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REGULATORY GUIDE

OFFICE OF NUCLEAR REGULATORY RESEARCH

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DESIGN-BASIS HURRICANE AND HURRICANE MISSILES FOR NUCLEAR POWER PLANTS

A. INTRODUCTION

This guide describes a method that the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable to support reviews of applications that the agency expects to receive for new nuclear reactor construction permits or operating licenses under Title 10 of the *Code of Federal Regulations*, Part 50, "Domestic Licensing of Production and Utilization Facilities" (10 CFR Part 50) (Ref. 1); design certifications under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants" (Ref. 2); and combined licenses under 10 CFR Part 52 that do not reference a standard design. Specifically, this regulatory guide provides new guidance that the NRC staff considers acceptable for use in selecting the design-basis hurricane windspeed and hurricane-generated missiles that a new nuclear power plant should be designed to withstand to prevent undue risk to public health and safety. This guidance applies to the contiguous United States but does not address the determination of the design-basis hurricane windspeed and hurricane-generated missiles for sites located along the Pacific coast or in Alaska, Hawaii, or Puerto Rico; the NRC will evaluate such determinations on a case-by-case basis. This guide also does not identify the specific structures, systems, and components that should be designed to withstand the effects of the design-basis hurricane or that should be protected from hurricane-generated missiles and remain functional. Additionally, this guide does not address effects resulting from externally generated hazards, such as aviation crashes, nearby accidental explosions resulting in blast overpressure levels and explosion-borne debris and missiles, or turbine missiles.

General Design Criterion (GDC) 2, "Design Bases for Protection against Natural Phenomena," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, requires that structures, systems, and components that are important to safety be designed to withstand the effects of natural phenomena, such as hurricanes, without loss of the ability to perform their safety functions. GDC 2 also requires that the design bases for these structures, systems, and components reflect

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The NRC issues regulatory guides to describe and make available to the public methods that the NRC staff considers acceptable for use in implementing specific parts of the agency's regulations, techniques that the staff uses in evaluating specific problems or postulated accidents, and data that the staff needs in reviewing applications for permits and licenses. Regulatory guides are not substitutes for regulations, and compliance with them is not required. Methods and solutions that differ from those set forth in regulatory guides will be deemed acceptable if they provide a basis for the findings required for the issuance or continuance of a permit or license by the Commission.

This guide was issued after consideration of comments received from the public.

Regulatory guides are issued in 10 broad divisions—1, Power Reactors; 2, Research and Test Reactors; 3, Fuels and Materials Facilities; 4, Environmental and Siting; 5, Materials and Plant Protection; 6, Products; 7, Transportation; 8, Occupational Health; 9, Antitrust and Financial Review; and 10, General.

Electronic copies of this guide and other recently issued guides are available through the NRC's public Web site under the Regulatory Guides document collection of the NRC Library at http://www.nrc.gov/reading-rm/doc-collections/ and through the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html, under Accession No. ML110940300. The regulatory analysis may be found in ADAMS under Accession No. ML110940303.

(1) appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated, (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena, and (3) the importance of the safety functions to be performed.

GDC 4, "Environmental and Dynamic Effects Design Bases," of Appendix A to 10 CFR Part 50 requires, in part, that structures, systems, and components that are important to safety be adequately protected against the effects of missiles resulting from events and conditions outside the plant.

For stationary power reactor site applications submitted before January 10, 1997, 10 CFR 100.10(c)(2) (Ref. 3) states that meteorological conditions at the site and in the surrounding area should be considered in determining the acceptability of a site for a power reactor.

For stationary power reactor site applications submitted on or after January 10, 1997, 10 CFR 100.20(c)(2) requires that meteorological characteristics of the site that are necessary for safety analysis or that may have an impact on plant design (such as maximum probable windspeed) be considered in determining the acceptability of a site for a nuclear power plant. In addition, 10 CFR 100.21(d) requires that the physical characteristics of the site, including meteorology, be evaluated and site parameters established such that potential threats from such physical characteristics will pose no undue risk to the type of facility proposed to be located at the site.

This regulatory guide contains information collection requirements covered by 10 CFR Part 50, 10 CFR Part 52, and 10 CFR Part 100 that the Office of Management and Budget (OMB) approved under OMB control numbers 3150-0011, 3150-0151, and 3150-0093, respectively. The NRC may neither conduct nor sponsor, and a person is not required to respond to, an information collection request or requirement unless the requesting document displays a currently valid OMB control number. This regulatory guide is a rule as designated in the Congressional Review Act (5 U.S.C. 801-808). However, OMB has not found it to be a major rule as designated in the Congressional Review Act.

