

## 4.0 REACTOR

This chapter of the application describes the reactor assembly, which consists of the reactor pressure vessel (RPV), pressure containing appurtenances that include control rod drive (CRD) housings, in-core instrumentation housing, and the head vent and spray assembly. The RPV includes the reactor internal pump (RIP) casing and flow restrictors in each of the steam outlet nozzles and the shroud support and pump deck that form the partition between the RIP suction and discharge.

### 4.1 Summary Description

The major reactor internal components are the core (fuel, channels, control blades, CRDs and instrumentation); the core support structure (including the shroud, top guide, and core plate); the shroud head and steam separator assembly; the steam dryer assembly; the feedwater spargers; RIPs; and the core flooding spargers. Except for the Zircaloy in the reactor core, these reactor internals are stainless steel or other corrosion-resistant alloys. The fuel assemblies (including fuel rods and channel), control blades, shroud head and steam separator assembly, steam dryers, and in-core instrumentation dry tubes are removable when the reactor vessel is opened for refueling or maintenance.

Section 4.1 of the South Texas Project (STP) combined license (COL) Final Safety Analysis Report (FSAR) incorporates by reference Section 4.1, "Summary Description," of the certified 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." A computer code (ACSTIC2) that is used for analysis of reactor internal components was added to Subsection 4.1.4.1 of the STP COL FSAR. The staff's evaluation of this computer code is in Section 3.9.1 of this SER. There were no other departures or supplements.

U.S. Nuclear Regulatory Commission (NRC) staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remains for review.<sup>1</sup> 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 "Summary Description" have been resolved and closed.

### 4.2 Fuel System Design

#### 4.2.1 Introduction

This section of the FSAR addresses the thermal, mechanical, and materials design of the fuel system. The fuel system consists of arrays (assemblies or bundles) of fuel rods including fuel pellets, insulator pellets, springs, tubular cladding, end closures, hydrogen getters, and fill gas; burnable poison rods that include components similar to those in fuel rods; spacer grids and springs; end plates; channel boxes; and reactivity control rods. This section discusses the fuel system design and reactivity control elements of the control rods that extend from the coupling interface of the CRD mechanism into the core.

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<sup>1</sup> 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.

#### **4.2.2 Summary of Application**

Section 4.2 and Appendices 4B through 4D of the STP Units 3 and 4 COL FSAR Revision 12 incorporates by reference Section 4.2 and Appendices 4B through 4D of the certified ABWR DCD Revision 4, referenced in 10 CFR Part 52, Appendix A. In addition, in COL FSAR Appendix 4C, the applicant provides the following:

##### *Tier 2 Departure Not Requiring Prior NRC Approval*

- STD DEP Admin

This administrative departure changes the following text in Section 4C.3.4 of the ABWR DCD from:

Scram time insertion performance and control rod drop times affect the total reactivity inserted into the core.

to the following text in Section 4C.3.4 in the STP Units 3 and 4 COL:

Scram time insertion performance affects the total reactivity inserted into the core.

#### **4.2.3 Regulatory Basis**

The regulatory basis of the information incorporated by reference is 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 fuel system design, and the associated acceptance criteria, are in Section 4.2 of NUREG–0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants.”

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.

#### **4.2.4 Technical Evaluation**

As documented in NUREG–1503, staff reviewed and approved Section 4.2 of the certified ABWR DCD. The staff reviewed Section 4.2 and Appendices 4B through 4D 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.<sup>1</sup> The staff’s review confirmed that the information in the application and the information incorporated by reference address the required information relating to fuel system design.

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<sup>1</sup> 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 staff reviewed the following information in the COL FSAR:

Appendix 4B Fuel Licensing Acceptance Criteria

Appendix 4B of the ABWR DCD contains the fuel licensing acceptance criteria for evaluating fuel designs and for determining the applicability of generic analyses to these designs. This is supplementary information supporting the fuel system design discussed in ABWR DCD Tier 2, Section 4.2. The staff reviewed and approved Appendix 4B as documented in NUREG–1503.

The COL applicant incorporates by reference Appendix 4B of the certified ABWR DCD referenced in Appendix A to 10 CFR Part 52. No departures from the certified design are identified. The applicant has submitted the applicable proprietary information as required by Section IV.A.3 of the ABWR Design Certification Rule.

