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REGULATORY GUIDE

REGULATORY GUIDE 1.117

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PROTECTION AGAINST EXTREME WIND EVENTS AND MISSILES FOR NUCLEAR POWER PLANTS

(Previously titled, "TORNADO DESIGN CLASSIFICATION")

A. INTRODUCTION

Purpose

This regulatory guide (RG) describes an approach that the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable for identifying those structures, systems, and components of light-water-cooled reactors that should be protected from the effects of the worst case extreme winds (tornados and hurricanes) and wind-generated missiles, so that they remain functional.

Applicable Rules and Regulations

- General Design Criterion 2, "Design Bases for Protection against Natural Phenomena," of Appendix A, "General Design Criteria for Nuclear Power Plants," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities" (Ref. 1), requires, in part, that structures, systems, and components 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 functions. Criterion 2 also requires that the design bases for these structures, systems, and components reflect (1) appropriate combinations of the effects of normal and accident conditions with the effects of natural phenomena, and (2) the importance of the safety functions to be performed.

Related Guidance

- RG 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants," (Ref. 2), provides a method to define design-basis tornado and design-basis tornado-generated missiles that a nuclear power plant should be designed to withstand.

- RG 1.221, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants," (Ref. 3), provides a method in selecting the design-basis hurricane wind speed and hurricane-generated missiles that a new nuclear plant should be designed to withstand.

Written suggestions regarding this guide or development of new guides may be submitted 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/reg-guides/contactus.html.

Electronic copies of this regulatory guide, previous versions 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/. The regulatory guide is also available through the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html, under ADAMS Accession No. ML15356A213. The regulatory analysis may be found in ADAMS under Accession No. ML14356A106 and the staff responses to the public comments on DG-1313 may be found under ADAMS Accession No. ML15356A214.

- RG 1.117 “Tornado Design Classification,” Rev. 1 (Ref. 4), describes a method acceptable to the NRC staff for identifying those structures, systems, and components of light-water-cooled reactors that should be protected from the effects of the Design Basis Tornado.

Purpose of Regulatory Guides

The NRC issues RGs to describe to the public the methods that the staff considers acceptable for use in implementing specific parts of the agency’s regulations, to explain techniques that the staff uses in evaluating specific problems or postulated accidents, and to provide guidance to applicants. Regulatory guides are not substitutes for regulations, and compliance with them is not required. Methods and solutions that differ from those set forth in RGs 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.

Paperwork Reduction Act

This RG contains and references information collections covered by 10 CFR Part 50 and 10 CFR Part 52 that are subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et seq.). These information collections were approved by the Office of Management and Budget (OMB), control numbers 3150 0011 and 3150 0151.

Public Protection Notification

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.

B. DISCUSSION

Reason for Revision

This revision of the RG (Revision 2) addresses new issues identified since the NRC originally issued the guide. As indicated in RG 1.76, tornado wind speeds may not bound hurricane wind speeds for certain portions of the Atlantic and gulf coasts. In this case, the structures, systems, and components should also be designed to withstand the effects of the design-basis hurricane and hurricane-generated missiles so that they remain functional, as defined in RG 1.221. In addition, the guide has been updated to use the term, "extreme winds," which encompasses both tornado and hurricane winds and better reflects the purpose of the guidance.

Background

Nuclear power plants should be protected from the effects of extreme winds and wind-generated missile strikes. The likelihood of a credible tornado or hurricane strike varies from about 10^{-7} per year to values several orders of magnitude higher.

Physical design parameters of tornado and hurricane protection provisions are such that designated structures, systems, and components will be able to maintain their necessary capabilities in the event of a design basis tornado or hurricane, as defined in RG 1.76 and RG 1.221 respectively. This ensures that protection of the designated items against all credible extreme wind events has been adequately considered.

A basic provision of extreme wind protection criteria is that those structures, systems, and components whose failure could result in conservatively calculated exposures comparable to the guideline exposures of 10 CFR Part 100, "Reactor Site Criteria," should be protected against design-basis tornado or hurricane effects to prevent such failure. This provision by itself, however, would not provide protection for certain other structures, systems, and components that could be damaged by less severe, but more likely, extreme wind events. To ensure protection for more probable events having less severe consequences, the selection of structures, systems, and components to be protected against the effects of a design-basis tornado and hurricane is based on not allowing offsite exposures to exceed an appropriate fraction of 10 CFR Part 100 guidelines.

Protection of designated structures, systems, and components may generally be accomplished by designing protective barriers to preclude extreme wind damage. For example, the primary containment, reactor building, auxiliary building, and control structures should be designed against collapse and should provide an adequate barrier against missiles. However, the primary containment need not necessarily maintain its leak-tight integrity. If protective barriers are not installed, the structures and components themselves should be designed to withstand the effects of the extreme winds, including tornado and hurricane missile strikes. The physical separation of redundant or alternative structures or components required for the safe shutdown of the plant is generally not considered acceptable by itself for protecting against extreme wind effects, including generated missiles. This is because of the large number and random direction of potential missiles that could result from wind effects, as well as the need to consider the single failure criterion.

As stated in GDC 2, "SSCs important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions. The design bases for these SSCs shall reflect … appropriate combinations of the effects of normal and accident conditions with the effects of the natural

phenomena." An applicant or licensee does not need to assume simultaneous occurrence of low probability events (e.g., loss-of-coolant accident with a design basis tornado) because the joint occurrence is sufficiently small. However, applicants and licensees should consider subsequently-occurring low probability events (e.g. loss-of-coolant accident followed by a design bases tornado). For this reason, equipment used to provide long term core cooling following a loss-of-coolant accident should be protected against extreme wind events.

Harmonization with International Standards

The NRC staff reviewed guidance from the International Atomic Energy Agency (IAEA) and did not identify any standards that provided useful guidance to NRC staff, applicants, or licensees.

C. STAFF REGULATORY GUIDANCE

Structures, systems, and components important to safety that should be protected from both the direct and indirect effects of extreme wind events (tornado or hurricane) are:

1. those necessary to ensure the integrity of the reactor coolant pressure boundary,

2. those necessary to ensure the capability to shut down the reactor and maintain it in a safe shutdown condition (this includes both hot standby and cold shutdown capability), and

3. those whose failure could lead to radioactive releases resulting in calculated offsite exposures greater than 25 percent of the guideline exposures of 10 CFR Part 100 using appropriately conservative analytical methods and assumptions.

Protection applies both the effects of the extreme wind directly acting on the SSCs, as well as wind effects such as wind-generated missiles acting on the SSCs.

It is the responsibility of applicants and licensees to determine which SSCs perform the above functions and thus are protected. The appendix to this guide lists structures, systems, and components, which together with their foundations and supports, typically should be protected from the effects of a design-basis tornado (see RG 1.76) and design-basis hurricane (RG 1.221), including generated missiles, without loss of capability to perform their safety functions. Those structures, systems, and components that should be protected may be different from the appendix list for designs that differ substantially from those now in use.

D. IMPLEMENTATION

The purpose of this section is to provide information on how applicants and licensees[1] may use this guide and information regarding the NRC's plans for using this RG. In addition, it describes how the NRC staff complies with 10 CFR 50.109, "Backfitting," and any applicable finality provisions in 10 CFR Part 52.

Use by Applicants and Licensees

Applicants and licensees may voluntarily[2] use the guidance in this document to demonstrate compliance with the underlying NRC regulations. Methods or solutions that differ from those described in this regulatory guide may be deemed acceptable if they provide sufficient basis and information for the NRC staff to verify that the proposed alternative demonstrates compliance with the appropriate NRC regulations. Current licensees may continue to use guidance the NRC found acceptable for complying with the identified regulations as long as their current licensing basis remains unchanged.

Licensees may use the information in this regulatory guide for actions that do not require NRC review and approval, such as changes to a facility design under 10 CFR 50.59, "Changes, Tests, and Experiments." Licensees may use the information in this regulatory guide or applicable parts to resolve regulatory or inspection issues.

Except in those cases in which an applicant or licensee proposes or has previously established an acceptable alternative method for complying with specified portions of the NRC's regulations, the NRC staff will use the methods described in this guide to evaluate (1) submittals in connection with applications for construction permits, standard plant design certifications, early site permits, operating licenses, and combined licenses, and (2) submittals from operating reactor licensees who voluntarily propose to initiate system modifications that have a clear nexus with the subject for which guidance is provided herein.

Use by NRC Staff

The NRC staff does not intend or approve any imposition or backfitting of the guidance in this regulatory guide. The NRC staff does not expect any existing licensee to use or commit to using the guidance in this regulatory guide, unless the licensee makes a 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. Examples of such unplanned NRC regulatory actions include 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 regulatory discussions on plant-specific operational issues, the staff may discuss with licensees various actions consistent with staff positions in this regulatory guide as one acceptable means of meeting the underlying NRC regulatory requirement. Such discussions would not ordinarily be

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1 In this section, "licensees" refers to licensees of nuclear power plants under 10 CFR Parts 50 and 52. The term "applicants," refers to applicants for licenses and permits for (or relating to) nuclear power plants under 10 CFR Parts 50 and 52, and applicants for standard design approvals and standard design certifications under 10 CFR Part 52.

2 In this section, "voluntary" and "voluntarily" mean that the licensee is seeking the action of its own accord, without the force of a legally binding requirement or an NRC representation of further licensing or enforcement action.

considered backfitting even if prior versions of this regulatory guide are part of the licensing basis of the facility. However, unless this regulatory guide is part of the licensing basis for a facility, the staff may not represent to the licensee that the licensee's failure to comply with the positions in this regulatory guide constitutes a violation.

