10.0 STEAM AND POWER CONVERSION SYSTEM

10.0.1 Introduction

This section of the South Texas Project (STP) Units 3 and 4 combined license (COL) Final Safety Analysis Report (FSAR) provides a list of the Tier 1 and Tier 2 departures that have administrative impacts on Chapter 10. The U.S. Nuclear Regulatory Commission (NRC) staff's evaluation of these proposed departures in Chapter 10 is in the following sections.

10.0.2 Summary of Application

Section 10.0 of the STP Units 3 and 4 COL FSAR Revision 12, incorporates by reference Section 10.0 of the certified U.S. Advanced Boiling-Water Reactor (ABWR) design control document (DCD), Revision 4, referenced in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Appendix A, "Design Certification Rule for the U.S. Advanced Boiling Water Reactor." In addition, in FSAR Section 10.0, the applicant provides the following:

Tier 1 Departure

- STD DEP T1 3.4-1 Safety-Related I&C Architecture

This departure modifies the design of certain devices, functions, and standards related to the essential multiplexing system (EMS) and safety system logic and controls (SSLC). The departure also updates the ABWR DCD design descriptions that reflected outdated technology.

Tier 2 Departures Not Requiring Prior NRC Approval

- STP DEP 9.2-3 Turbine Building Cooling Water System

This departure increases the heat removal capacity of each of the three turbine building cooling water (TCW) system heat exchangers and the flow rate of each of the three TCW pumps due to increased heat loads in turbine island equipment.

- STP DEP 10.1-1 Turbine Pressure Description

This departure corrects the description of the inlet pressure at the turbine main steam valves for the ABWR. Corrections in Section 10.1 of the FSAR reflect this departure.

- STP DEP 10.1-2 Steam Cycle Diagram

This departure revises FSAR Figure 10.1-1 to reflect the system configuration of the STP Units 3 and 4 steam and power conversion system, which consists of the addition of four condensate booster pumps, three low-pressure heater drain tanks, and a separate No. 1 feedwater heater drain cooler.

- STP DEP 10.1-3 Rated Heat Balance

This departure provides a new Figure 10.1-2 that is consistent with the changes in Figure 10.1-1 and with the new Toshiba turbine design described in FSAR Chapter 10.2.

- STP DEP 10.1-4 Valve Wide Open Heat Balance

This departure provides a new Figure 10.1-3 that is consistent with changes in Figure 10.1-1 and with the new Toshiba turbine design described in FSAR Chapter 10.2.

- STP DEP 10.2-1 Turbine Design

See Section 10.2.2 of this safety evaluation report (SER) for a detailed description of this departure.

- STP DEP 10.4-2 Main Condenser

See Subsection 10.4.1.2 of the SER for a detailed description of this departure.

- STD DEP 10.4-5 Condensate and Feedwater System

See Subsection 10.4.7.2 of the SER for a detailed description of this departure.

10.0.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is documented in NUREG-1503, "Final Safety Evaluation Report Related to the Certification of the Advanced Boiling-Water Reactor Design," (July 1994) (FSER related to the ABWR DCD). In addition, the relevant requirements of the Commission regulations for the steam and power conversion system, and the associated acceptance criteria, are in Section 10.0 of NUREG–0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, (LWR Edition)," the Standard Review Plan (SRP).

In accordance with Section VIII, "Processes for Changes and Departures," of, "Appendix A to Part 52-Design Certification Rule for the U.S. Advanced Boiling Water Reactor," the applicant identifies Tier 1 and Tier 2 departures. Tier 1 departures require prior NRC approval and are subject to the requirements of 10 CFR Part 52, Appendix A, Section VIII.A.4. Tier 2 departures not requiring prior NRC approval are subject to the requirements of 10 CFR Part 52, Appendix A, Section VIII.B.5, which are similar to the requirements of 10 CFR 50.59.

10.0.4 Technical Evaluation

As documented in NUREG–1503, NRC staff reviewed and approved Section 10.0 of the certified ABWR DCD. The staff reviewed Section 10.0 of the STP Units 3 and 4 COL FSAR and checked the referenced ABWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ABWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the required information relating to the principal design features of the steam and power conversion system.

The staff reviewed the following information in COL FSAR Section 10.0:

[1] See "*Finality of Referenced NRC Approvals*" in SER Section 1.1.3, for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

Tier 1 Departure Requiring Prior NRC Approval

- STD DEP T1 3.4-1 Safety-Related I&C Architecture

This departure modifies the design of certain devices, functions, and standards related to the EMS and SSLC. The departure also updates the ABWR DCD design descriptions that reflected outdated technology. The technical evaluation of this departure is in Chapter 7 of this SER. Changes to Chapter 10 resulting from the implementation of this departure are incorporated in FSAR Subsection 10.4.5.5, “Instrumentation Applications.”

Tier 2 Departures Not Requiring Prior NRC Approval

- STP DEP 9.2-3 Turbine Building Cooling Water System

This departure increases the heat removal capacity of each of the three TCW system heat exchangers and the flow rate of each of the three TCW pumps. This departure is also evaluated in Section 9.2.14 of this SER.

The applicant’s evaluation determined that this departure does not require prior NRC approval in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5. Within the review scope of this section, the staff found it reasonable that this departure does not require prior NRC approval. The applicant's process for evaluating departures and other changes to the DCD is subject to NRC inspections.

- STP DEP 10.1-1 Turbine Pressure Description

This departure describes the inlet pressure at the turbine main steam valves for STP Units 3 and 4.

The applicant's evaluation determined that this departure does not require prior NRC approval in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5. Within the review scope of this section, the staff found it reasonable that this departure does not require prior NRC approval. The applicant's process for evaluating departures and other changes to the certified ABWR DCD is subject to NRC inspections.

- STP DEP 10.1-2 Steam Cycle Diagram

This departure revises FSAR Figure 10.1-1 to reflect the system configuration of the STP Units 3 and 4 steam and power conversion system, which was revised due to the use of the new Toshiba turbine design described in FSAR Section 10.2. This change includes the addition of four condensate booster pumps, three low-pressure heater drain tanks, and a separate No. 1 feedwater heater drain cooler.

The applicant's evaluation determined that this departure does not require prior NRC approval in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5. Within the review scope of this section, the staff found it reasonable that this departure does not require prior NRC approval. The applicant's process for evaluating departures and other changes to the DCD is subject to NRC inspections.

- STP DEP 10.1-3 Rated Heat Balance

FSAR Figure 10.1-2 shows changes that are consistent with Figure 10.1-1 and with the new Toshiba turbine design described in Section 10.2 of the FSAR.

The applicant's evaluation determined that this departure does not require prior NRC approval in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5. Within the review scope of this section, the staff found it reasonable that this departure does not require prior NRC approval. The applicant's process for evaluating departures and other changes to the certified ABWR DCD is subject to NRC inspections.

- STP DEP 10.1-4 Valve Wide Open Heat Balance

FSAR Figure 10.1-3 shows changes that are consistent with Figure 10.1-1 and with the new Toshiba turbine design described in FSAR Chapter 10.2.

The applicant's evaluation determined that this departure does not require prior NRC approval in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5. Within the review scope of this section, the staff found it reasonable that this departure does not require prior NRC approval. The applicant's process for evaluating departures and other changes to the certified ABWR DCD is subject to NRC inspections.

- STP DEP 10.2-1 Turbine Design

See Sections 10.2.2 and 10.2.4 of the SER for a detailed description and evaluation of this departure.

- STP DEP 10.4-2 Main Condenser

See Subsections 10.4.1.2 and 10.4.1.4 of the SER for a detailed description and evaluation of this departure.

- STD DEP 10.4-5 Condensate and Feedwater System

See Subsections 10.4.7.2 and 10.4.7.4 of the SER for a detailed description and evaluation of this departure.

10.0.5 Post Combined License Activities

There are no post COL activities related to this section.

10.0.6 Conclusion

The NRC staff’s finding related to information incorporated by reference is in NUREG–1503. NRC staff reviewed the application and checked the referenced DCD. The staff’s review confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix A, Section VI.B.1, all nuclear safety issues relating to the steam and power conversion system that were incorporated by reference have been resolved.

In addition, the staff compared the additional information in the COL application to the relevant NRC regulations and the guidance in NUREG–0800. The staff's review concluded that the applicant has provided sufficient information to satisfy NRC regulations, and found it reasonable that the identified Tier 2 departures are characterized as not requiring prior NRC approval per 10 CFR Part 52, Appendix A, Section VIII.B.5.

10.1 Summary Description

This section of the FSAR describes the standard design features for the steam and power conversion system. The COL applicant proposes DCD departures to update the steam and power conversion technology associated with the ABWR design. The staff's evaluation of these proposed departures is in the following sections of Chapter 10 in this SER.

10.2 Turbine Generator

10.2.1 Introduction

This section of the FSAR provides information on the turbine generator (TG) system that is used to convert the energy in the steam from the nuclear steam supply system (NSSS) into electrical energy. The discussion includes information related to the TG system equipment and design bases, operation, turbine overspeed protection, material selection, inspection and testing, and programs that ensure the integrity of the turbine rotor.

10.2.2 Summary of Application

Section 10.2 of the STP Units 3 and 4 COL FSAR Revision 12, incorporates by reference Section 10.2 of the certified ABWR DCD, Revision 4, referenced in 10 CFR Part 52, Appendix A. In addition, in FSAR Section 10.2, the applicant provides the following:

Tier 1 Departure

- STD DEP T1 2.4-2 Feedwater Line Break Mitigation

In FSAR Tier 2, Subsection 10.2.2.1, the applicant adds this departure to indicate that the turbine building contains the safety-related electrical switchgear and trip breakers for the mitigation of a postulated feedwater line break. The design and location of these breakers are described in FSAR Tier 2, Subsection 8.3.1.1.1, "Medium Voltage Class 1E Power Distribution System," and are therefore not evaluated in this section of the SER.

Tier 2 Departures Not Requiring Prior NRC Approval

- STP DEP 1.1-2 Dual Units at STP 3 & 4

The referenced ABWR DCD is based on a single-unit site. This departure identifies STP Units 3 and 4 as a dual-unit site. This departure is included in FSAR Chapter 10 because the change to a dual-unit site affects the bulk hydrogen and CO_2 system described in FSAR Subsection 10.2.2.2 and illustrated in Figure 10.2-4.

- STP DEP 10.2-1 Turbine Design

This departure revises the turbine design by adding two reheat stages in place of a single stage reheat described in the ABWR DCD. The applicant is proposing this change to improve the

turbine-steam cycle efficiency. The ABWR DCD reheater shells are replaced with symmetrically combined reheater shells consisting of two stages of four U-tube bundles, which reduces the number of moisture separator reheaters (MSRs) from four in the DCD to two for STP Units 3 and 4. In Revision 6 of the COL application, the applicant revises the description of the combined intermediate valves (CIVs) to state that each CIV consists of two valves—an intermediate stop valve (ISV) and an intercept valve (IV)—each with its own valve disk and actuator contained in a common valve body to provide enhanced performance, reliability, and maintainability. As a result of these significant technical modifications, the applicant revises several subsections of DCD Tier 2, Section 10.2 to provide clarifications and changes based on the design, procedures, and vendor/manufacturer recommendations.

- STP DEP 10.2-2 Turbine Rotor Design

This departure describes the design change to select a monoblock turbine rotor. The departure also clarifies the descriptions of turbine overspeed and design speed and their relationship to turbine rotor integrity.

- STP DEP 10.2-3 Turbine Digital Control

This departure implements the following modifications to the turbine control and overspeed protection systems: (a) electronic monitoring for turbine control and overspeed protection; and (b) the use of two electrical trip systems, one for primary and the other for emergency overspeed trip functions that use diverse hardware and software/firmware functions. Both systems use two-out-of-three logic employed in each trip circuitry for additional reliability. In addition, FSAR Subsection 10.2.2.7 revises the testing frequency for main turbine valves, including a verification of the fast-closure function.

- STP DEP 10.2-4 Bulk Hydrogen Storage

This departure is related to Departure STP DEP 1.1-2, which makes STP Units 3 and 4 a dual-unit site. As stated above, the change to a dual-unit site affects the bulk hydrogen and CO_2 system described in FSAR Subsection 10.2.2.2 and illustrated in FSAR Figure 10.2-4. FSAR Subsection 10.2.2.2 states that a single bulk hydrogen storage facility will be used to store compressed hydrogen gas cylinders for both units, and that this storage facility will be located at least 100 meters (m) (328 feet [ft]) from any safety-related building.

- STD DEP Admin

This departure revises the final paragraph of Subsection 10.2.2.1 of the DCD and makes minor editorial changes in Figure 10.2-1 of the FSAR. These changes do not affect the TG system design and method of performing or controlling a design function of the TG components and instrumentation located in the TG building.

COL License Information Items

- COL License Information Item 10.1 Low Pressure Turbine Disk Fracture Toughness

This COL license information item addresses the requirement to update the FSAR to identify the turbine material property data that support the material properties used in the specified turbine rotor design.

- COL License Information Item 10.2 Turbine Design Overspeed

The applicant provides site-specific supplemental information in Subsection 10.2.5.2 to address COL License Information Item 10.2 of the referenced ABWR DCD. The applicant states that the highest anticipated speed resulting from the loss of load is normally in the range of 105 to 108 percent of the turbine-rated speed. Turbine components are designed so that calculated stresses do not exceed the minimum material strength at 120 percent of the rated speed. Factory balance verification tests the rotors at 120 percent of the rated speed, which is 12 percent greater than the highest anticipated speed resulting from the loss of load.

- COL License Information Item 10.3 Turbine Inservice Test and Inspection

To address COL License Information Item 10.3, the applicant provides site-specific supplemental information in FSAR Subsection 10.2.3.6 for turbine inservice test and inspection requirements.

10.2.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is in NUREG-1503. In addition, the relevant requirements of the Commission regulations for the turbine generator, and associated acceptance criteria, are in Sections 10.2 and 10.2.3 of NUREG–0800.

In accordance with Section VIII, "Processes for Changes and Departures," of, "Appendix A to Part 52-Design Certification Rule for the U.S. Advanced Boiling Water Reactor," the applicant identifies Tier 1 and Tier 2 departures. Tier 1 departures require prior NRC approval and are subject to the requirements of 10 CFR Part 52, Appendix A, Section VIII.A.4. Tier 2 departures not requiring prior NRC approval are subject to the requirements of 10 CFR Part 52, Appendix A, Section VIII.B.5, which are similar to the requirements of 10 CFR 50.59.

10.2.4 Technical Evaluation

As documented in NUREG–1503, NRC staff reviewed and approved Section 10.2 of the certified ABWR DCD. The staff reviewed Section 10.2 of the STP Units 3 and 4 COL FSAR and checked the referenced DCD to ensure that the combination of the information in the ABWR DCD and the information in the COL FSAR appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the required information relating to the principal design features of the TG system.

The staff reviewed the following information in COL FSAR:

Tier 1 Departure

- STD DEP T1 2.4-2 Feedwater Line Break Mitigation

This departure is evaluated in Chapter 8 and Chapter 14 of this SER and is therefore not evaluated in this SER section. A paragraph is added to Subsection 10.2.2.1 of the FSAR to reflect the addition of safety-related equipment in the turbine building as a result of this

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.1.3, for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

departure. The technical evaluation of this departure is in Section 8.3.1 and Chapter 14 of this SER.

Tier 2 Departures Not Requiring Prior NRC Approval

- STP DEP 1.1-2 Dual Units at STP 3 & 4

This departure references a two-unit site as opposed to the one-unit site of the certified ABWR DCD. The applicant's evaluation determined that this departure does not require prior NRC approval in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5. Within the review scope of this section, the staff found it reasonable that this departure does not require prior NRC approval. The applicant's process for evaluating departures and other changes to the DCD is subject to NRC inspections.

- STP DEP 10.2-1 Turbine Design

In this departure, the applicant states that significant technical differences exist between the latest TG system design of STP Units 3 and 4 and the referenced ABWR DCD. Therefore, the applicant has revised several subsections in Section 10.2 of the ABWR DCD including Subsection 10.2.2.1, "General Description"; Subsection 10.2.2.2, "Component Description"; Subsection 10.2.2.3, "Normal Operation"; Subsection 10.2.3.5, "Preservice Inspection"; and Subsection 10.2.3.6, "Inservice Inspection."

The applicant selected a Toshiba TG system for STP Units 3 and 4 consisting of a 188.5 radians-per-second (rads/s) (1,800 revolutions-per-minute [RPM]) turbine, a generator, an exciter, MSRs, controls, and associated subsystems. The turbine consists of one double-flow, high-pressure (HP) turbine and three double-flow, low-pressure (LP) turbines. Two combined MSRs perform moisture separation and reheating. The generator is a direct-driven, three-phase, 60-Hz, 188.5 rads/s (1,800 RPM) synchronous generator with a water-cooled armature winding and a hydrogen-cooled rotor.

NRC staff reviewed Departure STP DEP 10.2-1 and the STP Units 3 and 4 FSAR sections cited above, which reflect the modifications described in the departure. Revisions to the FSAR sections include adding two MSR reheat stages in place of a single-stage reheat in the ABWR DCD. This revision replaces the DCD reheaters with symmetrically combined reheater shells of two stages of four U-tube bundles and reduces the MSRs from four in the ABWR DCD to two. The applicant also states in the departure that two stages of reheat in the steam cycle will improve turbine steam cycle efficiency. The applicant further states in the evaluation summary of the departure that these changes do not result in any functional departure from the DCD. These changes also do not adversely affect the capability of the safety-related structures, systems, and components (SSCs) to perform their safety functions in case of any accident. Furthermore, the changes do not impact any transient analysis assumptions.

