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No figures were included in this chapter.

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10 STEAM AND POWER CONVERSION SYSTEM

This chapter describes the staff's evaluation of the steam and power conversion system in the U.S. EPR as it is conformed for the Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3. It includes evaluations of the turbine-generator, and the main steam and feedwater systems including the main condenser and its associated supporting systems.

CCNPP Unit 3 Final Safety Analysis Report (FSAR), Chapter 10, "Steam and Power Conversion System," incorporates by reference U.S. EPR FSAR Tier 2, Chapter 10, "Steam and Power Conversion System," with no departures and with supplements as identified in the following sections.

The staff reviewed the information in the U.S. EPR FSAR Tier 2, Chapter 10, on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the steam and power conversion system summary description incorporated by reference in the COL FSAR have been documented in the staff safety evaluation report (SER) on the design certification application for the U.S. EPR. The staff's SER on the U.S. EPR FSAR is not yet complete. **RAI 222, Question 01-05 is being tracked as an open item** as part of this chapter. The staff will update this chapter to reflect the final disposition of the U.S. EPR design certification application.

10.1 Summary Description

This section provides a general description of the steam and power conversion systems. A description of the turbine-generator, main steam supply, main condenser, turbine gland sealing, turbine bypass, circulating water, condensate clean-up, condensate and feedwater, steam generator blowdown, and emergency feedwater systems (EFSs) is presented. In addition, a description of the protective features is presented.

CCNPP Unit 3 FSAR combined license (COL) application; Section 10.1 incorporates by reference, with no departures or supplements, U.S. EPR FSAR Tier 2, Section 10.1. The staff reviewed the COL application and checked the referenced FSAR to ensure that no issues relating to this section remained for review. The staff's review confirmed that there are no outstanding issues related to this section.

10.2 Turbine-Generator

This section provides a general description of the turbine-generator and its associated design basis. In addition, details of the turbine rotor integrity assurance program are discussed. A presentation of the safety evaluation conducted for the turbine is presented with the relevant factors discussed.

COL FSAR Section 10.2 incorporates by reference with no departures U.S. EPR FSAR, Section 10.2. The staff's review confirmed that there is supplemental or outstanding information outside of the U.S. EPR FSAR that is related to the turbine-generator in COL FSAR Section 10.2.

10.2.1 Introduction

The Alstom turbine-generator is made up of a single high-pressure (HP) turbine, an intermediate-pressure (IP) turbine, and three low-pressure (LP) turbines coupled to a single generator. Moisture separator reheaters (MSRs) between high- and intermediate-pressure turbines are provided. The two MSRs have two stages, each of reheat. The turbine is equipped with steam stop and control valves to control the steam flow to the high-pressure turbine inlet and supervisory and protective instrumentation to control and protect the unit.

General Design Criterion (GDC) 4, "Environmental and Missile Dynamic Effects Design Bases," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," requires that structures, systems, and components (SSCs) important to safety shall be appropriately protected against environmental and dynamic effects that may result from equipment failure, including the effects of missiles. Because turbine rotors have large masses and rotate at relatively high speeds during normal reactor operation, failure of a rotor may result in the generation of high-energy missiles and excessive vibration of the turbine rotor assembly. Turbine rotor integrity is provided by the integrated combination of material selection, rotor design, fracture toughness requirements, tests, and inspections to minimize the probability of rotor failure and generation of a turbine missile.

10.2.2 Summary of Application

COL FSAR Section 10.2 incorporates by reference U.S. EPR FSAR Tier 2, Section 10.2, "Turbine-Generator," with no departures and with supplements as discussed below. U.S. EPR FSAR Tier 2, Sections 10.2.1, "Design Bases," 10.2.2, "General Description," 10.2.4, "Safety Evaluation," and 10.2.5, "References," are incorporated by reference with no departures or supplements.

In addition, in COL FSAR Section 10.2.3, "Turbine Rotor Integrity," the applicant provided the following:

Combined License Information Items:

The applicant provided additional information in COL FSAR Section 10.2.3.1, "Materials Selection," to address COL Information Item No. 10.2-2 from U.S. EPR FSAR Tier 2, Table 1.8-2, "U.S. EPR Combined License Information Items," as follows:

> A COL applicant that references the U.S. EPR design certification will provide applicable material properties of the turbine rotor after the site-specific turbine has been procured.

In response to this COL information item, the COL applicant committed to submitting the applicable material properties of the turbine rotor to the NRC.

The COL applicant also provided additional information in COL FSAR Section 10.2.3.2, "Fracture Toughness," to address COL Information Item No. 10.2-3 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

> A COL applicant that references the U.S. EPR design certification will provide applicable turbine disk rotor specimen test data, load-displacement data from the compact tension

specimens, and fracture toughness properties after the site-specific turbine has been procured.

In response to this COL information item, the COL applicant committed to submitting to the NRC the applicable turbine disk rotor specimen test data, load-displacement data from the compact tension specimens, and the fracture toughness properties to demonstrate that the associated information and data presented in the COL FSAR are bounding.

The COL applicant also provided additional information in COL FSAR Section 10.2.3.6, "Turbine Rotor Preservice Inspections and Testing," to address COL Information Item No. 10.2-5 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

> A COL applicant that references the U.S. EPR design certification will provide the site-specific turbine rotor inservice inspection interval consistent with the manufacturer's turbine missile analysis.

In response to this COL information item, the COL applicant provided a turbine rotor inservice inspection interval of 10 years.

10.2.3 Regulatory Basis

The regulatory basis of the information incorporated by reference with no departures is addressed within the Final Safety Evaluation Report (FSER) related to the U.S. EPR FSAR.

In addition, the relevant requirements of NRC regulations for turbine rotor integrity, and the associated acceptance criteria, are specified in NUREG-0800, Section 10.2.3, "Turbine Rotor Integrity."

The applicable regulatory requirements for turbine rotor integrity are as follows:

- GDC 4, which requires in part that structures, systems, and components important to safety shall be protected against environmental and dynamic effects, including the effects of missiles that may result from equipment failure.

The related acceptance criteria are as follows:

- Regulatory Guide (RG) 1.115, "Protection Against Low-Trajectory Turbine Missiles."

10.2.4 Technical Evaluation

The staff reviewed COL FSAR Section 10.2 and checked the referenced design certification FSAR to ensure that the combination of the information in the U.S. EPR FSAR and the information in the COL FSAR represents the complete scope of required information relating to this review topic. The review confirmed that the information contained in the application and incorporated by reference with no departures addresses the required information relating to this section. U.S. EPR FSAR Tier 2, Section 10.2 has been reviewed by the staff under Docket No. 52-020. The staff's technical evaluation of the information incorporated by reference related to the turbine generator has been documented in the staff safety evaluation report on the design certification application for the U.S. EPR.

The staff's review of the information contained in the FSAR is discussed as follows:

Combined License Information Items:

The staff reviewed the information in CCNPP Unit 3 COL FSAR Section 10.2.3 that addresses the COL information items identified in the U.S. EPR FSAR Tier 2, Section 10.2.3 related to turbine materials and maintenance/inspection. In its review, the staff used the applicable sections of NUREG-0800, "Standard Review Plan (SRP) for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," (hereafter referred to as NUREG-0800 or the SRP) and RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," as guidance.

The staff reviewed COL Information Item No. 10.2-2 from U.S. EPR FSAR Tier 2, Table 1.8-2 included under FSAR Section 10.2.3.1, related to the material properties of the site-specific turbine rotor. The COL applicant addressed this issue by stating that following procurement of the CCNPP Unit 3 turbine generator, the COL holder will submit to the NRC the applicable material properties of the turbine rotor. In addition, the COL applicant addressed COL Information Item No. 10.2-3, under COL FSAR Section 10.2.3.2, in that the COL holder would provide the applicable turbine disk rotor specimen test data, load-displacement data from the compact tension specimens, and the fracture toughness properties after the site-specific turbine is procured to demonstrate that the associated information and data presented in the COL FSAR are bounding.