B. DISCUSSION

Determination of Hurricane Windspeeds

Nuclear power 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 at the site. Initially, the NRC considered such conditions for tornadoes in Regulatory Guide 1.76 (RG 1.76), "Design-Basis Tornado for Nuclear Power Plants," issued April 1974 (Ref. 4). The NRC based the original version of RG 1.76 on WASH-1300, "Technical Basis for Interim Regional Tornado Criteria," issued May 1974 (Ref. 5). WASH-1300 chose the design-basis tornado windspeeds so that the probability that a tornado exceeding the design basis would occur was on the order of 10^{-7} per year per nuclear power plant. WASH-1300 used only two years (1971 and 1972) of observed tornado intensity data to derive the conditional probability of the maximum tornado windspeed exceeding a specified value in the event that a tornado were to strike a nuclear power plant. The probability that the tornado would strike a nuclear power plant (treated as a point) was based on more data. Estimates of tornado intensity were regionalized to three regions of the contiguous United States in the original version of RG 1.76. Each region was assigned an associated set of design-basis tornado characteristics, including maximum windspeed.

In March 2007, the NRC issued Revision 1 of RG 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants" (Ref. 6). This revised regulatory guide, which was based on Revision 2 of NUREG/CR-4461, "Tornado Climatology of the Contiguous United States," issued February 2007 (Ref. 7), resulted in the modification of the regionalization presented in the original version of RG 1.76. The tornado database used in Revision 2 of NUREG/CR-4461 included information recorded for more than 46,800 tornado segments occurring from January 1, 1950, through August 31, 2003. More than 39,600 of those segments had sufficient information on their location, intensity, length, and width to be used in the analysis of tornado strike probabilities and maximum windspeeds. The second revision of NUREG/CR-4461 also relied on the Enhanced Fujita Scale, which the National Weather Service implemented in February 2007. The Enhanced Fujita Scale is a revised assessment relating tornado damage to windspeed. The use of the Enhanced Fujita Scale, in addition to the availability of additional tornado data, supported a decrease in design-basis tornado windspeed criteria presented in Revision 1 of RG 1.76.

Since design-basis tornado windspeeds were decreased as a result of the analysis performed to update RG 1.76, it was no longer clear that the revised tornado design-basis windspeeds would bound design-basis hurricane windspeeds in all areas of the United States. This prompted an investigation into extreme wind gusts during hurricanes and their relation to design-basis hurricane windspeeds. The NRC commissioned a report, NUREG/CR-7005, "Technical Basis for Regulatory Guidance on Design-Basis Hurricane Windspeeds for Nuclear Power Plants,"(Ref. 8), that considers peak-gust windspeeds and estimates maximum hurricane windspeeds for hurricanes that originate in the Atlantic and make landfall along the Atlantic and Gulf coasts of the contiguous United States. This report does not include locations outside the contiguous 48 States and does not consider hurricanes that originate in the Pacific Ocean.

The NRC staff has determined that design-basis hurricane windspeeds should correspond to the exceedance frequency of 10^{-7} per year (calculated as a best estimate). This is the same exceedance frequency used to establish the design-basis tornado parameters in Revision 1 to RG 1.76. This exceedance frequency is also consistent with the criterion in Revision 3 of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition" (Ref. 9), Section 2.2.3, "Evaluation of Potential Accidents," issued March 2007, for identifying design-basis events involving hazardous materials or activities onsite and in the vicinity of a proposed site.

Design-Basis Hurricane Windspeeds

The analysis in NUREG/CR-7005 is based on the peer-reviewed hurricane simulation model that was used for the development of windspeed maps for the American Society of Civil Engineers (ASCE) and the Structural Engineering Institute (SEI) Standard, ASCE/SEI 7-05, "Minimum Design Loads for Buildings and Other Structures (Ref. 10)." The model generated peak-gust windspeeds at 3,575 grid points along and inland of the Atlantic and Gulf Coasts of the United States. A stratified sampling approach facilitated a simulation with an effective length of 10 million years that computed windspeeds for each model hurricane at each affected grid point. The range of hurricane parameters in the precomputed wind fields in the model was extended to cover the smaller and more intense hurricanes that are occasionally simulated in the 10-million-year event set. In addition to the computation of a deterministic peak-gust windspeed for each model hurricane, the analysis incorporated a wind field modeling error term. The error term includes the inability of the wind model to capture some asymmetries in the underlying model pressure fields, as well as the inability of the model to capture small-scale features, such as extreme convective gusts. The inclusion of this error term resulted in an effective maximum peak gust in the range of 1.7 to 1.8 times the mean windspeed.