The staff found that the modifications identified in Subsections 10.2.2.1, 10.2.2.2, and 10.2.2.3 of the FSAR do not adversely affect safety-related SSCs and their functional capability in case of an operational transient. These are non-safety-related components that do not perform any safety-related functions. More importantly, the modifications identified in the departure do not impact the regulatory basis of this STP TG system. Thus, the staff found Departure STP DEP 10.2-1 acceptable, as it relates to modifications to Subsections 10.2.2.1 through 10.2.2.3 of the DCD.

Departure STP DEP 10.2-1 includes revisions to Subsections 10.2.3.5 and 10.2.3.6 of the DCD. For example, Subsection 10.2.3.5 of the FSAR indicates that the rotor forgings may or may not be bored to remove defects, that the applicant should obtain material for testing, and that the applicant should conduct ultrasonic inspection. The staff conducted an audit to confirm that the applicant had evaluated these aspects of Departure STP DEP 10.2-1 according to the criteria in 10 CFR Part 52, Appendix A, Section VIII.B.5. During the audit, the applicant described the evaluation process and technical input to the evaluation. Based on the audit, the staff concluded that the applicant meets the regulatory requirements for evaluating these departures; therefore STD DEP 10.2-1 can be performed without prior NRC approval and no additional NRC review is required. The audit process and results are documented in the NRC letter dated January 25, 2010 (ML093360537).

- STP DEP 10.2-2 Turbine Rotor Design

Departure STP DEP 10.2-2 includes revisions to DCD Subsection 10.2.3.1, "Materials Selection"; Subsection 10.2.3.2, "Fracture Toughness"; Subsection 10.2.3.3 "High Temperature Properties"; and Subsection 10.2.3.4, "Turbine Design." For large monoblock forgings, the proposed values of 4.4 degrees Celsius (C) (40 degrees Fahrenheit [F]) and 61 Newton-meters (Nm) (45 foot-pounds [ft-lbs]) for a fracture appearance transition temperature (FATT) (50-percent FATT) and Charpy V-notch (C_v) energy at the minimum operating temperature, respectively, are different from the SRP criteria of -17.8 degrees C (0 degrees F) and 81.3 Nm (60 ft-lbs).

The applicant's evaluation determined that this departure does not require prior NRC approval, in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5, which states in part that an applicant may depart from Tier 2 information without prior NRC approval unless the proposed departure (1) involves a change to or departure from Tier 1 or Tier 2* information; (2) involves a change to or departure from technical specifications (TS); or (3) requires a license amendment. Because the subject departure involves a change only to Tier 2 information and is not applicable to Tier 1 or Tier 2* information or to the TSs, the staff evaluated whether the departure involves a license amendment.

10 CFR Part 52, Appendix A, Section VIII.B.5.b states that a proposed departure from Tier 2, other than one affecting resolution of a severe accident issue identified in the plant-specific FSAR, requires a license amendment if any of the eight criteria under Section VIII.B.5.b.1 through Section VIII.B.5.b.8 are met. The staff conducted an audit at the STP facility to confirm that the applicant had evaluated the Tier 2 departures for Subsections 10.2.3.1 through 10.2.3.4 according to the criteria in 10 CFR Part 52, Appendix A, Section VIII.B.5.b. During the audit, the applicant described the evaluation process and provided supporting documentation. The staff noted that the applicant had performed and documented the evaluations to determine whether a license amendment is required in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5.b. Based on the audit, the staff concluded that the applicant had satisfactorily evaluated the subject departure in accordance with the requirements of 10 CFR Part 52, Appendix A, Section VIII.B.5.b.1 through Section VIII.B.5.b.8, and no license amendment is necessary. The audit process and results are documented in ML093360537.

The staff's findings agree that the departure does not involve a change to Tier 1 or Tier 2* information or to the TSs and does not require a license amendment. Therefore, the staff concluded that the equipment changes under Departure STP DEP 10.2-2 can be performed without prior NRC approval and therefore, the departure requires no further NRC review.

- STP DEP 10.2-3 Turbine Digital Control

NRC staff reviewed Departure STP DEP 10.2-3, which replaces DCD Subsection 10.2.2.4, "Turbine Overspeed Protection System," in its entirety and modifies Subsection 10.2.2.5, "Turbine Protection Systems," and Subsection 10.2.2.7, "Testing."

In FSAR Subsection 10.2.2.4, the applicant states that the normal speed control system is the first line of defense against the turbine overspeed. Also, the applicant notes that the system includes the turbine main control valves (CVs); CIVs; extraction system non-return valves; and fast-acting, valve-closing functions within the electro-hydraulic control (EHC) system. The normal speed control unit utilizes three speed signals, and the loss of any two signals initiates a turbine trip via the emergency trip system (ETS). Furthermore, the applicant states that an increase in speed above the setpoint closes the control and intercept valves in proportion to the increase.

The applicant's evaluation determined that this departure does not require prior NRC approval in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5. The staff reviewed COL application Part 7, "Departures Report," regarding this departure and was unable to determine whether the departure meets Criteria (2), (4), and (6) in Appendix A, VIII.B.5.b or adequately addresses General Design Criterion (GDC) 4, "Environmental and dynamic effects design bases." Therefore, the staff issued request for additional information (RAI) 10.02-1 requesting the applicant to provide a clarification and/or additional information with respect to the details on the normal overspeed protection of the TG system.

The applicant's response to RAI 10.02-1 dated August 28, 2009 (ML092450155), describes the TG normal speed control system. The applicant states that the turbine EHC system closes the control and intercept valves in proportion to the increase in speed above the speed setpoint. The applicant adds that the EHC fully shuts off steam to the HP turbine at approximately 105 percent of its rated speed by closing the turbine control valves, and the EHC fully shuts off steam to the LP turbines at about 107 percent of the rated speed by closing the intercept valves. The normal speed control function is supplemented by the power-load unbalance (PLU) function. The PLU uses the difference between the turbine mechanical power and load indications to control the overspeed in the event of a full load rejection. Redundant measurements of the HP turbine exhaust steam pressure and generator current are used as inputs to the PLU function. Upon a prescribed PLU condition approximately greater than 40 percent, the fast-acting solenoid valves of the CVs and the IVs are energized to trip these valves to prevent rapid turbine acceleration. The applicant provides a markup of the revised FSAR Tier 2, Subsection 10.2.2.4 to reflect this response.

The staff evaluated the applicant's response to RAI 10.02-1 in conjunction with Revision 3 of FSAR Tier 2, Subsection 10.2.2.4. The staff found that for the normal speed control mode, the steam supply to the HP and LP turbines completely shuts-off at 105 percent and 107 percent of the turbine-rated speed, respectively. However, the applicant did not address the reason for eliminating the 103 percent value that is recommended in the SRP. The staff also noted that the ABWR DCD recommends closing the control and intercept valves when the main turbine reaches approximately 104 percent of its rated speed. Furthermore, for normal speed control, the system is supposed to re-open and modulate the control and intercept valves to achieve and maintain 100 percent of the rated speed at certain points of the normal overspeed.

Based on the above response, RAI 10.02-1 was closed and unresolved. The staff issued RAI 10.02-3 requesting the applicant to further clarify this issue. The resolution of this RAI was tracked as Open Item 10.02-3 in the SER with open items.

In the response to RAI 10.02-3 dated May 10, 2010 (ML102030020), the applicant provides a revised response to RAI 10.02-1. In this response, the applicant provides additional information stating that the Toshiba EHC system is not designed to cut off steam to the turbine at 103 percent of the rated speed. For normal speed control, the EHC system tends to close the control and intercept valves in proportion to the increase in speed above the speed setpoints. The applicant adds that at 105 percent of the turbine-rated speed, the EHC fully shuts off the steam to the HP turbine by closing the CVs; whereas at 107 percent of the rated speed, the EHC fully cuts off the steam to the LP turbines by closing the IVs. Before these setpoints are reached, the CVs begin to close when the turbine speed exceeds approximately 100.5 percent. Furthermore, the speed regulation of 5 percent for the CVs is based on considerations of operating experience, speed control stability, reactor pressure control stability, and preventing the turbine from reaching the peak transient speed of 110 percent of the rated speed upon load rejection. The staff reviewed the applicant's response and found the elimination of the 103 percent value acceptable, because the applicant's approach described above provides a level of normal overspeed protection equivalent to the 103 percent that is recommended in SRP Section 10.2, "Review Procedures," Item 2.A.i. Thus, the staff's concern in RAI 10.02-3 is resolved.

In addition, the applicant also states in the response to RAI 10.02-3 that the normal speed control system is supplemented by the PLU function. The PLU uses the difference between the turbine power and load indications to limit the overspeed in the event of a full load rejection. The HP turbine exhaust pressure indicates the turbine power, and the generator current indicates the load. The PLU actuation causes a fast closure of the turbine control and intercept valves when the difference between the power and the load exceeds approximately 40 percent to limit the overspeed in the event of a full load rejection.

The staff issued RAI 10.02-5 requesting the applicant to provide additional information on how the PLU function supplements the function of normal speed control, and its failure affects. In the response to RAI 10.02-5 dated February 21, 2011 (ML110550621), the applicant provides the proposed changes to FSAR Subsection 10.2.2.4 and states that a load rejection below the 40 percent power (the reactor trip threshold) will not result in a PLU actuation and subsequent control valve fast closure. Instead, it will result in (1) a normal closure of the control valve under normal servo control to prevent the turbine speed from exceeding the primary overspeed trip setpoint of 110 percent; and (2) opening the turbine bypass valves for reactor pressure control. The normal speed control system, including the PLU function, is designed to limit the peak overspeed resulting from a loss of the full load to at least 2 percent below the overspeed trip setpoint. Typically, this peak speed ranges from 105 to 108 percent of the rated speed. The applicant's proposed changes to FSAR Subsection 10.2.2.4 also state that the PLU supplements the normal speed control function, and together they constitute the first line of defense against the turbine overspeed. The primary and emergency overspeed systems (whose setpoints are 110 and 111 percent of the rated speed, respectively) constitute the second line of defense against the overspeed. Furthermore, the applicant states that based on a plant-specific analysis, the highest anticipated speed resulting from a loss of load ranges from 105 to 108 percent of the rated turbine speed. Accordingly, the design overspeed of 120 percent of the rated speed is approximately 12 percent above this highest anticipated speed.

The staff reviewed the applicant's responses to RAIs 10.02-3 and 10.02-5 and found them acceptable because they clarify how the PLU supplements the function of normal overspeed control. Thus, the staff's question regarding the PLU in RAIs 10.02-3 and 10.02-5 is resolved and Open Item 10.02-3 is resolved and closed. The staff confirmed that Revision 6 of COL FSAR, Subsection 10.2.2.4 includes the changes identified in the responses to RAIs 10.2-3 and 10.02-5. Therefore, RAIs 10.02-1, 10.02-3 and 10.02-5 are resolved and closed.

Additionally, FSAR Subsection 10.2.2.4 states that if the normal speed control system and the PLU function should fail, the turbine primary and emergency overspeed trip devices will close the steam admission valves (turbine stop, control, intermediate stop, and intercept valves) and the extraction steam non-return valves through the actuation of the air relay dump valve. This turbine overspeed protection system, which includes the diverse primary and emergency turbine overspeed protection functions, comprises the second line of defense against turbine overspeed. This overspeed protection system is designed to ensure that even with a failure of the normal speed control system; the resulting turbine speed will not exceed 120 percent of the rated speed. In addition, the components and circuits comprising the turbine overspeed protection system are testable when the turbine is in operation.

The staff guidance on the second line of defense for the turbine overspeed includes the following:

(1) A mechanical overspeed trip device will actuate the control, stop, and intercept valves to close at approximately 111 percent of the rated turbine speed.

(2) At approximately 112 percent, an independent and redundant backup electrical overspeed trip device will sense the turbine speed and will close all of the turbine valves to protect the turbine from the overspeed.

The applicant's evaluation of this departure (described above), in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5 determined that this departure does not require prior NRC approval. The staff reviewed COL application Part 7, "Departures Report," regarding this departure and was unable to determine whether the departure meets Criteria (2), (4), and (6) in Appendix A, VIII.B.5.b or adequately addresses GDC 4. Therefore, the staff issued RAI 10.02-2 requesting the applicant to provide the following additional information and/or clarifications with complete justifications:

(1) Describe the setpoints for the normal overspeed and the primary and emergency overspeed systems, with full descriptions of how they function.

(2) Describe how the two electrical overspeed (primary and emergency) systems are diverse; provide schematics and logic diagrams depicting how the overspeed systems are diverse and independent.

(3) Clarify whether all of these (normal and two electrical) overspeed systems share any common components or processors/inputs. If so, evaluate the impact of failures of any such features/components.

(4) Is there any software used for processors or performing trip logic actuations? If so, is it common to any of the above?

(5) Explain the diversity and defense-in-depth used to defend against a common cause failure (CCF) of the processors.

The applicant's response to RAI 10.02-2 dated August 28, 2009 (ML092450155), discusses the turbine overspeed protection system. The applicant states that the system consists of a primary overspeed trip system and an emergency backup overspeed trip system. The primary overspeed trip system contains redundant features and utilizes three speed sensors that are separate from those used for normal speed control. Each speed signal is compared to a speed setpoint of approximately 110 percent of the turbine-rated speed and produces signals to trip the turbine. These trip signals are arranged in two-out-of-three logic to de-energize the trip pilot valve solenoids of one of the two trip valves of the electro-hydraulic emergency trip device (ETD). The ETD has two redundant trip valves. Tripping either redundant trip valve will drain the emergency trip fluid and result in a turbine trip. The emergency backup overspeed trip system is also redundant and uses three speed sensors that are separate from those used by the primary overspeed trip function. The speed setpoint for this trip function is approximately 111 percent of the rated speed. The trip signals are arranged in two-out-of-three logic to de-energize the trip pilot valve solenoids of the other trip valve in the ETD to cause a turbine trip. The overspeed trip functions are redundant and diverse. Each overspeed trip function (primary and emergency) uses two-out-of-three trip logic devices. Diversity is achieved between the primary and emergency trip systems by using diverse electronic means (hardware and software/firmware) for each function. The emergency overspeed trip system and the normal speed control system use the same sensors. However, the failure of any two speed sensors will result in a turbine trip. A turbine trip will result in an orderly reactor shutdown. The scenarios and sequence of events following a turbine trip are discussed in FSAR Section 15.2.3. Periodic testing of the overspeed trip function components important to safety during operation at the rated load is discussed in FSAR Subsection 10.2.2.7, "Testing," and Subsection 10.2.3.6, "Inservice Inspection." The applicant also notes that the trip logic actuations are performed using diverse hardware and software/firmware and therefore do not contribute to any CCFs of these processors. The applicant adds that Part 2, Tier 2, Subsection 10.2.2.4 of the COL application, will be revised to reflect this RAI response and provides a markup of this subsection.

The staff reviewed the applicant's response to RAI 10.02-2. The evaluation of this response is summarized below.

According to the applicant's response, the staff noted that the turbine trip setpoints for the primary and emergency backup electrical overspeed systems are 110 and 111 percent of the rated speed, respectively. Based on the applicant's response to RAI 10.02-2, the two electrical overspeed control systems have diverse hardware and software/firmware for each of their functions, thus eliminating the CCFs in the system. Even though the ETS and normal speed control system use the same sensors, the failure of any two of the speed sensors will result in a turbine trip. The staff determined that diverse hardware and software/firmware are used for primary and emergency backup electrical overspeed systems and therefore cannot cause a CCF. Furthermore, in Tier 2, Subsection 10.2.2.4, the applicant states that a single component failure does not compromise trip protection and does not result in a turbine trip, which conforms to the guidance in SRP Section 10.2, Section III, Item 2.A, as it relates to single-failure criteria. However, the staff found that the applicant had not provided the schematics and logic diagrams for the two electric overspeed systems as requested in RAI 10.02-2. Without these schematics and associated site-specific inspections, tests, analyses, and acceptance criteria (ITAAC), the staff was unable to conclude that the applicant has provided sufficient information for the turbine

overspeed control systems. Therefore, the staff considered this RAI unresolved and issued followup RAI 10.02-4, which requested the applicant to provide the following:

(1) Provide the schematics and logic diagrams for the two electric overspeed systems.

(2) Provide a site-specific ITAAC in Part 9 of COL application Section 3 of "Site Specific ITAAC" for the two electric overspeed systems to confirm the design and hardware/firmware diversity and to provide a report in this regard.

(3) Explain whether each of these two emergency overspeed systems has its own power source and is installed in separate areas.

This RAI was tracked as Open Item 10.02-4 in the SER with open items.

The applicant's response to RAI 10.02-4 dated May 10, 2010 (ML102030020), provides a revised response that replaces the original response to RAI 10.02-2. Based on a review of the applicant's response to RAI 10.02-4 and the associated FSAR markup, the staff found that additional information and clarifications were needed with respect to the two (i.e., primary and emergency) electrical overspeed systems for the STP turbine protection system. Therefore, the staff issued RAIs 10.02-5 and 10.02-6 requesting additional information regarding (1) the redundancy and diversity of these two electrical overspeed systems; and (2) the associated mechanical and air/hydraulic systems to establish reliable operation of the TG system. The applicant provided revised responses to RAIs 10.02-5 and 10.02-6 in a letter dated February 21, 2011 (ML110550621). A summary of the applicant's responses and the staff's evaluation of these responses follows.

Diversity and Redundancy:

- Figure 10.2-5, "Turbine Overspeed Trip System Functional Diagram," is added to the FSAR, which depicts the diverse and independent primary and emergency turbine trip functions.

- The primary overspeed trip function is independent and diverse from the emergency overspeed trip function.

- Speed setpoints – The overspeed setpoints for primary and emergency trips are 110 percent and 111 percent of the turbine-rated speed, respectively.

- Speed sensors – The diverse primary overspeed trip function uses three speed magnetic pickups that are separate from the speed sensors used for the normal speed control and emergency trip functions. Similarly, the speed sensors between the primary overspeed and emergency overspeed trip are diverse (passive and active sensors).

- Hardware and software/firmware – The control signals from the two turbine-generator overspeed trip functions are isolated from and independent of each other. The two overspeed trip logic functions use diverse electronic means (hardware and software/firmware) to eliminate CCFs from rendering the trip functions inoperable. The two overspeed trip systems are installed in separate cabinets, each with its own redundant uninterruptable power sources. Further, the primary overspeed trip

function uses a separate speed wheel from that used for the normal speed control and the emergency overspeed trip function, thus making it independent and diverse.

The emergency electrical overspeed trip system uses the same turbine speed sensing techniques and the same speed sensors as the normal speed control system. The normal speed controllers and emergency overspeed protection trip controllers may be located in the same cabinet. However, the control signals from the normal speed control system and the trip signals from the emergency overspeed protection trip function are separate from and independent of each other. The emergency overspeed protection trip function is implemented in three separate trip controllers, and these trip controllers are separate from the normal speed controllers, so that the control signals from the two systems are isolated from, and independent of, each other.

- Trip logic and signals – Two-out-of-three logic is employed in both the primary and emergency overspeed trip circuitry. Each trip function can de-energize its associated trip pilot valve solenoids of the electro-hydraulic ETD.

- Power sources – The primary and emergency overspeed functions are installed in separate cabinets, each with its own redundant and uninterruptable power sources.

  The ETD is composed of two independent trip valves, each with two normally energized fail-safe solenoids. Each trip pilot valve solenoid is powered from a separate power source. The solenoids de-energize in response to the detection of an overspeed condition by the turbine speed control logic. De-energization of both pilot valve solenoids is necessary to cause the spool in their respective trip valve to reposition, which depressurizes the emergency trip fluid system, rapidly closing all steam inlet valves and indirectly closing the steam extraction non-return valves. Accordingly, the repositioning of only one of the two trip valves is necessary to trip the main turbine. A single electrical component failure does not compromise trip protection and does not result in a turbine trip.

- Cabinets – The primary overspeed trip function is installed in a separate cabinet from the normal speed control and emergency overspeed trip functions.

Based on the above considerations, the staff found that the primary and emergency overspeed trip functions are redundant, independent, and diverse from the speed sensors up to the trip valves of the ETD. Both overspeed trip functions are redundant to each other because each system uses separate speed sensors, two-out-of-three trip logic and associated signals, and independent trip valves operated by separate trip pilot valve solenoids. Also, the control signals from the emergency trip circuit are isolated from and independent of the control signals generated by the primary trip circuit. The primary and emergency electronic overspeed trip functions are also diverse, because each overspeed trip logic function uses diverse electronic means (hardware and software/firmware) to eliminate CCFs from rendering the trip functions inoperable. The two overspeed trip systems are installed in separate cabinets, each with its own redundant and uninterruptable power sources. Speed sensors are diverse (passive and active sensors) between the primary overspeed and emergency overspeed trip functions. The primary overspeed trip function uses a separate speed wheel from that used for the normal speed control and the emergency overspeed functions. Therefore, the redundancy and diversity provided by the two (i.e., primary and emergency) overspeed functions, in conjunction with the other considerations referred to above, are sufficient to provide reliable overspeed trip

protection for the main turbine. The turbine trip setpoints and corresponding bases are consistent with the review guidance specified in SRP Section 10.2, "Review Procedures," Items 2.A, 2.B, and 2.C. Therefore, the staff found the setpoints acceptable. Based on the above discussion, the staff considers the proposed alternate approach to SRP Section 10.2 acceptable in replacing the primary mechanical with another electrical overspeed device. Open Item 10.02-4 is closed, and RAIs 10.02-2 and 10.02-4 are resolved.

Isolation and Independence of Emergency Overspeed Trip Function from Normal Speed Control System:

- Control signals from the normal speed control system and the trip signals from the emergency overspeed protection trip function are separate from each other.
- The emergency overspeed protection trip function is implemented in three separate trip controllers that are separate from the normal speed controllers.
- Control signals from the two systems are isolated from and independent of each other.

Based on the above considerations, the staff also found that the control signals from the normal turbine speed control system and the emergency overspeed trip function are isolated from and independent of each other. They are therefore consistent with the review guidance specified in Item 2.D of SRP Section 10.2, "Review Procedures."

Additionally, the applicant's revised responses to RAIs 10.02-4 and 10.02-6 (ML110550621) provide a proposed ITAAC table for the main turbine system and state that the table will be added to Part 9 of the COL Application. The staff reviewed and accepted the proposed ITAAC table because it verifies that (1) there is independence and diversity between the two turbine overspeed trip functions; and (2) control signals from the normal turbine speed control system and the emergency overspeed trip function are isolated from and independent of each other. The staff confirmed that Revision 6 of COL Part 9, Section 3.0 includes the changes to ITAAC identified in the responses to RAIs 10.02-4 and 10.02-6. Therefore, RAIs 10.02-2, 10.02-4, 10.02-5 and 10.02-6 are resolved and closed.

Turbine Overspeed and Air/Hydraulic Control Systems

In order to address operating experience insights, and because the STP design provides an alternate approach to demonstrate diversity from the approach called for in SRP Section 10.2 (i.e., one mechanical and one electrical overspeed trip system), the staff issued RAIs 10.02-7 and 10.02-8 to address the details of the air/hydraulic systems as they relate to turbine overspeed systems. Specifically, the staff requested the applicant to address the flow paths, shared components, failure modes, and common cause failure vulnerabilities. The applicant responded to RAIs 10.02-7 and 10.02-8 in a letter dated October 15, 2010 (ML102930097), and provided revised responses to these RAIs in a letter dated February 21, 2011 (ML110550621). The staff's evaluations of these responses are summarized below:

- Shared components:

The applicant's response to RAI 10.02-4 dated February 21, 2011 (ML110550621), added Figure 10.2-5 to the FSAR in Revision 1. The figure depicts the electrical portion of the turbine

control system. As evaluated earlier in this report, both primary and emergency electrical overspeed systems are redundant; independent; and diverse to/from each other. The shared hydraulic components in this portion of the system are as follows:

- The fluid trip system (FTS) provides hydraulic fluid to the trip solenoid valves and steam admission valves. Failure of this supply line results in the FTS failing to a safe condition, because the loss of oil pressure will cause all valves to close quickly. There is one hydraulic central reservoir with two redundant pumps and associated filters and control valves. These pumps supply HP hydraulic fluid for the FTS, turbine control valves, and the main steam bypass valves.

- There is one drain header for the main stop valves (MSVs) and another header for the CVs, both of which drain the fluid to the central reservoir through a common header.

- There is one drain header for three ISVs and three IVs, with one common drain line to the central reservoir. A similar arrangement exists for the other three ISVs and three IVs.

- Each pair of ISVs and IVs shares a common valve body (also referred to as a CIV). However, each has its own valve disk, actuator, and instrumentation, and each valve operates separately.

- The trip solenoid valves and lockout valves drain to a common drain header, where the fluid is drained to the reservoir through a common drain pipe. The drain header has one vent line to the reservoir.

- The drain headers and drain lines are large diameter pipes that are arranged with appropriate slopes to drain toward the reservoir. Periodic surveillance testing of valves and trip devices ensure that the drain lines are not plugged.

- There is one air relay dump valve that controls air to the steam extraction non-return valves. Venting the air through the air relay dump valve will enable the spring-assisted closure of non-return valves. The instrument air system supplies clean and filtered air to the non-return valves and the relay dump valve. The extraction non-return valves are check valves, and should the air fail to vent, they would close on the reverse flow without the spring assist. (See FSAR Section 9.3.6 for a more in-depth description of the instrument air system.)

Based on a review of the above details, the staff found that the applicant has incorporated design provisions with multiple headers and adequate flow paths and drain lines in the hydraulic part of the overspeed control system. Multiple hydraulic oil return paths are provided to drain the fluid from the solenoid trip valves and steam admission valves (MSVs, CVs, ISVs, and IVs) to the central hydraulic fluid reservoir. Also, these drain lines are designed with large diameter pipes and appropriate slopes toward the central reservoir, and periodic testing will reduce the probability of blockages and of plugging the drain lines with corrosion products. Furthermore, periodic surveillance testing of the valves and trip devices will ensure that the drain lines are not plugged. Thus, the staff determined that the applicant has adequately designed provisions to the air/hydraulic systems and their flow paths to support the turbine overspeed protection functions; the design is therefore acceptable. The staff confirmed that Revision 6 of COL FSAR

includes the changes identified in the responses to RAI 10.02-4. Therefore, RAI 10.02-4 is resolved and closed.

Other Design/Operating Considerations

- Failure modes and effects analysis

According to the applicant, an initial failure mode and effects analysis was performed for the electrical, mechanical, and hydraulic portions of the turbine control and overspeed protection systems. The analysis concludes that the failure of a single component will not cause the turbine to exceed 120 percent of its rated speed. The applicant also states that this analysis addresses the operating experience identified in NUREG–1275 Volume 11, "Operating Experience Feedback Report – Turbine-Generator Overspeed Protection Systems," April 1995 (ML063560418).

- Common mode and common cause failures

As stated earlier in this evaluation, the two electrical overspeed control systems have different logic devices for each of their functions. The two overspeed trip logic functions use diverse electronic means (hardware and software/firmware) to eliminate CCFs from rendering the trip functions inoperable. Even though the emergency trip function and the normal speed control system use the same turbine speed sensors, the failure of any two of the speed sensors will result in a turbine trip. Also, in the two electrical overspeed trip systems, a single component failure does not compromise trip protection and does not result in a turbine trip, which conforms to the guidance in SRP Section 10.2, "Review Procedures," Item 2.A, as it relates to single-failure criteria. Also, a single failure of an extraction non-return valve will not cause the turbine to exceed its design overspeed after a full load rejection.

Furthermore, in the hydraulic portion of the turbine control and overspeed systems, multiple headers, drain lines, and flow paths are used to drain the hydraulic fluid. Also, for the extraction non-return valves and solenoid valves in the overspeed systems, clean control air is supplied from the instrument air system, which is described in FSAR Tier 2, Section 9.3.6. Periodic testing and inservice inspections of both air and hydraulic systems will be performed, which can identify problems and eliminate CCFs in these systems.

- Reliability assessment of the two electrical overspeed trip systems

The applicant states that a qualitative assessment was performed to compare the two types of overspeed trip systems (i.e.; two electrical versus one mechanical and another electrical). The applicant notes that the proposed new design with two electrical trip systems is more reliable and robust than the previous designs that include a mechanical overspeed trip protection device. According to the applicant, the mechanical trip design is unsupervised between startups, cannot be verified online, and can only be tested with a real overspeed test. The new design (1) can be tested online, (2) is able to verify trip functionality, and (3) can improve trip reliability due to the trip setpoint drift. Also, the new design eliminates the need for a trip lever at the front standard. Instead, an electrical switch can be provided to trip the turbine by interrupting power to the trip pilot valve solenoids. The trip lever is used primarily to support the testing and calibration of the mechanical trip mechanism.

Based on a review of the above details in the air/hydraulic portion of the turbine control and overspeed systems, the staff found that the applicant has incorporated design provisions with

multiple headers and adequate flow paths in the hydraulic control system. Multiple hydraulic oil return (drain) paths are provided to drain the fluid from the solenoid trip valves and steam admission valves (MSVs, CVs, ISVs, and IVs) to the central hydraulic fluid reservoir. Because these drain lines are designed with large diameter pipes which appropriately slope to the central reservoir, periodic testing will reduce the probability of blockage and plugging of drain lines with corrosion products. Further, periodic surveillance testing of the valves and trip devices will ensure that the drain lines are not plugged. Furthermore, a failure mode and effects analysis was performed to address the operating experience and problems, and issues identified in NUREG–1275 in these systems. Additionally, according to the applicant, a description of these air/hydraulic components and system interfaces will be added to the FSAR Tier 2, Subsection 10.2.2.4. Furthermore, the new design with two electrical trip systems provides more testing and continuous monitoring and diagnostic capabilities. Therefore, the staff concludes that the reliability of the proposed turbine overspeed system with two electrical overspeed devices for STP Units 3 and 4 is at least equivalent to that in the diverse mechanical and electrical overspeed trip systems. Thus, the staff's concerns in RAIs 10.02-4 through 10.02-8 are resolved.

Additionally, the applicant's response to RAI 10.02-7 provides a schematic for the main turbine overspeed trip hydraulic control diagram, which illustrates the hydraulic portion of these overspeed systems. The staff reviewed the schematic and determined that it adequately illustrates the hydraulic drain lines and flow paths. The staff confirmed that Revision 6 of COL FSAR includes the changes identified in the response to RAI 10.02-7. Therefore, RAIs 10.02-7 and 10.02-8 are resolved and closed.

Initially, the STP Units 3 and 4 COL application did not have enough information and the staff was unable to determine whether the Departure STP DEP 10.2-3 regarding the turbine digital control met the Criteria (2), (4), and (6) in 10 CFR Part 52, Appendix A, Section VIII.B.5 or GDC 4. Therefore, the staff issued a series of RAIs discussed in this report and the applicant provided adequate responses and revised the FSAR accordingly which the staff finds acceptable. Since, these RAIs were resolved and closed, the staff agrees that the Departure STP DEP 10.2-3 does not require prior NRC approval. The applicant's process for evaluating departures and other changes to the DCD is subject to NRC inspections.

- STP DEP 10.2-4 Bulk Hydrogen Storage

This departure from the ABWR DCD references sharing a bulk hydrogen gas storage facility between the two co-located STP Units 3 and 4, as opposed to having a single-bulk hydrogen storage facility per unit under the provisions of Section VIII.B.5 of Appendix A to 10 CFR Part 52. Based on this departure, the applicant has modified the description of the hydrogen storage facility in FSAR Subsection 10.2.2.2 and Figure 10.2-4. The staff evaluated the applicant's process for departures and agreed that these changes can be made without prior NRC approval. This departure is therefore acceptable.

With respect to the effect of these changes on the safe storage of hydrogen, the staff noted that this departure does not change the provision in the ABWR DCD to use the guidelines in Electric Power Research Institute (EPRI) Report NP-5283-SR-A, "Guidelines for Permanent BWR Hydrogen Water Chemistry Installations," for the safe design, installation, and operation of compressed hydrogen gas systems. These guidelines are endorsed in Regulatory Guide (RG) 1.189, "Fire Protection for Operating Nuclear Power Plants." The staff evaluated the effect of this departure on the hydrogen water chemistry system in Section 9.3.9 of this SER.

The applicant's evaluation determined that this departure does not require prior NRC approval in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5. Within the review scope of this section, the staff found it reasonable that the departure does not require prior NRC approval. The applicant's process for evaluating departures and other changes to the DCD is subject to NRC inspections.

COL License Information Items

- COL License Information Item 10.1 Low Pressure Turbine Disk Fracture Toughness

In FSAR Subsection 10.2.5.1, the applicant provides the following in order to address COL License Information Item 10.1:

> In accordance with 10 CFR 50.71(e), STPNOC will update the FSAR to identify the turbine material property data that supports the material properties used in the turbine rotor design specified in Subsection 10.2.3.2, after procurement and prior to initial fuel load (COM 10.2-1). Operating procedures to assure sufficient turbine warm-up time, as required by Subsection 10.2.3.2, are prepared in accordance with the guidelines in FSAR Section 13.5.

Because the information required by COL License Information Item 10.1 cannot be provided before the procurement of the turbine, the staff found it acceptable to establish a commitment for providing this information. However, NRC staff issued RAI 10.02.03-1 requesting the applicant to modify the COL license information and Commitment (COM10.2-1) to state that the as-built material property data will be identified in the updated FSAR.

In a letter dated September 22, 2009 (ML092660653), the applicant's response to RAI 10.02.03-1 proposes to add the term "as-built" to Revision 3 of the COL application in FSAR Subsection 10.2.5.1 and Commitment (COM10.2-1). The staff found this response acceptable because the proposed modifications clarify that the applicant is committing to provide the as-built material properties. Therefore, RAI 10.02.03-1 is resolved. The staff confirmed that Revision 4 of COL FSAR, Subsection 10.2.5.1 includes the provision to provide as-built material properties in Commitment (COM 10.2-1). Therefore, RAI 10.02.03-1 is resolved and closed.

- COL License Information Item 10.2 Turbine Design Overspeed

FSAR Subsection 10.2.5.2 as revised by the response to RAI 10.02-5 dated February 21, 2011 (ML110550621), provides the basis for turbine overspeed in order to address COL License Information Item 10.2 as follows:

> The highest anticipated speed resulting from loss of load is normally in the range of 105-108% of the rated speed. Turbine components are designed such that calculated stresses do not exceed the minimum material strength at 120% of the rated speed. Turbine rotors are spun to a speed of 120% rated as part of factory balance verification. This is approximately 12% above the highest anticipated speed resulting from loss of load, which meets the design criteria stated in Section 10.2.3.4 Item (4). The valve closure times used in the overspeed calculation are provided in Subsection 10.2.2.2. The turbine steam admission valves are assumed to be initially at valve-wide-open positions, which are conservative. The primary overspeed trip and the emergency overspeed trip setpoints are 110% and 111%, respectively.

