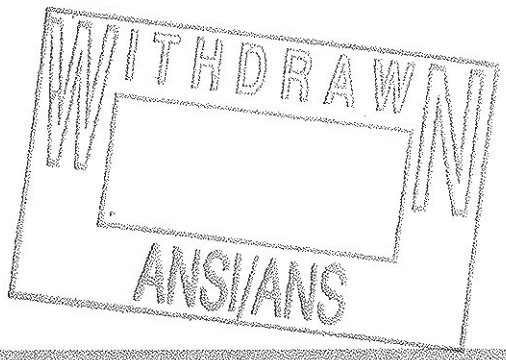
American Nuclear Society



earthquake instrumentation criteria for nuclear power plants

an American National Standard

No longer being maintained as an American National Standard. This standard may contain outdated material or may have been superseded by another standard. Please contact the ANS Standards Administrator for details.

published by the
American Nuclear Society
555 North Kensington Avenue
La Grange Park, Illinois 60525 USA

ANSI/ANS-2.2-1978

American National Standard Earthquake Instrumentation Criteria for Nuclear Power Plants

Secretariat
American Nuclear Society

Prepared by the
American Nuclear Society
Standards Committee
Working Group ANS-2.2

Published by the
American Nuclear Society
555 North Kensington Avenue
La Grange Park, Illinois 60525 USA

Approved September 5, 1978
by the
American National Standards Institute, Inc.

American National Standard

An American National Standard implies a consensus of those substantially concerned with its scope and provisions. An American National Standard is intended as a guide to aid the manufacturer, the consumer, and the general public. The existence of an American National Standard does not in any respect preclude anyone, whether he has approved the standard or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standard. American National Standards are subject to periodic review and users are cautioned to obtain the latest editions.

CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken to reaffirm, revise, or withdraw this Standard no later than five years from the date of publication. Purchasers of this Standard may receive current information, including interpretation, on all standards published by the American Nuclear Society by calling or writing to the Society.

Published by

American Nuclear Society
555 North Kensginton Avenue, La Grange Park, Illinois 60525 USA

Price: $20.00

Printed in the United States of America

Foreword

(This foreword is not a part of American National Standard Earthquake Instrumentation Criteria for Nuclear Power Plants, ANSI/ANS-2.2-1978; Revision 1 to 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 vibratory ground motion and resultant vibratory responses of representative Category I structures and equipment (defined in U.S. Nuclear Regulatory Commission, 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 calculated vibratory responses used in the design of the representative Category I structures and equipment have been exceeded at instrumented locations, 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," 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 application to the Nuclear Regulatory Commission (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 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.

An almost equally important instrument in measuring structural response is the response spectrum recorder (R/S), which measures and records spectral accelerations at specified frequencies during an earthquake. This may be a passive instrument, or an active instrument and may transmit data to a remote terminal.

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.

A response spectrum switch (R/SS) can provide an immediate signal to remotely indicate if a specified spectral acceleration has been exceeded. Such an instrument can provide the basis for immediate administrative procedures or decisions following an earthquake.

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.

In summary, the following instrumentation functions can be provided:

(1) Recording of the time-history of vibratory motion;

(2) Recording of a point or points on a response spectrum;

(3) Remote immediate indication that a specified acceleration has been exceeded;

(4) Remote immediate indication that specified spectral acceleration(s) has been exceeded

(5) Recording of peak acceleration by a non-powered, passive instrument.

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 (now the NRC) issued Safety Guide 12 (now Regulatory Guide 1.12, 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 N18, Nuclear Design Criteria, for comment. In November, 1971, the AEC proposed Seismic and Geologic Criteria for Nuclear Power Plants as Appendix A to Title 10, Code of Federal Regulations, Part 100, Reactor Site Criteria. Based on extensive comments received from N18, a new draft, dated February 7, 1973, was prepared by the working group and was sent to N18 for further review and comment. No negative comments on this draft were received. The working group incorporated most of the comments received prior to August 24 1973, and a draft, dated September 24, 1973, was submitted for final approval. The standard was finally approved and published on January 9, 1974. Upon issuance of Regulatory Guide, Revision 1, in April, 1974, and in attempts to resolve other comments which have been received on the standard, the working group started work on a revision to the standard. A draft of the revision dated September 1, 1976 was sent to the subcommittee for balloting and was ap-

proved with some comments. The comments received were reviewed and led to a draft of the revision dated January 24, 1977. Comments on this draft received from N18 have been reviewed and incorporated leading to the current draft of the revision dated February 27, 1978.

Working Group ANS-2.2 of the Standards Committee of the American Nuclear Society had the following membership:

A. K. Vaish, Chairman, *EDS Nuclear Inc.*
L. Benuska, *Kinemetrics, Incorporated*
P. M. Blanch, *Northeast Utilities Service Company*
M. M. B. Chan, *Brown & Root, Incorporated*
P. D. Engdahl, *Engdahl Enterprises*
L. E. Escalante, *Los Angeles Department of Water and Power*
D. Godfrey, *Duke Power Company*
K. G. