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Earthquake Instrumentation
Criteria for Nuclear Power Plants

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Foreword

(This Foreword is not a part of American National Standard "Earthquake Instrumentation Criteria for Nuclear Power Plants," ANSI/ANS-2.2-2002.)

The purpose of this standard is to specify for water-cooled nuclear power plants the minimum requirements for earthquake instrumentation. Should an earthquake occur, the instrumentation provides information on the vibratory ground motion and resultant vibratory responses of representative Category I structures [defined in U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.29, "Seismic Design Classification"] so that an evaluation can be made as to

(1) whether or not the design response spectra have been exceeded;

(2) whether or not the motion was damaging through determination of its Cumulative Absolute Velocity (CAV) as defined in American National Standard "Criteria for the Handling and Initial Evaluation of Records from Nuclear Power Plant Seismic Instrumentation," ANSI/ANS-2.10-2003;

(3) whether or not the calculated vibratory responses used in the design of the representative Category I structures and equipment have been exceeded at instrumented locations;

(4) the degree of applicability of the mathematical models used in the seismic analysis of the building and equipment.

In addition, instrumentation could be provided to furnish specific information that would increase knowledge and understanding of seismic design. The problem of determining what additional instrumentation is needed to perform this function should be the basis of research and development programs and is not addressed in this standard.

The seismic design of nuclear power facilities requires, in part,

(1) the determination of an input vibratory grounded motion for the site. Input vibratory ground motion could be described by "response spectra," or time-history earthquake records. Most nuclear plant owners have specified their design input vibratory ground motion by response spectra in the form of "design response spectra" in their license application to the NRC;

(2) the construction of mathematical models for dynamic analysis from which the vibratory response of structures and equipment to the input vibratory ground motion can be calculated.

Seismic designs for nuclear power plants utilize advanced analytical and design techniques. Therefore, evidence that the earthquake response spectra did not exceed appropriate spectrum values or that the CAV showed that the motion was not damaging, in accordance with ANSI/ANS-2.10-2003, would give reasonable assurance that plant structures and equipment were not damaged or made inoperable. In addition, the determination by actual instrument data of the resultant vibratory responses of representative structures and equipment and the check of the applicability of mathematical models used in the dynamic analysis would give further assurance that plant structures or equipment was not damaged.

When an earthquake occurs, it is important to determine as soon as possible (within 4 hours) whether or not the free-field motion exceeded predetermined conditions in accordance with ANSI/ANS-2.10-2003. An ideal instrumentation system would immediately provide usable data in a convenient form for making this determination. Through the use of commercially available instruments, the necessary functions of this ideal instrumentation system can be provided. The

providing of these functions is the basis for the minimum requirements specified in this standard.

The basic and most important instrument for measuring vibratory motion is the time-history accelerograph, which measures and records absolute acceleration as a function of time during an earthquake. This may be a self-contained instrument, or it may consist of acceleration sensors, which detect absolute acceleration and transmit the data to a remote central recorder. From the resulting time-history records, the peak accelerations and duration can be determined, and the response spectra and CAV can be derived by computation.

This standard was prepared by Working Group ANS-2.2 of the American Nuclear Society Standards Committee. This is a major revision to the ANSI/ANS-2.2-1988 standard. All comments received were reviewed and, where possible, were incorporated. Working Group ANS-2.2 had the following membership during its work on this standard:

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Contents

Earthquake Instrumentation Criteria for Nuclear Power Plants

1 Scope

This standard specifies the required earthquake instrumentation for the site and structures of light-water-cooled, land-based nuclear power plants. It may be used for guidance at other types of nuclear facilities. This standard does not address the following:

(1) instrumentation to shut down a nuclear power plant automatically at a predetermined ground acceleration;

(2) procedures for evaluating records obtained from seismic instrumentation and instructions for the treatment of data. These procedures and instructions are specified 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)].

2 Purpose

This standard defines the minimum requirements for an earthquake instrumentation system to be installed at nuclear power plants. These instruments are intended to provide timely (within 4 hours) information on the input vibratory motion of Category I structures, in the event of an earthquake. By comparing this information with the vibratory motions used in the facility's seismic design, an evaluation can be made as to whether or not the design vibratory motions have been exceeded.

3 Definitions

acceleration sensor: An instrument capable of sensing absolute acceleration and producing a signal that can be transmitted to a recorder.

accessible instruments: Instruments or sensors whose locations permit ready access during plant operation without violation of applicable safety regulations, such as those of the Occupational Safety and Health Administration, or regulations that address plant security or radiation protection safety.

category I structure: Guidance for determining the category of a structure, given in U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.29, "Seismic Design Classification" [2].

channel calibration (primary calibration): The determination and, if required, adjustment of an instrument, sensor, or system such that it responds within a specified range to an acceleration, velocity, or displacement input, as applicable, or responds as intended to the stimulus provided by a known constant input.

channel check: The qualitative verification of the functional status of a channel of the time-history accelerograph (T/A). This check is an "in situ" test and may be the same as a channel functional test.

channel functional test (secondary calibration): The determination, without adjustment, that an instrument, sensor, or system responds to a known input of such character that it will verify that the instrument, sensor, or system is functioning in a manner that can be calibrated.

containment foundation: The foundation of the containment or reactor building including adjacent foundations if they are constructed integrally with the containment foundation.

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.

free-field: A ground surface location for an earthquake sensor where the motion will be only of the ground surface and where the ef-

[1)] Numbers in brackets refer to corresponding numbers in Section 10, "References."