10.0 STEAM AND POWER CONVERSION SYSTEM

This chapter introduces the principle design features, systems and components of the steam and power conversion system. The systems discussed in this chapter include the Turbine Generator System (TGS) used to convert the energy in steam from the nuclear steam supply system (NSSS) into electrical energy; the Main Steam Supply System used to transport steam from the NSSS to the power conversion system and various safety-related and non-safety-related auxiliaries; and other features of the Steam and Power Conversion System.

10.1 Summary Description

Section 10.1 of the North Anna 3 combined license (COL) Final Safety Analysis Report (FSAR) incorporates by reference, without any departures or supplements, Section 10.1, "Summary Description," of the Economic Simplified Boiling–Water Reactor (ESBWR) design control document (DCD), Revision 5. The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the application and considered the referenced DCD. The staff's review confirmed that there is no outstanding information, outside of the DCD, related to this section.

The staff is reviewing the information in DCD Section 10.1 on Docket No. 52-010. The results of the staff's technical evaluation of the information related to "Summary Description," incorporated by reference in the North Anna 3 COL FSAR, will be documented in the staff safety evaluation report (SER) on the design certification application (DCA) for the ESBWR. This SER is not yet complete and is being tracked as part of Open Item [1-1]. The staff will update Section 10.1 of this SER to reflect the final disposition of the DCA.

10.2 Turbine Generator (Including Turbine Rotor Integrity)

10.2.1 Introduction

This section describes the TGS. This system is used to convert the energy in steam from the NSSS into electrical energy. This section describes TGS equipment design and design bases; potential impacts of and prevention/mitigation measures for the reactor coolant system and safety-related structures, systems, and components (SSCs); and programs to ensure turbine rotor integrity.

10.2.2 Summary of Application

Section 10.2 of the North Anna 3 COL FSAR incorporates by reference Section 10.2 of the ESBWR DCD, Revision 5.

In addition, in FSAR Section 10.2, the applicant provided the following:

COL Items

- STD COL 10.2-1-A Turbine Maintenance and Inspection Program
- STD COL 10.2-2-A Turbine Missile Probability Analysis

The applicant provided supplemental information to address COL Items 10.2-1-A and COL 10.2-2-A. The applicant stated that the probability of turbine missile generation will be calculated using bounding material properties. The analysis will be completed in the second quarter of 2009 and the FSAR will be revised to incorporate the maintenance and inspection frequencies as part of a subsequent FSAR update.

Supplemental Information

- STD SUP 10.2-1 Turbine Design

The applicant provided the model number and manufacturer of the TGS.

10.2.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the Final Safety Evaluation Report (FSER) related to the DCD.

In addition, the relevant requirements of Commission regulations and associated acceptance criteria for the review of this section are given in the Standard Review Plan (SRP) Section 10.2 of NUREG-0800.

10.2.4 Technical Evaluation

The NRC staff reviewed Section 10.2 of the North Anna 3 COL FSAR, including the corresponding sections in the referenced DCD. Specifically, the staff reviewed the sections of the DCD to ensure that the information is appropriate for incorporation by reference and that any supplemental information to be provided by the COL applicant has been addressed in the COL application. The staff's review confirmed that the information contained in the application and incorporated by reference addresses the relevant information related to the TGS. The staff is reviewing Section 10.2 of the ESBWR DCD on Docket No. 52-010. The staff's technical evaluation of the information incorporated by reference related to principal design features of the TGS will be documented in the corresponding SER.

The Staff reviewed the information contained in the COL FSAR:

COL Items

- STD COL 10.2-1- A Turbine Maintenance and Inspection Program
- STD COL 10.2-2-A Turbine Missile Probability Analysis

In FSAR Section 10.2.3.6, the applicant addressed COL Item 10.2-1-A, "Turbine Maintenance and Inspection Program," which states that the turbine maintenance and inspection frequencies program will be established upon completion of the bounding missile probability analysis. This analysis will be completed in the second quarter of 2009 and the FSAR will be revised to

incorporate the maintenance and inspection frequencies as part of a subsequent FSAR update. The completion of this activity is tracked as **Open Item 10.2-1**.

In FSAR Section 10.2.3.8, the applicant provided information to address COL Item 10.2-2-A, "Turbine Missile Probability Analysis," which states that the COL applicant will provide an evaluation of the main turbine missile generation analysis in accordance with NRC requirements. The applicant stated that the bounding analysis will be completed in the second quarter of 2009. The FSAR will be revised to reflect this analysis as part of a subsequent FSAR update. The completion of this activity is tracked as **Open Item 10.2-2**.

Supplemental Information

- STD SUP 10.2-1 Turbine Design

In FSAR Section 10.2.3.4, "Turbine Design," the applicant states that the General Electric Company will manufacture the turbine and generator for the North Anna 3. The Model N3R-6F52 turbine is selected by the applicant, which is one of the General Electric's N series nuclear steam turbines. NRC staff finds this selection acceptable, because General Electric nuclear steam turbines have provided many years of service in current operating nuclear power plants.

10.2.5 Post Combined License Activities

There are no post COL activities related to this section.

10.2.6 Conclusion

NRC staff reviewed the application, including the corresponding sections in the referenced DCD. Specifically, the staff reviewed the sections of the DCD to ensure that the information is appropriate for incorporation by reference and that any supplemental information to be provided by the COL applicant has been addressed in the COL application. The staff's review confirmed that the applicant has addressed the relevant information and no outstanding information is expected to be addressed in the COL FSAR related to this subsection.

NRC staff is reviewing the information in DCD Section 10.2 on Docket No. 52-010. The results of the staff's technical evaluation of the information related to "Turbine Generator Systems," incorporated by reference in the North Anna 3 COL FSAR, will be documented in the staff SER on the DCA for the ESBWR. This SER is not yet complete and is being tracked as part of Open Item [1-1]. The staff will update Section 10.2 of this SER to reflect the final disposition of the DCA.

In addition, NRC staff concludes that the information pertaining to North Anna 3 COL FSAR Section 10.2.3 is within the scope of the design certification and incorporates by reference ESBWR DCD, Section 10.2.3, "Turbine Integrity." As a result of Open Items 10.2-1 and 10.2-2, the staff is unable to finalize the conclusions on "Turbine Maintenance and Inspection Program" and "Turbine Missile Probability Analysis."

10.3 Turbine Main Steam Supply System

Section 10.3 of the North Anna Unit 3 COL FSAR incorporates by reference, without any departures or supplements, Section 10.3, "Turbine Main Steam Supply System," of the ESBWR DCD, Revision 5. Section 10.3 of the ESBWR DCD includes the Tier 1 and Tier 2 information.

NRC staff reviewed the application and considered the referenced DCD. The staff confirmed there is no outstanding information, outside of the DCD, related to this section.

The staff is reviewing the information in DCD Section 10.3 on Docket No. 52-010. The results of the staff's technical evaluation of the information related to "Turbine Main Stream Supply System," incorporated by reference in the North Anna 3 COL FSAR, will be documented in the staff SER on the DCA for the ESBWR. This SER is not yet complete and is being tracked as part of Open Item [1-1]. The staff will update Section 10.3 of this SER to reflect the final disposition of the DCA.

10.3.6 Steam and Feedwater System Materials

10.3.6.1 *Introduction*

This section addresses the applicant's flow accelerated corrosion (FAC) program related to steam and feedwater system materials.

10.3.6.2 *Summary of Application*

Section 10.3.6, "Steam and Feedwater System Materials," of the ESBWR DCD includes identification of the FAC program and states that the FAC program is discussed in Section 6.6.7, "Augmented Inservice Inspection." The North Anna Unit 3 FAC program is based on Section 6.6.7 of the ESBWR DCD. Section 6.6 of the North Anna 3 COL FSAR incorporates by reference, with no departures, Section 6.6 of the ESBWR DCD, Revision 5.

In addition, in FSAR Section 6.6, the applicant provided Section 6.6.7.1, "Flow Accelerated Corrosion Program Description." Section 6.6.7.1 describes general attributes of the applicant's program for monitoring and managing degradation (i.e., thinning) of piping and components susceptible to flow accelerated corrosion.

10.3.6.3 *Regulatory Basis*

10 CFR 50.55a provides the regulatory basis for the flow accelerated corrosion program as it pertains to meeting the requirements of ASME Code Section III for piping minimum wall thickness, and the guidelines in Generic Letter (GL) 89-08 as they pertain to establishing an erosion-corrosion monitoring program. SRP Section 10.3.6 discusses the need for a FAC program and identifies acceptance criteria.

