

## **3.0 Design of Structures, Components, Equipment, and Systems**

### **3.5.1.4 Missiles Generated by Natural Phenomena**

#### **3.5.1.4.1 Regulatory Criteria**

In this section the staff reviews 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 General Electric-Hitachi (GEH) Advanced Boiling-Water Reactor (ABWR) Design Certification (DC) renewal.

This evaluation documents the staff's review of the ABWR DC renewal to clarify the possible hazards attributable to missiles generated by hurricanes to ensure that the applicant has chosen and properly characterized appropriate design-basis missiles. In interim staff guidance (ISG), DC/COL-ISG-024, "Implementation of Regulatory Guide 1.221 on Design-Basis Hurricane and Hurricane Missiles," issued May 2013, the NRC staff explicitly addressed the ABWR and concluded that hurricane winds and missiles needed to be addressed to provide reasonable assurance of adequate protection of the public health and safety and ensure compliance with General Design Criteria (GDC) 2 and 4. Therefore, in accordance with Title 10 *Code of Federal Regulations* (10 CFR) 52.59(a) the proposed changes in this regard are defined as "modifications," as described in Chapter 1 of this staff safety evaluation report (SER) supplement, and will correspondingly be evaluated using the regulations applicable and in effect at the initial ABWR certification.

The relevant U.S. Nuclear Regulatory Commission (NRC) requirements associated with the review of the proposed changes are given in 10 CFR Part 50, Appendix A, GDC (1997), and are summarized below. The associated acceptance criteria are given in Section 3.5.1.4, "Missiles Generated By Natural Phenomena" of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)," (SRP (1981)). Review interfaces with other standard review plan (SRP) sections can also be found in NUREG-0800, Section 3.5.1.4.1 (1981).

1. 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.
2. 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**

Revision 5 to the GEH ABWR DCD, which GEH originally submitted in support of their GEH 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 proposed the following changes for the ABWR DC Renewal application in the ABWR DCD Revision 6:

**DCD Tier 1:** Design Control Document (DCD), Revision 6 Tier 1, Table 5.0, “ABWR Site Parameters,” included changes to address hurricane missiles.

**DCD Tier 2:** DCD, Revision 6, 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,” includes changes that describe the spectrum of missiles generated by hurricane winds and their associated velocities.

DCD, Revision 6, Tier 2, Table 2.0-1, provides the following description of the design-basis hurricane missile spectra for the GEH ABWR design:

- 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 markup to DCD, Revision 6, Tier 2, Table 2.0-1 (GEH RAI response letter Supplement 4) states that all missiles have a vertical hurricane missile velocity of 26 m/s (58 mph).

The applicant assumes the automobile missile impacts at all altitudes is less than 9.14 m (30 ft.) above plant grade within 0.8 km (0.5 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.” In addition, the applicant included a 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 to be added by the applicant as part of Revision 7 of the DCD to both Tier 1, Table 5.0 and Tier 2, Table 2.0-1 of the DCD will state 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 measured at 10 meters above ground over open terrain (this is part of Confirmatory Item 2.3-1 discussed in SER Section 2.3). 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 SER section the staff evaluates the hurricane missile parameters. Subsections 2.3.1 and 3.3 of this SER provide the staff’s evaluation of the hurricane winds and the resulting extreme wind loadings on structures important to safety, respectively.

In a letter dated September 25, 2014, the staff issued a Request for Additional Information (RAI) 02-1 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14267A352), requesting that GEH update their 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 Windspeeds for Nuclear Power Plants (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 meters (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.

The applicant in response provided updated hazards information in its ABWR DCD, Revision 6, using current staff guidance with respect to hurricane missiles based on RG 1.221, Revision 0.

Specifically in its RAI response letter dated, November 19, 2014 (ADAMS Accession No. ML14324A084), and its supplements including Supplement 1, June 26, 2015 (ADAMS Accession No. ML15177A036), Supplement 2, November 5, 2015 (ADAMS Accession No. ML15309A160), Supplement 3, January 12, 2016 (ADAMS Accession No. ML16012A290) and Supplement 4, November 16, 2016 (ADAMS Accession No. ML16321A413), the applicant provided proposed changes to the DCD to address hurricane winds and associated missiles as an update and modification to the ABWR DCD. Specifically, GEH responded with proposed changes to the DCD including Tier 1 and Tier 2 site parameters related to hurricane maximum wind speed and missile spectra.

The RAI supplements were submitted 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 were held with GEH on May 7, 2015 (ADAMS Accession No. ML15162A613), October 15, 2015 (ADAMS Accession No. ML15306A104) and on October 27, 2016 (ADAMS Accession No. ML17004A316). The staff review of the applicant's proposed changes to the GEH ABWR design for protecting SSCs important to safety against missiles generated by hurricanes is in accordance with the guidance of SRP Section 3.5.1.4.

The staff reviewed DCD, Revision 6, Tier 1, Section 2.0 and Section 5.0. The staff also reviewed DCD Revision 6, Tier 2, Section 3.5.1.4. Following DCD Revision 6, the applicant provided additional changes to the DCD in response to public meeting feedback from the staff. The staff reviewed all the RAI supplements which included additional changes to the DCD as presented in RAI Supplement 4.

Protection from a spectrum of missiles with the critical characteristics set forth in RG 1.221 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 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. In addition, the design-basis hurricane missile velocities presented in the revised DCD are bounded by the tornado missile velocities already included in the original ABWR DC.

Based on its review, and pending the incorporation into the DCD of final markups from GEH's RAI Supplement 4, the staff finds that the applicant conforms to the guidance in RG 1.221 for design-basis hurricane missiles. Therefore, the staff concludes that the GEH ABWR hurricane missile parameters meet the requirements of GDC 2 and GDC 4 in effect at initial certification with respect to hurricane generated missiles. All the changes identified in RAI supplement 4 are being tracked as **Confirmatory Item 3.5.1-1**.

#### **3.5.1.4.4 Conclusion**

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

Based on the evaluation provided in this final SER section supplement, the staff concludes that the proposed changes to the ABWR DCD are acceptable and do not alter the safety findings made in the ABWR DC NUREG-1503 and meets 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, "Missiles Generated By Natural Phenomena" of NUREG-0800 (1981).

Inclusion of the proposed changes in the DCD is being tracked by the **Confirmatory Item 3.5.1-1** discussed above.