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American Nuclear Society

categorization of nuclear facility structures, systems, and components for seismic design

an American National Standard

REAFFIRMED

September 12, 2017
ANSI/ANS-2.26-2004 (R2017)
May 27, 2010
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This standard has been reviewed and reaffirmed by the ANS Nuclear Facilities Standards Committee (NFSC) with the recognition that it may reference other standards and documents that may have been superceded or withdrawn. The requirements of this document will be met by using the version of the standards and documents referenced herein. It is the responsibility of the user to review each of the references and to determine whether the use of the original references or more recent versions is appropriate for the facility. Variations from the standards and documents referenced in this standard should be evaluated and documented. This standard does not necessarily reflect recent industry initiatives for risk informed decision-making or a graded approach to quality assurance. Users should consider the use of these industry initiatives in the application of this standard.

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American National Standard Categorization of Nuclear Facility Structures, Systems, and Components for Seismic Design

Secretariat
American Nuclear Society

Prepared by the
American Nuclear Society
Standards Committee
Working Group ANS-2.26

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Approved December 2, 2004
by the
American National Standards Institute, Inc.

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American National Standard

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Comments on this standard are encouraged and should be sent to Society Headquarters.

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Foreword

(This foreword is not part of American National Standard Categorization of Nuclear Facility Structures, Systems, and Components for Seismic Design, ANSI/ANS-2.26-2004.)

This standard has been developed based on methods used by the U.S. Department of Energy (DOE) for performance categorizing and designing structures, systems, and components (SSCs) in nuclear facilities to withstand the effects of natural phenomena (DOE-STD-1021-93, "Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components," July 1993, Reaffirmed 2002; DOE-STD-1020-2002, "Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities," January 2002; DOE-STD-1022-94, "Natural Phenomena Hazards Site Characterization Criteria," March 1994, Reaffirmed 2002; DOE-STD-1023-95, "Natural Phenomena Hazards Assessment Criteria," March 1995, Reaffirmed 2002).

This standard provides criteria and guidance for selecting a seismic design category (SDC) and Limit State for the SSCs with a safety function in a nuclear facility, other than commercial power reactors, whose seismic design requirements are established by other standards and regulations. The SDC and Limit State are to be used in conjunction with standards ANS-2.27, "Criteria for Investigations of Nuclear Materials Facilities Sites for Seismic Hazard Assessments"; ANS-2.29, "Probabilistic Seismic Hazard Analysis"; and ANSI/ASCE/SEI 43-05, "Seismic Design Criteria for Structures, Systems and Components in Nuclear Facilities." These standards together establish the design response spectra and the design and construction practices to be applied to the SSCs in the facility, dependent on which SDC and Limit State are assigned to the SSC. The objective is to achieve a risk-informed design that protects the public, the environment, and workers from potential consequences of earthquakes. Application of this group of standards will produce (a) the design response spectra, (b) the SSC Limit State necessary to achieve adequate safety performance during and following earthquakes, and (c) SSC designs that achieve the desired Limit State. Referenced standards and their procedural relationship to this standard are discussed in Appendix A of this standard.

Working Group ANS-2.26 of the Standards Committee of the American Nuclear Society had the following membership at the time of approval of this standard and indeed was stable throughout the development of the standard:

N. W. Brown (Chairman), *Lawrence Livermore National Laboratory*

S. Additon, *Rocky Flats Environmental Technology Site*
H. Chander, *U.S. Department of Energy*
D. Guzy, *U.S. Department of Energy*
A. Hadjian, *Defense Nuclear Facilities Safety Board*
Q. Hossain, *Lawrence Livermore National Laboratory*
C. Morrell, *Shaw Group, Inc.*
A. Persinko, *U.S. Nuclear Regulatory Commission*
H. C. Shaffer, *Consultant*
J. D. Stevenson, *Consultant*
C. M. Vaughan, *Global Nuclear Fuel*

This standard was prepared under the guidance of Subcommittee 21, Design Criteria/Operations, of the American Nuclear Society. At the time of the ballot, Subcommittee 21 was composed of the following members:

R. M. Ruby (Chairman), *Constellation Energy*
C. H. Moseley (Vice Chairman), *BWXT Y-12*
T. Dennis (Secretary), *Individual*