For the staff to conclude that the turbine-rotor material properties are bounded by the COL FSAR and the applicable turbine missile analysis, in RAI 69, Question 10.02.03-1, the staff requested that the COL applicant discuss whether COL Information Item No. 10.2-2 should be addressed in an inspection, test, analysis, and acceptance criterion (ITAAC) in the U.S. EPR design certification, or in the COL application, and discuss the completeness of the bounding analysis of the turbine rotor integrity. In a March 24, 2009, response to RAI 69, Question 10.02.03-1, the COL applicant stated that proposed license conditions for each of the COL information items, including COL Information Item Nos. 10.2-2 and 10.2-3, are provided in the COL application, Part 10, "ITAAC," Appendix A, "Proposed Combined License Conditions," Chapter 2, "COL information items." In addition, in a March 2, 2009, response to RAI 29, Questions 03.05.01-1 and 03.05.01-2, the COL applicant submitted the bounding turbine missile probability analysis, Alstom Report TSDMF 07-018 D, "ALSTOM Turbine Missile Analysis," dated May 30, 2007, for the Alstom turbine generator to be used in the U.S. EPR design at CCNPP Unit 3. The staff's review of this turbine missile probability analysis is discussed in Section 3.5.1.3 of this report. The staff determines this is an acceptable approach to ensuring that the as-built turbine rotor material properties will meet the criteria in SRP Section 10.2.3 based on the following:

> The proposed license condition ensures that the COL holder submits the applicable turbine rotor material properties to confirm that the applicable as-built material properties of the turbine rotors will be within the limits of the FSAR information. The as-built material properties are not available until after procurement and fabrication of the turbine generator. Therefore, it is acceptable that the COL holder, after procurement of the turbine generator, provides an analysis using the as-built material properties to confirm it meets the manufacturer's requirements and the bounding turbine missile analysis Alstom Report TSDMF 07-018 D.

In addition, Appendix B to Part 10 of the CCNPP Unit 3 COL FSAR incorporates by reference the information in U.S. EPR FSAR Tier 1, Table 2.8.1-3, "Turbine Generator System ITAAC." Included in this table are ITAAC Commitments 1.0a and 1.0b. ITAAC Commitment 1.0a states that an analysis will be performed to ensure the as-built rotor material properties still meet the requirements of the manufacturer's turbine missile probability analysis. ITAAC Commitment 1.0b ensures that a turbine missile probability analysis will be performed for the as-built turbine design, and the probability of a turbine missile will be less than 10^{-4}. Therefore, the probability of turbine material and overspeed-related failures resulting in turbine missiles will be less than 1×10^{-4}, which meets the guidance in RG 1.115.

However, the staff notes that SRP Section 10.2.3 states that the inservice inspection program should detect flaws that might lead to turbine rotor failure and should comply with the manufacturer's recommendations to provide assurance against turbine rotor failure. In a March 24, 2009, response to RAI 69, Question 10.02.03-2, the COL applicant stated that the COL FSAR incorporates U.S. EPR FSAR Tier 2, Section 10.2.3.6 by reference, with no departures or supplements. Therefore, the inspections will be performed based on the U.S. EPR inservice inspection plan. However, the staff notes that there are open items (reference RAI 100, Questions 10.02.03-9a and 9b) for the inservice inspection plan in U.S. EPR FSAR. Therefore, the CCNPP Unit 3 turbine rotor inservice inspection program is dependent on the satisfactory resolution of the aforementioned open items. The staff will update this report to reflect the final disposition of open items (reference RAI 100, Questions 10.02.03-9a and 9b). **RAI 100, Questions 10.02.03-9a and 9b are being tracked as confirmatory items**.

The staff reviewed COL Information Item No. 10.2-5 from U.S. EPR FSAR Tier 2, Table 1.8-2 included under COL FSAR, Section 10.2.3.6, related to providing a site-specific turbine rotor inservice inspection interval which is consistent with the manufacturer's turbine missile analysis. In a March 2, 2009, response to RAI 29, Question 03.05.01-2, the COL applicant addressed this issue by stating that COL FSAR Section 10.2.3.6 would include an inspection interval of 10 years for the turbine rotor. U.S. EPR FSAR Tier 2, Section 10.2.3.6, Revision 1"Turbine Rotor Inservice Inspection Program Plan," added that the inspections of the turbine rotors will be performed during intervals consistent with the inservice inspection schedules in American Society of Mechanical Engineers (ASME) Code, Section XI so that a total inspection of the turbine rotor will be completed at least once within a 10-year period. The staff notes that the inservice inspection interval of 10 years is within the bounding turbine missile analysis per Alstom Report TSDMF 07-018 D. However, the staff is still reviewing this report, which is discussed in Section 3.5.1.3 of this report. Therefore, upon satisfactory review and resolution of any open items for the turbine missile probability analysis, the staff determines a 10-year inservice inspection interval is acceptable and is consistent with the manufacturer's turbine missile analysis, and is therefore acceptable.

COL Information Item No. 10.2-2 directs the COL holder to provide, after the site-specific turbine has been procured, the turbine materials properties that support the material property assumptions in the turbine rotor analysis. COL Information Item No. 10.2-3 directs the COL holder to provide, after the site-specific turbine has been procured, the turbine disk rotor specimen test data, load-displacement data from the compact tension specimens, and fracture toughness properties. These COL information items are the subject of proposed license conditions in the COL application, Part 10, Appendix A, Chapter 2.

In addition, the COL application, Part 10, Appendix B, “Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC),” incorporates by reference with no departures the Tier 1 information in the U.S. EPR FSAR, including ITAAC Commitments 1.0a and 1.0b which require the COL holder, after procurement of the turbine generator, to provide an analysis using the as-built material properties to ensure it meets the manufacturer's requirements and the bounding turbine missile analysis.

The staff determined that the proposed license conditions in the COL application, Part 10, Appendix A, Chapter 2, which includes COL Information Item Nos. 10.2-2 and 10.2-3, provide sufficient information for the COL holder to submit the turbine rotor material properties.

The staff also determined that the COL application, Part 10, Appendix B, which incorporates by reference with no departures the Tier 1 information in the U.S. EPR FSAR, which includes ITAAC Commitments 1.0a and 1.0b from U.S. EPR FSAR Tier 1, Table 2.8.1-3 provides sufficient information to ensure that after construction of the turbine generator, an analysis using the as-built turbine rotor material properties will be performed to ensure it meets the requirements of the manufacturer's turbine missile analysis.

10.2.5 Post Combined License Activities

U.S. EPR FSAR Tier 2, Table 1.8-2 contains COL information items that the COL applicant is required to address. The following COL information items in Table 10.2.5-1 below include the proposed combined license activities which the staff has evaluated in this report, but that will be completed following issuance of the license as discussed in the SER section listed below.

Table 10.2.5-1 Post Combined License Activities

Item No.	Description	COL FSAR Section	COL SER Section
10.2-2	A COL applicant that references the U.S. EPR design certification will provide applicable material properties of the turbine rotor after the site-specific turbine has been procured.	10.2.3.1	10.3.4
10.2-3	A COL applicant that references the U.S. EPR design certification will provide applicable turbine disk rotor specimen test data, load displacement data from the compact tension specimens and the fracture toughness properties after the site-specific turbine has been procured.	10.2.3.2	10.3.4
10.2-5	A COL applicant that references the U.S. EPR design certification will provide the site-specific turbine rotor inservice inspection interval consistent with the manufacturer’s turbine missile analysis.	10.2.3.6	10.3.4

10.2.6 Conclusions

The staff reviewed the COL application and checked the referenced U.S. EPR FSAR. The staff's review confirmed that the COL applicant addressed the required information relating to turbine rotor integrity, and there is no outstanding information expected to be addressed in the COL FSAR related to this section.

The staff reviewed the information in the U.S. EPR FSAR on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the turbine generator incorporated by reference in the COL FSAR have been documented in the staff's safety evaluation report on the design certification application for the U.S. EPR. The SER on the U.S. EPR is not yet complete**.** The staff will update this report to reflect the final disposition of the design certification application.

In addition, the staff concludes that the COL applicant adequately addressed COL Information Item Nos. 10.2-2 and 10.2-3 by including these items as part of a proposed license condition in Chapter 2 of Appendix A to Part 10 (ITAAC) of the CCNPP Unit 3 COL FSAR requiring the COL holder to provide the turbine materials properties after the site-specific turbine has been procured in order to support the material property assumptions in the turbine rotor analysis.

The staff further concludes, contingent upon satisfactory review and resolution of any open items for the turbine missile probability analysis discussed in Section 3.5.1.3 of this report, that the COL applicant adequately addressed COL Information Item No. 10.2-5 in the COL FSAR and is, thus, acceptable because the inservice inspection interval conforms to guidance in SRP Section 10.2.3 and the turbine missile probability analysis.

Therefore, the staff concludes that the COL applicant has described methods for ensuring the integrity of low-pressure turbine rotors by the use of suitable material with adequate fracture toughness of a conservative design and appropriate inservice inspections which provides reasonable assurance that the probability of failure with missile generation is low during normal operation, including transients up to design overspeed. Furthermore, the staff concludes that these methods ensuring the integrity of low-pressure turbine rotors satisfy the requirements of GDC 4, "Environmental and dynamic effects design bases," with respect to the protection of SCCs important to safety from the effects of turbine missiles.

10.3 Main Steam Supply System

This section provides a general description of the main steam supply system and its associated design basis. In addition, details of the secondary water chemistry program and the flow accelerated corrosion (FAC) programs are presented.

10.3.1 Introduction

The main steam supply system provides high pressure (HP) steam from the four steam generators to the high-pressure turbine inlet nozzle. While the majority of information in the U.S. EPR FSAR is incorporated by reference with no departures at CCNPP Unit 3, the details of the secondary water chemistry and the flow accelerated corrosion are site specific and, therefore, supplementary information on these subjects is presented as discussed below.

10.3.2 Summary of Application

COL FSAR Section 10.3 incorporates by reference with no departures and with supplements U.S. EPR FSAR Tier 2, Section 10.3, "Main Steam Supply System," as discussed below. U.S. EPR FSAR Tier 2, Sections 10.3.1, "Design Bases," 10.3.2, "System Description," 10.3.3, "Safety Evaluation," and 10.3.4, "Inspection and Testing Requirements," are incorporated by reference with no departures or supplements.

In addition, in COL FSAR Sections 10.3.5, "Secondary Side Water Chemistry Program," and 10.3.6, "Steam and Feedwater System Materials," the COL applicant provided the following:

Combined License Information Items:

The COL applicant provided additional information in COL FSAR Section 10.3.5 to address COL Information Item No. 10.3-1 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

> A COL applicant that references the U.S. EPR design certification will identify the authority responsible for implementation and management of the secondary side water chemistry program.

In response to this COL information item, the COL applicant committed to the secondary water chemistry program as described in the U.S. EPR FSAR Tier 2, Section 10.3.5, "Secondary Side Water Chemistry Program," and stated that the Radiation Protection and Chemistry Manager is the authority responsible for implementation and management of the secondary side water chemistry program.

The COL applicant provided additional information in COL FSAR Section 10.3.6.3, "Flow-Accelerated Corrosion," (FAC) to address COL Information Item No. 10.3-2 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

> The COL applicant that references the U.S. EPR design certification will develop and implement a FAC condition monitoring program that is consistent with Generic Letter (GL) 89-08 and NSAC-202L-R3 for the carbon steel portions of the steam and power conversion systems that contain water or wet steam prior to initial fuel loading.

In response to this COL information item, the COL applicant stated that they would implement a flow accelerated corrosion program that provides a structured, logical approach to identifying locations in the steam and power conversion systems that could be susceptible to degradation of pressure boundary thickness due to erosion/corrosion and flow conditions. This program will be designed and applied to the main steam, condensate, feedwater, extraction steam, cold, and hot re-heat steam, heater drains, main steam relief (MSR) drains, steam dump system, and steam generator blowdown systems (SGBSs). In the commitment, the COL applicant states that the CCNPP Unit 3 FAC Program utilizes the guidance of Nuclear Safety Analysis Center (NSAC) - 202L-R3, "Recommendations for an Effective Flow Accelerated Corrosion Program" (Electrical Power Research Institute, 2006). The COL applicant further states that emphasis is placed on control of dissolved impurities that contribute to corrosion and removal of corrosion products. The COL applicant commits to recording and trending the Accelerated Corrosion Program results throughout the plant's operating life. Further, lessons learned through the program are applied to the program itself, and to other systems, program, and/or situations as may be appropriate.

10.3.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed within the FSER related to the U.S. EPR FSAR.

In addition, the relevant requirements of NRC regulations for the secondary side water chemistry and flow accelerated corrosion programs, and the associated acceptance criteria, are specified in NUREG-0800, Section 10.3.6, "Steam and Feedwater System Materials."

The applicable regulatory requirements for the secondary side water chemistry and flow accelerated corrosion programs are as follows:

- The regulatory basis for accepting the COL information addressing the FAC program is provided in 10 CFR 50.55a, "Codes and Standards," as it pertains to maintaining the requirements of the ASME Code, Section III for piping minimum wall thickness.

The related acceptance criteria are as follows:

- NSAC-202L-R3 and GL 89-08, "Erosion/Corrosion-Induced Pipe Wall Thinning," as they pertain to establishing an erosion-corrosion monitoring program.

10.3.4 Technical Evaluation

The staff reviewed COL FSAR Section 10.3 and checked the referenced design certification FSAR to ensure that the combination of the information in the U.S. EPR FSAR and the information in the COL FSAR represents the complete scope of required information relating to this review topic. The review confirmed that the information contained in the COL application and incorporated by reference with no departures addresses the required information relating to this section. U.S. EPR FSAR Tier 2, Section 10.3 has been reviewed by the staff under Docket No. 52-020. The staff's technical evaluation of the information incorporated by reference with no departures related to the main steam supply system has been documented in the staff safety evaluation report on the design certification application for the U.S. EPR.

The staff's review of the information contained in the FSAR is discussed as follows:

Combined License Information Items:

The staff reviewed COL Information Item No. 10.3-1 from U.S. EPR FSAR Tier 2, Table 1.8-2 included under COL FSAR Section 10.3.5 related to the COL applicant's Secondary side water chemistry program, which states:

> A COL applicant that references the U.S. EPR design certification will identify the authority responsible for implementation and management of the secondary side water chemistry program.

The COL applicant addresses COL Information Item No. 10.3-1 in COL FSAR Section 10.3.5. The COL applicant committed to the secondary water chemistry program as described in the U.S. EPR FSAR Tier 2, Section 10.3.5, "Secondary Water Chemistry Program," and stated that the Radiation Protection and Chemistry Manager is the authority responsible for implementation and management of the secondary water chemistry program. The staff finds that this is

acceptable, because it follows the Electrical Power Research Institute (EPRI) PWR Secondary Water Chemistry Guidelines Revision 6 (EPRI Report 1008224).

The staff reviewed COL Information Item No. 10.3-2 from U.S. EPR FSAR Tier 2, Table 1.8-2 included under COL FSAR Section 10.3.6.3 related to the COL applicant's FAC program, which states:

> A COL applicant that references the U.S. EPR design certification will develop and implement a FAC condition monitoring program that is consistent with GL 89-08 and NSAC-202L-R3 for the carbon steel portions of the steam and power conversion systems that contain water or wet steam prior to initial fuel loading.

The COL applicant addresses COL Information Item No. 10.3-2 in COL FSAR Section 10.3.6.3. The COL applicant states that it will implement a FAC program that provides a structured, logical approach to identifying locations in the steam and power conversion system that could be susceptible to degradation of pressure boundary thickness due to erosion/corrosion and flow conditions. In addition, the COL applicant states that the FAC program will be consistent with recommendations of GL 89-08 and NSAC-202L-R3.

The COL applicant will use multiple criteria to evaluate possible degradation in the steam and power conversion system. These criteria include process fluid characteristics, process flow rates, flow path configuration, temperature, pressure, duty cycles or cycling conditions, pressure boundary mechanical stresses, and materials of construction. The criteria are evaluated during the design and construction phases using industry operation experience to identify locations that are susceptible to FAC. Adjustments are then made to pipe routing and component locations to minimize flow velocities and turbulence. The staff finds this acceptable, because the COL applicant will modify systems as necessary to minimize conditions that can promote FAC.