10.3.6.4 *Technical Evaluation*

NRC staff reviewed Sections 6.6 and 10.3 of the North Anna 3 COL FSAR and considered the referenced DCD. The staff's review confirmed that the information contained in the application and incorporated by reference addresses the relevant information related to FAC. The staff is reviewing Sections 6.6 and 10.3 of the ESBWR DCD on Docket No. 52-010. The staff's technical evaluation of the information incorporated by reference related to steam and feedwater system materials will be documented in the corresponding SER.

The staff reviewed the information provided by the applicant in Section 6.6.7.1 of the COL FSAR, which describes the FAC program. FSAR Section 6.6.7.1 also refers to FSAR Section 13.4 for program implementation milestones. Therefore, the staff also reviewed the information provided in FSAR Table 13.4-201, "Operational Programs Required by NRC Regulations."

As part of the review, the staff requested in RAI 10.03.06-1 that the applicant discuss an implementation schedule for the detailed FAC program, (e.g., FAC program activities that will be conducted during the plant construction phase and the schedule for those activities). RAI 10.03.06-2 requested the applicant to confirm (1) that the FAC program will include pre-service thickness measurements of the as-built components considered susceptible to FAC, and (2) that these measurements will use the grid locations and measurement methods most likely to be used for inservice inspection (ISI) according to industry guidelines.

In a response dated July 14, 2008 (ML082050559), the applicant stated that the FAC program is considered an Operational Program under the ISI program listed in Table 13.4-201, "Operational Programs Required by NRC Regulations." The letter included a revised Table 13.4-201 that explicitly lists the FAC program under the ISI program in the FSAR with an implementation milestone of "prior to commercial service." The response also stated that during the construction phase, a comprehensive FAC susceptibility screening and preservice inspection of susceptible systems will be performed.

The applicant's response provided portions of a FAC program description the applicant had developed to address the requirement in ESBWR DCD Revision 5, under COL Item 6.6-1-A. The proposed description of the FAC program included a statement that the North Anna 3 FAC program will be based on EPRI NSAC 202-L, "Recommendations for an Effective Flow-Accelerated Corrosion Program." The response also stated that preservice, baseline, and non-destructive examinations will be performed on as-fabricated components in susceptible systems and that these preservice inspections will use grid locations and measurement methods most likely to be used for ISIs.

The changes proposed in the applicant's response addressed the staff concerns about the implementation activities and schedule by making the FAC program an explicit part of the operational programs. The proposed revision also addressed the staff concerns about preservice inspections by adding a description of the preservice inspection plan to the FSAR, including the affirmation that locations and measurement methods will be those most likely to be used in subsequent inspections. The staff reviewed the FAC program information provided in Section 6.6.7.1 of Revision 1 of the FSAR and confirmed that the FAC program is included in Chapter 13 as an operational program and that it addresses the concerns discussed above regarding preservice inspection requirements. Therefore, the staff finds the information on the FAC program acceptable.

10.3.6.5 *Post-Combined License Activities*

The staff will determine the specific set of commitments to be included as conditions to the license pertaining to the FAC program. Based on these commitments, the staff will identify any license conditions in a future SER.

10.3.6.6 *Conclusion*

NRC staff is reviewing the information in DCD Sections 6.6 and 10.3.6 on Docket No. 52-010. The results of the staff's technical evaluation of the information related to FAC, incorporated by reference in the North Anna 3 COL FSAR, will be documented in the staff SER on the DCA for the ESBWR. This SER is not yet complete and is being tracked as part of Open Item [1-1]. The staff will update Section 10.3 of this SER to reflect the final disposition of the DCA.

The staff concludes that the FAC program described in FSAR Section 6.6.7.1 is consistent with industry practices for addressing the concerns related to FAC and for monitoring the piping wall degradation caused by FAC during plant operations. The establishment of an FAC monitoring program adequately addresses the concerns identified in GL 89-08. The commitments proposed by the applicant will be identified as license conditions in a future SER.

10.4 Other Features of Steam and Power Conversion System

This section describes other features of the steam and power conversion system:

- The main condenser system (Section 10.4.1) functions as the steam cycle heat sink in receiving, condensing, and deaerating steam from the main turbine and other vents and drains in the steam cycle system.

