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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 3.5.1.4, "Missiles Generated by Natural Phenomena," 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.

3.5.1.4 Missiles Generated by Natural Phenomena

3.5.1.4.1 Regulatory Criteria

In this FSER supplemental section the staff reviews the ABWR DCD, Revision 7, and evaluates the applicant's assessment of possible hazards attributable to missiles generated by hurricanes to ensure that the applicant has chosen and properly characterized appropriate design-basis missiles. The applicant provided additional information to address hurricane-generated missiles for the GEH ABWR DC renewal to clarify the possible hazards attributable to missiles generated by hurricanes. 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 DCD Tier 1, Section 5.0 and Tier 2, Section 2.0. Since the applicant's changes were in response to the staff's concerns regarding compliance with regulations in effect at initial certification, these changes are "modifications," as described in Chapter 1 of this staff FSER supplement and will correspondingly be evaluated using the regulations applicable and in effect at the time of the initial ABWR certification.

The relevant NRC requirements associated with the review of the changes are summarized below. The associated acceptance criteria are given in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," (SRP) Section 3.5.1.4, "Missiles Generated by Natural Phenomena" Revision 2, 1981. Review interfaces with other SRP sections can also be found in SRP, Section 3.5.1.4.1 (1981).

- GDC 2 (1997) "Design Bases for Protection Against Natural Phenomena," requires, in part, that structures, systems, and components (SSCs) important to safety shall be designed to

withstand the effects of natural phenomena such as tornadoes and hurricanes without loss of capability to perform their safety function.

- GDC 4 (1997) "Environmental and Dynamic Effects Design Bases," requires, in part, that SSCs important to safety shall be appropriately protected against dynamic effects, including the effects of missiles that may result from equipment failures and from events and conditions outside the nuclear power unit.

3.5.1.4.2 Summary of Technical Information

ABWR DCD, Revision 5, which was 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 did not contain any site parameters related to hurricane wind speed or hurricane missiles.

The applicant included the following changes for the ABWR DC Renewal application in ABWR DCD Revision 6:

- DCD Tier 1, Table 5.0, "ABWR Site Parameters," included changes to address hurricane missiles.
- DCD Tier 2, Table 2.0-1, "Envelope of ABWR Standard Plant Site Design Parameters," and Section 3.5.1.4, "Missiles Generated by Natural Phenomena," included changes that describe the spectrum of missiles generated by hurricane winds and their associated velocities.

DCD Tier 2, Table 2.0-1, describes the design-basis hurricane missile spectra for the GEH ABWR design as follows:

"a rigid missile that tests penetration resistance, such as a 130 kg (287 lb), 20 cm (7.9 in.) diameter armor piercing shell "

"a small rigid missile of a size that is sufficient to pass through openings in protective barriers, such as a 2.54 cm (1 in.) diameter solid steel sphere"

These missiles all have a horizontal hurricane missile velocity of 59 percent of the maximum hurricane wind speed. In addition, the ABWR DCD, Revision 6, markup to DCD Tier 2, Table 2.0-1 (submitted by GEH as discussed in the technical evaluation section of this SER) states that all missiles have a vertical hurricane missile velocity of 26 meters per second (m/s) (58 miles per hour (mph)).

The applicant assumed that the automobile missile impacts at all altitudes is less than 9.14 meters (m) (30 feet (ft.)) above plant grade within 0.8 kilometer (km) (0.5 mile (mi)) of the plant structures, in accordance with the guidance of SRP Section 3.5.1.4 and Regulatory Guide (RG) 1.221, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants," Revision 0, issued October 2011. In addition, the applicant included a combined license (COL) Information Item in DCD Tier 2, Section 3.5.3, for the COL applicant to confirm there are no elevated parking lots within 0.8 km (0.5 mi) of the plant structures that can cause an automobile impact higher than 9.14 m (30 ft.) above plant grade.

Footnotes added by the applicant as part of ABWR DCD, Revision 7, to both DCD Tier 1, Table 5.0 and DCD Tier 2, Table 2.0-1 state that 257 km/h is a fastest-mile wind speed which corresponds to 286.5 km/h 3-second gust wind speed, as the design-basis hurricane wind speed parameter for the ABWR DC, in accordance with RG 1.221, Revision 0, measured at 10 m above ground over open terrain. The staff notes that a wind speed of 286.5 km/h is equivalent to 178 mph or 79.6 m/s.

3.5.1.4.3 Technical Evaluation

In this supplemental FSER section, the staff evaluates the hurricane missile parameters for the ABWR DC renewal. Supplemental FSER Sections 2.3.1 and 3.3 provide the staff's evaluation of the hurricane winds and the resulting extreme wind loadings on structures important to safety, respectively.

