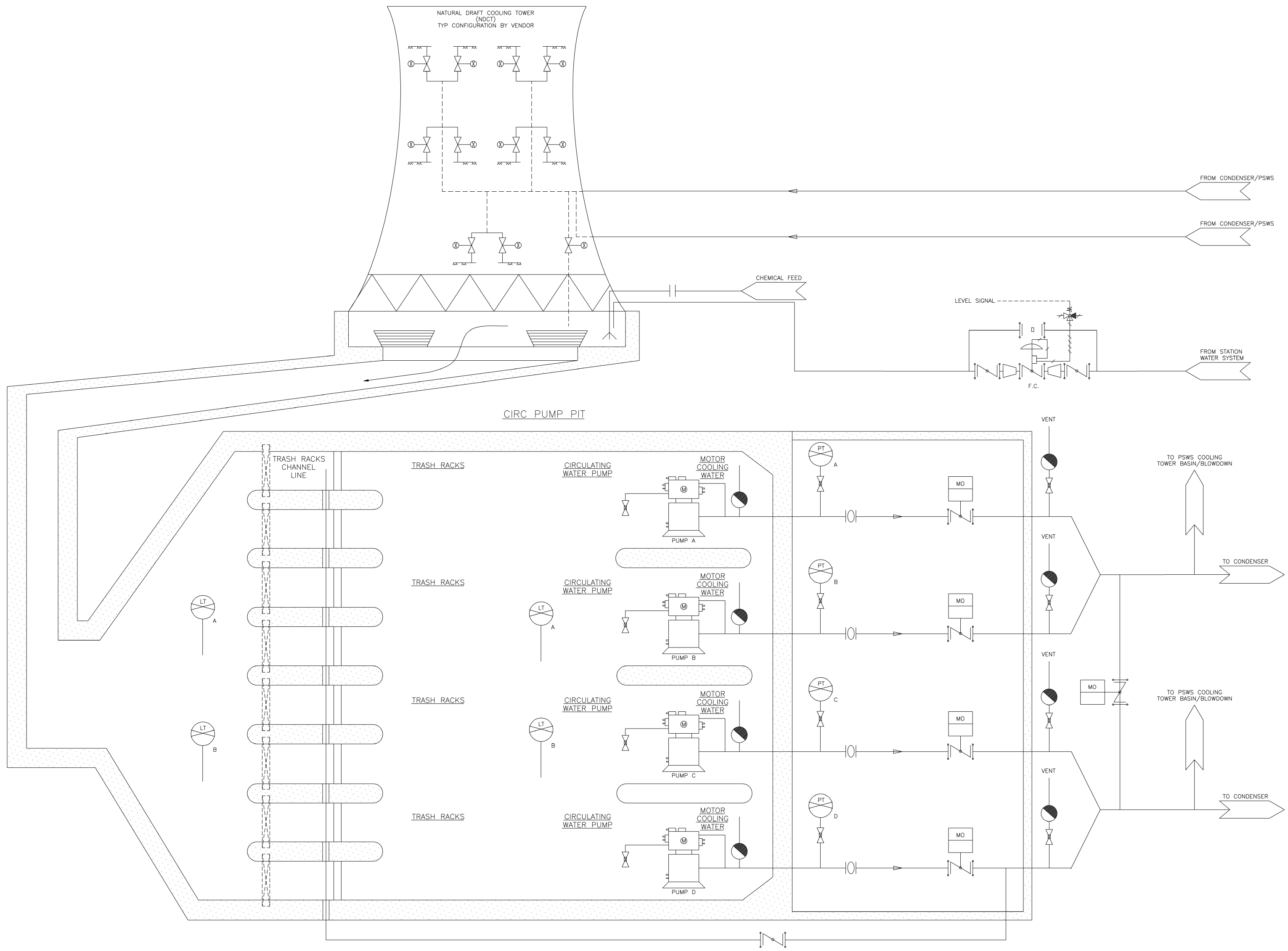

Figure 10.4-202 Condenser and Ball Cleaning System

[EF3 CDI]