The resulting windspeeds are nominal 3-second peak-gust values at a height of 10 meters (m) (33 feet (ft)) in flat open terrain, which is consistent with the definition of design windspeeds in the ASCE/SEI design standard. Figures 1 through 3 provide hurricane windspeed contour maps from NUREG/CR-7005 that correspond to an exceedance frequency of 10^{-7} per year.

Hurricane-Generated Missiles

In accordance with GDC 2 and 4, structures, systems, and components that are important to safety must be designed to withstand the effects of natural phenomena without losing the ability to perform their safety function. Hurricane missiles (i.e., objects moving under the action of aerodynamic forces induced by the hurricane wind) are among the most extreme effects of credible natural phenomena that can occur at nuclear power plant sites subject to hurricanes.

To ensure the safety of nuclear power plants in the event of a hurricane strike, NRC regulations require that nuclear power plant designs consider the impact of hurricane-generated missiles, in addition to the direct action of the hurricane wind. Hurricanes are capable of generating missiles from objects lying within the path of the hurricane wind and from the debris of nearby damaged structures. The two basic approaches used to characterize hurricane-generated missiles are (1) a standard spectrum of hurricane missiles, and (2) a site-specific probabilistic assessment of the hurricane hazard. No definitive guidance has been developed for use in applying hazard probability methods to characterize site-dependent hurricane-generated missiles. Damage to safety-related structures by hurricanes or other wind-generated missiles implies that a sequence of random events has occurred. That event sequence typically includes an occurrence of a hurricane in the plant vicinity, existence and availability of missiles in the area, injection of missiles into the wind field, suspension and flight of those missiles, impact of the missiles on safety-related structures, and resulting damage to critical equipment. Given defense-in-depth considerations, the uncertainties in these events preclude the use of a probabilistic assessment as the sole basis for assessing how well the plant is protected against hurricane missile damage.

Protection from a spectrum of missiles (ranging from a massive missile that deforms on impact to a rigid penetrating missile) provides assurance that the necessary structures, systems, and components will be available to mitigate the potential effects of a hurricane on plant safety. Given that the design-basis hurricane windspeed has a very low frequency of occurrence, to be credible, the representative missiles must be common items around the plant site and must have a reasonable probability of becoming airborne within the hurricane wind field.

Design-Basis Hurricane Missile Spectrum

To evaluate the resistance of barriers to penetration and gross failure, the hurricane missile velocities must also be defined. In addition to NUREG/CR-7005 on design-basis hurricane windspeeds, the NRC also commissioned a report on design-basis, hurricane-borne missile velocities, NUREG/CR-7004, "Technical Basis for Regulatory Guidance on Design-Basis Hurricane-Borne Missile Speeds for Nuclear Power Plants" (Ref. 11). This report describes the method used to calculate the horizontal and total velocities associated with several types of missiles considered for different hurricane windspeeds. The selected design-basis hurricane missile spectrum for nuclear power plants is the same as the design-basis tornado missile spectrum presented in RG 1.76. This spectrum includes (see Table 1) (1) a massive high-kinetic-energy missile that deforms on impact (an automobile), (2) a rigid missile that tests penetration resistance (a pipe), and (3) a small rigid missile of a size sufficient to pass through any opening in protective barriers (a solid steel sphere).

The NRC considers the design-basis hurricane missiles listed in Table 1 to be capable of striking in all directions with the horizontal velocities shown in Table 2 and with a vertical velocity of 26 m/s. The horizontal missile velocities shown in Table 2 were taken from Table 5 of NUREG/CR-7004 and represent maximum horizontal missile speeds in open terrain. The vertical missile velocity of 26 m/s bounds all the vertical missile velocities calculated from Table 2 of NUREG/CR-7004, which shows terminal total missile velocities (over open terrain) and the associated angle of incidence with respect to the ground. RG 1.76 uses two different automobile missiles as a function of tornado region (i.e., a larger and heavier automobile for tornado Regions I and II and a smaller and lighter automobile for tornado Region III) because the lighter automobile was found to have a higher kinetic energy in Region III as compared to the heavier automobile. However, in the case of the hurricane wind field, the heavier automobile was found to have a higher kinetic energy for all windspeeds as compared to the lighter automobile; therefore, the design-basis hurricane automobile missile is based only on the heavier design-basis automobile missile presented in RG 1.76.

The barrier design should be evaluated assuming a normal impact to the surface for the automobile and Schedule 40 pipe (6.625-inch diameter) missiles. The automobile missile is considered to have an impact at all altitudes less than 9.14 m (30 ft) above all grade levels within 0.8 kilometers (0.5 miles) of the plant structures.

The hurricane missile analyses presented in Reference 11 are based on missile aerodynamic and initial condition assumptions that are similar to those used for the analyses of tornado-borne missile velocities adopted for Revision 1 of RG 1.76. In particular, no dependence of missile drag coefficient on missile position or relative missile speed with respect to the windflow was considered. However, the assumed hurricane wind field differs from the assumed tornado wind field in that the hurricane wind field does not change spatially during the missile's flight time but does vary with height above ground. Because the size of the hurricane zone with the highest winds is large relative to the size of the missile trajectory, the hurricane missile is subjected to the highest windspeeds throughout its trajectory. In contrast, the tornado wind field is smaller, so the tornado missile is subject to the strongest winds only at the beginning of its flight. This results in the same missile having a higher maximum velocity in a hurricane wind field than in a tornado wind field with the same maximum (3-second gust) windspeed.

C. STAFF REGULATORY GUIDANCE

The NRC staff has established the following regulatory positions for use in selecting the design-basis hurricane windspeed and hurricane-generated missiles that a new nuclear power plant should be designed to withstand to prevent undue risk to public health and safety.

1. Design-Basis Hurricane Windspeeds

Windspeeds specified in Figures 1, 2, and 3 for the appropriate regions identified are acceptable to the NRC staff for defining the design-basis hurricane for a new nuclear power plant. If a design-basis hurricane proposed for a given site is characterized by parameter values less conservative than the values presented in Figures 1 through 3, a comprehensive analysis should be provided to justify the selection of the less conservative design-basis hurricane. Linear interpolation for sites located between two wind contour lines is permitted.

2. Design-Basis Hurricane-Generated Missiles

The design-basis hurricane-generated missile spectrum given in Table 1 and the corresponding missile velocities given in Table 2 are acceptable to the staff for the design of new nuclear power plants.

D. IMPLEMENTATION

The purpose of this section is to provide information on how applicants and licensees may use this guide and information regarding the NRC's plans for using this regulatory guide. In addition, it describes how the NRC staff has complied with the Backfit Rule, 10 CFR 50.109, and any applicable finality provisions in 10 CFR Part 52.

Use by Applicants and Licensees

Applicants and licensees may voluntarily use the information in this regulatory guide to develop applications for initial licenses, amendments to licenses, requests for exemptions, or NRC regulatory approval. Licensees may use the information in this regulatory guide for actions that do not require prior NRC review and approval (e.g., changes to a facility design under 10 CFR 50.59 that do not require prior NRC review and approval). Licensees may voluntarily use the information in this regulatory guide or applicable parts to resolve regulatory or inspection issues (e.g., by committing to comply with provisions in the regulatory guide).

Current licensees may continue to use the guidance that was found acceptable for complying with specific portions of the regulations as part of their license approval process.

A licensee who believes that the NRC staff is inappropriately imposing this regulatory guide as part of a request for a license amendment or request for a change to a previously issued NRC regulatory approval may file a backfitting appeal with the NRC in accordance with applicable procedures.

Use by NRC Staff

The NRC staff does not intend or approve any imposition or backfitting of the guidance in this regulatory guide. The staff does not expect any existing licensee to use or commit to using the guidance in this regulatory guide in the absence of a licensee-initiated change to its licensing basis. The NRC staff does not expect or plan to request licensees to voluntarily adopt this regulatory guide to resolve a generic regulatory issue. The NRC staff does not expect or plan to initiate NRC regulatory action that would require the use of this regulatory guide (e.g., issuance of an order requiring the use of the regulatory guide, requests for information under 10 CFR 50.54(f) as to whether a licensee intends to commit to use of this regulatory guide, generic communication, or promulgation of a rule requiring the use of this regulatory guide) without further backfit consideration.

During inspections of specific facilities, the staff may suggest or recommend that licensees consider various actions consistent with staff positions in this regulatory guide as one acceptable means of meeting the underlying NRC regulatory requirement. Such suggestions and recommendations would not ordinarily be considered backfitting even if prior versions of this regulatory guide are part of the licensing basis of the facility with respect to the subject matter of the inspection. However, the staff may not represent to the licensee that: (1) the licensee's failure to comply with the positions in this regulatory guide constitutes a violation, (2) the licensee may avoid the violation only by agreeing to comply with this regulatory guide, or (3) the only acceptable way for the licensee to address the NRC-identified noncompliance or violation is to commit to this regulatory guide (i.e., including this regulatory guide in the facility's licensing basis).