- The main condenser evacuation system (Section 10.4.2) establishes and maintains the main steam condenser vacuum and removes noncondensable gases and air from the main condenser.

- The turbine gland seal system (Section 10.4.3) prevents air leakage into and steam out of the annulus space between the turbine and steam valve shafts.

- The turbine bypass system (Section 10.4.4) enables a system to allow some main steam flow directly to the main condensers, bypassing the turbine.

- The circulating water system (CWS) (Section 10.4.5) provides a continuous supply of cooling water to the main condenser.

- The condensate purification system (CPS) (Section 10.4.6) purifies the condensate and minimizes corrosion/erosion products in the power conversion cycle.

- The condensate and feedwater system (Section 10.4.7) supplies high-purity feedwater to the reactor at the required flow rate, pressure, and temperature.

10.4.1 Main Condenser

Section 10.4.1of the North Anna 3 COL FSAR, Revision 1, incorporates by reference, with no departures or supplements, Section 10.4.1, “Main Condenser,” of the ESBWR DCD, Revision 5. NRC staff reviewed the application and considered the referenced DCD. The staff’s review confirmed that there is no outstanding information, outside of the DCD, related to this subsection.

The staff is reviewing the information in DCD Section 10.4.1 on Docket No. 52- 010. The results of the staff’s technical evaluation of the information related to the “Main Condenser,” incorporated by reference in the North Anna 3 COL FSAR, will be documented in the staff SER on the DCA for the ESBWR. This SER is not yet complete and is being tracked as part of Open Item [1-1]. The staff will update Section 10.4.1 of this SER to reflect the final disposition of the DCA.

10.4.2 Main Condenser Evacuation System

Section 10.4.2 of the North Anna 3 COL FSAR, Revision 1, incorporates by reference, with no departures or supplements, Section 10.4.2, "Main Condenser Evacuation System," of the ESBWR DCD, Revision 5. The NRC staff reviewed the application and considered the referenced DCD. The staff's review confirmed that there is no outstanding information, outside of the DCD, related to this subsection.

The staff is reviewing the information in DCD Section 10.4.2 on Docket No. 52- 010. The results of the staff's technical evaluation of the information related to the "Main Condenser Evacuation System," incorporated by reference in the North Anna 3 COL FSAR, will be documented in the staff SER on the DCA for the ESBWR. This SER is not yet complete and is being tracked as part of Open Item [1-1]. The staff will update Section 10.4.2 of this SER to reflect the final disposition of the DCA.

10.4.3 Turbine Gland Seal System

Section 10.4.3 of the North Anna 3 COL FSAR, Revision 1, incorporates by reference, with no departures or supplements, Section 10.4.3, "Gland Seal Steam System," of the ESBWR DCD, Revision 5. The NRC staff reviewed the application and considered the referenced DCD. The staff's review confirmed that there is no outstanding information, outside of the DCD, related to this subsection.

The staff is reviewing the information in DCD Section 10.4.3 on Docket No. 52-010. The results of the staff's technical evaluation of the information related to the "Turbine Gland Seal System," incorporated by reference in the North Anna 3 COL FSAR, will be documented in the staff SER on the DCA for the ESBWR. This SER is not yet complete and is being tracked as part of Open Item [1-1]. The staff will update Section 10.4.3 of this SER to reflect the final disposition of the DCA.

10.4.4 Turbine Bypass System

Section 10.4.4 of the North Anna 3 COL FSAR, Revision 1, incorporates by reference, with no departures or supplements, Section 10.4.4, "Turbine Bypass System," of the ESBWR DCD, Revision 5. NRC staff reviewed the application and considered the referenced DCD. The staff's review confirmed that there is no outstanding information, outside of the DCD, related to this subsection.

The staff is reviewing the information in DCD Section 10.4.4 on Docket No. 52- 010. The results of the staff's technical evaluation of the information related to the "Turbine Bypass System," incorporated by reference in the North Anna 3 COL FSAR, will be documented in the staff SER on the DCA for the ESBWR. This SER is not yet complete and is being tracked as part of Open Item [1-1]. The staff will update Section 10.4.4 of this SER to reflect the final disposition of the DCA.

10.4.5 Circulating Water System

10.4.5.1 *Introduction*

The CWS provides cooling water for removal of the power cycle heat from the main condensers and transfers this heat to the Normal Power Heat Sink.