If an existing licensee voluntarily seeks a license amendment or change 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 the staff may request that the licensee either follow the guidance in this regulatory guide or provide an equivalent alternative process 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.

Additionally, an existing applicant may be required to comply to new rules, orders, or guidance if 10 CFR 50.109(a)(3) applies.

If a licensee believes that the NRC is either using this regulatory guide or requesting or requiring the licensee to implement the methods or processes in this regulatory guide in a manner inconsistent with the discussion in this "Implementation" section, then the licensee may file a backfit appeal with the NRC in accordance with the guidance in NRC Management Directive 8.4, "Management of Facility-specific Backfitting and Information Collection" (Ref. 5), and NUREG-1409, "Backfitting Guidelines" (Ref. 6).

REFERENCES[3]

1. *U.S. Code of Federal Regulations* (CFR), Title 10, Part 50, "Domestic Licensing of Production and Utilization Facilities," Appendix A, General Design Criterion 2, "Design Bases for Protection against Natural Phenomena."

2. U.S. Nuclear Regulatory Commission (NRC), Regulatory Guide (RG) 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants," Washington, DC.

3. NRC, RG 1.221, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants," Washington, DC.

4. NRC, RG 1.117, "Tornado Design Classification," Revision 1, Washington D.C.

5. NRC, Management Directive 8.4, "Management of Facility-specific Backfitting and Information Collection," Washington, DC.

6. NRC, NUREG-1409, "Backfitting Guidelines," July 1990, Washington, DC.

[3] 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/ and through the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html 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. For problems with ADAMS, contact the PDR staff at 301-415-4737 or (800) 397-4209; fax (301) 415-3548; or e-mail pdr.resource@nrc.gov.

APPENDIX A

STRUCTURES, SYSTEMS, AND COMPONENTS TO BE PROTECTED AGAINST EXTREME WIND EVENTS (TORNADO AND HURRICANE)

This appendix provides a minimum list of structures, systems, and components (SSCs), which together with their foundations and supports, should be protected from the extreme wind events, including generated missiles, without loss of capability to perform their safety functions. In addition, SSCs that are not on the list but are necessary to meet the requirements outlined in Section C of this guide should also be protected against extreme wind events.

1. the reactor coolant pressure boundary.[4]

2. those portions of the main steam and main feedwater systems[5] in pressurized-water reactors (PWRs) up to and including the outermost isolation valves.

3. the reactor core and individual fuel assemblies, at all times, including during refueling.

4. systems or portions of systems that are required for (1) attaining safe shutdown, (2) residual heat removal, (3) cooling the spent fuel storage pool, (4) mitigating the consequences of a tornado-caused PWR steam line break,[6] (5) makeup water for the primary system, and (6) supporting the above systems, e.g., cooling water, ultimate heat sink, air supply, auxiliary feedwater, and ventilation.

5. the spent fuel storage pool, to the extent necessary to preclude significant loss of watertight integrity of the storage pool and to prevent missiles from contacting fuel within the pool.

6. the reactivity control systems, e.g., control rod drives and boron injection system.

7. the control room, including all equipment needed to maintain the control room within safe habitability limits for personnel and safe environmental limits for protected equipment.

8. those portions of the gaseous radwaste treatment system whose failure caused by tornado or hurricane effects could result in potential offsite exposures in excess of the criterion given in subitem (3) of the regulatory position.

9. systems or portions of systems that are required for monitoring, actuating, and operating protected portions of systems listed in items 4, 6, 7, and 13.

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4 As defined in Title 10 of the *Code of Federal Regulations* 50.2, "Definitions."

5 The system boundary includes those portions of the system required to accomplish the specified safety function and connecting piping up to and including the first valve (including a safety or relief valve). This is either normally closed or capable of automatic closure when the safe function is required.

6 Alternatively, the main steam system, up to and including a second isolation valve such as a redundant series main steam isolation valve, or a turbine stop valve, may be protected.

10. all electric and mechanical devices and circuitry between the process sensors and the input terminals of the actuator systems involved in generating signals that initiate protective actions by tornado-protected portions of systems listed in items 4, 6, 7, and 13.

11. those portions of the long-term emergency core cooling system that would be required to maintain the plant in a safe condition for an extended time after a loss-of-coolant accident.

12. primary reactor containment and other structures, such as the control room building and auxiliary building, to the extent that they not collapse, allow perforation by missiles, or generation of secondary missiles, any of which could cause unacceptable damage to protected items. However, the primary containment need not necessarily maintain its leak-tight integrity.

13. the Class 1E electric systems and necessary support systems, including the auxiliary systems for the onsite electric power supplies, that provide the emergency electric power needed for the functioning of plant features included in items 1 through 11 above.

14. those portions of structures, systems, and components whose continued function is not required but whose failure could reduce to an unacceptable safety level the functional capability of any plant features included in items 1 through 13 above or could result in incapacitating injury to occupants of the control room.