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3.0 DESIGN OF STRUCTURES, COMPONENTS, EQUIPMENT, AND SYSTEMS

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 3, "Design of Structures, Components, Equipment, And Systems," Section 3.3, "Wind and Tornado Loadings," 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.

3.3 Wind and Tornado Loadings

3.3.1 Regulatory Criteria

In accordance with NRC regulations, nuclear plants must be designed so that they remain in a safe condition under extreme meteorological events, including those that could result in the most extreme wind events (tornadoes and hurricanes) that could reasonably be predicted to occur. In the GEH ABWR DCD, Revision 7, the applicant added hurricane wind speed and hurricane missile spectra to the list of site parameter values presented in DCD Tier 1, Section 5.0, and DCD Tier 2, Section 2.0, of the GEH ABWR DCD. A combined license (COL) applicant that references the ABWR DC will assess whether the actual site characteristics fall within the site parameters specified for the ABWR design.

The applicant is making the changes to provide criteria for a COL applicant to determine whether an ABWR located at a particular site is appropriately protected against the effects of hurricane winds and missiles. In a letter dated September 25, 2014, the staff issued a request for additional information (RAI) 02-1, to the applicant, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14267A352), raising concerns about compliance with GDC 2 (1997) and 4 (1997) for hurricane loads and hurricane-generated missiles. In response, the applicant added information to address hurricane winds and missiles in DCD Tier 1 and Tier 2. Since the applicant's changes were in response to the staff's concerns regarding compliance with the regulations in effect at initial certification, these changes are "modifications," as described in Chapter 1 of this FSER supplement, and the staff will therefore evaluate them using the regulations applicable and in effect at the time of initial certification.

As a result of adding hurricane wind and missile site parameters, GEH updated the ABWR DCD to account for extreme hurricane wind and missile loading consistent with the methodology

applicable at the time of initial certification. This evaluation documents the staff's review of these changes.

The relevant NRC requirements associated with the review of DCD Tier 2, Sections 3.3.1, "Severe Wind Loads," and DCD Tier 2, 3.3.2, "Extreme Wind Loads (Hurricanes and Tornados)," are given in GDC 2 (1997) and summarized below. The associated acceptance criteria are provided in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," (SRP) Sections 3.3.1 "Wind Loadings" and 3.3.2 "Tornado Loadings" Revision 2, 1981. The staff also considered the guidance in Regulatory Guide (RG) 1.221, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants," Revision 0, October 2011, which reflects an understanding of hurricane winds and missiles that was not reflected in earlier guidance.

- GDC 2 (1997), "Design Bases for Protection Against Natural Phenomena," requires, in part, that structures systems and components (SSCs) important to safety be designed to withstand the effects of natural phenomena such as tornadoes and hurricanes without loss of capability to perform their safety function.

3.3.2 Summary of Technical Information

ABWR DCD, Revision 5, which GEH originally submitted in support of the ABWR DC renewal application, contained tornado site parameters related to the maximum tornado wind speed and missile spectra, but it did not contain any site parameters related to hurricane wind speed or hurricane missiles.

In Revision 6 to DCD Tier 2, Section 3.3.2.2, "Determination of Forces on Structures," the applicant proposed the inclusion of design-basis hurricane wind and missile loading.

- DCD Tier 1, Table 5.0, "ABWR Site Parameters," includes the addition of hurricane wind speed and missile spectra for the potential site.
- DCD Tier 2, Table 2.0-1, "Envelope of ABWR Standard Plant Site Design Parameters," includes the addition of hurricane wind speed and missile spectra for the potential site.

In Supplement 5, of its response, to RAI 02-1, dated April 13, 2017 (ADAMS Accession No. ML17103A125), following the submission of ABWR DCD, Revision 6, the applicant modified the DCD Tier 2, Table 2.0-1, to define the design-basis maximum hurricane wind speed of 257 kilometers per hour (km/h) as a fastest-mile wind speed which corresponds to 286.5 km/h 3-second gust wind speed in accordance with RG 1.221, Revision 0, measured at 10 meters above ground over open terrain. The applicant also clarified the maximum tornado wind speed of 483 km/h as a fastest quarter-mile (1/4-mile) wind speed which corresponds to 483 km/h 3-second gust wind speed.

3.3.3 Technical Evaluation

The staff's evaluation of the missiles generated by extreme winds (hurricane) is provided in Section 3.5.1.4 "Missiles Generated by Natural Phenomena" of this FSER supplement and the staff's complete evaluation of meteorological site parameters is evaluated in Section 2.3 of this FSER supplement. In this FSER supplement section the staff evaluates the resulting hurricane wind and missile loading.

In the RAI dated September 25, 2014, the staff asked GEH to address the possibility that the wind speeds from the design-basis tornado may not be bounding for ABWR SSCs in certain locations along the United States Gulf Coast and the southern Atlantic Coast. In a letter dated November 19, 2014 (ADAMS Accession No. ML14324A084), GEH submitted its proposed changes to show that SSCs important to safety are protected from the effects of hurricane winds and missiles. In addition, GEH updated its RAI response in the following RAI supplements as follows:

- Supplement 1 by letter dated June 26, 2015 (ADAMS Accession No. ML15177A036)
- Supplement 2 by letter dated November 5, 2015 (ADAMS Accession No. ML15309A158)
- Supplement 3 by letter dated January 12, 2016 (ADAMS Accession No. ML16012A290)
- Supplement 4 by letter dated November 16, 2016 (ADAMS Accession No. ML16321A413)
- Supplement 5 by letter dated April 13, 2017 (ADAMS Accession No. ML17103A124)

In its responses to RAI 02-1, the applicant provided up-to-date hazards information in its ABWR DCD using current staff guidance with respect to hurricane wind speed and hurricane missiles based on RG 1.221, Revision 0.