The COL applicant's FAC program includes preservice examinations, including thickness measurements, prior to plant operation. Preservice examinations are conducted using grid locations and measurement methods anticipated for the inservice examination. Preservice examinations will also be performed on components containing greater than or equal to 0.10 percent chromium. The minimum level of chromium provides resistance to FAC. These components will be inspected at least once, after the plant goes into operation, to verify that they are not experiencing an appreciable amount of degradation. Grid locations are determined based on industry operation experience and a FAC modeling software program in accordance with GL 89-08 and NSAC-202L-R3. Examination results are recorded and trended throughout the life of the plant to determine required adjustments in location and frequency of subsequent examination in order to maintain minimum wall thickness, design margins of safety, and piping integrity. The staff finds that the supplemental information provided by the applicant, to address the FAC monitoring program, is acceptable, because the COL applicant's FAC program will meet requirements and recommendations of GL 89-08 and NSAC-202L-R3.

10.3.5 Post Combined License Activities

There are no Post Combined License Activities related to this section.

10.3.6 Conclusions

The staff reviewed the COL application and checked the referenced U.S. EPR FSAR. The staff's review confirmed that the COL applicant addressed the required information relating to the main steam supply system, and there is no outstanding information expected to be addressed in the COL FSAR related to this section.

The staff reviewed the information in the U.S. EPR FSAR on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the main steam supply system incorporated by reference with no departures in the COL FSAR have been documented in the staff's safety evaluation report on the design certification application for the U.S. EPR. The SER on the U.S. EPR is not yet complete. The staff will update this report to reflect the final disposition of the design certification application.

The staff finds that the COL applicant has appropriately addressed COL Information Item No. 10.3-1, because the secondary water chemistry program will follow the EPRI PWR Secondary Water Chemistry Guidelines Revision 6 (EPRI Report 1008224).

The staff concludes that supplemental information provided by the COL applicant in COL FSAR Section 10.3.6.3 provides a program in conformance with industry practice for addressing the concerns related to FAC and for monitoring the piping wall degradation caused by FAC during plant operation. The establishment of a FAC monitoring program adequately addresses the concerns identified in GL 89-08, which includes the requirements of 10 CFR 50.55a, and is thus acceptable.

10.4 Other Features of Steam and Power Conversion System

This section provides a general description of the main condenser, evacuation system, turbine gland sealing system (TGSS), turbine by-pass system, circulating water system (CCS), condensate polishing system (CPS), condensate and feedwater system (CFS), steam generator blowdown system, and emergency feedwater system.

The steam and power conversion system support systems for CCNPP Unit 3 are, in general, the same as the reference U.S. EPR steam and power conversion support systems. The major differences relate to the materials of construction and operating pressure of the main condenser and the features of the circulating water system. These changes are a function of the local source and water quality of cooling water at the CCNPP Unit 3 Site.

COL FSAR Section 10.4, "Other Features of Steam and Power Conversion System," incorporates by reference with no departures U.S. EPR FSAR Tier 2, Section 10.4, "Other Features of Steam and Power Conversion System," and with supplements as discussed below. U.S. EPR FSAR Tier 2, Sections 10.4.2, "Main Condenser Evacuation System (MCES)," 10.4.3, "Turbine Gland Sealing System," 10.4.4, "Turbine Bypass System (TBS)," 10.4.6, "Condensate Polishing System," 10.4.7, "Condensate and Feedwater System," 10.4.8, "Steam Generator Blowdown System," and 10.4.9, "Emergency Feedwater System," are incorporated by reference with no departures or supplements.

In addition, in COL FSAR Sections 10.4.1, "Main Condensers," and 10.4.5, "Circulating Water System," the COL applicant provided the following:

10.4.1 Main Condensers

10.4.1.1 *Introduction*

The steam and power conversion system support systems for CCNPP Unit 3 are, in general, the same as the reference U.S. EPR steam and power conversion support systems. The major differences relate to the materials of construction and operating pressure of the main condenser and the features of the circulating water system. These changes are a function of the local source and water quality of cooling water at the CCNPP Unit 3 Site.

10.4.2 Summary of Application

COL FSAR Section 10.4.1 incorporates by reference with no departures U.S. EPR FSAR Tier 2, Section 10.4.1, “Main Condensers.”

In addition, in COL FSAR Section 10.4.1.2, “System Description,” the COL applicant provided the following:

Combined License Information Items:

The COL applicant provided additional information in COL FSAR Section 10.4.1.2 to address COL Information Item No. 10.4-1 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

> The COL applicant that references the U.S. EPR design certification will describe the site-specific main condenser materials.

This COL information item has been satisfied for CCNPP Unit 3 as specified in COL FSAR Section 10.4.1.2, by the COL applicant committing to construct the condenser tubes of titanium and the tube sheets of titanium clad material.

The COL applicant provided additional information in COL FSAR Section 10.4.1.2 to address COL Information Item No. 10.4-2 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

> The COL applicant that references the U.S. EPR design certification will describe the site-specific design pressure and test pressure for the main condenser.

This COL information item has been satisfied for CCNPP Unit 3 as specified in COL FSAR Section 10.4.1.2 by the COL applicant stating that the site-specific design pressure and test pressure for the main condenser at CCNPP Unit 3 are 150 psig (1,034 kPa-gauge) and 225 psig (1,551 kPa-gauge), respectively.

10.4.3 Regulatory Basis

The regulatory basis of the information incorporated by reference with no departures is addressed within the FSER related to the U.S. EPR FSAR.

In addition, the relevant requirements of NRC regulations for the main condenser, and the associated acceptance criteria, are specified in NUREG-0800, Section 10.4.1, “Main Condensers.”

The applicable regulatory requirements for main condensers are as follows:

- GDC 60, "Control of Releases of Radioactive Materials to the Environment," as it relates to preventing excessive releases of radioactivity to the environment which may result from a failure of a structure, system or component in the main condenser.

10.4.4 Technical Evaluation

The staff reviewed COL FSAR Section 10.4.1 and checked the referenced design certification FSAR to ensure that the combination of the information in the U.S. EPR FSAR and the information in the COL FSAR represents the complete scope of required information relating to this review topic. The review confirmed that the information contained in the application and incorporated by reference with no departures addresses the required information relating to this section. U.S. EPR FSAR Tier 2, Section 10.4.1 has been reviewed by the staff under Docket No. 52-020. The staff's technical evaluation of the information incorporated by reference related to the main condenser has been documented in the staff safety evaluation report on the design certification application for the U.S. EPR.

The staff's review of the information contained in the FSAR is discussed as follows:

Combined License Information Items:

COL FSAR Section 10.4.1 incorporates by reference with no departures U.S. EPR FSAR Tier 2, Section 10.4.1; except for the COL information items in COL FSAR Section 10.4.1.2 for the following:

- COL Information Item No. 10.4-1 for site-specific condenser materials - the site-specific main condenser for CCNPP Unit 3 will be comprised of titanium tubes and titanium-clad tube sheet.

The staff determined these materials acceptable, since titanium is highly corrosive resistant material and widely used in power plants.

- COL Information Item No. 10.4-2 for condenser design and test pressures - the site-specific design pressure and test pressure for the CCNPP Unit 3 main condenser are 1,034 kPa-gauge (150 psig) and 1,551 kPa-gauge (225 psig), respectively.

The staff determined these pressures acceptable, since these are typical for power plant main condensers and also consistent with those in the U.S. EPR FSAR.

10.4.5 Post Combined License Activities

There are no post COL activities related to this section.

10.4.6 Conclusions

The staff reviewed the COL application and checked the referenced U.S. EPR FSAR. The staff's review confirmed that the applicant addressed the required information relating to the main condensers, and there is no outstanding information expected to be addressed in the FSAR related to this section.

The staff reviewed the information in the U.S. EPR FSAR on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the main condenser incorporated by reference with no departures in the COL FSAR have been documented in the staff's safety evaluation report on the design certification application for the U.S. EPR. The SER on the U.S. EPR is not yet complete. The staff will update this report to reflect the final disposition of the design certification application.