NRC staff found this information acceptable because the design overspeed is consistent with the SRP Section 10.2.3 overspeed design criteria (i.e., 5 percent above the highest anticipated speed resulting from the loss of load), and the rotor is tested at its design overspeed.

- COL License Information Item 10.3 Turbine Inservice Test and Inspection

FSAR Subsection 10.2.5.3 refers to Subsection 10.2.3.6 to address COL License Information Item 10.3 as follows:

> Turbine inservice test and inspection requirements are discussed in Subsection 10.2.3.6.

NRC staff found this COL license information item acceptable because it correctly refers to Subsection 10.2.3.6 for the inservice test and inspection requirements, which are included in the staff's review.

As discussed in Subsection 3.5.1.3 of this SER, within 3 years of obtaining an operating license, the licensee will submit to the NRC a turbine system maintenance program for STP Units 3 and 4. Because this program depends on as-built information, it cannot be provided before the procurement of the turbine. The program will include probability calculations of turbine missile generation based on NRC-approved methodology. At that time, the staff will confirm that the applicant's program for turbine rotor integrity meets the regulatory requirements for turbine missile generation discussed in Subsection 3.5.1.3 of this SER and includes the information incorporated by reference into the certified design, the information provided through departures, and the maintenance program for the as-built turbine. In addition, in accordance with Commitment (COM 10.2-1), the applicant will update the FSAR to identify as-built turbine material property data.

10.2.5 Post Combined License Activities

The applicant identifies the following commitment:

- Commitment (COM 10.2-1) – Update the FSAR to identify the as-built turbine material property data that support the material properties used in the turbine rotor design specified in Subsection 10.2.3.2, after procurement and prior to initial fuel load.

In addition, the applicant identifies a site-specific ITAAC for main turbine system to be added in COL application Part 9, Section 3, Table 3.0-20,"Main Turbine (MT) System."

10.2.6 Conclusion

The NRC staff's finding related to information incorporated by reference is in NUREG–1503. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the applicant has addressed the required information relating to the TG system and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix A, Section VI.B.1, all nuclear safety issues relating to the TG system that were incorporated by reference have been resolved.

In addition, the staff compared the additional information referred to in the COL application to the relevant NRC regulations and the guidance in Section 10.2 of NUREG–0800. The staff's review concluded that the applicant has adequately addressed COL License Information

Items 10.1, 10.2, and 10.3 in accordance with the guidance in Sections 10.2 and 10.2.3 of NUREG–0800, and found it reasonable that the identified Tier 2 departures are characterized as not requiring prior NRC approval per 10 CFR Part 52, Appendix A, Section VIII.B.5.

NRC staff evaluated the plant-specific information relative to the TG system for the STP Units 3 and 4 COL application. Based on the results of this evaluation, the staff found that implementation of the site-specific departures described in the "Technical Evaluation" section has no adverse impact on the TG system. The design of the turbine generator is acceptable and satisfies GDC 4 requirements with respect to the protection of SSCs important to safety from the effects of turbine missiles based on the following considerations:

- The design of the TG control systems will control the speed of the turbine under all operating conditions and will ensure that turbine speed will not exceed 120 percent of rated speed following a load rejection while operating at full power. Although the turbine overspeed control systems do not include a mechanical overspeed trip device, SRP considerations are satisfied by implementing design and programmatic measures to ensure diversity and independence between two electrical overspeed trip functions, and highly reliable performance.

- SSCs important to safety that are located in the turbine building are fail-safe such that a rupture of the connection joint between the LP turbine exhaust hood and the condenser will have no adverse affect.

10.3 Main Steam Supply System

10.3.1 Introduction

The main steam supply system (MSSS) transports the steam generated in the reactor to the main turbine and various auxiliaries of the steam and power conversion (S&PC) system. Portions of the MSSS may be used as part of the heat sink that removes heat from the reactor facility during certain operations and may also be used to supply steam to drive engineered safety feature pumps. The MSSS for direct-cycle, boiling-water reactors extends from the outermost containment isolation valves up to and including the turbine stop valves.

10.3.2 Summary of Application

Section 10.3 of the STP Units 3 and 4 COL FSAR Revision 12, incorporates by reference Section 10.3 of the certified ABWR DCD Revision 4, referenced in 10 CFR Part 52, Appendix A. In addition, in the COL FSAR, the applicant provides the following:

Tier 2 Departures Not Requiring Prior NRC Approval

- STP DEP 10.2-1 Turbine Design

This site-specific departure modifies the turbine design. This departure is incorporated in FSAR Table 10.3-1 and Figures 10.3-1 and 10.3-2.

- STD DEP 10.3-1 Main Steam Line Drains

This standard departure expands the discussion in FSAR Subsection 10.3.2.1 to state that the MSSS also serves as the "alternative leakage path" to contain the radioactive steam, which

passes through the main steam isolation valves (MSIVs) before they close to isolate the reactor under emergency conditions. This departure is incorporated in FSAR Subsection 10.3.2.1.

- STD DEP 10.4-1 Turbine Gland Seal System

This standard departure adds a non-safety-related gland seal evaporator to supply steam to the main turbine shaft seal glands and various turbine valve stems, including the turbine bypass and main turbine stop-control valve stems. The source of heat steam for the evaporator is main steam or turbine extraction steam. This departure is incorporated in FSAR Subsection 10.3.2.3.

- STP DEP 10.4-3 Main Condenser Evacuation System

This site-specific departure changes the source of the motive steam supplying the steam jet air ejectors during power operation. This departure is incorporated in FSAR Figure 10.3-2.

- STP DEP Admin

This administrative departure in FSAR Section 10.3.7 changes the general description of the MSSS by changing the following sentence to state:

> The four main steamlines are connected to a header upstream of the turbine stop valves to permit testing of these valves during plant operation with a minimum load reduction.

COL License Information Items

- COL License Information Item 10.4 Procedures to Avoid Steam Hammer and Discharge Loads

This COL license information item states that the COL applicant will provide operating and maintenance procedures that include adequate precautions to avoid steam hammer and relief valve discharge loads.

- COL License Information Item 10.5 MSIV Leakage

This COL license information item states that the "MSIVs are designed to limit the leakage to less than 66.1 liters/min for all four lines, at a pressure corresponding to the calculated peak containment pressure for design-basis accidents identified in Table 6.2-1."

10.3.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is in NUREG–1503. In addition, the relevant requirements of the Commission regulations for the MSSS, and associated acceptance criteria, are in Section 10.3 of NUREG–0800.

In accordance with Section VIII, "Processes for Changes and Departures," of, "Appendix A to Part 52-Design Certification Rule for the U.S. Advanced Boiling Water Reactor," the applicant identifies Tier 2 departures. Tier 2 departures not requiring prior NRC approval are subject to the requirements in 10 CFR Part 52, Appendix A, Section VIII.B.5, which are similar to the requirements in 10 CFR 50.59.

In particular, the regulatory basis and review criteria that the staff used for reviewing Departures STP DEP 10.2-1, STD DEP 10.3-1, STD DEP 10.4-1, and STP DEP 10.4-3; and COL License Information Items 10.4 and 10.5; as they relate to the protection of SSCs important to safety and water (steam) hammer considerations, are specified in SRP Section 10.3.

10.3.4 Technical Evaluation

As documented in NUREG–1503, NRC staff reviewed and approved Section 10.3 of the certified ABWR DCD. The staff reviewed Section 10.3 of the STP Units 3 and 4 COL FSAR and checked the referenced ABWR DCD to ensure that the combination of the information in the ABWR DCD and the information in the COL FSAR appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the required information relating to the MSSS.

The staff reviewed the following information in the COL FSAR:

Tier 2 Departures Not Requiring Prior NRC Approval

- STP DEP 10.2-1 Turbine Design

NRC staff reviewed Departure STP DEP 10.2-1, which is a site-specific departure that describes modifications to the main turbine-generator design. [Note: This statement is only valid for the reheaters and is evaluated in SER Section 10.2, "Turbine Generator."]

The applicant's evaluation of this departure, in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5, determined that the departure does not require prior NRC approval. Within the review scope of this section, the staff found it reasonable that this departure does not require prior NRC approval. The applicant's process for evaluating departures and other changes to the DCD is subject to NRC inspections.

- STD DEP 10.4-1 Turbine Gland Seal System

NRC staff reviewed Departure STD DEP 10.4-1, which adds a non-safety-related gland seal evaporator to supply steam to the main turbine shaft seal glands and various turbine valve stems, including the turbine bypass and main turbine stop-control valve stems. The source of heat steam for the evaporator is main steam or turbine extraction steam.

The applicant's evaluation of this departure, in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5, determined that the departure does not require prior NRC approval. Within the review scope of this section, the staff found it reasonable that this departure does not require prior NRC approval. The applicant's process for evaluating departures and other changes to the DCD is subject to NRC inspections.

- STP DEP 10.4-3 Main Condenser Evacuation System

NRC staff reviewed Departure STP DEP 10.4-3, which changes the source of the motive steam supply to the steam jet air ejectors during power operation.

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.1.3, for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

The applicant's evaluation of this departure, in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5, determined that the departure does not require prior NRC approval. Within the review scope of this section, the staff found it reasonable that this departure does not require prior NRC approval. The applicant's process for evaluating departures and other changes to the DCD is subject to NRC inspections.

- STD DEP 10.3-1 Main Steam Line Drains

NRC staff reviewed Departure STD DEP 10.3-1, which expands the discussion in Section 10.3.2 to state that the MSSS also serves as the "alternate leakage path" to contain the radioactive steam, which passes through the MSIVs before they close to isolate the reactor under emergency conditions. Departure STD DEP 10.3-1 provides information concerning the "alternate leakage path" that does not appear to be consistent with the information in ABWR DCD Tier 2, Subsection 3.2.5.3, "Main Steam Line Leakage Path." Also, some of the information that is characterized as a departure is already reflected in DCD Subsection 3.2.5.3. It is not clear why this information is included in the proposed departure, which refers to the "alternate leakage path," and it is not clear why the term "alternate" is used.

The applicant's evaluation of this departure, in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5, determined that the departure does not require prior NRC approval. The staff reviewed the Part 7 "Departures Report" regarding this departure and was unable to determine whether the departure meets Criteria (2), (4), and (6) in Appendix A of 10 CFR Part 52, Section VIII.B.5.b or adequately addresses GDC 4. Therefore, the staff issued RAI 10.03-2 requesting the applicant to provide the above information and clarifications on whether any credit is taken for plate-out in the steam line drains.

The applicant responded to RAI 10.03-2 in a letter dated May 20, 2008 (ML081440107). In this response, the applicant states that no performance change to the DCD wording for this function was intended, and the addition of the term "alternate" to the phrase "main steam line leakage path" was an error. The applicant further notes that Departure STD DEP 10.3-1 is intended to address the MSIV closure (to isolate the reactor) under emergency conditions. The MSSS contains the radioactive steam that passes through the MSIVs before they close. Any leakage past the closed MSIVs, which will flow in the main steam lines and the main steam drain lines downstream of the corresponding containment isolation valves, will be contained. The function of containment is performed by the main steam lines from the containment isolation valves to the turbine stop valves, the bypass lines from the containment isolation valves to the condenser, the main steam drain lines to the condenser, and other main steam lines larger than 6.4 centimeters (cm) (2.5 inches [in.]) (e.g., steam lines to the steam jet-air ejector) up to their automatic isolation valves and the condenser. Regarding the plate-out, the applicant clarifies that DCD Tier 2, Subsection 15.6.5.5.1.2, "Main Steamline Modeling," includes the plate-out in the steam line drains and condenser as part of a fission product release and pathway to the environment. Additionally, the applicant states that FSAR Subsection 10.3.2.1 will be revised to reflect the response described above. The applicant also includes a markup of this FSAR section, which provides new information with respect to the MSSS piping design details and ASME code compliance. Accordingly, the piping and branch lines 6.4 cm (2.5 in.) and larger from (but not including) the outboard MSIVs to the turbine stop valves and to the turbine bypass valves are designed to Quality Group B and NC-Class 2 in Division 1 of ASME Section III. Furthermore, the main steam lines and the branch lines 6.4 cm (2.5 in.) and larger from the seismic restraint on the outboard side of the MSIVs are designed based on the appropriate dynamic and seismic system analysis to withstand the safe-shutdown earthquake design loads of the ABWR standard design and other appropriate loads and are within the limits specified for

Class 2 piping. Lines smaller than 6.4 cm (2.5 in.) are designed to withstand the loads expected for the ABWR standard plant. Furthermore, the mathematical model for the dynamic and seismic analyses includes the turbine stop valves and piping up to the turbine casing.

The staff reviewed the applicant's response to RAI 10.03-2 and the FSAR markup and determined that the STP Units 3 and 4 main steam piping and components, including the supports, are designed adequately in accordance with the industry codes and standards and are consistent with the ABWR design standard. The staff concluded that the applicant has provided adequate clarifications that resolve the staff's concerns in RAI 10.03-2. The staff verified that FSAR Revision 3 incorporates the applicant's response. Therefore, RAI 10.03-2 is resolved. The staff found it reasonable that this departure does not require prior NRC approval. The applicant's process for evaluating departures and other changes to the DCD is subject to NRC inspections.

- STD DEP Admin

The applicant defines administrative departures as minor corrections, such as editorial or administrative errors in the referenced ABWR DCD (e.g., misspelled words, incorrect references, table headings, etc.). Administrative departures do not affect the presentation of any design discussion or the qualification of any design margin. Within the review scope of this section, NRC staff found it reasonable that this departure does not require prior NRC approval. The applicant's process for evaluating departures and other changes to the certified ABWR DCD is subject to NRC inspections.

COL License Information Items

- COL License Information Item 10.4 Procedures to Avoid Steam Hammer and Discharge Loads

NRC staff reviewed STP Units 3 and 4 COL FSAR Subsection 10.3.7.1 as it relates to COL License Information Item 10.4. ABWR DCD Subsection 10.3.7.1 states that the COL applicant will provide operating and maintenance procedures that include adequate precautions to avoid steam hammer and discharge loads. In FSAR Subsection 10.3.7.1, the applicant states that the procedures to avoid steam hammer and discharge loads were prepared in accordance with the plant operating procedure development plan described in FSAR Subsection 13.5.3.k. However, the procedures were not submitted for NRC review. The information in FSAR Subsection 10.3.7.1 does not address the COL license information item in ABWR DCD, Subsection 10.3.7.1. Also, the staff reviewed DCD Section 10.3.3, "Evaluation," which states that all components and piping for the MSSS were designed in accordance with the codes and standards listed in Section 3.2 of the DCD, thus ensuring that the MSSS will accommodate operational stresses resulting from static and dynamic loads that include steam hammer and normal and abnormal environmental conditions. Additionally, SRP Section 10.3 Item I.5, "COL Action Items and Certification Requirements and Restrictions," states that for a COL application referencing a design certification (DC), a COL applicant must address COL license information items included in the referenced DC. Furthermore, SRP Section 10.3 Item II notes that the MSSS should adequately consider water (steam) hammer and relief valve discharge loads. This consideration should assure that system safety functions can be performed and operating and maintenance procedures will include adequate precautions to prevent water (steam) hammer and relief valve discharge loads. However, the information in FSAR Subsection 10.3.7.1 does not specify these elements in COL License Information Item 10.4. In order to ensure the adequacy of the MSSS and its agreement with the criteria in the SRP and

the DCD, the staff issued RAI 10.03-1, which requested the applicant to submit these procedures for the staff to review and evaluate. Also, the staff requested an explanation of the elements in these procedures and how they comply with SRP guidance and the codes and standards identified in Section 3.2 of the DCD.

The applicant responded to RAI 10.03-1 in a letter dated May 20, 2008 (ML081440107). With respect to submitting the procedures, the applicant cites RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," and Regulatory Position C.I.13.5 and states that the FSAR should provide a brief description of the nature and content of the detailed written procedures. The applicant further states that this general provision applies to the operating and maintenance procedures related to steam hammer and relief valve discharge loads. As a result, the applicant proposes to provide STP site-specific supplemental information regarding these precautions and to revise FSAR Subsection 10.3.7.1 to reflect the RAI response. In the supplemental information, the applicant lists several precautionary items, such as providing a sufficiently long main steam line warm-up period and a turbine soaking period, during which the low-point drain valves are opened to ensure that no condensed steam remains in the main steam lines. Additionally, maintenance procedures provide for the routine inspection of the low-point drain collection pots to ensure that they are operating properly. The applicant further states that at the COL application stage of the project, it is not necessary or appropriate to develop and issue operating and maintenance procedures.

The staff reviewed and determined that the applicant's response to RAI 10.03-1 is acceptable. Although the applicant did not include specific procedures for the staff to review, the applicant provided a list of procedural precautions (identified above) and included a proposed revision to COL application Part 2, FSAR Chapter 10, Subsection 10.3.7.1. Also, the staff reviewed FSAR Subsection 10.3.7.1 and DCD Section 10.3.3 and found that they address design considerations for the steam and water hammer and the relief valve discharge loads. The staff compared these design considerations and the above identified precautions to industry experience and staff guidance and determined that they adequately address the provisions to avoid steam and water hammer conditions and the negative effects of relief valve discharge loads. Furthermore, the staff reviewed the applicant's response in conjunction with Section 13.5, "Plant Procedures," of the FSAR and the DCD. The staff concluded that the plant operations and maintenance procedures will be developed when appropriate, and they will include these precautions. Therefore, the staff's concern in RAI 10.03-1 is resolved and COL License Information Item 10.4 is thus acceptable.