Appendix 4C Control Rod Licensing Acceptance Criteria

Appendix 4C of the ABWR DCD contains the control rod licensing acceptance criteria for evaluating new control rod designs. This is supplementary information supporting the fuel system design discussed in ABWR DCD Tier 2 Section 4.2. The staff reviewed and approved Appendix 4C as documented in NUREG–1503.

The applicant incorporates by reference Appendix 4C of the certified ABWR DCD referenced in Appendix A to 10 CFR Part 52 with one administrative departure:

Appendix 4D Reference Fuel Design Compliance with Acceptance Criteria

Appendix 4D of the ABWR DCD contains the fuel design compliance with the fuel licensing acceptance criteria (from Appendix 4B). This supplementary information supports the fuel system design discussed in ABWR DCD Tier 2 Section 4.2. The staff reviewed and approved Appendix 4D as documented in NUREG–1503.

The applicant incorporates by reference Appendix 4D of the certified ABWR DCD referenced in Appendix A to 10 CFR Part 52. No departures from the certified design are identified. The applicant has submitted the applicable proprietary information as required by Section IV.A.3 of the ABWR Design Certification Rule.

Tier 2 Departure Not Requiring Prior NRC Approval

- STD DEP Admin

This administrative departure changes the following text in Section 4C.3.4 of the ABWR DCD Tier 2 from:

Scram time insertion performance and control rod drop times affect the total reactivity inserted into the core.

to the following text in Section 4C.3.4 in the STP Units 3 and 4 COL:

Scram time insertion performance affects the total reactivity inserted into the core.

This administrative departure changes the text in Section 4C.3.4, "Reactivity," of the ABWR DCD to agree with the terminology used in the technical specifications. Therefore, this departure is acceptable.

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.

#### **4.2.5 Post Combined License Activities**

There are no post COL activities related to this section.

#### **4.2.6 Conclusion**

The staff's finding related to information incorporated by reference is in NUREG-1503. The 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 fuel system design that were incorporated by reference have been resolved and closed.

In addition, the staff compared the additional information in the application to the relevant NRC regulations and the guidance in Section 4.2 of NUREG-0800. The staff's review concluded that the applicant has adequately addressed the Appendix 4C STD DEP Admin, and has provided sufficient information in accordance with Section 4.2 of NUREG-0800.

### **4.3 Nuclear Design**

#### **4.3.1 Introduction**

This section of the FSAR addresses whether the nuclear design of the fuel assemblies, control systems, and reactor core is carried out to aid in confirming that fuel design limits will not be exceeded during normal operation or anticipated operational occurrences, including stability, and that postulated reactivity events will not (1) violate specified acceptable fuel design limits; (2) cause significant damage to the reactor coolant pressure boundary; or (3) impair the capability to cool the core.

#### **4.3.2 Summary of Application**

Section 4.3 and Appendix 4A of the STP Units 3 and 4 COL FSAR Revision 12 incorporates by reference Section 4.3 and Appendix 4A of the certified ABWR DCD Revision 4, referenced in 10 CFR Part 52, Appendix A. In addition, in COL FSAR Section 4.3, the applicant provides the following:

### COL License Information Item

- COL License Information Item 4.1 Thermal Hydraulic Stability

This COL license information item addresses the use of an approved stability compliance methodology if the fuel design is changed. The applicant states that the DCD fuel design remains unchanged.

#### **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 nuclear design, and the associated acceptance criteria, are in Section 4.3 of NUREG–0800.

The regulatory basis for reviewing the COL license information item is also in Section 4.3 of NUREG–0800.

#### **4.3.4 Technical Evaluation**

As documented in NUREG–1503, the staff reviewed and approved Section 4.3 of the certified ABWR DCD. The staff reviewed Section 4.3 and Appendix 4A of the STP Units 3 and 4 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.<sup>1</sup> The staff's review confirmed that the information in the application and the information incorporated by reference address the required information relating to nuclear design.

The staff reviewed the following information in the COL FSAR:

### COL License Information Item

- COL License Information Item 4.1 Thermal Hydraulic Stability

Specific information provided by the applicant to address COL License Information Item 4.1 includes a statement in the DCD indicating that if a different fuel design is chosen by the COL applicant, the methodology used to demonstrate compliance with acceptable thermal hydraulic stability criteria will be one that has been approved by the NRC. This methodology is discussed in DCD Subsection 4.3.2.6.2

In COL License Information Item 4.1, the applicant states that the fuel design has not changed, and that this COL License Information Item is, therefore, resolved and closed.

The staff issued request for additional information (RAI) 04.03-2 requesting that the applicant explain the inconsistencies in the typical loading patterns for Figure 4.3-2 within their application and the generic ABWR DCD. This RAI was tracked as an open item in the Safety Evaluation Report (SER) with open items. In response to this RAI, in a letter dated June 28, 2010 (ML101830418), the applicant provides the correct Figure 4.3-2. The staff found this response

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<sup>1</sup> 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.

acceptable and verified that this figure was incorporated into the COL FSAR, Revision 4. Therefore, RAI 04.03-2 is resolved and closed.

#### Appendix 4A Typical Control Rod Patterns and Associated Power Distribution for ABWR

Appendix 4A of the ABWR DCD contains a typical simulation of an equilibrium cycle core. This appendix is supplementary information supporting the nuclear design discussed in ABWR DCD Tier 2 Section 4.3.

The COL applicant incorporates by reference Appendix 4A of the certified ABWR DCD referenced in Appendix A to 10 CFR Part 52. No departures from the certified design are identified.

The staff issued RAI 04.03-1 requesting that the applicant provide an explanation for the inconsistencies between the STP Units 3 and 4 COL application and the generic ABWR DCD within Appendix 4A for the maximum linear heat generation rate (MLHGR) values and the Integrated Power per Bundle values. The applicant responded to this RAI in a letter dated June 25, 2009 (ML093160323). The staff's review of the response did not agree with the applicant that "there have been no changes to the figures from what was previously approved and is not subject to re-review." The staff issued RAI 04.03-3 requesting the applicant to submit the correct figures. RAI 04.03-3 was tracked as an open item in the SER with open items. The applicant's response to RAI 04.03-3 dated June 28, 2010 (ML101830418), provides the correct Figures 4A-1a and 4A-1d. The staff found this response acceptable and verified that these figures were incorporated into the COL FSAR, Revision 4. Therefore, RAI 04.03-3 is resolved and closed.

#### **4.3.5 Post Combined License Activities**

There are no post COL activities related to this section.

#### **4.3.6 Conclusion**

The staff's finding related to information incorporated by reference is in NUREG-1503. The 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 nuclear design that were incorporated by reference have been resolved and closed.

In addition, the staff compared the additional information in the application to the relevant NRC regulations and the guidance in Section 4.3 of NUREG-0800. The staff's review concluded that the applicant has adequately addressed COL License Information Item 4.1 in accordance with Section 4.3 of NUREG-0800.

### **4.4 Thermal Hydraulic Design**

#### **4.4.1 Introduction**

This section of the FSAR addresses the thermal and hydraulic design of the core and the reactor coolant system (RCS). The contents of this section verify that the core thermal-hydraulic designs (1) use acceptable analytical methods, (2) are equivalent to or are a justified

extrapolation from proven designs, (3) provide acceptable margins of safety from conditions that would lead to fuel damage during normal reactor operation and anticipated operational occurrences, and (4) are not susceptible to thermal-hydraulic instability.

#### **4.4.2 Summary of Application**

Section 4.4 of the STP Units 3 and 4 COL FSAR Revision 12 incorporates by reference Section 4.4 of the certified ABWR DCD Revision 4, referenced in 10 CFR Part 52, Appendix A. In addition, in COL FSAR Section 4.4, the applicant provides the following:

##### *Tier 2 Departures Not Requiring Prior NRC Approval*

- STD DEP 6C-1 Containment Debris Protection for ECCS Strainers

This departure incorporates the new complex emergency core cooling system (ECCS) (e.g., cassette type) strainer design, and identifies an analysis that will be performed to determine the required cooling for a fuel assembly post-loss-of-coolant accident (LOCA).

- STD DEP Admin

In FSAR Subsection 4.4.3.1.3, "Reactor Coolant System Geometric Data," a reference to "recirculation loops of the Reactor Coolant System" was deleted.

In FSAR Subsection 4.4.3.5.2, "MCPR Operating Limit Computational," "v CPR" was changed to " $\Delta$  CPR."

##### *COL License Information Items*

- COL License Information Item 4.2 Power/Flow Operating Map

In FSAR Revision 4, the applicant states that the fuel design licensing bases, including the core loading map, are those identified in the referenced ABWR DCD. The applicant adds that DCD Tier 2, Subsection 4.4.3.3.1 and Figures 4.4-1 and 4.4-2 provide the specific power/flow operating map to be used at the plant.

- COL License Information Item 4.3 Thermal Limits

In FSAR Revision 4, the applicant states that the fuel design licensing bases, including the core loading map, are those identified in the referenced ABWR DCD. The applicant adds that DCD Tier 2, Subsection 4.4.3.3.1 provides the result of the analysis for determining thermal limits.

#### **4.4.3 Regulatory Basis**

The regulatory basis for the information incorporated by reference is in NUREG-1503. In addition, the relevant requirements of the Commission regulations for the thermal hydraulic design, and the associated acceptance criteria, are in Section 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.

#### 4.4.4 Technical Evaluation

As documented in NUREG–1503, the staff reviewed and approved Section 4.4 of the certified ABWR DCD. The staff reviewed Section 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.<sup>1</sup> The staff's review confirmed that the information in the application and the information incorporated by reference address the required information relating to thermal hydraulic design.

The staff reviewed the following information in the COL FSAR:

##### Tier 2 Departures Not Requiring Prior NRC Approval

- STD DEP 6C-1 Containment Debris Protection for ECCS Strainers

FSAR Section 4.4.6 addresses the testing and verification techniques that will be used to assure that the planned thermal and hydraulic design characteristics of the core have been provided and will remain within required limits throughout core lifetime. The detailed discussion is presented in FSAR Chapter 14, and the staff evaluation is provided in Chapter 14 of this SER.

FSAR Section 4.4.6 also identifies an analysis which is performed to determine the required cooling for a fuel assembly post-LOCA. This analysis is in FSAR Appendix 6C, and is used to develop acceptance criteria for a downstream fuel effects test which will be performed prior to the initial cycle operation to assess fuel and ECCS performance considering the effects of LOCA-generated debris. The staff's evaluation of this analysis is in Section 6.2 of this SER.

Although the applicant has identified Departure STD DEP 6C-1, as not requiring prior NRC approval, the staff found it necessary to evaluate it within the scope of conformance with Regulatory Guide (RG) 1.82, Revision 3, because the applicant has committed to conform to this guidance which is applicable to downstream effects of containment debris on the reactor fuel. Downstream effects of LOCA-generated debris is a safety-related issue that was identified after the ABWR DCD was certified. Therefore, in RAI 06.02.02-2, the staff requested that the applicant describe how they will address the downstream effects identified in RG 1.82, Revision 3. In response to RAI 06.02.02-2 dated September 28, 2009 (ML092730448), the applicant agrees to a COL license condition and to submit an evaluation as part of a license amendment confirming that the fuel for the initial fuel load satisfies the downstream effects of containment debris on the reactor fuel. The staff's review found the acceptance criteria specified in the response was not sufficient, and issued RAI 04.04-3 requesting the applicant to provide verifiable criteria for the fuel testing, revise FSAR Section 4.4 to include the details of the acceptance criteria, and confirm that the protective coatings debris characteristics for fuel assembly tests will be consistent with the NRC guidance for operating pressurized water reactors (PWRs). RAI 04.04-3 was tracked as an open item in the SER with open items.

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<sup>1</sup> 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 submitted the response to RAI 04.04-3 in a letter dated February 22, 2010 (ML100560113). As a follow-up to the review, the staff audited the calculation that Westinghouse performed to determine the acceptance criteria. The staff issued RAI 04.04-4 requesting the applicant to explain how the proposed acceptance criterion is suitable for the fuel design that is currently the basis for the ABWR design. The staff's evaluation of the applicant's response to this RAI is in Subsection 6.2.1.4 of this SER. The staff found the applicant's response acceptable. Therefore, RAI 04.04-3 and RAI 04.04-4 are resolved and closed.

- STD DEP Admin

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's review found the applicant's editorial and administrative changes acceptable. However, the staff identified an inconsistency between the DCD and the FSAR and issued RAI 04.04-1.

In the response to this RAI dated June 25, 2009 (ML093160323), the applicant agrees that there is a typographical error, and adds that FSAR Subsection 4.4.3.5.2 will be changed to Subsection 4.4.5.5.2 to be consistent with the DCD. This change will be incorporated into the next revision of the COL FSAR. The staff confirmed that the typographical error identified in RAI 04.04-1 was corrected in the COL FSAR, Revision 4, and RAI 04.04-1 is therefore resolved and closed.