If an existing licensee seeks an amendment or change in an already approved area of NRC regulatory concern and (1) the NRC staff's consideration of the request involves a regulatory issue directly relevant to this new or revised regulatory guide and (2) the specific subject matter of this regulatory guide is an essential consideration in the staff's determination of the acceptability of the licensee's request, then, as a prerequisite for NRC approval of the license amendment or change, the staff may require the licensee to either follow the guidance in this regulatory guide or to provide an equivalent alternative method that demonstrates compliance with the underlying NRC regulatory requirements. This is not considered backfitting as defined in 10 CFR 50.109(a)(1) or a violation of any of the issue finality provisions in 10 CFR Part 52.

Conclusion

This regulatory guide is not being imposed upon current licensees and may be voluntarily used by existing licensees. In addition, this regulatory guide is issued in conformance with all applicable internal NRC policies and procedures governing backfitting. Accordingly, the issuance of this regulatory guide by the NRC staff is not considered backfitting, as defined in 10 CFR 50.109(a)(1), nor is it deemed to be in conflict with any of the issue finality provisions in 10 CFR Part 52.

Figure 1 Design-Basis Hurricane Windspeeds for the Western Gulf of Mexico U.S. Coastline Representing Exceedance Probabilities of 10^{-7} per Year. Values are nominal 3-second gust windspeeds in miles per hour (meters per second) at 33 ft (10 m) above ground over open terrain (reproduced from NUREG/CR-7005).

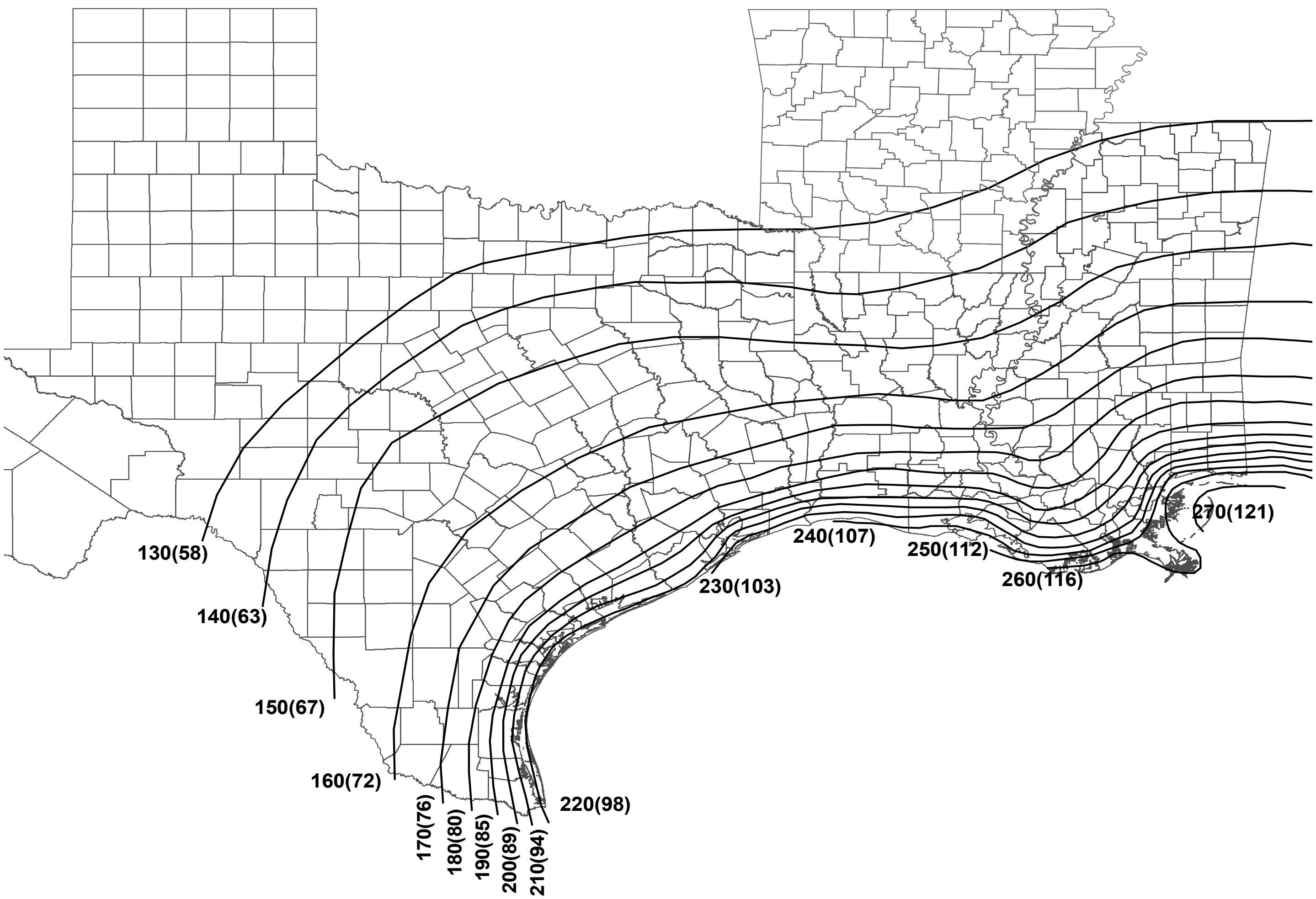

Figure 2 Design-Basis Hurricane Windspeeds for the Eastern Gulf of Mexico and Southeastern Atlantic U.S. Coastline Representing Exceedance Probabilities of 10^{-7} per Year. Values are nominal 3-second gust windspeeds in miles per hour (meters per second) at 33 ft (10 m) above ground over open terrain (reproduced from NUREG/CR-7005).

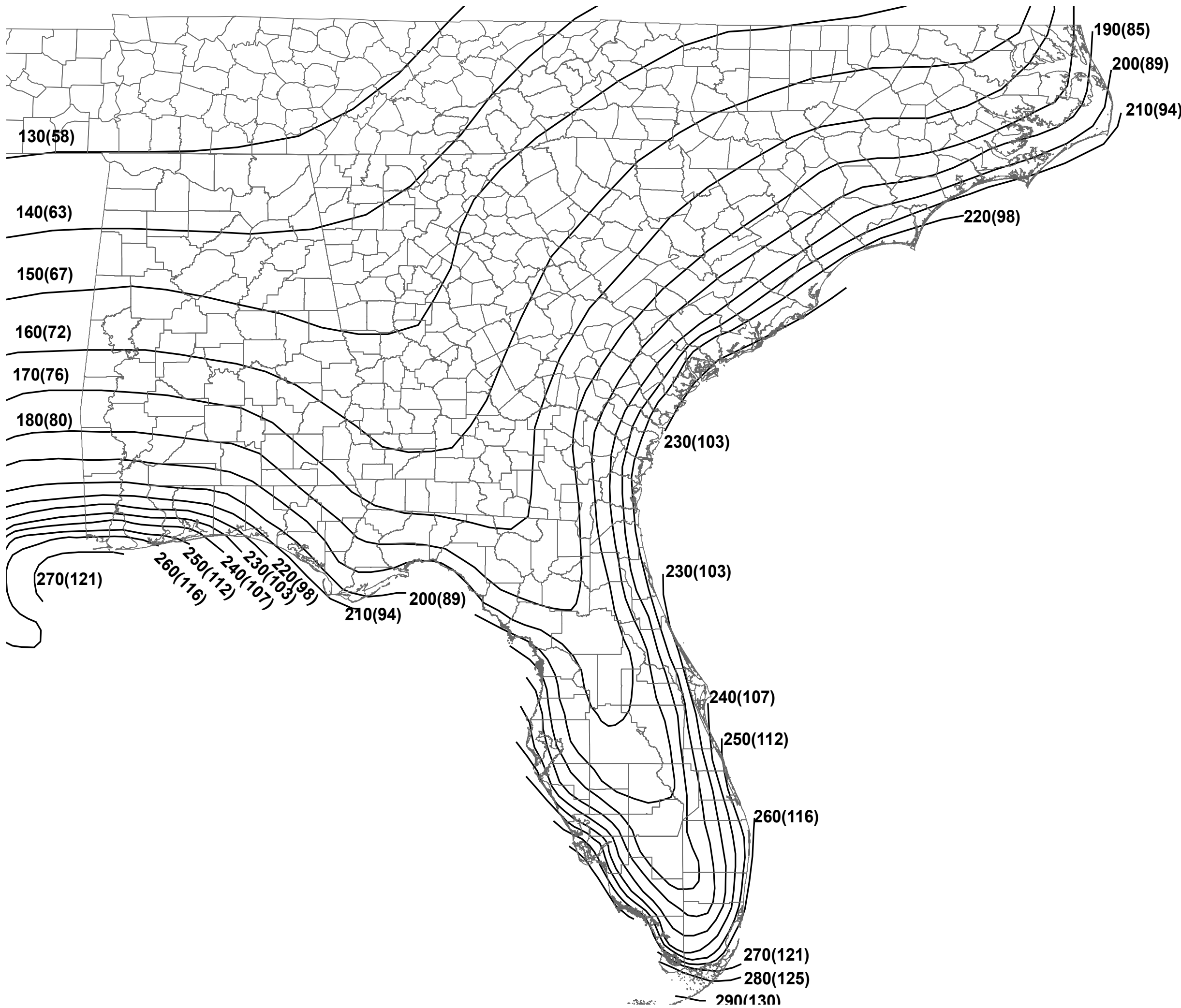

Figure 3. Design-Basis Hurricane Windspeeds for the Mid- and Northern Atlantic U.S. Coastline Representing Exceedance Probabilities of 10^{-7} per year. Values are nominal 3-second gust windspeeds in miles per hour (meters per second) at 33 ft (10 m) above ground over open terrain (reproduced from NUREG/CR-7005).