N. Brown, *Lawrence Livermore National Laboratory*
C. Eldridge, *Pacific Gas & Electric Company*
S. Floyd, *Nuclear Energy Institute*

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J. Glover, *Graftel, Inc.*
M. P. Horrell, *Washington Group, Inc.*
R. P. Kassawara, *Electric Power Research Institute*
L. Krieder, *Engineering Planning & Management, Inc.*
R. Morris, *Tennessee Valley Authority*
D. Ostrom, *Individual*
W. J. Rudolph, *FirstEnergy Corporation*
J. D. Stevenson, *Individual*
M. Wilson, *Millstone Nuclear Generating Station*

This standard was processed and approved for submittal to ANSI by the Nuclear Facilities Standards Committee (NSFC) of the American Nuclear Society on ANSI/ANS-2.26, "Categorization of Nuclear Facility Structures, Systems, and Components for Seismic Design." Committee approval of this standard does not necessarily imply that all members voted for approval. At the time it approved this standard, the NFSC had the following membership:

D. J. Spellman (Chairman), *Oak Ridge National Laboratory*
R. M. Ruby (Vice Chairman), *Constellation Energy*

C. K. Brown, *Southern Nuclear Operating Company*
R. H. Bryan, *Tennessee Valley Authority*
H. Chander, *U.S. Department of Energy*
M. T. Cross, *Westinghouse Electric Corporation*
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Contents

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Categorization of Nuclear Facility Structures, Systems, and Components for Seismic Design

1 Scope

This standard provides (a) criteria for selecting the seismic design category[1)] (SDC) for nuclear facility structures, systems, and components (SSCs) to achieve earthquake safety and (b) criteria and guidelines for selecting Limit States for these SSCs to govern their seismic design. The Limit States are selected to ensure the desired safety performance in an earthquake.

2 Definitions

common-cause failure: Multiple failures of SSCs as the result of a single phenomenon.

engineered mitigating feature: An SSC that is relied upon during and following an accident to mitigate the consequences of releases of energy, radioactive or toxic material.

failure consequence: A measure of the radiological and toxicological consequences of exposure to the public, the environment, and workers that may result from failure of an SSC by itself or in combination with other SSCs.

graded approach: The process of assuring that the level of analysis, documentation, and actions used to comply with requirements in this standard are commensurate with (a) the relative importance to safety, safeguards, and security; (b) the magnitude of any hazard involved; (c) the life cycle stage of the facility; (d) the programmatic mission of a facility; (e) the particular characteristics of the facility; (f) the relative importance of the radiological and nonradiological hazards; and (g) any other relevant factor.

Limit State: The limiting acceptable deformation, displacement, or stress that an SSC may experience during or following an earthquake and still perform its safety function. Four Limit States are identified and used by this standard and ANSI/ASCE/SEI 43-05 [1].[2)]

seismic design category (SDC): One of five categories used in this standard and the accompanying three standards identified in Appendix A that are used to establish seismic hazards evaluations and SSC seismic design requirements.

target performance goal: Target annual frequency of an SSC exceeding its specified Limit State. Target performance goals of 1×10^{-4}/year, 4×10^{-5}/year, and 1×10^{-5}/year are used in ANSI/ASCE/SEI 43-05. The importance of target performance goals in this standard is discussed in Appendix A.

total effective dose equivalent: The sum of the deep-dose equivalent (for external exposure) and the committed effective dose equivalent (for the internal exposure).

unmitigated consequences: The product of a specific type of consequence analysis used for the selection of the SDC for an SSC. Unmitigated consequence analysis is described in 6.2.

3 Applicability

This standard is applicable to the design of SSCs of nuclear facilities. For the purpose of this standard, a nuclear facility is a facility that stores, processes, tests, or fabricates radioactive materials in such form and quantity that a nuclear risk to the workers, to the offsite public, or to the environment may exist. These include but are not limited to nuclear fuel manufacturing facilities; nuclear material waste-processing, storage, fabrication, and reprocessing facilities; uranium enrichment facil-

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[1)] The SDCs used in this standard are not the same as the SDCs referred to in the International Building Code (IBC).

[2)] Numbers in brackets refer to corresponding numbers in Section 7, “References.”