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.

#### COL License Information Items

- COL License Information Item 4.2 Power/Flow Operating Map
- COL License Information Item 4.3 Thermal Limits

In FSAR Revision 4, the applicant states that the fuel design licensing bases, including the core loading map and thermal limits, are those identified in the referenced ABWR DCD. Therefore, the current licensing basis for STP Units 3 and 4 includes the fuel design described in the DCD which is incorporated by reference. Hence, these COL license information items are closed.

#### **4.4.5 Post Combined License Activities**

There are no post COL activities related to this section.

#### **4.4.6 Conclusion**

The staff's finding related to information incorporated by reference is in NUREG-1503. The 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 thermal hydraulic design that were incorporated by reference have been resolved and closed.

In addition, the staff compared the additional information in the application to the relevant NRC regulation and the guidance in Section 4.4 of NUREG–0800. The staff’s review concluded that the applicant has adequately addressed COL License Information Items 4.2 and 4.3 in accordance with Section 4.3 of NUREG–0800. The applicant identified Departure STD DEP Admin in Subsection 4.4.3.5.2 and Departure STD DEP 6C-1 in Section 4.4.6, as not requiring prior NRC approval. The staff found it reasonable that Departure STD DEP Admin in Subsection 4.4.3.5.2 was characterized as not requiring prior NRC approval per 10 CFR Part 52, Appendix A, Section VIII.B.5. However, the staff found it necessary to review Departure STD DEP 6C-1 in Section 4.4.6, and concludes that it meets the criteria in Section 4.4 of NUREG–0800 and satisfies NRC regulations.

## **4.5      Reactor Materials**

### **4.5.1      Control Rod Drive System Structural Materials**

#### **4.5.1.1      Introduction**

This section of the FSAR addresses information related to the materials selection, processing, fabrication, and cleaning and cleanliness controls applied to CRD structural components. Materials selected for CRD structural components must provide adequate performance throughout the design life of the plant (or the component).

#### **4.5.1.2      Summary of Application**

Section 4.5.1 of the STP Units 3 and 4 COL FSAR Revision 12 incorporates by reference Section 4.5.1 of the certified ABWR DCD Revision 4, referenced in 10 CFR Part 52, Appendix A. In addition, in FSAR Section 4.5.1, the applicant provides the following:

##### *Tier 2 Departure Not Requiring Prior NRC Approval*

- STD DEP 4.5-1                      Reactor Materials

This departure addresses the additional materials specifications and grades for some components and updates descriptions of operational experience. The applicant also modifies the CRD materials list to allow for the use of alternative materials specifications (for non-reactor coolant pressure boundary components) from those listed in DCD Tier 2, Subsection 4.5.1.1, as long as the materials are equivalent. The applicant considers materials with similar chemical composition, mechanical properties, and operating experience to be equivalent.

##### *COL License Information Item*

- COL License Information Item 4.4      CRD Inspection Program

The applicant provides supplemental information in COL FSAR Subsection 4.5.3.1 describing the CRD inspection program, which addresses the inspection needs identified in ABWR DCD Subsection 4.5.3.1.

#### **4.5.1.3      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 CRD structural

materials, and the associated acceptance criteria are in Section 4.5.1 of NUREG-0800. The regulatory basis for reviewing COL Information Item 4.4 is in 10 CFR 50.55a, “Codes and standards,” and general design criterion (GDC) 26, “Reactivity control system redundancy and capability.”

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 not requiring 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.

#### **4.5.1.4 Technical Evaluation**

As documented in NUREG–1503, the staff reviewed and approved Section 4.5.1 of the certified ABWR DCD. The staff reviewed Section 4.5.1 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 COL FSAR and the information in the ABWR DCD represents the complete scope of information relating to this review topic.<sup>1</sup> The staff’s review confirmed that the information in the application and the information incorporated by reference address the required information relating to control rod drive system structural materials.

The staff reviewed the following information in the COL FSAR:

##### *Tier 2 Departure Not Requiring Prior NRC Approval*

- STD DEP 4.5-1 Reactor Materials

In Departure STD DEP 4.5-1, the applicant modifies materials specifications and grades for some components and updates descriptions of operational experience. The applicant also modifies the CRD materials list to allow for the use of alternative materials specifications (for non-reactor coolant pressure boundary components) from those listed in DCD Tier 2 Subsection 4.5.1.1, as long as the materials are equivalent. The applicant considers materials with similar chemical composition, mechanical properties, and operating experience to be equivalent.

