

## **9 AUXILIARY SYSTEMS**

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Appendix A, “Design Certification Rule for the U.S. Advanced Boiling Water Reactor,” to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” constitutes the standard design certification (DC) for the U.S. Advanced Boiling Water Reactor (ABWR) design. To document the U.S. Nuclear Regulatory Commission (NRC) staff’s review supporting initial certification of the ABWR, the staff issued a final safety evaluation report (FSER) in NUREG-1503, “Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Reactor Design,” in July 1994 and NUREG-1503, Supplement 1, in May 1997.

The staff is documenting its review of the GE-Hitachi Nuclear Energy (GEH or the applicant) application for renewal of the ABWR DC in Supplement 2 to NUREG-1503. Chapter 1 of this supplemental FSER describes the staff’s review process for the ABWR DC renewal. This supplemental FSER section documents the NRC staff’s review specifically related to Chapter 9, “Auxiliary Systems,” Section 9.1.2.1, “New and Spent Fuel Storage,” of the GEH Design Control Document (DCD), Revision 7. Except as modified by this supplement to the FSER, the findings made in NUREG-1503 and its Supplement 1 remain in full effect.

### **9.1.2.1 New and Spent Fuel Storage**

#### *9.1.2.1.1 Regulatory Criteria*

The originally certified GEH ABWR DCD describes the fuel racks in the spent fuel pool (SFP) as a seismic Category I structure, and states that the combined license (COL) applicant will perform the necessary confirmatory criticality and load drop analysis, including consideration of the free fall of a fuel assembly and its associated handling tool. In NUREG-1503, the NRC staff FSER approved the fuel storage racks in the SFP as described in the ABWR DCD, Revision 4, as part of the original ABWR DC. This is documented in Section 9.1.2, “Spent Fuel Storage,” of NUREG-1503.

In a letter dated July 20, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12125A385), the NRC staff identified 28 items for consideration by GEH as part of its application to renew the ABWR DC. In Item Nos. 19 and 20 of the letter, the applicant was requested to provide thermal-hydraulic analysis and criticality analyses of new and spent fuel racks.

In response to the staff, in a letter dated August 11, 2015 (ADAMS Accession No. ML15223B138), the applicant stated that the fuel racks are highly dependent on the specific rack design; therefore, these analyses are more appropriately addressed as a COL item, so GEH submitted changes to the COL license information regarding SFP thermal-hydraulic and criticality analysis. In this letter, the applicant also proposed to remove the new fuel storage vault from the ABWR design and instead use the racks in the SFP for storage of new fuel prior to loading into the reactor; this change is evaluated in Section 9.1.1, “New Fuel Storage,” of this supplemental FSER.

The ABWR DCD, Revision 6, submitted on February 19, 2016, reflects the changes described above. Specifically, the applicant made changes to a thermal-hydraulic analysis COL Information Item in the DCD Tier 2, Section 9.1.6.8, “Spent Fuel Racks Thermal-Hydraulic

Analysis,” and additional criticality analysis information to the COL Information Item in DCD Tier 2, Section 9.1.6.3, “Spent Fuel Storage Racks Criticality Analysis.”

Because the applicant proposed to provide clarifications consistent with the original understanding of the design information regarding SFP thermal-hydraulic and criticality analysis, it is a “modification,” as this term is defined in Chapter 1 of this FSER supplement. Therefore, the staff evaluated this change using the regulations in effect at the time the certification was originally issued.

The relevant requirements for this area of review and the associated acceptance criteria are in NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition” (SRP) Section 9.1.1, Revision 2, “Criticality Safety of Fresh and Spent Fuel Storage and Handling,” and Section 9.1.2, Revision 3, “New and Spent Fuel Storage,” both issued July 1981, as summarized below:

- 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities,” Appendix A, “General Design Criterion for Nuclear Power Plants,” (GDC) 61, “Fuel Storage and Handling and Radioactivity Control,” as it relates to the facility design for fuel storage, specifically item 4 of GDC 61, requiring the system to be designed with a residual heat removal capability having reliability and testability that reflects the importance to safety of decay heat and other residual heat removal;
- GDC 62, “Prevention of Criticality in Fuel Storage and Handling,” as it relates to the prevention of inadvertent criticality in the fuel storage system by physical systems or processes, preferably by use of geometrically safe configurations.

#### *9.1.2.1.2 Summary of Technical Information*

The changes proposed by GEH in the letter dated August 11, 2015, to address Items Nos. 19 and 20 of the staff’s July 20, 2012, letter include both Tier 1 and Tier 2 changes to the ABWR DCD. A DCD markup based on Revision 5 of the ABWR DCD was provided in Enclosure 2 of the August 11, 2015, letter (ADAMS Accession No. ML15223B141). The changes augment a COL Information Item for the combined new and spent fuel storage racks in the SFP.

In Item No. 19 the staff requested that a thermal-hydraulic analysis be provided to evaluate the rate of naturally circulated flow and the maximum rack water exit temperatures. GEH stated that, because the thermal-hydraulic analysis of the fuel racks is highly dependent on the specific rack design, this item is more appropriately addressed as a COL item. DCD Tier 2, Section 9.1.6.8 already included a COL Information Item to provide a confirmatory thermal-hydraulic analysis to the NRC for the spent fuel racks that evaluates the rate of naturally circulated flow and the maximum rack water exit temperature. The ABWR DCD markup from the August 11, 2015, letter adds a reference to existing inspection, tests, analysis, and acceptance criterion (ITAAC) 2.5.6.4 and provides specific acceptance criteria, including that the analysis will use maximum decay heat generation rates for the worst-case power history. Also, the natural circulation flow through the rack arrangement should prevent water temperatures from exceeding 100 degrees Celsius (°C)/(212 degrees Fahrenheit (°F)) under normal, abnormal, and accident conditions.

