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U.S. NUCLEAR REGULATORY COMMISSION

Revision 2
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REGULATORY GUIDE

OFFICE OF NUCLEAR REGULATORY RESEARCH

REGULATORY GUIDE 1.100
(Task EE 108-5)

SEISMIC QUALIFICATION OF ELECTRIC AND MECHANICAL EQUIPMENT FOR NUCLEAR POWER PLANTS

A. INTRODUCTION

The Commission's regulations in 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," require that certain structures, systems, and components in a nuclear power plant be designed to withstand the effects of natural phenomena such as earthquakes and that design control measures such as testing be used to check the adequacy of design. This general requirement is contained in Appendix A, "General Design Criteria for Nuclear Power Plants," to Part 50; in Criterion III, "Design Control," and Criterion XVII, "Quality Assurance Records," of Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to Part 50, and in Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants," to Part 100, "Reactor Site Criteria."

In Appendix A to 10 CFR Part 100, Section VI, "Application to Engineering Design," requires that the nuclear power plant be designed so that, if the safe shutdown earthquake occurs, certain structures, systems, and components will remain functional. These safety-related structures, systems, and components are those necessary to ensure (1) the integrity of the reactor coolant pressure boundary, (2) the capability to shut down the reactor and maintain it in a safe condition, or (3) the capability to prevent or mitigate the consequences of accidents that could result in offsite exposures comparable to the Part 100 guidelines. In Appendix A to Part 100, Section VI(a)(2) requires that structures, systems, and components of the nuclear power plant necessary for continued operation without undue risk to the health and safety of the public be designed to remain functional and within applicable stress and deformation limits when subjected to the effects of the vibratory motion of an operating basis earthquake in combination with normal operating loads. The engineering method used to ensure that the required safety functions are maintained during and after the vibratory ground motion associated with the safe shutdown earthquake or the operating basis earthquake must involve the use of either a suitable dynamic analysis or a suitable qualification test to demonstrate that structures, systems, and components can withstand the seismic and other concurrent loads.

This regulatory guide describes a method acceptable to the NRC staff for complying with NRC's regulations with respect to seismic qualification of electric and mechanical equipment.

The Advisory Committee on Reactor Safeguards has been consulted concerning this guide and has concurred in the regulatory position.

Any information collection activities mentioned in this regulatory guide are contained as requirements in 10 CFR Parts 50 or 100, which provide the regulatory basis for this guide. The information collection requirements in 10 CFR Parts 50 and 100 have been cleared under OMB Clearance Nos. 3150-0011 and 3150-0093, respectively.

B. DISCUSSION

IEEE Std 344-1987, "Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations,"* was prepared by Working Group 2.5 (Seismic Qualification) of Subcommittee 2 (Equipment Qualification) of the Institute of Electrical

*Copies may be obtained from the Institute of Electrical and Electronics Engineers, IEEE Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855.

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and Electronics Engineers (IEEE) Nuclear Power Engineering Committee, and was subsequently approved by the IEEE Standards Board on June 11, 1987.

The IEEE standard includes principles, procedures, and methods of seismic qualification that, when satisfied, will confirm the adequacy of the equipment design for the performance of safety functions before, during, and after the time the safety-related equipment is subjected to high stresses resulting from design basis events. For this guide, the design basis events are the loadings imposed by seismic events: the operating basis earthquake (OBE) and the safe shutdown earthquake (SSE). It is also necessary to combine other dynamic or vibratory loads as part of seismic qualification. It is recognized that hydrodynamic loads have their primary energy content in a frequency range greater than that of seismic vibrations; however, they are a part of the inplant equipment aging process, along with other nonseismic vibration loads, and therefore should be considered in seismic testing.

Revision 1 of this guide was issued in August 1977. Since then, several new technical issues have arisen, such as treatment of hydrodynamic loads, the limits of generic testing, the treatment of rattling, methods of qualifying line-mounted devices, and the use of actual seismic experience data bases to qualify identical or similar equipment. These issues are covered by IEEE Std 344-1987, which reflects the state-of-the-art technology. Further, the NRC has extended the application of this standard to the qualification of mechanical equipment on an interim basis. In extending the application of IEEE Std 344-1987 to mechanical equipment, the NRC staff recognizes that there are differences in qualification methods for electric and mechanical equipment. Specifically, qualification of mechanical equipment by analysis is permitted when such equipment can be modeled to adequately predict its response. The American Society of Mechanical Engineers is currently developing a standard for seismic qualification of mechanical equipment. Upon publication of this standard, the NRC staff will review it for suitability for endorsement by a revision to this regulatory guide.

