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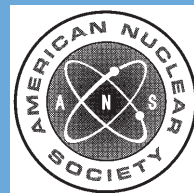
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**American National Standard
for Nuclear Plant Response
to an Earthquake**

Secretariat
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Working Group ANS-2.23**

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American National Standard

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Foreword

(This Foreword is not part of American National Standard Nuclear Plant Response to an Earthquake, ANSI/ANS-2.23-2002.)

This standard describes actions a utility should take following an earthquake felt at a nuclear power plant site to determine the need to shut down and, if shutdown is required, actions to determine the plant's readiness to restart based on exceedance of the Operating Basis Earthquake (OBE) ground motion or damage found during post-earthquake inspections. The utility makes the decision to shut down the nuclear power plant. In some cases shutdown is part of the licensing basis (e.g., condition of license, FSAR commitment, or Technical Specification). The criteria which define OBE exceedance are given in American National Standard Criteria for the Handling and Initial Evaluation of Records from Nuclear Power Plant Seismic Instrumentation, ANSI/ANS-2.10-2003. Requirements for seismic instrumentation are given in American National Standard Earthquake Instrumentation Criteria for Nuclear Power Plants, ANSI/ANS-2.2-2002.

This standard addresses the required sequences of response to an earthquake. It defines immediate actions, as well as post-shutdown and long-term actions. The findings at each stage indicate the need for, and the level of, any additional effort. The standard specifies that plant personnel perform initial inspections, gather seismic recordings, and reach decisions on the need for plant shutdown and on plant readiness for shutdown. If the plant is shut down, the standard defines procedures for near-term actions by plant operators to determine the earthquake effects, with engineers performing focused inspections and tests to determine if structures have sustained significant damage or if operating systems are in any way impaired. The standard then defines actions necessary to establish the readiness of the plant to restart. Finally, the standard provides for long-term, confirmatory evaluations which, in most cases, can be performed after plant restart.

Specifically, the standard specifies actions in four main areas:

Pre-Earthquake Preparatory Actions. These actions include preparation of plant procedures, selection of equipment to be examined following an earthquake, and base-line inspection of this equipment.

Post-Earthquake Short-Term Actions. These actions determine the physical condition of the plant immediately following an earthquake and assess the severity of the earthquake effects on the plant in order to determine whether shutdown is warranted.

Post-Shutdown Inspections and Tests. These actions examine the detailed condition of the nuclear power plant and its readiness to resume operation after it has been shut down. These inspections and tests are designed to provide a graded response commensurate with the type and severity of any damage found.

Long-Term Evaluations. These evaluations assess the potential for hidden damage that might have occurred to safety-related equipment and structures. Except for earthquakes which cause significant damage, long-term evaluations can be performed after plant restart.

The combination of the preparatory, short-term, post-shutdown, and long-term actions provides a rational approach for determining the real damage potential of a felt earthquake, a systematic methodology for assessing plant readiness for restart, and realistic criteria for ensuring the long-term integrity of the plant.

The technical basis for this standard is EPRI report NP-6695, "Guidelines for Nuclear Plant Response to an Earthquake," which serves as the commentary for this standard.

Many of the requirements involving the degree of damage and necessary levels of inspection are based on experience gained from investigations of the performance of equipment and structures at power and industrial facilities which have undergone actual earthquakes. The Electric Power Research Institute, United States Department of Energy, and the Earthquake Engineering Research Institute are among the organizations which have published reports on these investigations.

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Nuclear Plant Response to an Earthquake

1. Scope

This standard specifies actions that the owner of a nuclear power plant should take in the event of an earthquake. The requirements of this standard supplement those given in American National Standard Criteria for the Handling and Initial Evaluation of Records from Nuclear Power Plant Seismic Instrumentation, ANSI/ANS-2.10-2003 [1].¹ The application of these standards provides a complete evaluation of the need for post-earthquake plant shutdown in a timely manner. This standard also provides guidelines that will enable the owner to develop plant-specific procedures for determining the condition of components, systems, and structures needed for shutdown and criteria for restart when a nuclear power plant is required to shut down following an earthquake.

This standard does not cover those operator actions performed in connection with the operation and control of the nuclear power plant following an earthquake. These actions are specified in plant operating procedures, emergency operating procedures, and alarm response procedures.

2. Purpose

The purpose of this standard is to describe actions to be taken in preparation for, and following, a felt earthquake at a nuclear power plant. This standard will assist nuclear plant personnel in the preparation of detailed plant-specific earthquake response procedures. The earthquake response procedures will help determine and document:

- The effects of an earthquake on the physical condition of the nuclear power plant;
- If shutdown of the plant is warranted, based on ground motion recordings and observed damage to the plant;

- The readiness of the plant to shut down, if shutdown is required due to an earthquake; and
- The readiness of the plant to resume operation following shutdown due to an earthquake.

3. Definitions

cumulative absolute velocity (CAV). The time integral of absolute acceleration over the duration of the strong shaking. This quantity has been shown to be a good indicator of the damage potential of an earthquake time history and is defined in ANSI/ANS-2.10-2003 [1].

felt earthquake. An earthquake of sufficient intensity such that: (a) the vibratory ground motion is felt at the nuclear plant site and recognized as an earthquake based on a consensus of the control room operators on duty at the time, and (b) for plants with operable seismic instrumentation, the seismic triggers installed at the plant are activated.

functional damage. Significant damage to plant systems, components, and structures, either physical or other, which impairs the operability or reliability of the damaged item to perform its intended function. Minor damage such as slight or hairline cracking of concrete elements in structures does not necessarily constitute functional damage.

limiting conditions for operation. Those conditions which must be satisfied during specific modes of operation of the nuclear power plant. Limiting conditions for operation are defined in Title 10, Code of Federal Regulations, Part 50, Section 50.36(c)(2), Limiting Conditions of Operation [2], as the “lowest functional capability or performance levels of equipment required for safe operation of the facility.” They are listed individually in the plant technical specifications and provide the basis for operation of the plant within the conditions of the operating license.

¹Numbers in brackets refer to corresponding numbers in Section 9, References.