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REGULATORY GUIDE

OFFICE OF STANDARDS DEVELOPMENT

REGULATORY GUIDE 1.117
TORNADO DESIGN CLASSIFICATION

A. INTRODUCTION

General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires, in part, that structures, systems, and components important to safety be designed to withstand the effects of natural phenomena such as tornadoes 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.

This guide 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 (see Regulatory Guide 1.76, "Design Basis Tornado for Nuclear Power Plants"), including tornado missiles, and remain functional. The Advisory Committee on Reactor Safeguards has been consulted concerning this guide and has concurred in the regulatory position.

B. DISCUSSION

Nuclear power plants should be protected from the effects of tornado strikes. The likelihood of a credible tornado strike varies from about 10^{-7} per year to values several orders of magnitude higher. Physical design parameters of tornado 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 (DBT), as defined in Regulatory Guide 1.76. This ensures that protection of the designated items against all credible tornadoes has been adequately considered.

A basic provision of tornado 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 DBT effects to prevent such failure. This provision by itself, however, would not provide protection for certain other structures, systems, and components which could be damaged by a less severe, but more likely, tornado. In order 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 DBT 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 tornado 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 leaktight integrity. If protective barriers are not installed, the structures and components themselves should be designed to withstand the effects of the tornado, including tornado 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 tornado effects, including tornado-generated missiles. This is because of the large number and random direction of potential missiles that could result from a tornado as well as the need to consider the single failure criterion.

It is not necessary to maintain the functional capability of all Seismic Category I structures, systems, and components because the probability of the joint occurrence of low-probability events (loss-of-coolant

*Lines indicate substantive changes from previous issue.

accident with DBT or smaller tornado, or earthquake with DBT or smaller tornado) is sufficiently small. However, equipment used to provide long-term core cooling following a LOCA should be protected.

Similarly, it is not generally necessary to protect the radioactive waste systems since, even in the event of gross failure, offsite exposures would remain well below the guideline exposures of 10 CFR Part 100 because of the limited inventory allowed in these systems.

C. REGULATORY POSITION

Structures, systems, and components important to safety that should be protected from the effects of a Design Basis Tornado 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% of the guideline exposures of 10 CFR Part 100 using appropriately conservative analytical methods and assumptions.

The appendix to this guide lists structures, systems, and components, which together with their foundations and supports, should be protected from the effects of a DBT (see Regulatory Guide 1.76), including tornado missiles, without loss of capability to perform their safety functions. Those structures, systems, and components that should be protected may require reevaluation for designs that differ substantially from those now in use.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants regarding the NRC staff's plans for using this regulatory guide.

Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used in the evaluation of construction permit applications docketed after May 30, 1978.

If an applicant wishes to use this regulatory guide in developing submittals for applications docketed on or before May 30, 1978, the pertinent portions of the application will be evaluated on the basis of this guide.

APPENDIX

STRUCTURES, SYSTEMS, AND COMPONENTS OF LIGHT-WATER-COOLED REACTORS TO BE PROTECTED AGAINST TORNADOES

1. The reactor coolant pressure boundary.[1]

2. Those portions of the main steam and main feedwater systems[2] in 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,[3] (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 tornado-protected equipment.

8. Those portions of the gaseous radwaste treatment system whose failure due to tornado 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 tornado-protected portions of systems listed in items 4, 6, 7, and 13.

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 safety-related 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 tornado-protected items. However, the primary containment need not necessarily maintain its leaktight integrity.

13. The Class 1E electric 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.

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[1] As defined in §50.2 of 10 CFR Part 50.

[2] 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.

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