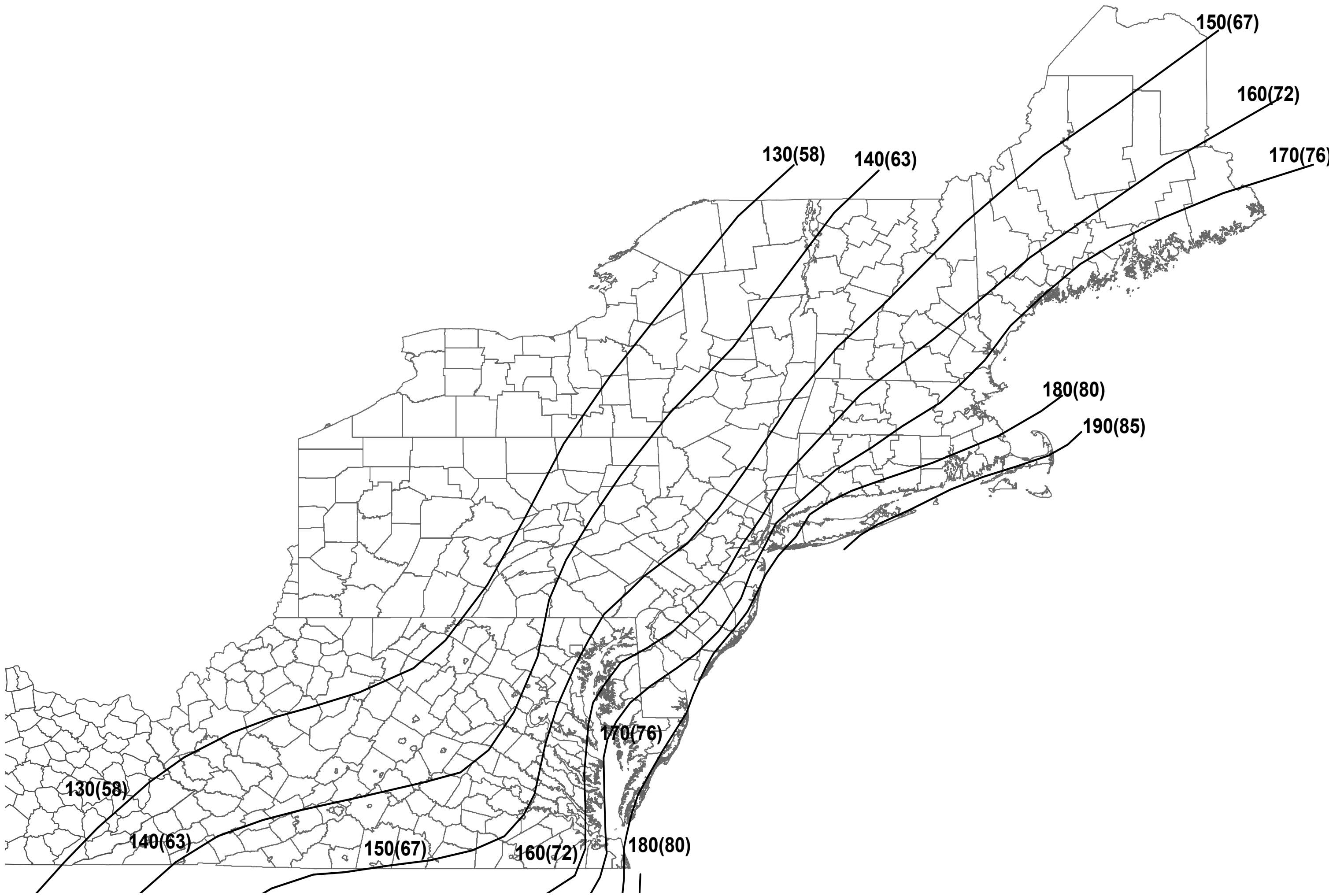

Table 1 Design-Basis Hurricane Missile Spectrum

Missile Type	Dimensions	Mass
Automobile	5 m × 2 m × 1.3 m (16.4 ft x 6.6 ft x 4.3 ft)	1,810 kg (4,000 lb)
Schedule 40 Pipe	0.168 m dia × 4.58 m long (6.625 in. dia × 15 ft long)	130 kg (287 lb)
Solid Steel Sphere	25.4 mm (1 in.) diameter	0.0669 kg (0.147 lb)