10.4.5.2 *Summary of Application*

Section 10.4.5 of the North Anna 3 COL FSAR, Revision 1, incorporates by reference Section 10.4.5, of the ESBWR DCD, Revision 5.

In addition, in FSAR, Section 10.4, the applicant provided the following:

Site-Specific Information Replacing Conceptual Design Information (CDI)

- NAPS CDI Circulating Water System

The applicant replaced the CDI provided in the DCD with a detailed description of the site-specific system for North Anna 3.

10.4.5.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference will be addressed in the FSER related to the DCD.

In addition, the relevant requirements of Commission regulations and associated acceptance criteria for the review of this section are given in SRP Section 10.4.5 of NUREG-0800.

10.4.5.4 *Technical Evaluation*

NRC staff reviewed Section 10.4.5 of the North Anna 3 COL FSAR and considered the referenced DCD. The staff's review confirmed that the information contained in the application and incorporated by reference addresses the relevant information related to this system. Section 10.4.5 of the ESBWR DCD is being reviewed by the staff on Docket No. 52-010. The staff's technical evaluation of the information incorporated by reference related to the other features of this system will be documented in the corresponding SER.

The staff reviewed the information contained in the COL FSAR:

Site-Specific Information Replacing CDI

- NAPS CDI Circulating Water System.

The staff reviewed the NAPS CDI related to the design description and operation of the CWS in FSAR Section 10.4.5. The staff's review is provided below.

- NAPS CDI FSAR Section 10.4.5.2.1, "General Description"

In FSAR Section 10.4.5.2.1, "General Description," the applicant described the CWS by replacing the CDI provided in the DCD with a more detailed general description of the site-specific system proposed for Unit 3. The applicant provided the design for the condenser water

boxes, piping, and valves; condenser tube cleaning equipment; water box drain subsystem; circulating water pumps; screens; and cooling towers. The system configuration for the CWS is depicted in FSAR Figures 10.4-201 through 10.4-203, which replaces the conceptual diagram in Figure 10.4-1 of the DCD.

NRC staff reviewed the design information provided in FSAR Section 10.4.5.2.1. The staff finds that the applicant has addressed the final configuration of the CWS as specified in Section 10.4.5.2.1, "General Description," of the ESBWR DCD, Revision 5. The CWS consists of four motor-driven pumps, each with the capability of pumping 25 percent of the water; a dry-cooling tower array; a hybrid-cooling tower; and associated piping, valves, and instrumentation. The CWS and the dry- and hybrid-cooling towers provide heat sink for waste heat exhausted from the main steam turbine. The four motor-driven pumps normally circulate the water through the condenser and back to the cooling towers. Depending on ambient conditions and heat load, one CWS pump may be taken out of operation with the flow of the remaining three pumps providing sufficient water for condenser heat removal. The four pumps are arranged in parallel and the discharge of each pump is fitted with a remotely operated valve. This arrangement permits the isolation and maintenance of any one pump while the other pumps remain in operation and minimizes the backward flow through a tripped pump. The staff finds that the system configuration and piping and valve arrangement of the CWS are in agreement with the conceptual design as recommended in ESBWR DCD, Revision 5, and is therefore acceptable.

Also, in FSAR Table 10.4-3R, "Circulating Water System," the applicant provides site-specific parameters to replace the values given in ESBWR DCD Table 10.4-3, "Circulating Water System." The staff finds that the operating temperatures and circulating water pump information given in Table 10.4-3R of the NAPS application are acceptable, because they are bounded by the values in the DCD.

Furthermore, the CWS design includes vents to help fill in and remove air and other gases from the condenser water-boxes during start-up and normal operations. The system includes design features such as slow-stroke, motor-operated valves; air- and vacuum-release valves; and control and interlock features that ensure proper valve lineup and open and close with pump startup and stop signals. These provisions will minimize pressure transients during start-up and normal operations of the system. NRC staff finds that these vents, air releases, and vacuum relief valve provisions in the CWS adequately address the requirements of General Design Criterion (GDC) 4, "Environmental and Dynamic Effects Design Bases," as it relates to the design features to accommodate the effects of discharging water and to prevent water hammer and subsequent CWS piping or component failures from occurring at pump startup from initial system depressurization.

- NAPS CDI FSAR Section 10.4.5.2.2, "Component Description"

In FSAR Section 10.4.5.2.2, "Component Description," the applicant provided information regarding industry codes and standards that are applicable to the CWS design. In FSAR Section 10.4.5.2.2, Revision 0, the applicant described that the codes and standards applicable to the CWS are in accordance with DCD Section 3.2, with the exception of large-bore piping (i.e., piping with a nominal diameter of 700 mm [27.6 in] and larger). The applicant further stated that the large-bore CWS piping is constructed using American Water Works Association (AWWA) standards and the system is designed and constructed in accordance with Quality Group D specifications. NRC staff, however, finds that Table 3.2-3 of the DCD specifies standard ASME B31.1 for quality group D piping. Also, RG 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear

Power Plants," recommends the ASME standards. In accordance with SRP (SRP) Section 10.4.5, Item III.1, design provisions are to be incorporated that minimize the effects of hydraulic transients on the functional capability and integrity of the components of the system. Therefore, in RAI 10.4.5-1, the staff requested the applicant to justify the above deviation from the DCD and its compliance with the applicable regulations. Also, the staff requested the applicant to explain and ensure that the failure of this large-bore piping will not affect the intended functions of the safety-related equipment and/or systems.

The applicant responded on August, 7, 2008, and stated that it is not necessary to take an exception to DCD Section 3.2, and FSAR Section 10.4.5.2.2 will be revised to delete this exception for large-bore piping. The staff confirmed that FSAR Revision 1 incorporates this change. ASME B31.1 states that AWWA standards are an acceptable means to comply with the code for large-bore piping. Because the applicant has proposed to meet AWWA standards for large-bore CWS piping, the staff agrees that the design and construction are consistent with DCD Section 3.2 and RG 1.26.

Furthermore, in FSAR, Revision 1, the applicant revised Section 10.4.5.2.1 and clarified that the CWS design incorporates provisions to minimize the effects of hydraulic transients on system functional capability and component integrity. Specifically, these provisions include design features such as a slow-stroke, motor-operated valves; air-release valves to fill and keep the system full; vacuum-release valves to minimize pressure transients; and valve control and interlock features. The staff agrees that these design features meet the guidance in SRP Section 10.4.5 relating to minimizing the effects of hydraulic transients on the CWS.

Also in response to RAI 10.4.5-1, the applicant stated that the portion of RAI 10.4.5-1 related to the impact of CWS large-bore piping failure is addressed in the applicant's response to RAI 10.4.5-2, which is discussed later in this report.

Based on the above discussion, the staff finds that the applicant's response to RAI 10.4.5-1 is acceptable, and the staff's concern is resolved.

FSAR Table 10.4-3R provides parameters for major components of the CWS. The staff reviewed these parameters and finds those values acceptable, because they are bounded by the conceptual design values depicted in ESBWR DCD Table 10.4-3.

- NAPS CDI FSAR Section 10.4.5.2.2.1, "CWS Chemical Injection"

FSAR Section 10.4.5.2.2.1 provides information about the chemical injection in the CWS that is not included in the DCD. The proposed chemical injection maintains a non-corrosive, non-scale forming condition within the CWS and ensures that biological film growth that may affect the cooling tower and condenser heat transfer rate does not occur. Circulating water chemistry is maintained by the Chemical Storage and Transfer System. Chemical feed equipment injects the required chemicals into the circulating water at the pump bay before water enters the circulating water pumps. 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 towers. 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 towers. Chemicals that are

injected in the CWS include sodium hypochlorite, acid, bromide, dispersants, and non-oxidizing biocides. Circulating water chemistry is also controlled as required with blowdown. Chemicals selected are compatible with selected materials or components used in the CWS.

The staff finds the chemical injection acceptable because the chemicals selected are compatible with the selected materials and components used in the CWS and the chemical injection maintains a non-corrosive, non-scale forming condition within the CWS that may affect the cooling tower and condenser heat transfer rate.

- NAPS CDI FSAR Section 10.4.5.2.3, "System Operation"

In FSAR Section 10.4.5.2.3, "System Operation," the applicant described the site-specific CWS operation. The applicant stated that blowdown flow from the CWS is discharged to the plant discharge canal at a maximum temperature of 37.8°C (100°F). The applicant stated that leakage from the main condenser into the CWS via a condenser tube leak is not likely during power operation, because the CWS normally operates at a greater pressure than the shell (condensate) side of the condenser, and therefore the staff finds the applicant's discussion of CWS operation acceptable.

