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4 REACTOR

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 4, “Reactor,” Section 4.2, “Fuel System Design,” 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.

4.2 Fuel System Design

4.2.1 Regulatory Criteria

In the ABWR DCD, Revision 7, GEH proposed to include additional clarity in the ABWR DCD concerning a combined license (COL) applicant’s responsibility to perform an analysis of the combined loading on the reactor core from a seismic event and loss-of-coolant-accident (LOCA) to demonstrate conformance to the structural acceptance requirements for the reactor core.

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. 18a of the letter, the staff requested the applicant to provide the analysis of the combined seismic and LOCA loading on the reactor core to demonstrate conformance to the structural acceptance criteria described in NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants,” LWR Edition (SRP) Section 4.2, “Fuel System Design,” Appendix A, “Evaluation of Fuel Assembly Structural Responses to Externally Applied Forces.” In a letter dated September 24, 2015 (ADAMS Accession No. ML15271A169), the applicant stated that the DCD need not be revised because the criteria of SRP Section 4.2, Appendix A, are directly satisfied by a requirement in ABWR DCD Tier 2, Chapter 4, Section 4.2.3.1.2(1). However, to provide further clarity for potential COL applicants in the future, GEH added COL Information Item 4.2.5.2 to DCD Tier 2, Revision 6, Section 4.2.5, “COL License Information.”

Because the applicant’s proposed change clarifies information in the original ABWR design certification, it is a “modification,” as this term is defined in Chapter 1 of this supplement. Therefore, this modification must comply with the Atomic Energy Act of 1954, as amended, and the Commission’s regulations applicable and in effect at the time the certification was originally issued. Therefore, the staff evaluated the proposed change using the regulations in effect at the time the certification was originally issued.

Appendix A to SRP Section 4.2, Revision 2, issued July 1981, describes the relevant requirements for this area of review and the associated acceptance criteria. These requirements appear in 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," Appendix A, "General Design Criteria for Nuclear Power Plants," (GDC) 2, "Design Bases for Protection Against Natural Phenomena," as it relates to the structural protection for fuel assemblies and control blades during accidents involving earthquakes. GDC 2 requires the design bases of structures, systems, and components, which include fuel assemblies and control blades, to reflect appropriate consideration of natural phenomena, including consideration of combined loading due to natural phenomena and limiting hydrodynamic loads.

4.2.2 Summary of Technical Information

In its letter dated September 24, 2015, GEH proposed a resolution to Item No. 18a of the staff letter dated July 20, 2012. GEH submitted the proposed ABWR DCD, Revision 6, markups in Enclosure 2 of the September 24, 2015, letter to address the staff's request. In Enclosure 1 of that letter, GEH described the proposed changes it would make to the ABWR DCD, Tier 2, Subsection 4.2.5 and Table 1.9-1 to include the new COL Information Item clarifying the responsibility of future COL applicants regarding analysis of the combined seismic and LOCA loading on the reactor fuel.

4.2.3 Technical Evaluation

The ABWR DCD reference fuel is GE P8x8R as described in GE Topical Report NEDE-31152P, "General Electric Fuel Bundle Designs Evaluated with GESTAR-Mechanical Analysis Bases (proprietary)," dated December 1988, which used the fuel bundle design methodologies described in GE Topical Report NEDE-24011-P (GESTAR II), Amendment 7. The staff approved the fuel design methodologies in GESTAR II, Amendment 7, in an NRC safety evaluation letter dated March 1, 1985, from C. O. Thomas to J. S. Charnley (GE), "Acceptance for Referencing of Licensing Topical Report NEDE-24011-P Amendment 7 to Revision 6, General Electric Standard Application for Reactor Fuel" (ADAMS Accession No. ML090760583 (non-public)).

ABWR DCD Tier 2, Section 4.2.3.1.1, describes these approved, referenced fuel design methodologies. Additionally, DCD Tier 2, Appendix 4B lists the fuel licensing acceptance criteria and Appendix 4D demonstrates that the reference fuel meets the acceptance criteria. The GESTAR II, Amendment 7, references the seismic-and-LOCA loading evaluation in GE Topical Report NEDE-21175-3-P, "BWR Fuel Assembly Evaluation of Combined Safe Shutdown Earthquake (SSE) and Loss-of-Coolant Accident (LOCA) Loadings," Amendment 3, issued July 1982. In the NRC safety evaluation for GESTAR II, Amendment 7, the NRC stated the following:

The entire seismic-and-LOCA loads evaluation (including design limits) has been described by GE in the approved topical report NEDE-21175-3 to which GESTAR II makes reference. We conclude that the criteria for fuel assembly structural damage from external forces in NEDE-21175-3 are acceptable for GESTAR II.