This regulatory guide covers two categories of equipment: (1) safety-related electric (Class 1E) equipment and safety-related mechanical equipment, and (2) nonsafety-related equipment whose failure can prevent the satisfactory accomplishment of safety functions. Examples of mechanical equipment within the scope of this guide are valves, valve operators, pumps, compressors, chillers, air handlers, fans, blowers, fuel rod assemblies, and control rod drive mechanisms.

IEEE Std 344-1987 recognizes the use of justified experience data as a method for seismic qualification. This method of qualification will be evaluated by the NRC staff on a case-by-case basis.

IEEE Std 344-1987 references other standards that contain valuable information. Those referenced standards not endorsed by a regulatory guide or incorporated into the regulations, if used, are to be used in a manner consistent with current regulations.

C. REGULATORY POSITION

The procedures described by IEEE Std 344-1987, "Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," are acceptable to the NRC staff for satisfying the Commission's regulations pertaining to seismic qualification of electric and mechanical equipment subject to the following.

For mechanical equipment, thermal distortion effects on operability should be considered, and loads imposed by the attached piping should also be accounted for.

If dynamic testing of a pump or a valve assembly is impracticable, static testing of the assembly is acceptable provided that (1) the end loadings are applied and are equal to or greater than postulated event loads, (2) all dynamic amplification effects are accounted for, (3) the component is in the operating mode during and after the application of loads, and (4) an adequate analysis is made to show the validity of the static application of loads.

D. IMPLEMENTATION

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

Except in those cases in which the applicant or licensee proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the methods described herein will be used in the evaluation of seismic qualification of electric and mechanical equipment for the following nuclear power plants.

1. Plants for which the construction permit is issued after June 30, 1988.
2. Plants for which the operating license application is docketed after December 30, 1988.
3. Plants for which the applicant or licensee voluntarily commits to the provisions of this guide.

VALUE/IMPACT STATEMENT

BACKGROUND

IEEE Std 344-1975, "Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," was approved by the IEEE in January 1975. In August 1977, the NRC staff issued Revision 1 to Regulatory Guide 1.100, which endorsed IEEE Std 344-1975, subject to four exceptions. Since then the staff has worked with the IEEE in developing IEEE Std 344-1987. As a result of these efforts, the exceptions to IEEE Std 344-1975 have been satisfactorily resolved.

IEEE Std 344-1987 also addresses several recent technical issues, for example, treatment of hydrodynamic loads, the limits of generic testing, the treatment of rattling, methods of qualifying line-mounted devices, and the use of actual seismic experience data bases to qualify identical or similar equipment. IEEE Std 344-1987 thus reflects the state-of-the-art technology.

Issuance of Revision 2 is consistent with the NRC policy of evaluating the latest versions of national standards in terms of their suitability for endorsement by regulatory guides.

SUBSTANTIVE CHANGES

IEEE Std 344-1987 applies to seismic and dynamic qualification of Class 1E (safety-related electric) equipment. The nuclear industry has used this standard for seismic qualification of mechanical equipment as well. The NRC staff recognizes this fact and intends to extend the application of this standard to seismic qualification of mechanical equipment by this regulatory guide. Specifically, this regulatory guide covers two categories of equipment. (1) safety-related electric (Class 1E) equipment and safety-related mechanical equipment, and (2) non-safety-related equipment whose failure can prevent the satisfactory accomplishment of safety functions. The regulatory position provides guidance for qualification of mechanical equipment that is consistent with current NRC practice.

Regulatory Positions C.1 to C.4 in Revision 1 are not included in Revision 2 because they have been incorporated in IEEE Std 344-1987 as follows:

Regulatory Position in Rev. 1 of this Guide	IEEE Std 344-1987 Section Number
C.1	6.3
C.2	7.6.2.1
C.3	7.6.2.5
C.4	10.3.2(6)

VALUE

This guide endorses the latest version of a national standard and reflects the current state-of-the-art technology. The guide should also enhance the licensing process.

IMPACT

Although the scope of this revision has been extended to include seismic qualification of mechanical equipment, the requirements are consistent with NRC current licensing practice. Thus, this regulatory guide does not impose any new requirements or costs on licensees or applicants.

NUCLEAR REGULATORY COMMISSION

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In the matter of _____

Staff _____	IDENTIFIED ✓
Applicant ✓	RECEIVED ✓
Intervenor _____	REJECTED _____
Other _____	WITHDRAWN _____
DATE 06-03-02	Witness Khan
Clerk Suzette Snider	