- COL License Information Item 10.5 MSIV Leakage

COL License Information Item 10.5 states that the applicant needs to provide the amount of allowable MSIV leakage for review by the NRC. The applicant addresses this COL license information item in STP Units 3 and 4 COL FSAR, Subsection 10.3.7.2.

NRC staff reviewed the applicant's response to this COL license information item and found the response acceptable because the amount of allowable MSIV leakage in the response is consistent with (1) the leakage limit value specified in STP Units 3 and 4 Technical Specification Surveillance Requirement 3.6.1.3.12; and (2) the information incorporated by reference to the ABWR DCD regarding the design-basis accident radiological consequence analyses in the STP Units 3 and 4 FSAR Chapter 15, Accident Analysis.

10.3.5 Post Combined License Activities

There are no post COL activities related to this section.

10.3.6 Conclusion

The NRC staff's finding related to information incorporated by reference is in NUREG–1503. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix A, Section VI.B.1, all nuclear safety issues relating to the MSSS that were incorporated by reference have been resolved.

In addition, the staff compared the additional information referred to in the COL application to the relevant NRC regulations and the guidance in Section 10.3 of NUREG–0800. The staff's review concluded that the applicant has adequately addressed COL License Information Items 10.4 and 10.5 in accordance with the guidance in Section 10.3 of NUREG–0800, and found it reasonable that the identified Tier 2 departures are characterized as not requiring prior NRC approval per 10 CFR Part 52, Appendix A, Section VIII.B.5.

NRC staff evaluated the plant-specific information relative to the MSSS for the STP Units 3 and 4 COL application. Based on the results of this evaluation, the staff found that implementation of the site-specific departures described in the "Technical Evaluation" section have no adverse impact on the MSSS.

10.4 Other Features of Steam and Power Conversion

10.4.1 Main Condensers

10.4.1.1 *Introduction*

This section of the FSAR addresses the steam cycle heat sink. During normal operation, the main condenser (MC) receives, condenses, deaerates, and holds up (for N-16 decay) the main turbine exhaust steam and the turbine bypass steam, whenever the turbine bypass system (TBS) is operated. The MC is also a collection point for other steam cycle miscellaneous drains and vents.

10.4.1.2 *Summary of Application*

Section 10.4.1 of the STP Units 3 and 4 COL FSAR Revision 12, incorporates by reference Section 10.4.1 of the certified ABWR DCD Revision 4, referenced in 10 CFR Part 52, Appendix A. In addition, in FSAR Section 10.4.1, the applicant provides the following:

Tier 2 Departure Not Requiring Prior NRC Approval

- STP DEP 10.4-2 Main Condenser

This site-specific departure involves replacing the multi-pressure, three-shell reheating condenser design of the DCD with a single-pass, single-pressure, three-shell deaerating unit. The three condenser shells are cross-connected to equalize pressure. Each shell has at least two bundles. Circulating water will flow in a parallel direction through the three single-pass shells, instead of in a series as the design states in the DCD.

10.4.1.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–1503. In addition, the relevant requirements of the Commission regulations for the MC, and the associated acceptance criteria, are in Section 10.4.1 of NUREG–0800.

In addition, in accordance with Section VIII, "Processes for Changes and Departures," of, "Appendix A to Part 52-Design Certification Rule for the U.S. Advanced Boiling Water Reactor," the applicant identifies a Tier 2 departure that does not require prior NRC approval. This departure is subject to the requirements of 10 CFR Part 52, Appendix A, Section VIII.B.5, which are similar to the requirements in 10 CFR 50.59.

10.4.1.4 *Technical Evaluation*

As documented in NUREG–1503, NRC staff reviewed and approved Section 10.4.1 of the certified ABWR DCD. The staff reviewed Section 10.4.1 of the STP Units 3 and 4 COL FSAR and checked the referenced ABWR DCD to ensure that the combination of the information in the ABWR DCD and the information in the COL FSAR appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the required information relating to the MCs.

The staff reviewed the following information in the COL FSAR:

Tier 2 Departure Not Requiring Prior NRC Approval

- STP DEP 10.4-2 Main Condenser

NRC staff reviewed STP DEP 10.4-2, which involves the use of an MC design that is different from the one approved in the ABWR DCD. Subsection 10.4.1.2.1 of the ABWR DCD describes the MC as a multi-pressure, three-shell, reheating/deaerating unit. The DCD MC design is modified by STP DEP 10.4-2 in the COL application to be a single-pass, single-pressure, three-shell deaerating unit. The departure also indicates that the three condenser shells are cross-connected to equalize pressure.

The applicant's evaluation of this departure, in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5, determined that this departure does not require prior NRC approval. The staff reviewed the Part 7 "Departures Report" regarding this departure and was unable to determine whether the departure meets Criteria (2), (4), and (6) in 10 CFR Part 52, Appendix A, Section VIII.B.5.b, or adequately addresses GDC 4. Therefore, the staff issued RAI 10.04.01-1 requesting the applicant to provide the following clarifications.

The staff requested the applicant to explain the impact from the temperature and pressure surges in the MC on the LP turbine and condenser internals during the most limiting turbine steam bypass event. Also, the staff requested additional information regarding the maximum temperature and pressure reached during this event compared to the maximum design values, the impact of a blowdown and transient effects on condenser internals, and the limiting

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.1.3, for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

assumptions that apply. The staff also requested the applicant to explain how the MC design capability for the most limiting case will be confirmed during preoperational testing.

In addition, the staff identified inconsistencies in the FSAR because of the changes in Departure STP DEP 10.4-2. FSAR Table 10.4-1, "Condenser Design Data," indicates that the full power MC shell pressure for the STP Units 3 and 4 design is 9.38 kilopascals absolute (kPaA) (1.36 pounds per square inch absolute [psia]) when the circulating water temperature is 32.2 degrees C (90.0 degrees F). However, FSAR Figure 10.1-3, "Reference Heat Balance for Valves Wide Open," shows the pressure of the MC as 6.37 kilopascals (kPa) (0.92 pounds per square inch [psi]) and the rated turbine exhaust pressure as 6.77 kPa (0.98 psi). Therefore, the staff requested the applicant to provide an explanation for this apparent inconsistency, as well as a confirmation that the MC shell design pressure range of 0 to 207 kPaA (0 to 30 psia) that is specified in Table 10.4-1 continues to apply to the STP Units 3 and 4 MCs. Also, the staff asked the applicant to clarify which pressures are absolute and which are gauge.

The applicant responded to RAI 10.04.01-1 in a letter dated May 20, 2008 (ML081440107). The applicant states that with respect to the impact of the steam bypass discharge on the LP turbine and MC internals, the bypass system consists of three headers with each routed to one of the three condenser shells. The bypass steam is discharged into each of the three condensers through a perforated header between the MC tube bundle and the LP feedwater heaters, which are installed in the condenser neck. The steam exit velocity from the perforated header is expected to be sonic. Therefore, the condenser internal support members are designed and routed with consideration to the bypass steam jet impingement impact and temperature effect. Additionally, tubes located at the top of the condenser tube bundle are designed to withstand the resulting velocities and temperatures. Furthermore, the MC design includes a spray system that is initiated based on a turbine bypass valve open signal. This MC spray system provides a protective water curtain between the turbine components and the bypass line to shield the turbine from the bypass steam. The MC spray is initiated based on the turbine bypass valve open signal. The staff determined that the applicant's response provides a reasonable assurance that the MC design includes features that protect the LP turbine and the condenser internals from the adverse effects of the steam bypass. The staff found the applicant's response acceptable.

Regarding the preoperational testing to verify condenser capacity during the bypass steam dump, the STP Initial Test Program procedures require that one of the three bypass steam headers be allowed to discharge into the condenser at 75 percent of the rated load. At this load, the main steam inlet pressure to the turbine and the bypass flow rate are expected to be at their maximum design values. The procedures also require that the selected header remain open for 5 minutes to verify that no adverse transient conditions can result. Furthermore, following the test, the condenser internal components are visually inspected for any significant damage or erosion. The staff found the applicant's preoperational test procedures adequate because they ensure that the system will function at its maximum design values.

Additionally, regarding the condenser pressure at low circulating water temperatures and the condenser shell design pressure, the applicant states that Table 10.4-1 indicates a condenser capability design pressure of 9.38 kPaA (1.36 psia). This pressure corresponds to the condenser design pressure calculated by the turbine heat balance at the rated thermal power. The pressure values of 6.37 kPaA and 6.77 kPaA (0.92 psia and 0.98 psia) indicated in Figure 10.1-3 represent the condenser pressure and turbine exhaust pressure each at the guaranteed condition. The applicant's response thus confirms that both pressures are absolute. The condenser shell is designed for a pressure range of 0 to 207 kPaA (0 to 30 psia). The

upper pressure value is based on the hydrostatic pressure test performed in accordance with the Heat Exchange Institute Standard for Steam Surface Condensers, 9th Edition Addenda equivalent to 103.4 kilopascals gauge (kPaG) (15 pounds per square inch gauge [psig]). The staff found the above explanation adequate because it clarifies that there is no inconsistency and the values identified in the FSAR are absolute.

Further, the applicant's response notes that no COL application revision is required as a result of this RAI response. The staff concluded that the applicant has provided adequate clarifications that resolve the staff's concerns in RAI 10.04.01-1. The staff verified that FSAR Revision 3 incorporates the applicant's response. Therefore, RAI 10.04.01-1 is resolved. Thus, the staff found it reasonable that the departure does not require prior NRC approval. The applicant's process for evaluating departures and other changes to the DCD is subject to NRC inspections.

10.4.1.5 *Post Combined License Activities*

There are no post COL activities related to this section.

10.4.1.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1503. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix A, Section VI.B.1, all nuclear safety issues relating to the MC that were incorporated by reference have been resolved.

In addition, the staff compared the information in the COL application to the relevant NRC regulations and the guidance in Section 10.4.1 of NUREG–0800. The staff's review concluded that the applicant has provided sufficient information to satisfy NRC regulations, and found it reasonable that the identified Tier 2 departure is characterized as not requiring prior NRC approval per 10 CFR Part 52, Appendix A, Section VIII.B.5.

NRC staff evaluated the plant-specific information relating to the MC design for the STP Units 3 and 4 COL application. Based on the results of this evaluation, the staff concluded that implementation of the site-specific departure and the RAI responses described in the "Technical Evaluation" section will in fact enhance system reliability and will have no adverse impact on the MC system. The staff also determined that there are no TSs and ITAAC considerations related to this area of review. Therefore, the STP Units 3 and 4 COL application is acceptable with respect to the MC system.

10.4.2 Main Condenser Evacuation System

10.4.2.1 *Introduction*

This section of the FSAR addresses the process that removes noncondensable gases from the power cycle steam. Noncondensable gases include mostly the hydrogen and oxygen produced by the radiolysis of water in the reactor, but also other power cycle noncondensable gases that might mix with the steam. The main condenser evacuation system (MCES) removes the hydrogen and oxygen produced by the radiolysis of water in the reactor and the S&PC system and other noncondensable gases produced by the power cycle. The MCES exhausts these

noncondensable gases to the offgas system during plant power operation and to the turbine building compartment exhaust system at the beginning of each plant startup.

10.4.2.2 *Summary of Application*

Section 10.4.2 of the STP Units 3 and 4 COL FSAR Revision 12, incorporates by reference Section 10.4.2 of the certified ABWR DCD, with the following departure:

Tier 2 Departure Not Requiring Prior NRC Approval

- STP DEP 10.4-3 Main Condenser Evacuation System:

This site-specific departure adds an additional mechanical vacuum pump to the MCES. The design now consists of two (100 percent capacity) vacuum pumps, which is an increase from the single vacuum pump specified in the DCD. The departure also changes the source of the motive steam supply to the steam jet air ejectors from cross-around steam to main steam during power operation.

10.4.2.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–1503. In addition, the relevant requirements of the Commission regulations for the MCES, and the associated acceptance criteria, are in Section 10.4.2 of NUREG–0800.

In accordance with Section VIII, "Processes for Changes and Departures," of, "Appendix A to Part 52-Design Certification Rule for the U.S. Advanced Boiling Water Reactor," the applicant identifies one Tier 2 departure. Tier 2 departures not requiring prior NRC approval are subject to the requirements of 10 CFR Part 52, Appendix A, Section VIII.B.5, which are similar to the requirements in 10 CFR 50.59.

In particular, the regulatory basis and review criteria that the staff used for Departure STP DEP 10.4-3 are specified in SRP Section 10.4.2 and GDC 60, "Control of releases of radioactive materials to the environment," as they relate to the ability to control the release of radioactive materials in gaseous and liquid effluents.

10.4.2.4 *Technical Evaluation*

As documented in NUREG–1503, NRC staff reviewed and approved Section 10.4.2 of the certified DCD for the ABWR design. The staff reviewed Section 10.4.2 of the STP Units 3 and 4 COL FSAR and checked the referenced ABWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ABWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the required information relating to the MCES.

The staff reviewed the following information in the COL FSAR:

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.1.3, for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

Tier 2 Departure Not Requiring Prior NRC Approval

- STP DEP 10.4-3 Main Condenser Evacuation System

NRC staff reviewed Departure STP DEP 10.4-3, which increases the number of vacuum pumps with 100 percent capacity from one to two.

The applicant's evaluation of this departure, in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5, determined that this departure does not require prior NRC approval. Within the scope of this review, the staff found it reasonable that the departure does not require prior NRC approval. The applicant's process for evaluating departures and other changes to the DCD is subject to NRC inspections.

10.4.2.5 *Post Combined License Activities*

There are no post COL activities related to this section.

10.4.2.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1503. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix A, Section VI.B.1, all nuclear safety issues relating to the MCES that were incorporated by reference have been resolved.

In addition, the staff compared the additional information in the COL application to the relevant NRC regulations and the guidance in Section 10.4.2 of NUREG–0800. The staff found it reasonable that the identified Tier 2 departure is characterized as not requiring prior NRC approval per 10 CFR Part 52, Appendix A, Section VIII.B.5.

The staff evaluated the plant-specific information that was provided relative to the MCES for the STP Units 3 and 4 COL application. Based on the results of this evaluation, the staff found that implementation of the site-specific departure described in the "Technical Evaluation" section will in fact enhance system reliability and will have no adverse impact on the MCES, as it relates to the regulatory criteria cited for this system. The staff also determined that there are no TS, ITAAC, or Initial Test Program considerations related to this area of review.

10.4.3 Turbine Gland Sealing System

10.4.3.1 *Introduction*

This section of the FSAR addresses how the turbine gland sealing system (TGSS) prevents the escape of radioactive steam from the turbine shaft, turbine casing penetrations, and valve stems. The TGSS also prevents air in-leakage through sub-atmospheric turbine glands. The TGSS consists of a gland steam evaporator (GSE); sealing steam pressure regulator; sealing steam header; gland steam condenser (GSC) with two full-capacity exhauster blowers; and the associated piping, valves, and instrumentation. The TGSS provides a source of sealing steam to the annulus space where the turbine and large steam valve shafts penetrate the turbine casings.

10.4.3.2 *Summary of Application*

Section 10.4.3 of the STP Units 3 and 4 COL FSAR Revision 12, incorporates by reference Section 10.4.3 of the certified ABWR DCD, Revision 4, referenced in 10 CFR Part 52, Appendix A. In addition, in FSAR Chapter 10.4.3, the applicant provides the following:

Tier 2 Departure Not Requiring Prior NRC Approval

- STD DEP 10.4-1 Turbine Gland Seal Steam

This departure describes a design change that adds a non-safety-related GSE to the referenced ABWR DCD TGSS that will supply sealing steam to the main turbine shaft seal glands and various turbine valve stems, including the turbine bypass and main turbine stop-control valve stems. The applicant states that the addition of the GSE will allow operational flexibility and will minimize the use of the auxiliary boiler during plant startup and shutdown. Also, the use of the clean steam for gland sealing will minimize the release of radioactivity into the environment pursuant to the as low as reasonably achievable (ALARA) policy. The applicant states that this departure was evaluated and determined to comply with the requirements in 10 CFR Part 52, Appendix A, Section VIII.B.5.

In addition, in FSAR Section 10.4.3, the applicant provides the following:

COL License Information Item

- COL License Information Item 10.6 Radiological Analysis of the TGSS Effluents

This COL license information item states that the "performance of a radiological analysis of the TGSS effluents is included in the offsite dose calculation manual (ODCM) that contains the methodology and parameters used for calculation of offsite doses resulting from gaseous and liquid effluents, including the turbine gland seal steam condenser exhaust."

10.4.3.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–1503. In addition, the relevant requirements of the Commission regulations for the TGSS, and the associated acceptance criteria, are in Section 10.4.3 of NUREG–0800.

In accordance with Section VIII, "Processes for Changes and Departures," of, "Appendix A to Part 52-Design Certification Rule for the U.S. Advanced Boiling Water Reactor," the applicant identifies one Tier 2 departure. This Tier 2 departure does not require prior NRC approval and is subject to the requirements of 10 CFR Part 52, Appendix A, Section VIII.B.5, which are similar to the requirements in 10 CFR 50.59.

In particular, the regulatory basis and review criteria that the staff used for COL License Information Item 10.6 and Tier 2 Departure STD DEP 10.4-1 are specified in GDC 60 as it relates to the TGSS features incorporated to monitor and control releases of radioactive materials in effluents.

10.4.3.4 *Technical Evaluation*

As documented in NUREG–1503, NRC staff reviewed and approved Section 10.4.3 of the certified ABWR DCD. The staff reviewed Section 10.4.3 of the STP Units 3 and 4 COL FSAR

and checked the referenced ABWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ABWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the required information relating to the TGSS.

The staff reviewed the following information in the COL FSAR:

Tier 2 Departure Not Requiring Prior NRC Approval

- STD DEP 10.4-1 Turbine Gland Seal Steam

NRC staff reviewed Departure STD DEP 10.4-1, which refers to the addition of a GSE to supply sealing steam to the main turbine shaft seal glands and various turbine valve stems, including the turbine bypass and main turbine stop-control valve stems, as shown in FSAR Tier 2, Figure 10.4-2, "Turbine Gland Seal System." The GSE will provide isolation from the potentially contaminated heating steam and provide clean steam to the gland seal system. Also, the use of the clean steam for gland sealing will minimize the release of radioactivity into the environment pursuant to the ALARA policy. Due to the addition of the GSE, FSAR Figure 10.4-2 in FSAR Revision 0 of the COL application modifies ABWR DCD Figure 10.4-2. The modification to Figure 10.4-2 as part of Departure STD DEP 10.4-1 did not show how the GSE ties in with the turbine auxiliary steam header, main steam lines ahead of the turbine MSV, turbine extraction, and condensate described in Departure STD DEP 10.4-1. Also, FSAR Figure 10.4-2 did not show the GSE relief valves that protect the tubeside and shellside from overpressure, the relief valve flow paths, and the modulating control valves. Additionally, the removal and addition of flow lines in Figure 10.4-2 created confusion as to the source and disposition of the sealing steam.

The applicant's evaluation of this departure described above, in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5, determined that this departure does not require prior NRC approval. The staff reviewed the Part 7 "Departures Report" regarding this departure and was unable to determine whether the departure meets Criteria (2), (4), and (6) in Appendix A of 10 CFR Part 52, Section VIII.B.5.b or adequately addresses GDC 4. Therefore, the staff issued RAI 10.04.03-3 requesting that the applicant provide the above information and clarifications.

In the response to RAI 10.04.03-3 dated May 20, 2008 (ML081440107), the applicant provides a markup of FSAR Figure 10.4-2. The applicant states that some of the changes in the COL application are due to the revised Toshiba design of the TGSS. A summary of the applicant's response and the staff's evaluation follows:

(1) The applicant states that the loop-seal between the turbine building ventilation exhaust and the condensate drain tank was deleted in the Toshiba design. Instead, the blower drain line is connected to the U-seal at the bottom of the GSC. The staff's review of the applicant's markup of Figure 10.4-2 found that the applicant did not explain how this modification to the certified design would not impact the TGSS. The staff issued supplemental RAI 10.04.03-4 requesting the applicant to provide additional information in this regard. Item 1 in RAI 10.04.03-3 was tracked as Open Item 10.04.03-4 in the SER with open items.

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.1.3, for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

The applicant's response to RAI 10.04.03-4 dated May 3, 2010 (ML101260118), states that exhaust blowers and associated piping for the gland steam condenser (GSC) are designed to remove the noncondensable gases from the TGSS to the plant vent stack. In the process, it could carry moisture. Therefore, to account for this moisture removal, the GSC exhaust blower system is provided with drain lines. Furthermore, industry practice is to use loop-seals between the process lines and the drain lines to act as a barrier to prevent gas/vapor leakages from the process lines to the drain lines. In the ABWR DCD, a single drain line is provided in the exhaust blower discharge line for this moisture removal, which is routed to the condensate drain tank with a loop-seal in it. To account for this moisture removal, in the STP design drains from each blower casing are combined and routed to a loop-seal at the GSC before it discharges into the condensate return tank. Also, the blower drain connection at the GSC loop-seal is at a point in the loop where fluid isolation is achieved with the condensate column in both legs of the loop. Thus, the STP GSC drain and loop-seal design allows for drainage as well as for a leakage trap to prevent a vapor/gas drain from escaping into the GSC drain line. Based on the above discussion, the staff found the applicant's modification from the DCD acceptable, because it provides the same functions of drainage and a leakage trap as those in the DCD. Also, this modification does not adversely impact the function of the TGSS or the functions of any safety-related SSCs. Therefore, Item 1 in RAI 10.04.03-3 is resolved and Open Item 10.04.03-4 is closed.

(2) The applicant states that the pressure switch between the exhaust blowers and the condensate storage and transfer line is not needed in the Toshiba design. In the certified design, the standby blower starts on a pressure signal. In the Toshiba design, the standby blower is started manually. Because the unit relies on an operational blower to maintain a vacuum, the staff issued RAI 10.04.03-4 requesting the applicant to explain why this modification in the TGSS design does not adversely affect the GSC and prevent it from performing its intended function. Item 2 in RAI 10.04.03-3 was tracked as Open Item 10.04.03-5 in the SER with open items.

The applicant's response to RAI 10.04.03-4 dated May 3, 2010, provides the following justification for the pressure switch modification:

During normal plant operation, the GSC operates under negative pressure as the exhaust blowers remove the noncondensable gases from the GSC to the plant vent system. Also in the DCD, a pressure switch is used to start the standby blower when the operating blower trips and the gland discharge line builds up pressure as the noncondensable gases accumulate in the GSC. The pressure switch is located between the main turbine gland discharge and the suction of the GSC exhaust blowers. In the STP design, the standby blower is started manually. When the operating blower trips, operators in the control room are alerted and can start the standby backup blower. Therefore, the pressure switch is eliminated. The applicant adds that the TGSS is consistent with the DCD with respect to the displays for the gland seal condenser and the seal steam header pressure in the main control room.

Based on the above discussion, the staff found the applicant's modification to the DCD acceptable, because it does not adversely impact the function of the TGSS or the functions of any safety-related SSCs. Therefore, Item 2 of RAI 10.04.03-3 is resolved and Open Item 10.04.03-5 is closed.

(3) The applicant adds that the vent on the condensate drain tank line to the GSC is necessary. However, in the revised design, the vent is incorporated into the U-seal line. The applicant indicates that the FSAR will be revised to relocate the vent, which the revised Figure 10.4-2 depicts. The staff found this relocation of the vent acceptable, because it is in the Toshiba design and does not impact the TGSS operation. The staff determined that the applicant has provided adequate clarifications that resolved the staff's concerns regarding this issue as part of the applicant's response to RAI 10.04.03-3. The staff verified that FSAR Revision 3 incorporates the applicant's response. Therefore, Item 3 in RAI 10.04.03-3 is resolved.

(4) The applicant notes that the flow arrow of the condensate admittance into the GSC was removed in error and FSAR Figure 10.4-2 will be revised to correct the error, as shown in revised Figure 10.4-2. The staff determined that the applicant has provided adequate clarifications that resolved the staff's concerns regarding this issue as part of RAI 10.04.03-3. The staff verified that FSAR Revision 3 incorporates the applicant's response. Therefore, Item 4 in RAI 10.04.03-3 is resolved.

(5) The applicant notes that the "4A, B, and C" labeling for the feedwater heater line was removed in error. The applicant provided a markup of revised FSAR Figure 10.4-2 to restore the labeling. The staff determined that the applicant has provided adequate clarifications that resolved the staff's concerns regarding this issue as part of RAI 10.04.03-3. The staff verified that FSAR Revision 3 incorporates the applicant's response. Therefore, Item 5 in RAI 10.04.03-3 is resolved.

(6) The applicant states that the depiction of the valve configuration in COL application Revision 1 is incorrect, and it will be revised as shown in the markup of Figure 10.4-2. The staff noted that the auxiliary steam valve sequence was altered in FSAR Revision 1 compared to the ABWR DCD, Revision 4. The valve configuration in the revised Figure 10.4-2 deleted a check valve between the motor-driven and regulating valve. The check valves, in general, prevent backflow in the system. Therefore, the staff issued RAI 10.04.03-4 requesting the applicant to justify the deletion of this check valve. This issue was tracked as Open Item 10.04.03-6 in the SER with open items.

The applicant's response to RAI 10.04.03-4 dated May 3, 2010 (ML101260118), states that Departure STD DEP 10.4-1 incorporates the GSE between the steam seal header (SSH) and two of the three sources of steam for the TGSS (i.e., crossaround and main steam). With this modification, there are only two lines going directly to the SSH: the plant auxiliary boiler steam and the steam from the GSE. The steam from the GSE is at a lower pressure than the auxiliary steam. Therefore, the check valve in the auxiliary steam supply line is not required to prevent back flow, so this valve is deleted. Furthermore, when the GSE steam begins to be supplied to the SSH, the auxiliary steam supply is isolated with normally closed motor-operated valves. The staff reviewed all three sources of the TGSS steam supply lines and determined that the Departure STD DEP 10.4-1 modification with respect to the piping and valves is appropriately designed. Therefore, the modification is acceptable. Accordingly, Item 6 of RAI 10.04.03-3 is resolved and Open Item 10.04.03-6 is closed.

(7) The applicant notes that the depiction of the gland seal steam connection in COL application Revision 1 is incorrect and provided a markup of FSAR Figure 10.4-2. In the ABWR DCD, a gland seal steam line that apparently goes nowhere was added between the relief valve to the condenser and the feedwater heater flow line. The applicant indicates that this additional line is incorrect and will be removed in the revision of Figure 10.4-2. The applicant commits to revise the FSAR as shown in the markup of FSAR Figure 10.4-2. The staff determined that the applicant has provided adequate clarifications that resolve the staff's concerns regarding this issue as part of RAI 10.04.03-3. The staff verified that FSAR Revision 3 incorporates the applicant's response. Therefore, this issue is resolved.

(8) The applicant states that FSAR Figure 10.4-2 will be revised as shown in the markup of Figure 10.4-2 to show the GSE ties with the turbine auxiliary steam header, the main steam lines ahead of the turbine MSVs, turbine extraction, and the condensate as described in Departure STD DEP 10.4-1. The staff determined that the applicant has provided adequate clarifications that resolved the staff's concerns regarding this issue in RAI 10.04.03-3. The staff verified that FSAR Revision 3 incorporates the applicant's response. Therefore, this issue is resolved.

(9) The applicant states that FSAR Figure 10.4-2 will be revised in the markup of Figure 10.4-2 to show the GSE relief valves that protect the tube side and shell side from overpressure, the relief valve flow paths, and the modulating control valves. The applicant has provided a revised Figure 10.4-2 in Revision 3 of the FSAR that includes relief valves (on both shell and tube sides of the GSE), the relief valve discharge flow paths to the MC, and the modulating valves as described in Departure STD DEP 10.4-1. The staff determined that the applicant has provided adequate clarifications that resolve the staff's concerns regarding this issue as part of RAI 10.04.03-3. The staff verified that FSAR Revision 3 incorporates the applicant's response. Therefore, this issue is resolved.

Based on the above discussion, the staff's concerns in supplemental RAIs 10.04.03-4, 10.04.03-5 and 10.04.03-6 are resolved and the corresponding open items are closed.

The staff's review of additional information in the COL FSAR Section 10.4.3 is summarized below.

FSAR Subsection 10.4.3.2.2, "System Operation," states that the seal steam header pressure is regulated automatically by the sealing steam pressure regulator. The discussion also states that the pressure is controlled at approximately 27.6 kPaG (4.0 psig), and relief valves protect the sealing steam header from overpressure. The FSAR does not discuss the basis for the specific controller operating pressure and does not describe how it controls the release of radioactive material. In order to comply with SRP Section 10.4.3 criteria and the GDC 60 requirement, the staff issued RAI 10.04.03-1 requesting the applicant to provide additional information in this regard.

The applicant's response to RAI 10.04.03-1 dated May 20, 2008 (ML081440107), states that the basis for a controller operating pressure for each turbine gland requires sufficient steam to seal the gland. The larger the gland clearance, the greater the steam flow required to seal the gland. Approximately 11 kPaG (1.6 psig) of steam header pressure is required to supply sufficient steam flow to the maximum clearance gland. The 27.6 kPaG (4.0 psig) controller operating pressure provides a sufficient margin to the required 11 kPaG (1.6 psig). The applicant further

states that the minimum of 11 kPaG (1.6 psig) prevents turbine internal steam from releasing into the GSC and leaking into the plant stack. Also, the applicant indicates that no FSAR revision is required as a result of this RAI response. The staff concluded that the applicant has provided adequate clarifications that resolve the staff's concerns regarding RAI 10.04.03-1. Therefore, RAI 10.04.03-1 is resolved.

In addition, the staff reviewed FSAR Subsection 10.4.3.3, "Evaluation," which states that the TGSS is designed to prevent the leakage of radioactive steam from the main turbine shaft glands and valve stems. This discussion also notes that the HP turbine shaft seals must accommodate a range of turbine shell pressure from a full vacuum to approximately 17.3 MPaA (2509 psia). Referring to the ABWR DCD, the staff noticed that in the COL application, the maximum operating pressure limit for the HP turbine shaft seals had been increased from 1.52 to 17.3 MPaA (220.5 to 2509 psia). Although the staff recognized that increasing the maximum operating pressure may indicate that the seals are capable of functioning under a greater range of pressures, the staff expressed the following three concerns: (1) how the TGSS will accommodate this increased pressure demand for the supply of sealing steam at 17.3 MPaA (2509 psia) pressure; (2) whether the TGSS will have the ability to prevent radioactive releases into the environment; and (3) whether the TGSS will satisfy the requirements of the GDC 60 criteria with respect to radioactive releases. The staff issued RAI 10.04.03-2 requesting the applicant to provide additional information in this regard.

The applicant's response dated May 20, 2008 (ML081440107), states that the 17.3 MPaA (2509 psia) TGSS operating pressure was an error and would be revised to 1.77 MPaA (257 psia). The new 1.77 MPaA (257 psia) pressure is still a change from the ABWR DCD. However, the applicant states that the TGSS can accommodate the slight pressure increase. According to the applicant, FSAR Subsection 10.4.3.3 will be revised to state that the HP turbine shaft seals must accommodate a range of turbine shell pressure from full vacuum to approximately 1.77 MPaA (257 psia). The staff concluded that the applicant has provided adequate clarifications that resolve the staff's concerns in RAI 10.04.03-2. The staff verified that FSAR Revision 3 incorporates the applicant's response. Therefore, RAI 10.04.03-2 is resolved.

Based on the adequate resolution of the above RAIs, the staff found it reasonable that the departure does not require prior NRC approval. The applicant's process for evaluating departures and other changes to the DCD is subject to NRC inspections.

COL License Information Item

- COL License Information Item 10.6 Radiological Analysis of the TGSS Effluents

NRC staff reviewed FSAR Subsection 10.4.10.1 and Section 10.4.3, as they relate to COL License Information Item 10.6. ABWR DCD Subsection 10.4.10.1, "Radiological Analysis of the TGSS Effluents," states that the COL applicant will provide an analysis of the TGSS effluents and will include planned discharge flow rates, including the level at which the TGSS steam supply will be switched over to the auxiliary steam. FSAR Subsections 10.4.10.1 and 10.4.3.3 provide information and an evaluation that (1) the ODCM will provide the means and methodology to capture any gaseous effluent from the TGSS in the plant vent system, and (2) the ODCM will include any radioactive content of the sealing steam. Although the applicant did not provide specific information to be included in the ODCM, the applicant is required to sample, analyze, and monitor all radioactive inputs to the plant vent that exhausts into the atmosphere (FSAR Section 11.3). The staff reviewed the applicant's information and determined that the applicant's response to COL License Information Item 10.6 is acceptable.

ITAAC Considerations

ITAAC listed in Table 2.10.9 of Part 2, Tier 1, Section 2.10.9 of the ABWR DCD are incorporated by reference with no departures or supplements for the STP Units 3 and 4 COL FSAR.

10.4.3.5 *Post Combined License Activities*

There are no post COL activities related to this section.

10.4.3.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1503. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the applicant has addressed the required information relating to the TGSS, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix A, Section VI.B.1, all nuclear safety issues relating to the TGSS that were incorporated by reference have been resolved.

In addition, the staff compared the additional information in the COL application to the relevant NRC regulations and the guidance in Section 10.4.3 of NUREG–0800. The staff's review concluded that the applicant has adequately addressed COL License Information Item 10.6 in accordance with the guidance in Section 10.4.3 of NUREG–0800, and found it reasonable that the identified Tier 2 departure is characterized as not requiring prior NRC approval per 10 CFR Part 52, Appendix A, Section VIII.B.5.

The staff reviewed the TGSS documented in STP Units 3 and 4 COL FSAR Section 10.4.3, Departure STD DEP 10.4-1, and the applicant's RAI responses as they relate to the new Toshiba design of the TGSS. On the basis of this review, the staff found that the STP TGSS continues to meet all acceptance criteria documented in NUREG–1503 and is therefore considered acceptable.

10.4.4 Turbine Bypass System

10.4.4.1 *Introduction*

This section of the FSAR addresses the capability to discharge main steam from the reactor directly to the MC to minimize step load reduction transient effects on the reactor coolant system. The TBS is designed to discharge a certain percentage of the rated main steam flow directly to the MC, thus bypassing the turbine. The bypassed quantity is sufficient to allow a 33 percent electrical step load reduction without a reactor trip. The TBS is also used to discharge main steam during reactor hot standby and cooldown operations.