In ABWR DCD Tier 2, Section 4.2, GEH stated that each COL applicant may have different fuel and core designs that the COL applicant will provide to the NRC for review and approval. In Section 4.2 of NUREG-1503, "Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Reactor Design, issued July 1994 (the final safety evaluation report

(FSER) for the original certification of the ABWR design), the NRC approved the ABWR fuel design with the following condition in DCD Tier 2, Section 4.2.3.1.2:

The license/applicant must provide a plant-specific analysis of combined seismic and LOCA loading using NRC-approved methodology or another acceptable method to demonstrate conformance to the structural acceptance requirements described in Appendix A of Standard Review Plan Section 4.2.

The staff notes that because this seismic and LOCA analysis is site-specific, deferring to the COL applicant to perform this analysis is also acceptable under current guidance in accordance with Regulatory Guide 1.206, "Applications for Nuclear Power Plants," Revision 1, issued October 2018, Section C.1.11.b, "Supplemental Information." In the September 24, 2015 letter responding to Item 18a, GEH proposed the following COL Information Item in DCD Tier 2, Section 4.2.5, "COL License Information" to ensure clarity concerning the COL applicant's responsibility to perform an analysis of reactor core combined seismic and LOCA loading:

4.2.5.1 - Reactor Core Seismic and LOCA Structural Acceptance

The COL applicant shall provide the NRC a confirmatory plant-specific analysis of the reactor core combined seismic and LOCA loading using NRC-approved methodology or another acceptable method to demonstrate conformance to the structural acceptance requirements described in Appendix A of Standard Review Plan, Section 4.2, for the fuel referenced in the COL application. This analysis will use as input the site-specific ground motion and the fuel characteristics of the plant's initial core load.

The staff evaluated the above information and determined that the NRC previously approved ABWR reference fuel and design methodologies, and that the proposed COL Information Item will add clarity to the ABWR DCD concerning the COL applicant's responsibility to perform an analysis of the combined seismic and LOCA loading on the reactor core that will meet the structural acceptance criteria in Appendix A to SRP Section 4.2. Therefore, GEH's response to Item 18a of the staff's letter dated July 20, 2012, is acceptable. In addition, the staff confirmed incorporation of the COL Information Item into DCD Tier 2, Revision 7 of Section 4.2.5.2.

4.2.4 Conclusions

The staff reviewed the applicant's proposed changes to the ABWR DCD, Revision 7, as described above. Based on this evaluation, the staff concludes that the changes are acceptable because the ABWR reference fuel and methodologies continue to meet all applicable regulatory requirements at the time of original certification, including GDC 2 as referenced in Appendix A to SRP Section 4.2, Revision 2, July 1981, and the changes do not alter the safety conclusions made previously in the staff FSER as documented in NUREG-1503.

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. NRC, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Section 4.2, Revision 2, "Fuel System Design," July 1981 (ADAMS Accession No. ML052340660).
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, Regulatory Guide 1.206, "Applications for Nuclear Power Plants," Revision 1, October 2018, Section C.1.11.b, "Supplemental Information."
8. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 5, Tier 1 and Tier 2, November 2010 (ADAMS Accession No. ML110040323).
9. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 6, Tier 1 and Tier 2, February 2016 (ADAMS Accession No. ML16214A015).
10. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 7, Tier 1 and Tier 2, December 2019 (ADAMS Accession No. ML20007E371).
11. GEH, Topical Report - NEDE-31152P, "General Electric Fuel Bundle Designs Evaluated with GESTAR-Mechanical Analysis Bases (proprietary)," December 1988 (ADAMS Accession No. ML003725063 (non-public)).
12. GEH, Topical Report - NEDE-21175-3-P, "BWR Fuel Assembly Evaluation of Combined Safe Shutdown Earthquake (SSE) and Loss-of-Coolant Accident (LOCA) loadings," Amendment 3, July 1982.
13. Letter from C. O. Thomas, NRC, to J. S. Charnley, (GE), ""Acceptance for Referencing of Licensing Topical Report NEDE-24011-P Amendment 7 to Revision 6, General Electric Standard Application for Reactor Fuel,"" March 1, 1985 (ADAMS Accession No. ML090760583 (non-public)).