Table 2 Design-Basis Missile Velocities as a Function of Hurricane Windspeed

Hurricane Windspeed m/s (mph)		Horizontal Missile Velocity m/s (mph)					
		Auto		Pipe		Sphere	
40	(89)	16.6	(37)	11.7	(26)	9.9	(22)
45	(101)	19.9	(45)	14.2	(32)	12.1	(27)
50	(112)	23.4	(52)	17.0	(38)	14.4	(32)
55	(123)	27.1	(61)	19.8	(44)	17.0	(38)
60	(134)	30.9	(69)	22.9	(51)	19.6	(44)
65	(145)	34.9	(78)	26.0	(58)	22.4	(50)
70	(157)	39.0	(87)	29.3	(66)	25.4	(57)
75	(168)	43.1	(96)	32.8	(73)	28.4	(64)
80	(179)	47.4	(106)	36.3	(81)	31.6	(71)
85	(190)	51.8	(116)	39.9	(89)	34.9	(78)
90	(201)	56.2	(126)	43.7	(98)	38.3	(86)
95	(213)	60.7	(136)	47.5	(106)	41.8	(94)
100	(224)	65.2	(146)	51.4	(115)	45.3	(101)
105	(235)	69.9	(156)	55.4	(124)	49.0	(110)
110	(246)	74.5	(167)	59.4	(133)	52.7	(118)
115	(257)	79.2	(177)	63.6	(142)	56.5	(126)
120	(268)	84.0	(188)	67.7	(151)	60.4	(135)
125	(280)	88.8	(199)	72.0	(161)	64.3	(144)
130	(291)	93.6	(209)	76.3	(171)	68.3	(153)
135	(302)	98.5	(220)	80.6	(180)	72.3	(162)
140	(313)	103.4	(231)	85.0	(190)	76.4	(171)
145	(324)	108.3	(242)	89.5	(200)	80.6	(180)
150	(336)	113.2	(253)	94.0	(210)	84.8	(190)

The hurricane windspeed values are nominal 3-second gust windspeeds at 10 m (33 ft) above ground.
The design-basis vertical missile velocity for all missiles is 26 m/s (58 mph).

REFERENCES[1]

1. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," U.S. Nuclear Regulatory Commission, Washington, DC.

2. 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, Washington, DC.

3. 10 CFR Part 100, "Reactor Site Criteria," U.S. Nuclear Regulatory Commission, Washington, DC.

4. Regulatory Guide 1.76, Revision 0, "Design-Basis Tornado for Nuclear Power Plants," U.S. Atomic Energy Commission, Washington, DC, April 1974.

5. WASH-1300, "Technical Basis for Interim Regional Tornado Criteria," U.S. Atomic Energy Commission, Washington, DC, May 1974.

6. Regulatory Guide 1.76, Revision 1, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

7. NUREG/CR-4461, Revision 2, "Tornado Climatology of the Contiguous United States," PNNL-15112, U.S. Nuclear Regulatory Commission, Washington, DC, February 2007.

8. NUREG/CR-7005, "Technical Basis for Regulatory Guidance on Design-Basis Hurricane Windspeeds for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, Washington, DC.

9. NUREG-0800, Revision 3, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," U.S. Nuclear Regulatory Commission, Washington, DC March 2007.

10. Standard ASCE/SEI 7-05, "Minimum Design Loads for Buildings and Other Structures," American Society of Civil Engineers (ASCE) and the Structural Engineering Institute (SEI).[2]

11. NUREG/CR-7004, "Technical Basis for Regulatory Guidance on Design-Basis Hurricane-Borne Missile Speeds for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, Washington, DC.

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[1] Publicly available NRC published documents are available electronically through the NRC Library on the NRC's public Web site at: http://www.nrc.gov/reading-rm/doc-collections/. The documents can also be viewed online or printed for a fee in the NRC's Public Document Room (PDR) at 11555 Rockville Pike, Rockville, MD; the mailing address is USNRC PDR, Washington, DC 20555; telephone 301-415-4737 or (800) 397-4209; fax (301) 415-3548; and e-mail PDR.resource@nrc.gov.

[2] Copies of the ASCE document may be obtained directly from the American Society of Civil Engineers 1801 Alexander Bell Drive, Reston, VA 20191; telephone (800) 548-2723; Fax (703)-295-6211; e-mail: pubsful@asce.org.