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American National Standard

earthquake instrumentation criteria for nuclear power plants

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American National Standard Earthquake Instrumentation Criteria For Nuclear Power Plants

Secretariat

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Foreword

(This Foreword is not a part of American National Standard Earthquake Instrumentation Criteria for Nuclear Power Plants, N18.5-1974)

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 input vibratory ground motion and resultant vibratory responses of representative Category I (formerly seismic Class I) structures and equipment (defined in AEC Safety Guide 29) so that an evaluation can be made as to:

(1) Whether or not the input design response spectra have been exceeded,

(2) Whether or not the calculated resultant vibratory responses used in the design of the representative Category I structures and equipment have been exceeded, and

(3) The degree of applicability of the mathematical models used in the seismic analysis of the buildings and equipment.

In addition, instrumentation could be provided to furnish specific information which 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 ground motion for the site. Input vibratory ground motion could be described by "response spectra" (defined in ANS-2.1), 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" (defined in ANS-2.1) in their applications to the Atomic Energy Commission (AEC).

(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.

The determination of input vibratory ground motion and construction of mathematical models for dynamic analysis are complex. Therefore, the specified instruments to be installed are those which can measure the input vibratory ground motion at the site, and the resultant vibratory response of representative Category I structures and equipment, should an earthquake occur.

Seismic designs for nuclear power plants utilize advanced analytical and design techniques. Therefore, evidence that the earthquake response spectra did not exceed the design response spectra would give reasonable assurance that plant structures and equipment were not damaged. 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 additional assurance that plant structures or equipment were not damaged.

When an earthquake occurs, it is important to determine as soon as possible whether or not seismic design conditions were exceeded. An ideal instrumentation system would immediately provide in usable and convenient form (for example, permanent visual record, remote indication) the information for making this determination. Using 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" (T/A), 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 can be determined, and the response spectra can be derived by computation.

A "peak accelerograph" (P/A) is a passive instrument requiring no power that can detect and record peak acceleration. Such a passive instrument can provide needed information after an earthquake, in the event a powered instrument fails to operate.

A "seismic switch" (S/S) can provide an immediate signal to remotely indicate if a specified acceleration has been exceeded. It consists of an acceleration sensor and a switch closure. Such an instrument can provide the basis for immediate administrative procedures or decisions following an earthquake.

Instruments which can perform other functions than those described above are available and could supply supplementary information, if desired. Examples are:

(1) The "seismoscope," a passive instrument which models the response of an average structure of natural period of about 0.75 second and 10% damping.

(2) The "response spectrum recorder," a passive instrument which records the information defining points on a response spectrum.

In summary, the following instrument functions can be provided:

(1) Recording of the time history of vibratory motion;
(2) Remote immediate indication that a specified acceleration has been exceeded;
(3) Recording of peak acceleration by a non-powered, passive instrument;
(4) Recording of a point or points on a response spectrum.

Instrument locations should be related to the locations of the "input" and "output" vibratory motions used in the seismic design. Typical general locations are:

(1) Input vibratory ground motion
  (a) "Free field"
  (b) Containment foundation
(2) Output vibratory response motion
  (a) Containment structure or reactor building
  (b) Reactor equipment
  (c) Reactor piping
  (d) Other Category I structures, equipment and piping.

Specific locations should be selected by the nuclear plant designer to obtain the most pertinent information.

This standard was prepared by Working Group ANS-2.2 of Subcommittee ANS-2, Site Evaluation, of the American Nuclear Society Standards Committee.

The first draft was submitted to the ANS-2 Subcommittee for review on July 7, 1969. Subsequently, a Working Group was formed and held its first meeting on February 5, 1970. After several Working Group meetings, a draft dated January 21, 1971 was prepared and widely distributed to industry for review and comment. On April 9, 1971 the AEC issued Safety Guide 12, Instrumentation for Earthquakes. The Working Group reviewed the comments received from industry and the recommendations in the AEC Guide. This resulted in the November 1971 draft which was published by ANS and submitted to the ANSI Board of Standards Review and the American National Standards Committee N-18, Reactor Design Criteria, for comment. In November 1971, the AEC proposed Seismic and Geologic Criteria for Nuclear Power Plants as Appendix A to 10-CRF-100, Reactor Site Criteria. Based on extensive comments received from N-18, a new draft, dated February 7, 1973 was prepared by the Working Group and was sent to N-18 for further review and comment. No negative comments on this draft were received. The current draft, dated September 24, 1973 incorporates all N-18 comments received prior to August 24, 1973.

The American National Standards Committee N18, Nuclear Design Criteria, which reviewed and approved this standard in 1973, had the following membership:

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	J. F. West
	C. B. Zitek

At the time of approval of the standard, the membership of Subcommittee ANS-2, Site Evaluation, was:

R.V.Bettinger, *Chairman, Pacific Gas and Electric Co.*
L.E.Escalante, *Department of Water and Power*
J.A.Fischer, *Dames and Moore*
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J.M.Smith, Jr., *General Electric Co.*
J.D.Stevenson, *Westinghouse Electric Co.*
N.R.Wallace, *Bechtel Corporation*

This standard was prepared by Working Group ANS-2.2, Earthquake Instrumentation Criteria for Nuclear Power Plants. At the time of approval, the membership of the Group was:

E.J.Keith, *Chairman, EDS Nuclear, Inc.*
P.Engdahl, *Engdahl Enterprises*
H.T.Halverson, *Kinemetrics, Inc.*
P.S.Klasky, *Teledyne Geotech*
C.W.Lin, *Westinghouse Electric Corporation*
D.S.Mehta, *Bechtel Power Corporation*
D.K.Ostrom, *Southern California Edison Company*
S.Peters, *Pacific Gas and Electric Company*
C.B.Smith, *Consultant*

Special acknowledgement is given to Mr. M. Frankel of the Los Angeles Department of Water and Power who guided the activities of this Working Group as its chairman for a considerable period of time prior to resigning from the Working Group in July 1973. His efforts were instrumental in the development of this standard, and his services are greatly appreciated.

Comments on this standard should be addressed to:

Edward J. Keith, Chairman, ANS-2.2 Working Group
EDS Nuclear, Inc.
220 Montgomery Street, Room 598
San Francisco, California 94104

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