In addition, the staff concludes that the relevant information presented within the COL FSAR is acceptable and meets the requirements of GDC 60. The staff based its conclusion on the following:

The main condenser materials are acceptable, because titanium is a highly corrosive resistant material and widely used in power plants.

The site-specific design pressure and test pressure for the main condenser materials are acceptable, because they are typical for power plant main condensers and also consistent with those in the U.S. EPR FSAR.

10.4.7 Main Condenser Evacuation System

The main condenser evacuation system removes air and non-condensable gases from the main condenser and connected steam side systems during plant startup, cooldown, and normal operation.

COL FSAR Section 10.4.2, "Main Condenser Evacuation System," incorporates by reference, with no departures or supplements, U.S. EPR FSAR Tier 2, Section 10.4.2. The staff reviewed the application and checked the referenced FSAR to ensure that no issues relating to this section remained for review. The staff's review confirmed that there are no outstanding issues related to this section.

The staff reviewed the information in the U.S EPR FSAR Tier 2, Section 10.4.2 on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the main condenser evacuation system incorporated by reference with no departures in the COL FSAR have been documented in the staff SER on the design certification application for the U.S. EPR. The SER on the U.S. EPR FSAR is not yet complete. The staff will update Section 10.4.2 of this report to reflect the final disposition of the design certification application.

10.4.8 Turbine Gland Sealing System

The turbine gland sealing system prevents the escape of steam from the turbine shaft and casing penetrations and the glands of main steam stop and control valves. This system also prevents air leakage into the low pressure (LP) turbine glands.

CCNPP Unit 3 FSAR COL application, Section 10.4.3, "Turbine Gland Sealing System," incorporates by reference, with no departures or supplements, U.S. EPR FSAR Tier 2, Section 10.4.3. The staff reviewed the application and checked the referenced FSAR to ensure that no issues relating to this section remained for review. The staff's review confirmed that there are no outstanding issues related to this section.

The staff reviewed the information in the U.S. EPR FSAR Tier 2, Section 10.4.3 on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the turbine gland sealing system incorporated by reference with no departures in the COL FSAR have been documented in the staff SER on the design certification application for the U.S. EPR. The SER on the U.S. EPR FSAR is not yet complete. The staff will update Section 10.4.3 of this report to reflect the final disposition of the design certification application.

10.4.9 Turbine Bypass System

The turbine bypass system discharges main steam from the steam generators (SGs) directly to the main condenser in a controlled manner, bypassing the turbine. This process minimizes transient effects on the reactor coolant system (RCS) during plant startup, hot shutdown and cooldown; and step load reductions in generator load. The TBS is also referred to as the steam dump system.

COL FSAR Section 10.4.4, "Turbine Bypass System," incorporates by reference, with no departures or supplements, U.S. EPR FSAR Tier 2, Section 10.4.4. The staff reviewed the application and checked the referenced COL FSAR to ensure that no issues relating to this section remained for review. The staff's review confirmed that there are no outstanding issues related to this section.

The staff reviewed the information in the U.S. EPR FSAR Tier 2, Section 10.4.4 on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the turbine bypass system incorporated by reference with no departures in the COL FSAR have been documented in the staff SER on the design certification application for the U.S. EPR. The SER on the U.S. EPR FSAR is not yet complete. The staff will update Section 10.4.4 of this report to reflect the final disposition of the design certification application.

10.4.10 Circulating Water System

10.4.10.1 *Introduction*

The circulating water system supplies cooling water from the normal heat sink to the turbine condensers and auxiliary cooling water system (ACWS). After removing heat from the condensers and ACWS, the circulating water is returned to the normal heat sink. For the CCNPP, the normal heat sink consists of a single wet mechanical draft cooling tower with plume abatement dissipating heat to the atmosphere.

10.4.10.2 *Summary of Application*

COL FSAR Section 10.4.5 incorporates by reference with no departures U.S. EPR FSAR Tier 2, Section 10.4.5, "Circulating Water System."

In addition, in COL FSAR Sections 10.4.5.2, "System Description," 10.4.5.3, "Safety Evaluation," and 10.4.5.5, "Instrumentation Requirements," the COL applicant provided the following:

Interface Requirements

The COL applicant provided site-specific design details for the CWS including makeup water, and water treatment to address Interface Item No. 10-1 in U.S. EPR FSAR Tier 2, Table 1.8-1, "Summary of U.S. EPR Plant Interfaces with Remainder of Plant."

Combined License Information Items

The COL applicant provided additional information in COL FSAR Section 10.4.5.2 to address COL Information Item Nos. 10.4-3, 10.4-4, and 10.4-5 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

> A COL applicant that references the U.S. EPR design certification should provide the description of the site-specific portions of the CWS.

CCNPP Unit 3 uses a brackish-water closed-loop CWS to dissipate heat. The CWS system uses a single plume abated (hybrid) mechanical draft cooling tower for heat dissipation. The term "hybrid" refers to the tower's use of a dry section (for sensible cooling), as well as a wet section (for sensible and latent cooling) for heat dissipation. The CWS has four 25 percent capacity vertical circulating water pumps housed in the circulating water pump building adjacent to the cooling tower. The majority of the CWS flow is directed through the main condenser, where the water removes (primarily) latent heat of vaporization from the turbine exhaust steam. The water travels through the three condenser shells (tube side), which are arranged in series, and then returns to the CWS cooling tower via the CWS return piping. Makeup water for the CWS is taken from the Chesapeake Bay by three 50 percent capacity vertical pumps to the cooling tower basin. Makeup water from the Chesapeake Bay is received into the intake structure via the common forebay shared with the ultimate heat sink (UHS) makeup water intake structure. The common forebay is shared between CWS makeup water system and UHS makeup water system. A CWS chemical treatment system is used to minimize fouling, inhibit scaling on the heat exchange surfaces, to control growth of bacteria, and to inhibit corrosion of piping materials. Water treatment for the CWS is based on site makeup water chemistry, blowdown requirements, environmental regulations, and system materials.

Additionally, two 100 percent capacity ACWS pumps receive cooling water from the CWS and deliver the water to the closed cooling water system (CLCWS) heat exchangers. Heat from the CLCWS is transferred to the auxiliary cooling water system, and heated auxiliary cooling water is returned to the CWS downstream of the main condenser. The heated CWS water is sent to the spray headers of the cooling tower. After passing through the cooling tower, the cooled water is recirculated back to the circulating water pump building to complete the closed cycle cooling water loop.

> A COL applicant that references the U.S. EPR design certification should provide the specific chemicals used within the chemical treatment system as determined by the site-specific water conditions.

The specific chemicals to be injected at CCNPP Unit 3 are a biocide (sodium hypochlorite), an algaecide or non-oxidizing biocide, a pH adjuster, a corrosion inhibitor, a scale inhibitor, and a dispersant. Sodium bisulfite may also be injected at retention basin outlet or other appropriate point to ensure that the plant discharge meets the National Pollution Discharge Elimination System (NPDES) permit limit on residual chlorine.

The various chemical parameters to be sampled in the circulating water system are also given. The parameters sampled characterize the levels of the chemical additives, as well as natural constituents of the water, both organic and inorganic, which will allow the chemical treatment to be adjusted as necessary. Sample points are at the condenser cold water inlet and the line to the seal well (near the outlet).

> A COL applicant that references the U.S. EPR design certification should provide the site-specific CWS piping design pressure.

The COL applicant stated that CWS piping design pressure is 150 psig (1,034 kPa-gauge).

COL Information Item No. 14.2-5 from U.S. EPR FSAR Tier 2, Table 1.8-2 states as follows:

> COL applicant that references the U.S. EPR design certification should provide site-specific test abstract information for the circulating water supply system.

The COL applicant provided additional information in COL FSAR Section 10.4.5.3 to address COL Information Item No. 10.4-6 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

> If a vacuum priming system is required, a COL applicant that references the U.S. EPR design certification should provide the site-specific information.

The applicant stated that a vacuum priming system is not required at CCNPP Unit 3.

The COL applicant provided additional information in COL FSAR Section 10.4.5.5 to address COL Information Item No. 10.4-7 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

> A COL applicant that references the U.S. EPR design certification will provide information to address the potential for flooding of safety-related equipment due to failures of the site specific CWS.