10.4.4.2 *Summary of Application*

Section 10.4.4 of the STP Units 3 and 4 COL FSAR Revision 12, incorporates by reference Section 10.4.4 of the certified ABWR DCD Revision 4, referenced in 10 CFR Part 52, Appendix A. In addition, in FSAR Section 10.4.4, the applicant provides the following:

Tier 2 Departures Not Requiring Prior NRC Approval

- STD DEP 10.4-6 Load Rejection Capability

This standard departure modifies the capability of the TBS from 40 percent of the turbine-generator rated load to 33 percent of the load. The applicant states that this departure complies with the requirements of 10 CFR Part 52, Appendix A, Section VIII.B.5, and does not require prior NRC approval.

- STD DEP Admin

This departure clarifies the description of TBS components. The applicant determined that this departure complies with the requirements of 10 CFR Part 52, Appendix A, Section VIII.B.5, and does not require prior NRC approval.

10.4.4.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–1503. In addition, the relevant requirements of the Commission regulations for the TBS, and the associated acceptance criteria, are in Section 10.4.4 of NUREG–0800.

In accordance with Section VIII, "Processes for Changes and Departures," of, "Appendix A to Part 52-Design Certification Rule for the U.S. Advanced Boiling Water Reactor," the applicant identifies Tier 2 departures. Tier 2 departures not requiring prior NRC approval are subject to the requirements of 10 CFR Part 52, Appendix A, Section VIII.B.5, which are similar to the requirements in 10 CFR 50.59.

In particular, the regulatory basis and review criteria that the staff used for Departure STD DEP 10.4-6 are specified in SRP Section 10.4.4 and GDC 34, "Residual heat removal," as they relate to the ability to use the system for shutting down the plant during normal operations. The operation of the TBS eliminates the need to rely solely on safety systems, which are required to meet the redundancy and power source requirements of this criterion.

10.4.4.4 *Technical Evaluation*

As documented in NUREG–1503, NRC staff reviewed and approved Section 10.4.4 of the certified ABWR DCD. The staff reviewed Section 10.4.4 of the STP Units 3 and 4 COL FSAR and checked the referenced ABWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ABWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the required information relating to the TBS.

The staff reviewed the following information in the COL FSAR:

Tier 2 Departures Not Requiring Prior NRC Approval

[1] See "Finality of Referenced NRC Approvals" in SER Section 1.1.3, for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

- STD DEP 10.4-6 Load Rejection Capability

NRC staff reviewed Departure STD DEP 10.4-6, which involves a reduced design capacity for the TBS.

The applicant determined that this departure does not require prior NRC approval, in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5. Within the review scope of this section, the staff found it reasonable that the departure does not require prior NRC approval. The applicant's process for evaluating departures and other changes to the DCD is subject to NRC inspections.

- STD DEP Admin

The applicant defines administrative departures as minor corrections, such as editorial or administrative errors in the referenced ABWR DCD (e.g., misspellings, incorrect references, table headings, etc.). Administrative departures do not affect the presentation of any design discussion or the qualification of any design margin. NRC staff reviewed the administrative departure listed by the applicant in FSAR Section 10.4.4. This departure clarifies the description of TBS components. The applicant determined that this departure does not require prior NRC approval, in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5. Within the review scope of this section, the staff found it reasonable that the departure does not require prior NRC approval with regard to its applicability to turbine bypass capacity. The applicant's process for evaluating departures and other changes to the certified ABWR DCD is subject to NRC inspections.

10.4.4.5 *Post Combined License Activities*

There are no post COL activities related to this section.

10.4.4.6 C*onclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1503. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix A, Section VI.B.1, all nuclear safety issues relating to the TBS that were incorporated by reference have been resolved.

In addition, the staff compared the additional information in the COL application to the relevant NRC regulations, and the guidance in Section 10.4.4 of NUREG–0800. The staff's review concluded that the applicant has provided sufficient information to satisfy NRC regulations, and found it reasonable that the identified Tier 2 departures are characterized as not requiring prior NRC approval per 10 CFR Part 52, Appendix A, Section VIII.B.5.

The staff evaluated the plant-specific information that was provided relative to the TBS for the STP Units 3 and 4 COL application. Based on the results of this evaluation, the staff found that the heat removal capability of the TBS for shutting down during normal operations remains adequately protected. The staff determined that there are no TS, ITAAC, or Initial Test Program considerations related to this area of review.

10.4.5 Circulating Water System

10.4.5.1 *Introduction*

This section of the FSAR describes how the circulating water system (CWS) provides cooling water for the removal of the power cycle waste heat from the MCs and transfers this heat to the power cycle heat sink. For STP Units 3 and 4, the power cycle heat sink utilizes a main cooling reservoir to reject power cycle waste heat.

10.4.5.2 *Summary of Application*

Section 10.4.5 of the STP Units 3 and 4 COL FSAR Revision 12, incorporates by reference Section 10.4.5 of the certified ABWR DCD Revision 4, referenced in 10 CFR Part 52, Appendix A. In addition, in FSAR Section 10.4.5, the applicant provides the following:

Tier 1 Departure

- STD DEP T1 3.4-1 Safety-Related I&C Architecture

This standard departure modifies the design of certain devices, functions, and standards related to the EMS and SSLC. The departure also updates the ABWR DCD design descriptions that reflected outdated technology. This departure is incorporated in FSAR Subsection 10.4.5.5, "Instrumentation Applications."

Tier 2 Departure Not Requiring Prior NRC Approval

- STP DEP 10.4-2 Main Condenser

This site-specific departure changes the main condenser, provides four circulating water pumps each with a 25 percent capacity, adds the water box vacuum priming system, and eliminates the warm water recirculation operating mode and associated recirculation components. This departure is incorporated in FSAR Subsection 10.4.5.5, "Instrumentation Applications," and Subsection 10.4.5.7, "Portions of the CWS Outside of Scope of ABWR Standard Plant."

- STP DEP 1.2-2 Turbine Building

This departure addresses changes to the turbine building because of design change to the STP Units 3 and 4 turbine generator, use of the main cooling reservoir (instead of the natural draft cooling tower), and the use of a dual voltage design versus a medium voltage electrical system design in the ABWR DCD.

Interface Requirements

Flooding Considerations for CWS:

In ABWR DCD Tier 1, Section 2.10.23, the interface requirements for the CWS state that "the design features shall be provided to limit flooding in the Turbine Building."

Conceptual Design Information

Power Cycle Heat Sink (FSAR Subsection 10.4.5.8):

In the ABWR DCD, the conceptual design of the power cycle heat sink utilizes a natural draft cooling tower. In the STP Units 3 and 4 COL FSAR, the applicant replaces this conceptual design information with a site-specific supplement. The STP Units 3 and 4 power cycle heat sink uses a main cooling reservoir to reject power cycle waste heat. The main cooling reservoir contains approximately 202,700 acre-feet of water and is discussed in FSAR Section 2.4S.

In the STP Units 3 and 4 COL FSAR, the applicant provides detailed, site-specific, design-basis information in accordance with Subsection 10.4.5.8.2, "Power Generation Design Basis (Interface Requirements)," of the referenced ABWR DCD for the interface requirements between the main condenser and the main cooling reservoir, as divided at the turbine building wall (see ABWR DCD Tier 1, Figure 2.10.23, "Circulating Water System").

Portions of the CWS Outside of Scope of ABWR Standard Plant (FSAR Subsection 10.4.5.7):

In STP Units 3 and 4 COL FSAR Subsection 10.4.5.7, the applicant replaces the phrase "screen house" with "intake structure" to accommodate the change from the natural draft cooling tower (conceptual design) to a main cooling reservoir. The applicant also provides a site-specific supplement. The supplement describes the intake structure, circulating water flow-path, and vacuum priming pump function.

In STP Units 3 and 4 COL FSAR Subsection 10.4.5.7.2, the applicant provides detailed, site-specific, design-basis information in accordance with Subsection 10.4.5.7.2, "Power Generation Design Basis (Interface Requirements)," of the referenced ABWR DCD, for the interface requirements between the site-specific portions of the CWS and the ABWR standard plant.

10.4.5.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–1503. In addition, the relevant requirements of the Commission regulations for the CWS, and associated acceptance criteria, are in Section 10.4.5 of NUREG–0800.

In accordance with Section VIII, "Processes for Changes and Departures," of, "Appendix A to Part 52-Design Certification Rule for the U.S. Advanced Boiling Water Reactor," the applicant identifies Tier 1 and Tier 2 departures. Tier 1 departures require prior NRC approval and are subject to the requirements of 10 CFR Part 52, Appendix A, Section VIII.A.4. Tier 2 departures not requiring prior NRC approval are subject to the requirements of 10 CFR Part 52, Appendix A, Section VIII.B.5, which are similar to the requirements in 10 CFR 50.59.

In particular, the regulatory basis and review criteria that the staff used for the conceptual design, interface requirements, and departures described above—as they relate to the protection of SSCs important to safety from the effects of CWS considerations—are specified in SRP Section 10.4.5.

10.4.5.4 *Technical Evaluation*

As documented in NUREG–1503, NRC staff reviewed and approved Section 10.4.5 of the certified DCD for the ABWR design. The staff reviewed Section 10.4.5 of the STP Units 3 and 4 COL FSAR and checked the referenced ABWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ABWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the required information relating to the CWS.

The staff reviewed the following information in the COL FSAR:

Tier 1 Departures

- STD DEP T1 3.4-1 Safety-Related I&C Architecture

The staff reviewed Departure STD DEP T1 3.4-1, which modifies the design of certain devices, functions, and standards related to the EMS and SSLC to update the referenced ABWR DCD design descriptions that reflected outdated technology. This departure also enables specific architectural changes in the engineered safety functions portion of the instrumentation and control (I&C) architecture and deletes or supplements references to specific outdated communication protocol standards. This departure is incorporated in FSAR Subsection 10.4.5.5, "Instrumentation Applications." The staff's evaluation of this departure is discussed in Chapter 7 of this SER.

Tier 2 Departure Not Requiring Prior NRC Approval

- STP DEP 10.4-2 Main Condenser

NRC staff reviewed STP DEP 10.4-2, a site-specific departure that changes the MC, utilizes a main cooling reservoir as the power cycle heat sink to reject power cycle waste heat, provides four circulating water pumps each with a 25 percent capacity, and adds a water box vacuum priming system and intake structure. The staff reviewed the modifications described in Departure STP DEP 10.4-2 and determined that this departure does not adversely affect the design and operational aspects of the CWS considerations that were approved for the ABWR DCD. Additionally, this departure is identified by the applicant in FSAR Subsection 10.4.5.5, "Instrumentation Applications," and Subsection 10.4.5.7, "Portions of the CWS Outside of Scope of ABWR Standard Plant."

The applicant's evaluation determined that this departure does not require prior NRC approval in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5. Within the review scope of this section, the staff found it reasonable that this departure does not require prior NRC approval. The applicant's process for evaluating departures and other changes to the DCD is subject to NRC inspections.

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.1.3, for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

- STP DEP 1.2-2 Turbine Building

In Subsection 10.4.5.3 of the STP Units 3 and 4 COL FSAR, the applicant provides editorial changes indicating that all credible potential circulating water spills inside the “Turbine Building remain confined inside the Turbine Building.”

The applicant's evaluation determined that this departure does not require prior NRC approval in accordance with 10 CFR Part 52, Appendix A, Section VIII.B.5. Within the review scope of this section, the staff found it reasonable that this departure does not require prior NRC approval. The applicant's process for evaluating departures and other changes to the DCD is subject to NRC inspections.

Interface Requirements

The interface requirement for the CWS in ABWR DCD Tier 1, Section 2.10.23 states:

> The parts of the CWS (including the power cycle heat sink) which are not within the Certified Design shall meet the following requirements:
>
> Design features shall be provided to limit flooding in the Turbine Building.

NRC staff reviewed STP Units 3 and 4 COL FSAR Section 10.4.5 for the CWS. This section does not specifically address this interface requirement specified in the DCD. Furthermore, the staff noticed that in FSAR Subsections 10.4.5.7.2 and 10.4.5.8.2, the applicant characterizes these items as COL license information items. It is not clear as to which is the interface item and which is the COL license information item. Furthermore, with respect to flooding, the “Acceptance Criteria” in STP Units 3 and 4 COL Application Part 9, ITAAC Table 3.0-9, ”Circulating Water System (CWS),” state that the circulating water condenser valves are closed and the CWS pumps are tripped following the receipt of a system isolation signal from the condenser area level switches. However, the criteria do not include the closure of the CWS pump valves upon receipt of the above signal.

The staff issued RAI 10.04.05-1 requesting the applicant to provide the above information and clarifications as they relate to flooding.

The applicant responded to RAI 10.04.05-1 in a letter dated July 2, 2008 (ML081890239), which is summarized below:

(1) ABWR DCD Subsections 10.4.5.7.2 and 10.4.5.8.2 require the COL applicants to provide interface requirements information for the CWS. However, in STP Units 3 and 4 COL FSAR Revision 1, Section 10.4.5, the applicant inadvertently identifies these sections as COL license information items. The applicant further states that there are no COL license information items required for Section 10.4.5. The staff found the applicant’s response acceptable, because there are no COL license information items identified in the DCD for the CWS.

(2) Regarding the closure of the CWS pump valves, DCD Subsection 10.4.5.2.3 states that the circulating water pumps are tripped and the pump and condenser isolation valves are closed in the event of a system isolation signal from the condenser pit high-high level switches. Because the STP Units 3 and 4 COL FSAR incorporates Subsection 10.4.5.2.3 of the DCD by reference in the case of the STP, when a

circulating water pump is stopped, the associated pump discharge valve will also close. The staff found the applicant's clarification acceptable.

(3) With respect to flooding considerations, the applicant states that DCD Tier 1, Section 2.10 is incorporated by reference in the STP Units 3 and 4 COL application, with no changes from the certified design, and that Section 2.10 of DCD Tier 1 contains ITAAC Table 2.10.23 for the parts of the CWS that are in the certified design. ITAAC Table 2.10.23, Item 2 ("Design Commitment"), states that the circulating water condenser valves are closed in the event of a system isolation signal from the condenser area level switches, thereby covering this aspect of the flood prevention provisions. The applicant further states that "Interface Requirements," as specified in DCD Tier 1, Section 2.10.23, pertain to the parts of the CWS that are not in the certified design. The intent of STP Units 3 and 4 COL application Part 9, Table 3.0-9, is to fulfill this interface requirement by providing additional verification of features designed to limit flooding in the turbine building. Therefore, COL application Part 9 Table 3.0-9 will be revised to indicate additional design requirements and acceptance criteria for the CWS pumps and pump discharge valves, as described above. The staff found this site-specific interface requirement acceptable, because it adds provisions to prevent flooding.

The applicant committed to revise the STP FSAR sections and COL application Part 9 to reflect the above changes. The staff verified that FSAR Revision 3 incorporates the applicant's response. Therefore, RAI 10.04.05-1 is resolved and the staff finds that the interface requirement of ABWR DCD Tier 1, Section 2.10.23 is met.

Conceptual Design Information

In accordance with Subsection 10.4.5.8.2 of the referenced ABWR DCD, the applicant provides site-specific system design features and additional information for the interface requirements between the CWS and the power cycle heat sink (i.e., main cooling reservoir) in the FSAR. NRC staff reviewed the applicant's supplements with respect to the interface requirements in ABWR DCD Subsections 10.4.5.7.2 and 10.4.5.8.2. A brief description of these supplements follows:

(1) Design Features (FSAR Subsection 10.4.5.2):

The power cycle heat sink design is compatible with the requirements described in Subsection 10.4.5.2 of the ABWR DCD. Heated circulating water from the main condenser is discharged to the main cooling reservoir, and the cooled water is returned to the main condenser to complete the closed cycle circulating water loop. The reservoir makeup pumping facility supplies makeup water from the Colorado River to the main cooling reservoir.

(2) Evaluation of the Power Cycle Heat Sink (FSAR Section 10.4.5.3):

The main cooling reservoir is not a safety-related system, as described in FSAR Subsection 10.4.5.3. The potential for a flood from the main cooling reservoir breach is documented in FSAR Sections 2.4S.4 and 2.4S.10. The staff's evaluation of this issue is in Sections 2.4S.4 and 2.4S.10 of this SER.

(3) Tests and Inspections (FSAR Subsection 10.4.5.4):

The CWS and related systems and facilities that are tested and checked for leakage integrity before the initial plant startup are described as part of the CWS preoperational test, which is part of FSAR Subsection 14.2.12.1.60. The staff reviewed the CWS preoperational test that referred back to this part of Section 10.4.5 and found it acceptable. The staff's full evaluation of this information is in Section 14.2 of this SER.

(4) Instrument Applications (FSAR Subsection 10.4.5.5):

The staff's evaluation of instrumentation applications involved reviewing manual controls for the vent valves in the condenser water boxes, monitoring the performance of the CWS by differential pressure transducers across the condenser and temperature signals from both the supply and discharge sides of the condenser. The staff's full evaluation of this information is in Chapter 7 of this SER.

(5) Flood Protection (FSAR Subsection 10.4.5.6):

Flood protection is described in FSAR Section 3.4, and the flooding that results from the main cooling reservoir breach is discussed in FSAR Sections 2.4S.4 and 2.4S.10. Additional information relating to the staff's evaluation of flood protection is in Sections 3.4, 2.4S.4, and 2.4S.10 of this SER.

(6) Turbine Service Water System Cooling (FSAR Section 9.2.16):

The main cooling reservoir continues to serve as the heat sink for the turbine service water system in the event of a loss of offsite power. The turbine service water system (FSAR Section 9.2.16) is designed to operate with electrical power from the combustion turbine generator in the absence of offsite power. This information was reviewed as part of Section 9.5.11 of this SER.