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 Item*

- COL License Information Item 4.4 CRD Inspection Program

The applicant provides additional information in COL FSAR Subsection 4.5.3.1 addressing COL License Information Item 4.4. The applicant states the following:

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<sup>1</sup> 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 CRD condition and integrity are monitored by a routine visual inspection of a selected sample of CRDs during each outage period. The number and selection process for the CRDs is based on vendor recommendations and included in the preventive maintenance program. CRD performance is monitored under the provisions of the Maintenance Rule, and this monitoring coupled with the CRD inspections detects incipient defects before they become serious enough to cause operating problems. The CRD nozzle and bolting are included in the inservice inspection program. CRD bolting is accessible for inservice examinations during normally scheduled CRD maintenance.

ABWR DCD Subsection 4.5.3.1 states the following:

The CRD inspection program shall include provisions to detect incipient defects before they become serious enough to cause operating problems. The CRD nozzle and bolting are included in the in-service inspection program (Table 5.2-8, System Number B11/B12). CRD bolting is accessible for inservice examinations during normally scheduled CRD maintenance.

The staff found that the supplemental information provided by the applicant, as stated above, appropriately addresses ABWR DCD COL Information Item 4.4. The inclusion of the CRD nozzle and bolting in the in-service inspection program satisfies the requirements of 10 CFR 50.55a. Additional information related to the applicant's in-service inspection program is in Section 5.2.4 of this SER. The applicant's CRD inspection program will contain provisions to ensure that incipient defects will be detected before they become an operational concern thus meeting the requirements of GDC 26.

#### **4.5.1.5 Post Combined License Activities**

There are no post COL activities related to this section.

#### **4.5.1.6 Conclusion**

The staff's finding related to information incorporated by reference is in NUREG-1503. The 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 CRD structural materials that were incorporated by reference have been resolved and closed.

In addition, the staff compared the additional information in the application to the relevant NRC regulation and the guidance in Section 4.5.1 of NUREG-0800. The staff's review concluded that the applicant has adequately addressed COL License Information Item 4.4 in accordance with Section 4.3 of NUREG-0800 and the requirements in 10 CFR 50.55a, and GDC 26. The applicant identified Departure STD DEP 4.5-1 in FSAR Subsection 4.5.1.1. The staff found it reasonable that this departure is characterized as not needing prior NRC approval per 10 CFR Part 52, Appendix A, Section VIII.B.5.

## **4.5.2 Reactor Materials, (Related to RG 1.206, Section C.I.4.5.2, “Reactor Internals and Core Support Materials”)**

### **4.5.2.1 Introduction**

This section of the FSAR addresses information related to materials selection and component design, fabrication, and inspection to ensure the structural integrity of internal and core support structures during reactor operation. Materials selected for reactor internals and structural components must perform adequately throughout the design life of the plant (or component).

### **4.5.2.2 Summary of Application**

Section 4.5.2 of the STP Units 3 and 4 COL FSAR Revision 12 incorporates by reference Section 4.5.2 of the certified ABWR DCD Revision 4, referenced in 10 CFR Part 52, Appendix A. In addition, in FSAR Section 4.5.2, the applicant provided the following:

#### *Tier 2 Departure Not Requiring Prior NRC Approval*

- STD DEP 4.5-1 Reactor Materials

The applicant provides Departure STD DEP 4.5-1 to revise text and provide additional information to ABWR DCD Tier 2, Subsection 4.5.2.1, “Materials Specifications;” Subsection 4.5.2.2, “Controls on Welding;” Section 4.5.2.3, “Non-Destructive Examination of Wrought Seamless Tubular Products;” Subsection 4.5.2.4, “Fabrication and Processing of Austenitic Stainless Steel – Regulatory Guide Conformance;” and Section 4.5.2.5, “Other Materials.”

### **4.5.2.3 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 reactor internal and core support structure materials, and the associated acceptance criteria, are in Section 4.5.2 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 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.

### **4.5.2.4 Technical Evaluation**

As documented in NUREG–1503, the staff reviewed and approved Section 4.5.2 of the certified ABWR DCD. The staff reviewed Section 4.5.2 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.<sup>1</sup> The staff’s review confirmed that the information in

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<sup>1</sup> 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 application and the information incorporated by reference address the required information relating to reactor internal material.