The staff reviewed the changes to DCD Tier 1, Table 5.0 and Table 2.0-1, and DCD Tier 2 Sections 3.3.1 and 3.3.2, in order to determine compliance with GDC 2 (1997) using the guidance in SRP Sections 3.3.1, Revision 2 and Section 3.3.2, Revision 2.

The staff reviewed DCD Tier 1, Table 5.0 and DCD Tier 2, Table 2.0-1, and compared the design-basis hurricane wind speed and its missile velocities with the design-basis tornado wind speed and its missile velocities. The staff found that the design-basis hurricane wind speed and its missile velocities are bounded by the design-basis tornado wind speed and its missile velocities. The staff also reviewed the RG 1.221, Revision 0, and found that the methodology used in combining the effects of the design-basis hurricane winds and hurricane-generated missiles is the same as the one for the design-basis tornado winds and tornado-generated missiles in the original certification. Therefore, the staff concluded that the design-basis tornado loading governs as described in the original certification.

In addition, the staff reviewed DCD Tier 2, Section 3.3.1, and confirmed that the ABWR design-basis code, the American National Standards Institute (ANSI)/American Society of Civil Engineers (ASCE) 7-88, 1990, "Minimum Design Loads for Buildings and Other Structures," issued October 5, 2018, was not changed. The staff also reviewed DCD Tier 2, Section 3.3.2.2, and found that the procedures for transforming the extreme hurricane wind loading into effective load distribution across the structures are consistent with those of the ABWR design-basis code, ANSI/ASCE, 7-88, 1990, which was approved in the original certification, and therefore are acceptable.

In a public teleconference on March 2, 2017, the staff requested further clarification on the ABWR DCD wind parameters in order to be consistent with the guidance for a design-basis hurricane wind speed in RG 1.221, Revision 0, based on the nominal 3-second peak-gust

values at a height of 10 meters in flat open terrain, which is consistent with the definition of design wind speeds in the ANSI/ASCE, 7-88, 1990, design standard.

In GEH RAI Supplement 5, the applicant provided additional DCD changes to indicate the severe wind and extreme hurricane wind speed in terms of "fastest-mile", consistent with the ANSI/ASCE 7-88, 1990, methodology at the time of original certification. The corresponding equivalent "3-second gust" is provided in the site-parameter table to facilitate comparison of design wind speeds consistent with RG 1.221, Revision 0.

Additionally, for tornado wind speed, the applicant updated the ABWR DCD to confirm the tornado design wind speed in the "fastest 1/4-mile". The corresponding equivalent "3-second gust" design wind speed is also provided in the site-parameter table for future COL applicants' site-specific tornado wind speeds.

The applicant provided the necessary wind speed information in the ABWR DCD, Revision 7, which incorporated the appropriate changes described in the applicant's response to RAI 02-1, Supplement 5. Therefore, Confirmatory Item 3.3-1 from the staff advanced safety evaluation report with no open items for the ABWR DC renewal is resolved and closed.

3.3.4 Conclusion

Based on the evaluation provided in this FSER section supplement, and as reviewed by the staff in accordance with the acceptance criteria in SRP Section 3.3.1, Revision 2, and Section 3.3.2, Revision 2, the staff concludes that the changes to the ABWR DCD, Revision 7, are acceptable and do not alter the safety findings made in NUREG-1503. The changes meet the applicable regulations in effect at initial certification including the requirements of GDC 2 (1997).

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," (1997).
3. 10 CFR Part 50, Appendix A, GDC 4, "Environmental and Dynamic Effects Design Bases," (1997).
4. 10 CFR Part 52, Appendix A, "Design Certification Rule for the U.S. Advanced Boiling Water Reactor."
5. 10 CFR 52.59, "Criteria for renewal."
6. NRC, DC/COL-ISG-024, "Implementation of Regulatory Guide 1.221 on Design-Basis Hurricane and Hurricane Missiles," issued May 2013 (ADAMS Accession No. ML13015A693).
7. NRC, NUREG-1503, "Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Reactor Design," July 1994 (ADAMS Accession No. ML080670592).
8. 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).
9. NRC, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Section 3.3.1, "Wind Loadings," Revision 2, 1981 (ADAMS Accession No. ML052340621).
10. NRC, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Section 3.3.2 "Tornado Loadings," Revision 2, July 1981 (ADAMS Accession No. ML052340625).
11. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 5, Tier 1 and Tier 2, December 2010 (ADAMS Accession No. ML110040323).
12. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 6, Tier 1 and Tier 2, February 2016 (ADAMS Accession No. ML16214A015).
13. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 7, Tier 1 and Tier 2, December 2019 (ADAMS Accession No. ML20007E371).
14. NRC, RG 1.221, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants," Revision 0, October 2011 (ADAMS Accession No. ML110940300).
15. ANSI/ASCE, 7-88, "Minimum Design Loads for Buildings and Other Structures," 1990.