- NAPS CDI FSAR Section 10.4.5.5, "Instrumentation Applications"

The applicant provided the following additional instrumentation: (1) level instrumentation in the circulating water pump fore bay where the CWS pumps take suction from and provide alarms in the main control room on abnormally low or high water levels, (2) pressure indications on the CWS pump discharge and differential pressure instrumentation across the inlet and outlet to the condenser to determine the frequency of operating the condenser tube cleaning system, and (3) local grab samples to periodically test the circulating water quality. The staff finds this addition of new instrumentation acceptable, because it enhances the design and operational capability of the CWS.

- NAPS CDI FSAR Section 10.4.5.6, "Flood Protection" and FSAR Section 10.4.5.8, "Normal Power Heat Sink"

In FSAR Section 10.4.5.8, "Normal Power Heat Sink," the applicant described the site-specific normal power heat sink. This site-specific design consists of the combined dry-cooling tower array and a hybrid wet/dry-cooling tower. The combination of dry- and hybrid-cooling tower arrangements supports a condenser-inlet maximum cold water temperature of 35°C (100°F). The station water system supplies makeup water to the CWS due to losses from evaporation and blowdown. The dry- and hybrid-cooling towers are both located at least a distance equal to their height away from seismic Category 1 and 2 structures. Therefore, there is no potential for the cooling towers to fall or damage safety-related structures or components. Both the dry- and the hybrid-cooling towers use fans whose failure could generate missiles. The applicant stated that site arrangement and cooling tower construction will prevent damage to any seismic Category 1 or 2 structures or to any safety-related SSCs from possible missiles generated by cooling tower mechanical fan failure. However, in Revision 0 of the FSAR, the applicant did not specifically address flooding considerations due to a hybrid-cooling tower failure in the application. Also, the applicant did not provide any information with respect to Section 10.4.5.6, "Flood Protection," of the DCD. In accordance with SRP Section 10.4.5, "Circulating Water System," Item II.1, design provisions need to be provided to accommodate the effects of discharging water that may result from a failure of a component or piping in the CWS.

Therefore, the staff requested the applicant in RAI 10.4.5-2 to provide additional information regarding the cooling tower failure analysis

The applicant responded on August, 7, 2008, and stated that a failure of a pipe or component in the hybrid-cooling tower or other CWS piping in the yard would not have an adverse impact on safety-related SSCs. The bounding piping failure for the hybrid-cooling tower is a failure of the two vertical large-bore CWS pipes that connect to the distribution header of the hybrid-cooling tower. In this failure scenario, due to site grading, water from the ruptured pipes will flow to the drainage ditch on the west side of the cooling tower area and away from the plant.

Failure of the hybrid-cooling tower basin will not lead to any discharge of water to the surface, because it is an in-ground structure. The maximum water level elevation in the basin is lower than the elevations of the surrounding areas. If surface discharge were to occur, the water would flow away from the plant toward Lake Anna.

The staff finds that the applicant's response to RAI 10.4.5-2 provides acceptable design provisions to accommodate the effects of discharging water that may result from a failure of a component or piping in the CWS. The staff's concern described in RAI 10.4.5-2 is resolved, and Revision 1 of the FSAR has been revised to include this additional information. Therefore, the staff finds that the conclusions in the ESBWR DCD SER regarding the requirements of GDC 4 and SRP guidance with respect to flooding remain valid.

10.4.5.5 *Post Combined License Activities*

There are no post COL activities related to this subsection.

10.4.5.6 *Conclusion*

NRC staff reviewed the application and considered the referenced DCD. The staff's review confirmed that the applicant has addressed the relevant information and no outstanding information is expected to be addressed in the COL FSAR related to this subsection.

The staff is reviewing the information in DCD Section 10.4.5 on Docket No. 52-010. The results of the staff's technical evaluation of the information related to "Other Features of Steam and Power Conversion System," incorporated by reference in the North Anna 3 COL FSAR, will be documented in the staff SER on the DCA for the ESBWR. This SER is not yet complete and is being tracked as part of Open Item [1-1]. The staff will update Section 10.4.5 of this SER to reflect the final disposition of the DCA.