The staff reviewed the following information in the COL FSAR:

*Tier 2 Departure Not Requiring Prior NRC Approval*

- STD DEP 4.5-1 Reactor Materials

In Departure STD DEP 4.5-1, the applicant proposed to provide additional information in ABWR DCD Subsection 4.5.2.1, "Materials Specifications"; Section 4.5.2.2, "Controls on Welding"; Subsection 4.5.2.3, "Non-destructive Examination of Wrought Seamless Tubular"; Section 4.5.2.4, "Fabrication and Processing of Austenitic Stainless Steel – Regulatory Guide Conformance"; and Subsection 4.5.2.5, "Other Materials."

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.

**4.5.2.5 Post Combined License Activities**

There are no post COL activities related to this section.

**4.5.2.6 Conclusion**

The staff's finding related to information incorporated by reference is in NUREG-1503. The 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 reactor internal materials that were incorporated by reference have been resolved and closed.

In addition, the applicant identified Departure STD DEP 4.5-1 in FSAR Section 4.5.2. The staff found it reasonable that this departure is characterized as not requiring prior NRC approval per 10 CFR Part 52, Appendix A, Section VIII.B.5. In conclusion, the staff finds that Section 4.5.2 of the STP Units 3 and 4 COL FSAR is acceptable.

**4.6 Functional Design of Control Rod Drive System**

**4.6.1 Introduction**

This section of the FSAR addresses the functional performance of the CRD system (CRDS) to confirm that the system can affect a safe shutdown, respond within acceptable limits during anticipated operational occurrences, and prevent or mitigate the consequences of postulated accidents.

#### **4.6.2 Summary of Application**

Section 4.6 of the STP Units 3 and 4 COL FSAR Revision 12 incorporates by reference Section 4.6 of the certified ABWR DCD Revision 4, referenced in 10 CFR Part 52, Appendix A. In addition, in FSAR Section 4.6, the applicant provides the following:

##### *Tier 2 Departures Not Requiring Prior NRC Approval*

- STD DEP 4.6-1 FMCRD Friction Test Equipment

This departure changes the description of the fine motion control rod drive (FMCRD) friction test equipment.

- STP DEP 7.7-1 RPV Water Level Instrumentation

This departure “clarifies that the source of water for purging of the instrument lines in the nuclear boiler system (NBS) is the CRD hydraulic system (CRDHS). It further clarifies that for the RPV level instruments; this purging is only performed on instrument lines with condensing chambers.”

##### *COL License Information Item*

- COL License Information Item 4.5 CRD and FMCRD Installation and Verification During Maintenance

This COL license information item provides information regarding CRD and FMCRD installation and verification.

#### **4.6.3 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 functional design of CRDS, and the associated acceptance criteria, are in Section 4.6 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.

The regulatory basis for reviewing the COL license information item is also in Section 4.6 of NUREG–0800.

#### **4.6.4 Technical Evaluation**

As documented in NUREG–1503, the staff reviewed and approved Section 4.6 of the certified ABWR DCD. The staff reviewed Section 4.6 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.<sup>1</sup> The staff's review confirmed that the information in the application and the information incorporated by reference address the required information relating to the functional design of control rod drive system.

The staff reviewed the following information in the COL FSAR:

COL License Information Item

- COL License Information Item 4.5      CRD and FMCRD Installation and Verification During Maintenance

This COL License Information Item requests that the applicant develop procedures to ensure that maintenance procedures have provisions to prohibit coincident removal of the CRD blade and drive of the same assembly. In addition, the COL applicant shall develop contingency procedures to provide core and spent fuel cooling capability and mitigative actions during CRD replacement with fuel in the vessel.

Specific information provided by the applicant to address COL License Information Item 4.5 should include programs and procedures to address issues that could arise during maintenance. The applicant should provide the time frame when the administrative procedures will be available before fuel load. These procedures ensure that maintenance procedures have provisions to prohibit a coincident removal of the CRD blade and drive of the same assembly. In addition, the applicant should provide the time frame when the contingency procedures will be available for the staff to review. These procedures provide the core- and spent-fuel cooling capability and mitigating actions during CRD replacement with fuel in the vessel.