Based on a review of the applicant's proposed system design features and additional information, the staff concluded that the design of the power cycle heat sink, with respect to the interface with the CWS, is acceptable and meets the interface requirements of Subsections 10.4.5.7.2 and 10.4.5.8.2 of the referenced ABWR DCD.

10.4.5.5 *Post Combined License Activities*

There are no post COL activities related to this section.

10.4.5.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1503. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix A, Section VI.B.1, all nuclear safety issues relating to the CWS that were incorporated by reference have been resolved.

In addition, the staff compared the additional information in the application to the relevant NRC regulations and the guidance in Section 10.4.5 of NUREG–0800. The staff's review concluded that the applicant has provided sufficient information to satisfy NRC regulations, and found it reasonable that the identified Tier 2 departures are characterized as not requiring prior NRC approval per 10 CFR Part 52, Appendix A, Section VIII.B.5.

Based on the results of this evaluation, the staff determined that the additional information referred to above in the "Interface Requirements" of the "Technical Evaluation" section is acceptable. Also, the staff found that the applicant has adequately addressed the STP CWS design. In addition, the staff determined that there are no TS or ITAAC considerations related to this area of review.

10.4.6 Condensate Purification System

This section of the FSAR addresses the condensate purification system (CPS). The applicant removes feedwater turbidity monitoring by Departure STD DEP 7.7-3. This departure does not change the functional or the safety requirements of the feedwater or condensate system. Therefore, the change in Subsection 10.4.6.5 does not affect the incorporation by reference of the CPS.

Section 10.4.6 of the STP Units 3 and 4 COL FSAR Revision 12 incorporates by reference Section 10.4.6, "Condensate Purification System," of the certified ABWR DCD Revision 4, referenced in 10 CFR Part 52, Appendix A, with Departure STD DEP 7.7-3. NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remains for review.[1] The staff's review confirmed that there is no outstanding issue related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix A, Section VI.B.1, all nuclear safety issues relating to the CPS have been resolved.

10.4.7 Condensate and Feedwater System

10.4.7.1 *Introduction*

This section of the FSAR describes the condensate and feedwater system (CFS), which receives condensate from the condenser hotwells; supplies condensate to the cleanup system; and delivers feedwater at the required temperature, pressure, and flow rate to the reactor. The CFS consist of four condensate pumps (three normally operating and one on automatic standby); four reactor feed pumps (three normally operating and one on automatic standby); four condensate booster pumps (three normally operating and one on automatic standby); four stages of LP feedwater heaters; and two stages of HP feedwater heaters and associated piping, valves, and instrumentation. The CFS does not serve or support any safety function and has no safety-design basis. The only part of the CFS classified as safety-related is the feedwater piping from the NSSS to the outermost containment isolation valve.

10.4.7.2 *Summary of Application*

Section 10.4.7 of the STP Units 3 and 4 COL FSAR Revision 12, incorporates by reference Section 10.4.7 of the certified ABWR DCD Revision 4, referenced in 10 CFR Part 52, Appendix A. In addition, in FSAR Section 10.4.7, the applicant provides the following:

Tier 2 Departure Requiring NRC Approval

- STD DEP 10.4-5 Condensate and Feedwater System

This standard departure modifies the CFS. The modifications include: (1) the addition of four condensate booster pumps to allow for the design of condensate pumps to have a low

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.1.3, for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

discharge head; (2) the addition of one reactor feed pump and two heater drain pumps to improve plant availability; (3) the addition of one bypass valve for bypassing HP heaters; and (4) the addition of one low-flow control valve in the feed pump discharge header for startup. TS 3.3.4.2, Bases "Background," is also changed to show that there are four feedwater pumps and each one requires a feedwater pump adjustable speed drive (ASD), as opposed to the two feedwater pump ASDs specified in the certified ABWR design.

Tier 2 Departure Not Requiring NRC Approval

- STP DEP 9.2-3 Turbine Building Cooling Water System

This departure increases the heat removal capacity of the three TCW system heat exchangers and the flow rate of each of the three pumps. The technical evaluation of this departure is in Section 9.2.14 of this SER.

10.4.7.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–1503. In addition, the relevant requirements of the Commission regulations for the CFS, and the associated acceptance criteria, are in Section 10.4.7 of NUREG–0800.

In accordance with Section VIII, "Processes for Changes and Departures," of, "Appendix A to Part 52-Design Certification Rule for the U.S. Advanced Boiling Water Reactor," the applicant identifies one Tier 2 departure requiring prior NRC approval. Tier 2 departures affecting TS's require prior NRC approval and are subject to the requirements of 10 CFR Part 52, Appendix A, Section VIII.C.4. Tier 2 departures not requiring prior NRC approval are subject to the requirements of 10 CFR Part 52, Appendix A, Section VIII.B.5, which are similar to the requirements in 10 CFR 50.59.

In particular, the regulatory basis and review criteria that the staff used to review Departure STD DEP 10.4-5 include conformance with the guidelines of NUREG–0800, Section 10.4.7, and the requirements of 10 CFR Part 50, Appendix A, GDC 2, "Design bases for protection against natural phenomena"; GDC 4; GDC 5, "Sharing of structures, systems, and components"; GDC 44, "Cooling water"; GDC 45, "Inspection of cooling water system"; and GDC 46, "Testing of cooling water system."

10.4.7.4 *Technical Evaluation*

As documented in NUREG–1503, NRC staff reviewed and approved Section 10.4.7 of the certified ABWR DCD. The staff reviewed Section 10.4.7 of the STP Units 3 and 4 COL FSAR and checked the referenced ABWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ABWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the required information relating to the CFS.

The staff reviewed the following information in the COL FSAR:

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.1.3, for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

Tier 2 Departure Requiring Prior NRC Approval

- STD DEP 10.4-5 Condensate and Feedwater System

NRC staff reviewed Departure STD DEP 10.4-5, which modifies the basic configuration of the CFS. Specific modifications proposed by the departure include:

- The addition of four condensate booster pumps, each with a 33 percent capacity, in a system designed to have three of the pumps normally operating and the fourth on automatic standby.
- The addition of one reactor feed pump, which increases the total number of feed pumps from three to four.
- The addition of two reactor heater drain pumps, which increases the number of heater drain pumps from two to four.
- The addition of a flow control bypass valve in the discharge header for startup.
- The addition of one bypass valve for bypassing the HP heaters.

The above modifications resulted in the following revisions: FSAR Subsections 10.4.7.2.1, 10.4.7.2.2, 10.4.7.2.3, and 10.4.7.2.5; FSAR Tables 10.4-5 and 10.4-6; and FSAR Figures 10.4-5 through 10.4-8. The staff noted that the applicant's revision of FSAR Subsection 10.4.7.2.2, "Component Description," did not include a description of the condensate booster pumps that were added to the system as part of this departure. Because the condensate booster pumps are major components of the STP CFS, and the FSAR describes the major components of the CFS, the staff issued RAI 10.04.07-2 requesting the applicant to explain why the condensate booster pumps are not included in the descriptions in Subsection 10.4.7.2.2 of the FSAR.

In a letter dated May 29, 2008 (ML081560702), the applicant's response to RAI 10.04.07-2 proposes to revise FSAR Subsection 10.4.7.2.2 to include a description of the condensate booster pumps that were added to the design as a result of Departure STD DEP 10.4.5. The staff reviewed Subsection 10.4.7.2.2 of Revision 3 of the FSAR and confirmed that the applicant has revised it as committed in the RAI response. The applicant has also added descriptions of the "Low-Pressure Feedwater Heaters" and the "Low-Pressure Heater Drain Tanks" to FSAR Subsection 10.4.7.2.2. The staff found the applicant's response and FSAR Revision 3 acceptable because the information in the FSAR is consistent with the requirement of RG 1.206, Regulatory Position C.I.10.4.7. Therefore, RAI 10.04.07-2 is resolved.

The staff reviewed the above departure against the applicable acceptance criteria of SRP Section 10.4.7. The following evaluation discusses the results of the staff's review.

The CFS is designed to (1) receive condensate from the MC hotwell; (2) supply cooling water to the CPS, the gland steam exhauster, the steam jet-air ejector, and the offgas recombiner coolers; and (3) deliver high-purity feedwater to the reactor at the required flow rate, pressure, and temperature. The CFS includes all components and equipment from the main condenser outlet to the reactor vessel to the heater drain system. The CFS is not used to support any safety function and is therefore classified as non-safety-related. However, the system does penetrate the primary containment and therefore must meet the primary containment isolation

requirements. Therefore, the portion of the system between the reactor vessel and the turbine wall is safety-related.

Departure STD DEP 10.4-5 provides a CFS that uses condensate booster pumps. The CFS that is approved in the ABWR DCD does not use condensate booster pumps. The use of the booster pumps allows the condensate pumps to operate at a lower discharge head and eliminates the requirement to design the equipment downstream of the condensate pumps for HP application.

The CFS design incorporates four condensate booster pumps, each with a 33 percent capacity, three normally operating and one on automatic standby. They operate in parallel taking suction downstream of the condensate demineralizers and discharging through the four stages of the LP feedwater heaters. The condensate booster pumps provide the necessary suction head at the reactor feed pumps. The use of condensate booster pumps does not adversely impact the ability of the CFS to perform its designed function. Additionally, the booster pumps will be located outside the containment and are therefore not part of the safety-related portion of the system. The use of condensate booster pumps in the CFS does not change the compliance of the systems to the SRP guidance, as documented in NUREG–1503.

Departure STD DEP 10.4-5 also adds to the CFS an additional reactor feed pump and two additional reactor heater drain pumps. The CFS now incorporates in its design four reactor feedwater pumps, each with a 33 percent capacity, compared to the three reactor feedwater pumps with a capacity of 33 to 65 percent used in the certified design. The pumps operate in parallel and take suction from the last stage of the LP feedwater heaters and discharge through the HP feedwater heaters. Each pump is driven by an ASD. The addition of the reactor feed pump does not change the normal operation of the system and should result in an improvement in plant availability, because a standby pump will be available in the event of a trip of an operating pump. The CFS now incorporates in its design four heater drain pumps, each with a capacity of 33 percent, compared to the two heater drain pumps used in the certified design. In the event of a heater drain pump trip during normal operation, the standby pump is designed to start automatically to maintain the rated power operation. The reactor feed pumps and the reactor heater drain pumps are located outside the containment and are therefore not part of the safety-related portion of the system. The addition of the new reactor feed pump and the reactor heater drain pumps in the CFS does not change the compliance of the systems to the SRP guidance, as documented in NUREG–1503.

Departure STD DEP 10.4-5 changes the CFS flow control by using a low-flow control valve in the feed pump discharge header to regulate the flow of feedwater during startup. The CFS design in the ABWR DCD uses a feedwater pump bypass valve equipped with a feedwater flow control to regulate the flow of feedwater during startup. The revised design continues to allow feedwater flow to be regulated by a low-flow control valve during startup and to bypass the feedwater pumps. These modifications to the CFS flow control do not change the compliance of the systems to the SRP, as documented in NUREG–1503.

Finally, Departure STD DEP 10.4-5 adds one HP heater bypass valve. The bypass valve, used for bypassing the HP feedwater heaters, provides an additional operation mode when one HP heater is not used. This modification does not change the compliance of the systems to the SRP, as documented in NUREG–1503.

ITAAC Considerations

NRC staff reviewed the ITAAC the applicant has proposed for the CFS in the COL application, in accordance with SRP Section 14.3. The staff found that the applicant's CFS design is not consistent with the design used for the ITAAC. The applicant's departure redesigns the system by adding condensate booster pumps and by increasing the number of reactor feed and heater drain pumps in the CFS, thus modifying the functional arrangement of the system. Tier 1, Section 2.10 of the STP Units 3 and 4 COL application incorporates by reference Tier 1, Section 2.10 of the ABWR DCD, which contains a design description of the CFS and the applicable system DC ITAAC in Table 2.10.2a and Figure 2.10.2a. Because the departure in FSAR Section 10.4.7 changes the functional arrangement of the system, and the proposed system is no longer consistent with the one in the ABWR DCD, the staff issued RAI 10.04.07-1 requesting the applicant to explain why the ITAAC continue to be applicable to the STP design, in light of the CFS modifications introduced by Departure STD DEP 10.4-5.

In a letter dated June 12, 2008 (ML081710126), the applicant's response to RAI 10.04.07-1 states that adding condensate booster pumps and increasing the number of feed and heater drains pumps in the CFS alters the specific design, but the changes do not modify the functional arrangement of the system. The applicant adds that the ITAAC in DCD Tier 1, Table 2.10.2a are intended to perform an inspection of the as-built system. The acceptance criteria are to ensure that the as-built CFS conforms to the basic configuration shown in DCD Tier 1, Figure 2.10.2a. Lastly, the applicant's response states that (1) the condensate booster pumps are shown in COL FSAR Tier 2, Figures 10.1-1 and 10.4-5; (2) the detailed design drawings will expand the basic configuration to include the condensate booster pumps and other refinements; and (3) the drawings will be used to perform these inspections. Therefore, the appropriate ITAAC will be performed and the acceptance criteria will be met.

The staff disagreed with the applicant's determination that the modifications to the CFS in Departure STD DEP 10.4-5 do not modify the functional arrangement or basic system configuration. The basic configuration shown in DCD Tier 1, Figure 2.10.2a and referenced by the CFS ITAAC (Table 2.10.2a) does not reflect a CFS designed to use condensate booster pumps. Also, the ITAAC acceptance criteria state that the as-built CFS conforms to the design shown in ABWR DCD Tier 1, Figure 2.10.2a. In addition, the applicant's response indicates that the detailed design drawings will expand the basic configuration to include the condensate booster pumps along with other refinements. The applicant also indicates that the drawings and Tier 2, Figures 10.1-1 and 10.4-5 will be used to perform the inspections. However, the CFS design information in Tier 2 of the STP Units 3 and 4 FSAR is no longer consistent with the information regarding the CFS design description and ITAAC in DCD Tier 1, Section 2.10.2. The staff therefore found that there needs to be an ITAAC specific to Departure STD DEP 10.4-7, and the applicant's response did not resolve the concerns that were raised in RAI 10.04.07-1. Therefore, the staff issued RAI 10.04.07-3 requesting the applicant to update the referenced CFS design in Tier 1, Section 2.10.2, so it is consistent with the CFS design in Tier 2, Section 10.4.7 of the STP FSAR. This RAI was tracked as Open Item 10.04.07-3 in the SER with open items.

The applicant originally responded to RAI 10.04.07-3 in a letter dated May 3, 2010 (ML101260118), and then submitted a revised response in a letter dated October 20, 2010 (ML102990050). In the revised response, the applicant proposes to revise the COL application to reflect a new Tier 1 standard departure in FSAR Tier 1, Section 2.10. The applicant identifies this as Departure STD DEP T1 2.10-1 and revises Tier 2, Table 1.9S, "Conformance with Regulatory Criteria," and Table 19.2-2, "PRA Assessment of STP Departures from ABWR

DCD," in support of this change. This departure revises Tier 1, Figure 2.10-2a, which now shows a basic CFS configuration with condensate pumps receiving condensate from the main condenser and delivering it to the CPS, and with condensate booster pumps receiving condensate from the CPS and delivering it to the LP heaters.

The staff reviewed the applicant's proposed new departure (Departure STD DEP T1 2.10-1) and affected changes and determined that the revision to Tier 1 will eliminate the discrepancy between FSAR Tier 2, Section 10.4.7 and FSAR Tier 1, Section 2.10, because the CFS configuration will be the same in both the Tier 1 and Tier 2 sections of the FSAR. As previously noted, the use of condensate booster pumps does not adversely impact the ability of the CFS to perform its designed function, and the booster pumps will be located outside the containment and are therefore not part of the safety-related portion of the system. The use of condensate booster pumps in the CFS does not change its compliance with the SRP guidance, as documented in NUREG–1503. Based on the above discussion, the staff found that the applicant's RAI response resolves the concerns in RAI 10.04.07-1; Open Item 10.04.07-3 is therefore closed. The staff confirmed that Revision 6 of COL FSAR includes the changes identified in the responses to RAI 10.04.07-3. Therefore, RAIs 10.04.07-1 and 10.04.07-3 are resolved and closed.

10.4.7.5 *Post Combined License Activities*

There are no post COL activities related to this section.

10.4.7.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1503. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirmed that that the applicant has addressed the required information relating to the CFS and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix A, Section VI.B.1, all nuclear safety issues relating to the CFS that were incorporated by reference have been resolved.

In addition, the staff compared the additional information in the COL application to the relevant NRC regulations and the guidance in Section 10.4.7 of NUREG–0800. The staff's review concluded that the applicant has provided sufficient information to satisfy NRC regulations, and found it reasonable that the identified Tier 2 departure is characterized as not requiring prior NRC approval per 10 CFR Part 52, Appendix A, Section VIII.B.5. The staff also determined that the CFS design changes associated with the Tier 2 departure requiring NRC approval are acceptable. The evaluation of the acceptability of Departure STD DEP 10.4-5 on the plant TS, is addressed in Subsection 16.4.6.8 of this SER.

The staff evaluated the plant-specific information relating to the CFS design for the STP Units 3 and 4 COL application. Based on the results of this evaluation, the staff concluded that implementation of the departures specified in the COL application and the RAI responses described in the "Technical Evaluation" section will result in enhanced system reliability and will have no adverse impact on the CFS. The staff also determined that the departure and resulting system modifications are appropriately addressed by the plant's ITAAC.