In the RAI dated September 25, 2014, the staff requested that GEH update its ABWR DCD during the renewal process 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. The study of missile speeds during hurricanes, NUREG/CR-7005, "Technical Basis for Regulatory Guidance on Design-Basis Hurricane Wind Speeds for Nuclear Power Plants," issued November 2011 (ADAMS Accession No. ML11335A031), concluded that, because of assumed differences between the tornado and hurricane wind fields, airborne missiles can fly faster in a hurricane wind field with the same 3-second gust wind speed at 10 m (33 ft) above ground as a tornado wind field. Missiles in a hurricane wind field may have higher maximum velocities than in a tornado wind field because hurricane missiles are subject to high wind speeds throughout their trajectory.

In response, the applicant provided updated hazards information in its ABWR DCD with respect to hurricane missiles based on RG 1.221, Revision 0.

In its RAI response letter dated, November 19, 2014 (ADAMS Accession No. ML14324A084), GEH submitted its 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)

The applicant's RAI supplements were based on feedback from staff at public meetings held with GEH on their initial response to RAI 02-1, dated November 19, 2014. These public meetings took place on May 7, 2015 (ADAMS Accession No. ML15162A613), October 15, 2015 (ADAMS Accession No. ML15306A104) and October 27, 2016 (ADAMS Accession No. ML17004A316).

In its supplemental responses to RAI 02-1, the applicant provided additional changes to the ABWR DCD to address hurricane winds and associated missiles as an update and modification to the ABWR DCD, Revision 6.

The staff reviewed the additional changes as presented in RAI 02-1, Supplement 4, ABWR DCD, Revision 6 markups related to the design bases for the missile spectra.

Protection from a spectrum of missiles with the critical characteristics set forth in RG 1.221, Revision 0, provides assurance that the necessary SSCs will be available to mitigate the potential effects of hurricane winds and missiles on plant SSCs important to safety. RG 1.221, Revision 0, provides contour maps of U.S. coastal areas most susceptible to hurricanes and associated design-basis wind and missile speeds. The staff reviewed the information submitted by the applicant and finds the hurricane generated missile spectra and hurricane missile velocities to be either consistent or conservative with respect to the guidance of RG 1.221, Revision 0. In addition, the design-basis hurricane missile velocities presented in the revised ABWR DCD, Revision 7, are bounded by the tornado missile velocities already included in the original ABWR DC.

Based on its review, the staff finds that the applicant's changes meet the guidance in RG 1.221, Revision 0, for design-basis hurricane missiles. Therefore, the staff concludes that the ABWR hurricane missile parameters meet the requirements of GDC 2 and GDC 4 in effect at initial certification with respect to hurricane generated missiles.

The applicant provided the necessary hurricane parameters and hurricane-generated missile spectra in the ABWR DCD, Revision 7, which incorporates the appropriate changes described in the applicant's response to RAI 02-1, Supplement 4. Therefore, Confirmatory Item 3.5.1-1 from the staff advanced safety evaluation with no open items for the ABWR DC renewal is resolved and closed.

3.5.1.4.4 Conclusion

As discussed above, the staff's review concludes that the applicant's changes to its design-basis hurricane parameters and hurricane-generated missile spectra for the GEH ABWR design meet the guidance in RG 1.221, Revision 0, for design-basis hurricane wind borne missiles for nuclear power plants, and therefore are acceptable.

Based on the evaluation provided in this supplemental FSER section to NUREG 1503, the staff concludes that the changes to the ABWR DCD, Revision 7, are acceptable, do not alter the safety findings made in NUREG-1503 for the ABWR DC and meet the applicable regulations in effect at initial certification, including the requirements of GDC 2 (1997) and GDC 4 (1997), as reviewed by the staff in accordance with the associated acceptance criteria in SRP Section 3.5.1.4, Revision 2.

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, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Section 3.5.1.4, "Missiles Generated by Natural Phenomena," Revision 2, July 1981 (ADAMS Accession No. ML052340526).
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/CR-7005, "Technical Basis for Regulatory Guidance on Design-Basis Hurricane Windspeeds for Nuclear Power Plants," November 2011 (ADAMS Accession No. ML11335A031).
10. 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).
11. NRC, RG 1.221, Revision 0, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants," October 2011 (ADAMS Accession No. ML110940300).
12. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 5, Tier 1 and Tier 2, December 2010 (ADAMS Accession No. ML110040323).
13. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 6, Tier 1 and Tier 2, February 2016 (ADAMS Accession No. ML16214A015).
14. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 7, Tier 1 and Tier 2, December 2019 (ADAMS Accession No. ML20007E371).