The staff issued RAI 04.06-1 to address (1) the time frame for the availability of COL License Information Item 4.5 for the staff to review, and (2) the revision of Subsection 13.5.3.4.2 to assure that the specific procedures will be developed as required by COL License Information Item 4.5.

The applicant's response to RAI 04.06-1 dated May 26, 2009 (ML091490166), provides the following statement:

The incorporation of the COL License Information Item 4.5 into plant maintenance procedures is adequately addressed by the STP 3&4 Quality Assurance Program Description (QAPD) and FSAR Subsection 13.5.3.4.2 item (8) combined with FSAR Table 1.9-1.

However, to provide additional assurance that the subject of the RAI is incorporated, the applicant revised the first paragraph of COL application Section 13.5 to include the following:

The procedures that are identified in or required by the COL License Information Items in ABWR DCD, Tier 2, Table 1.9-1, will be incorporated into the plant procedures according to the following supplements, as applicable.

The staff confirmed that the FSAR revision is acceptable and RAI 04.06-1 is therefore resolved and closed.

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<sup>1</sup> 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 Departures Not Requiring Prior NRC Approval

- STD DEP 4.6-1 FMCRD Friction Test Equipment

In FSAR Subsection 4.6.1.2.3, this departure deletes the phrase "a small pump and associated" to read, "The test fixture contains hydraulic controls to pressurize the underside of the hollow piston."

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 COL application Part 7 "Departures Report," regarding this departure, and noted that the revised description was editorially incorrect, but the intent was understandable. The staff issued RAI 04.06-2 requesting the applicant to clarify the intended description of the special test fixture and to revise the FSAR narrative accordingly.

In the response to RAI 04.06-2 dated June 22, 2009 (ML091760629), the applicant provides an explanation for Departure STD DEP 4.6-1 that the staff found to be acceptable. And even though the Departures Report was not revised, the staff accepted the response because there is no impact on the design that would affect plant operation, and the intent of the statement is understandable. The staff concluded that RAI 04.06-2 is resolved and closed. Therefore, 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.

- STP DEP 7.7-1 RPV Water Level Instrumentation

In FSAR Subsection 4.6.1.2.4.1, the applicant states that "Approximately 4 L/min purge flow is provided to the NBS reference leg instrument lines." 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 Departures Report regarding this departure. From the description and the data in the FSAR, the staff was unable to confirm the validity of the "4 L/min" purge flow. Therefore, the staff issued RAI 04.06-3 requesting the applicant to provide the basis (e.g., assumptions, boundary conditions, references) for this value.

In the response to RAI 04.06-3 dated June 22, 2009 (ML091760629), the applicant includes a discussion and references a report (GENE-637-019-0893, "Analysis Guidelines for Backfill Modification of RPV Water Level Instrumentation," Revision 0, dated August 1993, [ML100290018]) that provides the method used in the purge flow calculation. The applicant also notes that the flow rate in the referenced report is incorrectly transcribed in the COL FSAR, Subsection 4.6.1.2.4.1(4). The value stated in the referenced report is 0.03 Liters per minute (L/min) (4 pound per hour [lb/hr]). To follow-up, the staff issued RAI 04.06-4 requesting the applicant to provide the referenced report to complete the evaluation. This RAI was tracked as an open item in the SER with open items.

In the response to this RAI dated January 25, 2010 (ML100290016), the applicant provides the referenced report (i.e., GENE-637-019-0893, Revision 0). The staff verified that the purge flow of 0.03 L/Min (4 lb/hr) is correct. Therefore, RAIs 04.06-3 and 04.06-4 are closed.

#### **4.6.5 Post Combined License Activities**

There are no post COL activities related to this section.

#### **4.6.6 Conclusion**

The staff's finding related to information incorporated by reference is in NUREG-1503. The 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 functional design of CRDS that were incorporated by reference have been resolved and closed.

In addition, the staff compared the additional information in the application to the relevant NRC regulations and the guidance in Section 4.6 of NUREG-0800. The staff's review concluded that the applicant has adequately addressed COL license Information Item 4.5 in accordance with Section 4.6 of NUREG-0800 and NRC regulations. The applicant identified Departures STD DEP 4.6-1 and STD DEP 7.7-1 in COL FSAR Section 4.6. The staff found it reasonable that the identified departures are adequately characterized as not needing prior NRC approval, per 10 CFR Part 52, Appendix A, Section VIII.B.5.