In Item No. 20 the staff requested that a criticality analysis be provided. The certified ABWR DCD already contained a separate COL Information Item 9.1.6.3 for the spent fuel storage rack criticality analysis. The ABWR DCD markup from the August 11, 2015, applicant letter revised

the COL Information Item in Section 9.1.6.3 to add a specific reference to existing DCD ITAAC 2.5.6.1, 2.5.6.2, and 2.5.6.3 and specific acceptance criteria and analysis assumptions. The applicant subsequently incorporated the changes described above in DCD Tier 2, Revision 6 which are also reflected in the most current DCD Revision 7.

#### *9.1.2.1.3 Technical Evaluation*

The staff reviewed the changes to the ABWR DCD to address Items Nos.19 and 20 of the NRC staff's letter dated July 20, 2012, to determine compliance with GDC 61 and GDC 62 related to stored fuel cooling and criticality accident requirements. The staff relied on the guidance originally used for the ABWR DC, including SRP Section 9.1.1, Revision 2, and SRP Section 9.1.2, Revision 3, for the review. The review considered the placement of new fuel in the SFP due to the removal of the new fuel storage vault and new fuel storage racks from the ABWR design and how this change affects the staff's original ABWR FSER for the certified design.

The staff reviewed the design criteria, design bases, and safety classification for the fuel storage racks and the provisions necessary to maintain a subcritical array and adequate natural circulation cooling. The staff concluded that the design changes and related commitments conform to the regulations applicable and in effect at the time of the original certification and do not alter the original staff FSER conclusions, as described in NUREG-1503, and which are summarized below.

GDC 61 requires that the fuel storage system be designed for adequate safety under normal and postulated accident conditions. As relevant here, the design must be capable of adequately cooling the stored fuel under normal and postulated accident conditions. Since the detailed rack design is not specified in the ABWR DCD, and will be determined by the supplier, COL Information Item 9.1.6.8 is used to specify the acceptance criteria for thermal-hydraulic analysis. The GEH 100°C (212°F) limit for natural circulation flow through the racks under normal, abnormal, and accident conditions will ensure that boiling is prevented, and that adequate cooling can be maintained. A confirmatory analysis will be performed by the COL applicant which considers the number of racks in the storage pool and the limiting decay heat loading under normal, abnormal, and accident conditions.

GDC 62 requires the prevention of criticality in the fuel storage system through the use of physical systems or processes, with preference given to the application of geometrically safe configurations. The applicant revised COL Information Item 9.1.6.3 to specify acceptance criteria for the criticality analysis. A confirmatory analysis will be performed by the COL applicant which considers the number of racks in the storage pool, fuel capacity, rack material, neutron poison content, and fuel center-to-center distance. The analysis must demonstrate that the storage racks can be maintained subcritical (i.e.,  $k_{eff} \leq 0.95$ ) when fully loaded.

The staff evaluated the applicant changes to COL Information Items 9.1.6.3 and 9.1.6.8 and determined that these changes do not alter the scope, or the staff FSER conclusion reached as part of the original ABWR DC as documented in NUREG-1503. GEH provided sufficient additional details to the COL Information Items for the fuel racks related to thermal-hydraulic and criticality analyses to ensure that the detailed rack design will meet the applicable regulations. Therefore, the staff finds the changes to COL Information Items 9.1.6.3 and 9.1.6.8 acceptable.

The staff confirmed that the changes were appropriately incorporated in the ABWR DCD Revision 6, which are also reflected in the most current ABWR DCD Revision 7.

#### *9.1.2.1.4 Conclusions*

The staff reviewed the applicant's changes to the ABWR DCD, Revision 7, as described above. Based on this evaluation, the staff concludes that the revisions to the COL Information Items as described meet all applicable regulatory requirements at the time of original certification, specifically GDC 61 and 62, and therefore these COL Information Item clarifications as reflected in the ABWR DCD, Revision 7, are acceptable.

## References

1. 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants."
2. 10 CFR Part 50, Appendix A, GDC 61, "Fuel Storage and Handling and Radioactivity Control."
3. 10 CFR Part 50, Appendix A, GDC 62, "Prevention of Criticality in Fuel Storage and Handling."
4. NRC, NUREG-1503, "Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Reactor Design," July 1994 (ADAMS Accession No. ML080670592).
5. NRC, NUREG-1503, "Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Reactor Design," Supplement 1, May 1997 (ADAMS Accession No. ML080710134).
6. NRC, NUREG-800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Section 9.1.1, Revision 2, "Criticality Safety of Fresh and Spent Fuel Storage and Handling," July 1981 (ADAMS Accession No. ML052350536).
7. NRC, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Section 9.1.2, Revision 3, "New and Spent Fuel Storage," July 1981 (ADAMS Accession No. ML052360614).
8. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 4, Tier 1 and Tier 2, March 1997 (ADAMS Accession No. ML11126A129).
9. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 5, Tier 1 and Tier 2, December 2010 (ADAMS Accession No. ML110040323).
10. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 6, Tier 1 and Tier 2, February 2016 (ADAMS Accession No. ML16214A015).
11. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 7, Tier 1 and Tier 2, December 2019 (ADAMS Accession No. ML20007E371).