

9 AUXILIARY SYSTEMS

9.1.2.2 Fuel Racks	1
9.1.2.2.1 Regulatory Criteria	1
9.1.2.2.2 Summary of Technical Information	2
9.1.2.2.3 Technical Evaluation	2
9.1.2.2.4 Conclusion	3

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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 9.1.2.2, "Fuel Racks," 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.

9.1.2.2 Fuel Racks

9.1.2.2.1 Regulatory Criteria

In the ABWR DCD, Revision 7, the applicant provided changes to the accident load combinations and the fuel rack support description, along with changes to two combined license (COL) license information items.

In a letter dated July 20, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12125A385), the NRC staff identified 28 items for GEH's consideration as part of its application to renew the ABWR DC. In Item No. 18 Part B of the July 20, staff letter, the applicant was requested to provide structural, dynamic, and impact analysis of new and spent fuel racks in DCD Tier 2, Section 9.1.6.2, "Dynamic and Impact Analysis of New Fuel Storage Racks," and DCD Tier 2, Section 9.1.6.7, "Spent Fuel Racks Structural Evaluation."

The originally certified ABWR DCD, Revision 4, identifies that the fuel racks in the spent fuel pool (SFP) are seismic Category I structures. The staff evaluation documented in NUREG-1503, Section 9.1.2, "Spent Fuel Storage," approved the fuel storage racks in the SFP as described in the ABWR DCD.

In a letter dated August 11, 2015 (ADAMS Accession No. ML15223B139) GEH submitted proposed changes to the accident load combinations and fuel racks support description, along with a revised COL license information item in DCD Tier 2, Section 9.1.6.7. These changes have the effect of deferring the structural, dynamic, and impact analysis of the spent fuel racks to the COL applicant. In addition, the applicant deleted the COL license information item related to the dynamic and impact analysis of the new fuel storage racks described in DCD Tier 2, Section 9.1.6.2, Revision 5, as part of the removal of the new fuel storage vault evaluated by the staff in Section 9.1.1, "New Fuel Storage," of this supplemental FSER.

Because a potential COL applicant will perform the pertinent spent fuel rack analyses in accordance with the regulations in effect during the COL application review, these changes are “amendments,” as defined in Chapter 1 of this supplement. Therefore, in accordance with 10 CFR 52.59(c), these design analysis changes will be evaluated by the staff using the regulations in effect at renewal.

The relevant requirements of the NRC’s regulations 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 9.1.2, “New and Spent Fuel Storage,” Revision 4, issued March 2007, and Appendix D to SRP Section 3.8.4, “Other Seismic Category I Structures,” Revision 4, issued September 2013. The applicable requirement for this review is:

- 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 2, “Design Bases for Protection Against Natural Phenomena,” requires that structures housing the facility and the facility itself can withstand the effects of natural phenomena such as earthquakes, tornados, hurricanes, and appropriate combinations of all loads.

9.1.2.2.2 Summary of Technical Information

GEH submitted the markups to the ABWR DCD, Revision 5, in Enclosure 2 (ADAMS Accession No. ML15223B141) of the applicant letter dated August 11, 2015. In Enclosure 1 (ADAMS Accession No. ML15223B140) of this letter, GEH stated that structural, dynamic, and impact analyses of the fuel racks are more appropriately addressed as a COL information item since these analyses are highly dependent on the specific rack design. The staff confirmed that the ABWR DCD, Revision 5, markups were included in the ABWR DCD, Revision 6, and is reflected in the most current ABWR DCD Revision 7.

9.1.2.2.3 Technical Evaluation

The staff reviewed the changes in DCD Tier 2, Section 9.1.2.1.3, “Mechanical and Structural Design,” DCD Tier 2, Section 9.1.2.3.2, “Structural Design and Material Compatibility Requirements,” and DCD Tier 2, Section 9.1.6.7, “Spent Fuel Racks Structural Evaluation,” to ensure that the effects of natural phenomena such as earthquakes, tornadoes, and hurricanes on the fuel racks in the ABWR design are considered, as required by GDC 2, using the guidance in SRP Section 9.1.2, Revision 4, and Appendix D to SRP Section 3.8.4, Revision 4.

The ABWR DCD, Revision 5, did not provide the structural, dynamic, and impact analyses of the fuel racks. In its August 11, 2015 letter, GEH addressed these analyses through a COL information item and provided additional details regarding the structural, dynamic, and impact analyses of the fuel racks for the SFP. The applicant did not address the new fuel racks because the applicant proposes to remove these racks and store new fuel in the SFP; this change is evaluated in Section 9.1.1, of this supplemental SER. Therefore, only the structural, dynamic, and impact analyses of fuel racks in the SFP were evaluated as part of this ABWR supplemental FSER section.