The COL applicant stated that internal flooding of the Turbine Building due to an un-isolatable break or crack in CWS pipe or failure of a CWS component, including expansion joints, does not result in damage to safety-related SSCs, because there are no safety-related SSCs in the Turbine Building. There is also no direct pathway through which flooding could spread between the Turbine Building and adjacent structures that house safety-related SSCs.

Site-Information Replacing Conceptual Design Information

The COL applicant provided additional information to replace conceptual design information contained in the U.S. EPR FSAR.

The U.S. EPR FSAR Tier 2, Section 10.4.5.2.2, “Component Description,” includes conceptual design information for the cooling towers, circulating water pumps, cooling tower makeup system, and chemical treatment system.

10.4.10.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed within the FSER related to the U.S. EPR FSAR.

In addition, the relevant requirements of NRC regulations for the supplemental information provided on the CWS, and the associated acceptance criteria, are specified in NUREG-0800, Section 10.4.5, "Circulating Water System."

The applicable regulatory requirements for the CWS are as follows:

- GDC 4, as it relates to design provisions provided to accommodate the effects of discharging water that may result from a failure of a component or piping in the CWS.

The related acceptance criteria are as follows:

1. Means should be provided to prevent or detect and control flooding of safety-related areas so that the intended safety function of a system or component will not be precluded due to leakage from the CWS.

2. Malfunction or a failure of a component or piping of the CWS, including an expansion joint, should not have unacceptable adverse effects on the functional performance capabilities of safety-related systems or components.

3. The COL applicant's proposed methods for control of water chemistry and of long-term corrosion and organic fouling, and the chemical agents used for these purposes, are compatible with the system materials.

10.4.10.4 *Technical Evaluation*

The staff reviewed COL FSAR Section 10.4.5 and checked the referenced design certification FSAR to ensure that the combination of the information in the U.S. EPR FSAR and the information in the COL FSAR represents the complete scope of required information relating to this review topic. The review confirmed that the information contained in the application and incorporated by reference with no departures addresses the required information relating to this section. U.S. EPR FSAR Tier 2, Section 10.4.5 has been reviewed by the staff under Docket No. 52-020. The staff's technical evaluation of the information incorporated by reference related to the circulating water system has been documented in the staff safety evaluation report on the design certification application for the U.S. EPR.

The staff's review of the information contained in the COL FSAR is discussed as follows:

The staff reviewed the information contained in the COL FSAR related to the CWS in accordance with SRP Section 10.4.5, and the acceptability of the system is based on meeting the requirements and the acceptance criteria as described, above, in Section 10.4.5.3, "Regulatory Basis," of this report.

The CWS is a non-safety-related system and is designed to provide a continuous supply of cooling water to the main condensers and the ACWS. The system consists of circulating water pumps, mechanical draft cooling towers, and associated piping, valves, and instrumentation. The layout of the CCNPP Unit 3 CWS is shown in COL FSAR Figures 10.4-1, "Circulating Water System P&ID (Circulating Water Pump Building)," through 10.4-7, "Circulating Water System Plant Discharge," as described below. The cooling tower design specifications are provided in COL FSAR Table 10.4-1, "Circulating Water System Cooling Tower Design Specifications."

Interface Requirements

U.S. EPR FSAR Tier 2, Section 1.8-1, Interface Item No. 10-1 identifies a site interface requiring design details for the CWS including makeup water and water treatment. These site specific design details replace the conceptual design identified in the U.S. EPR FSAR. These site-specific design details are addressed in the COL information items below.

Combined License Information Items

- COL Information Item No. 10.4-3

COL Information Item No. 10.4-3 instructs a COL applicant that references the U.S. EPR design certification to provide a description of the site-specific portions of the CWS. The COL applicant provided site-specific supplemental information to address this COL information item as follows:

The CWS at CCNPP Unit 3 is a brackish-water closed-loop system. It has a hybrid mechanical draft cooling tower with plume abatement that rejects to the atmosphere up to 2.792×10^9 kcal/hr (1.108×10^{10} Btu/hr) of waste heat from the main condensers and the closed cooling water system during normal plant operation at full station load. The CWS has four 25 percent capacity vertical circulating water pumps housed in the circulating water pump building adjacent to the cooling tower, and has a nominal flow rate of 3,028,320 lpm (800,000 gpm). The pumped water travels through the tube side of three series connected steam condensers, and then returns to the CWS cooling tower via the CWS return piping. The cooling tower basin is sized to meet pump suction head requirements and to prevent formation of vortices at the pump suctions. The cooling tower basin level is controlled by a level control system. Also, there are two 100 percent capacity ACWS pumps that receive cooling water from the CWS and deliver the water to the CLCWS heat exchangers. Heat from the CLCWS is transferred to the ACWS and heated auxiliary cooling water is returned to the CWS downstream of the main condensers and then to the spray headers of the cooling tower. After passing through the cooling tower, the cooled water is recirculated back to the circulating water pump building to complete the cooling water loop.

The piping and instrumentation diagrams (P&IDs) for the CCNPP Unit 3 CWS are provided as FSAR Figures 10.4-1, and 10.4-2, “Circulating Water System P&ID (Turbine Building).” COL FSAR Figure 10.4-1 shows the system at the cooling tower and COL FSAR Figure 10.4-2 shows the system inside the Turbine Building.

The CCNPP Unit 3 cooling tower is a wet mechanical draft with plume abatement cooling tower, and is approximately 54 m (177 ft) high and 167 m (546 ft) wide at the base, and will be surrounded by a wind wall. The tower design specifications are shown in COL FSAR Table 10.4-1. The tower has the ability to function as an all-wet system or a hybrid system. As a hybrid system, the tower has a wet section for latent and sensible heat removal, and a dry sensible heat exchange section. The cooling tower has a blowdown system to maintain the concentration of dissolved solids in the CWS within the acceptable limits. Makeup water is required to replace the losses from evaporation, blowdown, and drift. Peak expected evaporative losses, blowdown, and maximum drift losses are depicted in COL FSAR Table 10.4-1. Approximately 179,375 lpm (47,383 gpm) of makeup water is taken from the Chesapeake Bay using three 50 percent capacity vertical makeup pumps housed in the CWS makeup water intake structure. To prevent debris from passing into the circulating water system, there are bar screens and traveling screens that remove debris prior to entering the makeup water pumps’ suction bells. Differential pressure across the traveling screens provides

indication of fouling and initiates the screen cleaning system consisting of two screen wash pumps.

The CWS makeup system is shown in COL FSAR Figure 10.4-3, "Circulating Water System Makeup System P&ID." The CWS makeup water intake structure is shown in COL FSAR Figures 10.4-4, "Circulating Water System Makeup Pump Intake Structure (Plan View)," and 10.4-5, "Circulating Water System Makeup Pump Intake Structure (Section View)." There is a retention basin to provide time for settling of suspended solids from the blowdown water, and to permit further chemical treatment of the wastewater, if required. The basin serves as a collection point for the cooling tower blowdown, essential service water system (ESWS) cooling tower blowdown, and other plant discharges prior to their discharge in the Chesapeake Bay. Discharge is routed through a seal well prior to entering the bay. The blowdown flowpath, including the retention basin and seal well is shown in COL FSAR Figure 10.4-6, "Circulating Water System Blowdown Flowpath."

The CWS outfall consists of a discharge header, diffuser nozzles, valves and associated instrumentation and controls for the control and monitoring of discharge flow into the Chesapeake Bay. One 76 cm (30 in.) diameter discharge header conveys flow from the CWS seal well into the bay. The piping extends approximately 168 m (550 ft) into the bay to ensure that at least 3 m (10 ft) of water exists above the top of the diffuser nozzles. Exit velocity for the discharge flow has been evaluated by the applicant to be adequate for thermal mixing purposes. The outfall piping is shown in COL FSAR Figure 10.4-7.