In addition, the staff has compared the additional COL information in the application to the relevant NRC regulations, acceptance criteria defined in Section 10.4.5 of NUREG-0800 and other NRC regulatory guides and concludes that the applicant is in compliance with NRC regulations.

10.4.6 Condensate Purification System

10.4.6.1 *Introduction*

ESBWR DCD Section 10.4.6, "Condensate Purification System," includes information related to the purification and treatment of condensate, as required, to maintain reactor feedwater purity.

The CPS) uses filtration to remove suspended solids, including corrosion products, and ion exchange to remove dissolved solids and other impurities.

10.4.6.2 *Summary of Application*

Section 10.4.6 of the North Anna 3 COL FSAR incorporates by reference Section 10.4.6 of the ESBWR DCD, Revision 5.

In addition, in FSAR, Section 10.4, the applicant provided the following:

COL Item

- STD COL 10.4-1-A Leakage (Circulating Water into the Condenser)

This applicant provided threshold values and recommended operator actions for chemistry excursions in the condensate system to address this COL item.

10.4.6.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference will be addressed in the FSER related to the DCD.

In addition, the relevant requirements of Commission regulations and associated acceptance criteria for the review of this section are given in SRP Section 10.4.6 of NUREG-0800.

10.4.6.4 *Technical Evaluation*

NRC staff reviewed Section 10.4.6 of the North Anna 3 COL FSAR and considered the referenced DCD. The staff's review confirmed that the information contained in the application and incorporated by reference addresses the relevant information related to the "Condensate Purification System." Section 10.4.6 of the ESBWR DCD is being reviewed by the staff on Docket No. 52-010. The staff's technical evaluation of the information incorporated by reference and related to the other features of this system will be documented in the corresponding SER.

The staff reviewed the information contained in the COL FSAR:

COL Item

- STD COL 10.4-1-A Leakage (Circulating Water into the Condenser)

The applicant provided threshold values and recommended operator actions to address STD COL 10.4-1-A in FSAR Table 10.4-201, "Recommended Water Quality and Action Levels."

NRC staff reviewed FSAR Table 10.4-201, which lists the recommended water quality control parameters and action levels for the reactor water and feedwater during power operations. The staff finds the provided water quality control parameters acceptable, because the stated values are within the limits specified by RG 1.56 Revision 1.

10.4.6.5 *Post Combined Operating License Activities*

There are no post COL activities related to this subsection.

10.4.6.6 *Conclusion*

NRC staff reviewed the application and considered the referenced DCD. The staff's review confirmed that the applicant has addressed the relevant information and no outstanding information is expected to be addressed in the COL FSAR related to this subsection.

The staff is reviewing the information in DCD Section 10.4.6 on Docket No. 52-010. The results of the staff's technical evaluation of the information related to the "Condensate Cleanup System," incorporated by reference in the North Anna 3 COL FSAR, will be documented in the staff SER on the DCA for the ESBWR. This SER is not yet complete and is being tracked as part of Open Item [1-1]. The staff will update Section 10.4.6 of this SER to reflect the final disposition of the DCA.

In addition, the staff compared the additional FSAR information to the relevant NRC regulations, acceptance criteria defined in Section 10.4.6 of NUREG-0800, and other NRC regulatory guides and concluded that the applicant is in compliance with NRC regulations. Furthermore, the staff finds the water quality control parameters included in Table 10.4-201 acceptable because the stated values are within the limits specified by RG 1.56 Revision 1.

10.4.7 Condensate and Feedwater System

Section 10.4.7 of the North Anna 3 COL FSAR, Revision 1, incorporates by reference, with no departures or supplements, Section 10.4.7, "Condensate and Feedwater System," of the ESBWR DCD, Revision 5. NRC staff reviewed the application and considered the referenced DCD. The staff's review confirmed that there is no outstanding information, outside of the DCD, related to this subsection.

The staff is reviewing the information in DCD Section 10.4.7 on Docket No. 52- 010. The results of the staff's technical evaluation of the information related to the "Condensate and Feedwater System," incorporated by reference in the North Anna 3 COL FSAR, will be documented in the staff SER on the DCA for the ESBWR. This SER is not yet complete and is being tracked as part of Open Item [1-1]. The staff will update Section 10.4.7 of this SER to reflect the final disposition of the DCA.