In DCD Tier 2, Section 9.1.2.1.3, GEH replaced the list of load combinations previously specified with a reference to the load combinations in Appendix D to SRP Section 3.8.4. The staff finds these revisions acceptable because GEH followed the guidance of Appendix D to SRP Section 3.8.4 Revision 4. GEH also deleted language regarding the use of linear elastic design methods in the structural evaluation of the fuel racks. This deletion is also acceptable

because (a) the structural, dynamic, and impact analyses of fuel racks is a COL license information item, (b) design methods can be determined by the COL applicant, and (c) the localized nonlinear plastic regime may occur due to postulated loading cases as proposed by a future COL applicant. In addition, GEH changed the text from “the dynamic method” to “an acceptable dynamic analysis method,” which is acceptable because the COL applicant will identify the dynamic analysis method, and the staff will determine the acceptability of the method during the COL application review. GEH deleted the statement “Compressive stability will be calculated according to the American Iron and Steel Institute (AISI) code for light gauge structures,” which is also acceptable to the staff because light gauge structures are no longer used as part of fuel rack fabrication and the AISI code is not referenced for acceptable fuel rack design in Appendix D to SRP Section 3.8.4, Revision 4.

In DCD Tier 2, Section 9.1.2.3.2, GEH revised the sentence related to an older SFP rack design that utilized a sub-structure with the description of updated designs that are considered “Freestanding” as follows:

“The fuel storage racks are designed to be supported vertically by the fuel floor. The support structure allows sufficient pool water flow for natural convection cooling of the stored fuel. The fuel rack modules are freestanding (i.e., not attached to the floor and can be removed)”.

The staff reviewed the design change and found it acceptable because GEH accurately described the boundary conditions of the SFP fuel racks. In addition, GEH deleted the statement “Lead-in guides at the top of the storage spaces provide guidance of the fuel during insert,” which is acceptable to the staff because it is not related to the structural design and material compatibility requirements of the fuel racks.

In DCD Tier 2, Revision 6, Section 9.1.6.7, GEH added the following italicized language to a COL Information Item:

“The COL applicant shall provide the NRC a confirmatory structural evaluation of the spent fuel racks, as outlined in Subsection 9.1.2.1.3. *This evaluation is dependent on a vendor specific design and the as-built configuration of spent fuel storage racks.*

Structural integrity of the racks will be demonstrated for the load combinations described in SRP 3.8.4 Appendix D. The fuel storage racks meet seismic Category I requirements”.

The staff reviewed the changes and found them acceptable because GEH provided additional details related to the COL license information for the fuel racks structural evaluation, and GEH refers to the guidance of Appendix D to SRP Section 3.8.4, Revision 4.

9.1.2.2.4 Conclusion

The staff’s review concludes that the applicant’s changes related to the fuel racks for GEH ABWR design comply with GDC 2, and the COL applicant will provide the detailed structural evaluations of the fuel racks in accordance with the guidance of Appendix D to SRP Section 3.8.4, Revision 4, which is acceptable.

References

1. 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants."
2. 10 CFR Part 50, Appendix A, GDC 2, "Design Bases for Protection Against Natural Phenomena."
3. 10 CFR Part 52, Appendix A, "Design Certification Rule for the U.S. Advanced Boiling Water Reactor."
4. 10 CFR 52.59, "Criteria for Renewal."
5. NRC, NUREG-1503, "Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Reactor Design," July 1994 (ADAMS Accession No. ML080670592).
6. 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).
7. NRC, NUREG-800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Section 3.8.4, Revision 4, "Other Seismic Category I Structures," Appendix D, "Guidance on Spent Fuel Pool Racks," September 2013.
8. NRC, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Section 9.1.2, Revision 4, "New and Spent Fuel Storage," March 2007.
9. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 4, Tier 1 and Tier 2, March 1997 (ADAMS Accession No. ML11126A129).
10. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 5, Tier 1 and Tier 2, December 2010 (ADAMS Accession No. ML110040323).
11. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 6, Tier 1 and Tier 2, February 2016 (ADAMS Accession No. ML16214A015).
12. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 7, Tier 1 and Tier 2, December 2019 (ADAMS Accession No. ML20007E371).