The staff reviewed the site-specific design information provided in the subsections of COL FSAR Section 10.4.5 of the COL application and finds that the COL applicant adequately addressed the final configuration of the CWS as specified in COL Information Item No. 10.4-1. The evaluation of the site-specific design against the regulatory criteria cited earlier is as follows:

The staff finds that the CCNPP Unit 3 CWS is a non-safety-related system and a non-seismically designed system, which is located in the Turbine Building. The staff concludes that failure of the CWS or its components due to natural phenomena will have no adverse affects on safety-related SSCs, since such components are not located in the Turbine Building. GDC 4 is satisfied because failure of CWS will not adversely impact safety related SSCs or SSCs important to safety.

The staff finds the site-specific portions of the CWS provided in the COL FSAR to be acceptable, since it provides adequate information to addresses COL Information Item No. 10.4-3. For additional staff evaluation of the adequacy of the CWS, see the staff's evaluation of COL information items below.

- COL Information Item No. 10.4-4

COL Information Item No. 10.4-4 instructs the COL applicant to provide methods for control of water chemistry, and to provide the specific chemicals used within the chemical treatment system. COL FSAR Section 10.4.5.2.2 describes the chemical treatment system and provides a description of the specific chemicals that will be used.

The COL applicant did not specifically identify all the treatment chemicals to be used for the circulating water. The COL applicant did identify that sodium hypochlorite and sodium bisulfite

may be used. The COL applicant did not identify the specific algaecide or non-oxidizing biocide, pH adjuster, scale inhibitor, or dispersant. Additionally, COL FSAR Section 10.4.5 did not identify any of the materials used for the CWS components. Therefore, in RAI 129, Question 10.04.05-2, the staff requested that the COL applicant provide additional information in order to evaluate compatibility of the treatment chemicals with the system materials. In a December 4, 2009, response to RAI 129, Question 10.04.05-2, the COL applicant provided additional information on the CWS materials and the treatment chemicals for the circulating water. In Item 1 of the RAI, the staff requested that the COL applicant identify the primary material types to be used for the piping and components of the CWS that will come in contact with the circulating water.

In response to Item 1, the COL applicant provided a proposed markup to COL FSAR Sections 10.4.1 and 10.4.5 providing additional details on the CWS materials.

The materials identified by the COL applicant for the circulating water system are concrete, titanium, duplex stainless steels, polymers, and carbon steel with an appropriate lining or coating. The staff finds that the metallic materials identified for the CWS are generally compatible with the circulating water, because the alloys that are identified have very low general corrosion rates, and are resistant to stress corrosion cracking in brackish water, and because all carbon steel components will have a lining material that is compatible with the circulating water. The staff determined that the non-metallic materials are compatible with the circulating water, because they consist of either concrete, fiber-reinforced plastic, or polymers, which do not corrode in brackish water. Although, the staff could not evaluate the compatibility of the CWS materials with some of the water treatment chemicals, since the chemicals are proprietary and could not be identified, the applicant did specify the necessary criteria to ensure compatibility with the system materials.

In Item 2 of RAI 129, Question 10.04.05-2, the staff requested that the COL applicant describe the criteria or process that will be used to ensure the compatibility of the proprietary corrosion inhibitor, scale inhibitor, and dispersant with the system materials. In a March 4, 2010, response to RAI 129, Question 10.04.05-2, the COL applicant stated that the water quality control focuses on corrosion/scaling control and preventing silt deposition and biofouling control. The COL applicant further stated that the chemicals chosen for use are compatible with the system metallurgy and are monitored for optimizing chemical feeds with periodic testing of metallic parts (using immersed metal coupons) to minimize metal loss (measured in mils per year) from the system. The staff determined that this response is acceptable, because compatibility with system metallurgy is part of the criteria, which will be verified by means of immersed metal coupons (to ensure the corrosion rates are acceptably low).

The staff determined that the COL applicant has satisfied COL Information Item No. 10.4-4, because it has identified the approach used to verify the compatibility of the chemicals to be used for chemical treatment of the CWS with the system materials. Although the COL applicant has not identified all the specific chemicals, the COL applicant has met the COL information item, because they have specified criteria to ensure compatibility with the system materials. Further, the types of chemicals identified perform the appropriate functions to minimize fouling of heat transfer surfaces and corrosion of the CWS materials. Although there are no specific regulatory criteria for the CWS materials and chemistry, SRP Section 10.4.5 states that GDC 4 establishes design limits for the CWS that will minimize the potential for creating adverse environmental conditions (e.g., flooding of systems and components important to safety). The staff concludes that the use of materials that are corrosion-resistant in the environment and

water treatment chemicals that are compatible with the system materials will support compliance with GDC 4 by minimizing the probability of catastrophic failures that could result in flooding.

- COL Information Item No. 10.4-5

COL Information Item No. 10.4-5 instructs the COL applicant that references the U.S. EPR design certification to provide the site-specific CWS piping design pressure. Under "Piping and Valves," in COL FSAR Section 10.4.5.2.2, the applicant stated that the piping design pressure is 1,034 kPa-gauge (150 psig). A piping design pressure of 1,034 kPa-gauge (150 psig) is typical for power plant CWS. The CWS piping design pressure is also consistent with the design pressures of the conceptual (non-site-specific) design of the U.S. EPR CWS. Therefore, the staff considers the CWS piping design pressure to be acceptable.

- COL Information Item No. 10.4-6

COL Information Item No. 10.4-6 instructs the COL applicant to provide site-specific design information for the vacuum priming system if a vacuum priming system is required. In COL FSAR Section 10.4.5.2.2, under "Vacuum Priming System," the COL applicant stated that a vacuum priming system is not required at CCNPP Unit 3. However, the COL applicant did not provide any justification for its statement. Therefore, in RAI 127, Question 10.04.05-1, the staff requested that the COL applicant provide additional information and/or clarification in this regard.

In a February 4, 2010, response to RAI 127, Question 10.04.05-1, the COL applicant provided additional details related to exclusion of the vacuum priming system. The COL applicant stated that the CWS is filled and vented using gravity fill from the circulating water pump forebay and using the pressure fill line with the CWS makeup water system pumps. The COL applicant proposed a revision to the COL FSAR to include this information. The staff has reviewed the COL applicant's response and determined that adequate details were provided to justify exclusion of the vacuum priming system. Therefore, the staff considers the COL applicant's response to this RAI to be acceptable. **RAI 127, Question 10.04.05-1 is being tracked as a confirmatory item.**

- COL Information Item No. 10.4-7

COL Information Item No. 10.4-7 instructs the COL applicant that references the U.S. EPR design certification to provide information to address the potential for flooding of safety-related equipment due to failures of the site specific CWS.

With respect to addressing COL Information Item No. 10.4.-7 and the requirements of GDC 4 as it relates to internal flooding, the COL applicant provided a site-specific discussion in COL FSAR Section 10.4.5.3. The COL applicant stated that internal flooding of the Turbine Building due to an unisolatable break or crack in a CWS pipe or failure of a CWS component, including expansion joints, does not result in damage to safety-related SSCs. The COL applicant further stated that below the main steam piping penetrations, no direct pathway through which flooding could spread exists between the Turbine Building and adjacent structures that house safety-related SSCs, and that flooding would exit the Turbine Building. However, the COL applicant did not provide a description of how the flood water would exit the Turbine Building (e.g., blowout panels or roll-up doors) before the water level would rise to flood through the main

steam line penetrations. Furthermore, the COL applicant did not provide a description of potential flooding hazards caused by collapse of the cooling tower, or failure of CWS yard piping. Therefore, in RAI 127, Question 10.04.05-1, the staff requested that the COL applicant provide additional information regarding the Turbine Building water level control and cooling tower and yard piping failure effects, as related to the CWS flood control.

