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Nuclear Power Plant Response to an Earthquake

An American National Standard

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American Nuclear Society
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American National Standard
Nuclear Power Plant Response to an Earthquake

Secretariat
American Nuclear Society

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American National Standard

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Foreword

(This foreword is not a part of American National Standard "Nuclear Power Plant Response to an Earthquake," ANSI/ANS- 2.23-2016.)

This standard describes actions a utility should take preceding and immediately following an earthquake felt at a nuclear power plant site to determine the need to shut the plant down and, if shutdown is required, actions to determine the power plant's readiness to restart. The plant operator makes the decision to shut down the nuclear power plant based on U.S. Nuclear Regulatory Commission (NRC) regulations that require shutdown in the event that the plant's design operating basis earthquake (OBE) is exceeded or damage is found during post-earthquake inspections. In some cases shutdown requirements are part of the plant's licensing basis (e.g., condition of license, final safety analysis report commitment, or technical specifications). An industry/NRC consensus criterion that defines OBE exceedance is presented in Electric Power Research Institute (EPRI) report NP-6695, "Guidelines for Nuclear Plant Response to an Earthquake" (1990); ANSI/ANS-2.10-2003 (withdrawn), "Criteria for the Handling and Initial Evaluation of Records from Nuclear Power Plant Seismic Instrumentation"; and NRC Regulatory Guide 1.166, "Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Post-earthquake Actions," issued in 1997. It should be noted that Sec. 4, "Overview of Nuclear Power Plant Response Actions," in this standard does not specify any requirements or recommendations. Requirements referred to are those that are mandated by long-standing NRC regulations such as the requirement that nuclear power plants have installed seismic instrumentation and that they shut down any time a felt earthquake exceeds the plant's OBE. It is only a summary listing of the topics and actions covered in the standard. The sections that specify requirements and recommendations of the standard are Secs. 5 through 9. These sections have been carefully written to implement the use of the American Nuclear Society (ANS) policy to use "shall" and "should" for requirements and recommendations, respectively. Clarifications of this criterion and conditions applicable to its implementation are included in this update of ANSI/ANS-2.23-2002 (R2009).

The standard addresses the required sequences of response to an earthquake. It defines pre-earthquake actions, immediate actions, post-shutdown actions, and long-term actions. The findings at each post-earthquake 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 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 that, in most cases, can be performed after plant restart.

Specifically, the standard specifies actions in five main areas:

(1) pre-earthquake preparatory actions;
(2) post-earthquake short-term actions;
(3) determination of the earthquake damage level, earthquake level, and recommended action level;
(4) post-shutdown inspections and tests;
(5) long-term evaluations.

In the years following the issuance of ANSI/ANS-2.23-2002 (R2009), a significant amount of experience has been gained on the effects of earthquakes on nuclear power

plants worldwide, in particular, during events affecting plants in high-seismic-hazard areas such as Japan. International Atomic Energy Agency (IAEA) Safety Reports Series No. 66, "Earthquake Preparedness and Response for Nuclear Power Plants" (2011), documented lessons learned from all significant earthquake ground motions affecting nuclear power plants pre-2010. Of interest are three multiunit nuclear power plants in Japan that experienced beyond-design-basis earthquakes over the past several years and one domestic plant (Dominion Energy's North Anna plant in Virginia) that recorded an earthquake with measured ground motion accelerations that exceeded its design safe shutdown earthquake level. None of these plants had comprehensive earthquake response procedures; none had implemented pre-earthquake preparations for a beyond-design-basis earthquake; and none had visible damage to safety-related structures, systems, or components. Nevertheless, many months (in some cases more than a year) and thousands of man-hours of plant inspections and evaluations were spent justifying restart of the plants. A comprehensive earthquake response plan such as the one described herein could have significantly focused and reduced these efforts.

Based on these events and the lessons learned in establishing the effects of the earthquakes on the plants and the actions ultimately undertaken to establish the readiness of the plants to restart, a significant update of EPRI report NP-6695 [the technical basis for ANSI/ANS-2.23-2002 (R2009)] was prepared and published in 2013 as EPRI report 3002000720, "Guidelines for Nuclear Plant Response to an Earthquake." This revised ANSI/ANS-2.23 standard incorporates the significant changes and additions included in EPRI report 3002000720, which serves as the commentary for this standard. It is also consistent with IAEA Safety Reports Series No. 66. Applicability of the aforementioned documents is specifically limited to nuclear power reactor–type plants.

This standard might reference documents and other standards that have been superseded or withdrawn at the time the standard is applied. A statement has been included in the references section that provides guidance on the use of references.

This standard does not incorporate the concepts of generating risk-informed insights, performance-based requirements, or a graded approach to quality assurance. The user is advised that one or more of these techniques could enhance the application of this standard.

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Contents