In a February 4, 2010, response to RAI 127, Question 10.04.05-1, the COL applicant provided additional details related to the external yard flooding concerns. Two scenarios were evaluated: (a) the potential flooding from a cooling tower basin wall collapse, and (b) potential flooding from a CWS pipe failure in the yard. The first scenario, the cooling tower basin wall collapse, has been evaluated by the COL applicant, and due to the evaluation of the basin and site topography, they have found that flood water from this event would flow away from the power block and, therefore, would not affect safety-related SSCs. The COL applicant proposed a COL FSAR revision to include this additional information. The staff finds that because water from this event would flow away from, and therefore not affect safety-related SSCs, the COL applicant's response in regard to this scenario is acceptable. **RAI 127, Question 10.04.05-1 is being tracked as a confirmatory item for the first scenario.**

To address the second scenario, the CWS pipe failure in the yard, the COL applicant performed an evaluation of a pipe break near the non-safety-related Switchgear Building. According to the COL applicant's response, the CWS piping in the area selected for evaluation is at the closest point to the power block. In this event, water flows away from the power block into drainage ditches. The COL applicant stated that elevation differences prevent water from reaching safety-related equipment. The COL applicant concludes that flood water from a postulated break of a CWS pipe in the yard area will not reach the power block area and will not create a flood hazard to safety-related SSCs. The COL applicant proposed a COL FSAR revision to include this additional information. The staff finds that because water from this event would flow away from, and therefore not affect safety-related SSCs, the applicant's response in regard to this scenario is acceptable. **RAI 127, Question 10.04.05-1 is being tracked as a confirmatory item for the second scenario.**

The February 4, 2010, response also included information related to the Turbine Building water level control. The Turbine Building sumps are provided with level instrumentation to control the pumps and to alert operators of a high level condition on increasing sump level. It was stated in the response that these sumps are not required or credited with terminating a flooding event in the Turbine Building to protect safety-related SSCs. However, the COL applicant did not provide information on how the flood water would exit the Turbine Building before the water level would rise to flood through the main steam line penetrations. Therefore, in follow-up RAI 246, Question 10.04.05-1, the staff requested this information. **RAI 246, Question 10.04.05-4 is being tracked as an open item.**

- COL Information Item No. 14.2-5

COL Information Item No. 14.2-5 instructs the COL applicant that references the U.S. EPR design certification to provide the site-specific test information for the circulating water supply system. Revision 6 of COL FSAR Section 14.2.14.7, "Circulating Water Supply System," provides site-specific test information to demonstrate that the CWS will perform as designed. The staff reviewed this section and determined that it meets COL Information Item No. 14.2-5, because it delineates the objectives, requirements, test methods, data required, and acceptance criteria for the CWS, and is therefore acceptable.

Site-Specific Information Replacing Conceptual Design Information

The evaluation of the conceptual design information on the chemical treatment system is addressed by the evaluation of COL Information Item No. 10.4-4, because the COL information item resolution essentially addresses the same information as the conceptual design information in greater detail.

10.4.10.5 *Post Combined License Activities*

There are no post-COL activities related to this section.

10.4.10.6 *Conclusions*

The staff reviewed the COL application and checked the referenced U.S. EPR FSAR. The staff's review confirmed that the COL applicant addressed the required information relating to the circulating water system, and there is no outstanding information expected to be addressed in the COL FSAR related to this section.

The staff reviewed the information in the U.S. EPR FSAR on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the circulating water system incorporated by reference in the COL FSAR have been documented in the staff's safety evaluation report on the design certification application for the U.S. EPR. The SER on the U.S. EPR is not yet complete. The staff will update this report to reflect the final disposition of the design certification application.

The staff reviewed the CWS documented in COL FSAR Section 10.4.5, and the COL applicant's RAI responses as they relate to CWS flooding concerns. On the basis of this review, the staff determined that the CCNPP Unit 3 CWS continues to meet all acceptance criteria documented in the U.S. EPR FSAR SER, and is therefore considered acceptable. However, as a result of the open items identified above, the staff is unable to finalize its conclusions on the CWS in accordance with NRC requirements.

The staff finds that the COL applicant has appropriately addressed COL Information Item No. 10.4-4, because the circulating water system materials, with the addition of water treatment chemicals as described in the COL FSAR, will provide reasonable assurance that corrosion-related failures and scaling are minimized, thus supporting compliance with GDC 4.

10.4.11 Condensate Polishing System

The condensate polishing system is part of the CCS and, as indicated in NUREG-0800, the purpose of the CCS is to remove dissolved and suspended impurities resulting from corrosion caused by condenser or steam generator leaks that could be introduced into the CCS by carryover from the main steam system. The CCS is not necessary for safe-shutdown or mitigation of postulated accidents, but it is important in maintaining the secondary coolant quality in pressurized water reactors.

COL FSAR Section 10.4.6, "Condensate Polishing System," incorporates by reference, with no departures or supplements, U.S. EPR FSAR Tier 2, Section 10.4.6. The staff reviewed the COL application and checked the referenced FSAR to ensure that no issues relating to this

section remained for review. The staff's review confirmed that there are no outstanding issues related to this section.

The staff reviewed the information in the U.S. EPR FSAR Tier 2, Section 10.4.6 on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the condensate polishing system incorporated by reference with no departures in the COL FSAR have been documented in the staff SER on the design certification application for the U.S. EPR. The SER on the U.S. EPR FSAR is not yet complete. The staff will update Section 10.4.6 of this report to reflect the final disposition of the design certification application.

10.4.12 Condensate and Feedwater System

The condensate and feedwater system provides feedwater to the steam generators at the required temperature, pressure and flow rate. Condensate is pumped from the main condenser hotwell by the condensate pumps, passes through the low pressure feedwater heaters and the deaerator-feedwater storage tank to the main feedwater (MFW) pumps, and is then pumped through the high pressure feedwater heaters to the SGs. The CFS includes a number of stages of regenerative feedwater heating and provisions for maintaining feedwater quality. It also includes extraction piping from the steam turbines and feedwater heater vents and drains, and drains from the moisture separator reheaters.

COL FSAR Section 10.4.7, "Condensate and Feedwater System," incorporates by reference, with no departures or supplements, U.S. EPR FSAR Tier 2, Section 10.4.7. The staff reviewed the COL application and checked the referenced FSAR to ensure that no issues relating to this section remained for review. The staff's review confirmed that there are no outstanding issues related to this section.

The staff reviewed the information in the U.S. EPR FSAR Tier 2, Section 10.4.7 on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the condensate and feedwater system incorporated by reference with no departures in the COL FSAR have been documented in the staff SER on the design certification application for the U.S. EPR. The SER on the U.S. EPR FSAR is not yet complete. The staff will update Section 10.4.7 of this report to reflect the final disposition of the design certification application.

10.4.13 Steam Generator Blowdown System (PWR)

The steam generator blowdown system assists in maintaining the chemical characteristics of the secondary water within permissible limits. The SGBS provides the capability for continuous hot blowdown of the secondary side of the steam generators. The SGBS includes equipment for heat recovery, purification, and reuse of SG blowdown.

COL FSAR Section 10.4.8 incorporates by reference, with no departures or supplements, U.S. EPR FSAR Tier 2, Section 10.4.8, "Steam Generator Blowdown System (PWR)." The staff reviewed the COL application and checked the referenced FSAR to ensure that no issues relating to this section remained for review. The staff's review confirmed that there are no outstanding issues related to this section.

The staff reviewed the information in the U.S. EPR FSAR Tier 2, Section 10.4.8 on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the steam generator blowdown system incorporated by reference in the COL FSAR have been

documented in the staff SER on the design certification application for the U.S. EPR. The SER on the U.S. EPR FSAR is not yet complete. The staff will update Section 10.4.8 of this report to reflect the final disposition of the design certification application.

10.4.14 Emergency Feedwater System

The emergency feedwater system supplies water to the steam generators to restore and maintain water level and to remove decay heat following the loss of normal feedwater during design basis transient and accident conditions. This removes heat from the reactor coolant system, which is first transferred to the secondary side via the SGs, then discharged as steam to the condenser or via the SG main steam relief valves (MSRVs).

COL FSAR Section 10.4.9, "Emergency Feedwater System," incorporates by reference, with no departures or supplements, U.S. EPR FSAR Tier 2, Section 10.4.9. The staff reviewed the COL application and checked the referenced FSAR to ensure that no issues relating to this section remained for review. The staff's review confirmed that there are no outstanding issues related to this section.

The staff reviewed the information in the U.S. EPR FSAR Tier 2, Section 10.4.9 on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the emergency feedwater system incorporated by reference in the COL FSAR have been documented in the staff SER on the design certification application for the U.S. EPR. The SER on the U.S. EPR FSAR is not yet complete. The staff will update Section 10.4.9 of this report to reflect the final disposition of the design certification application.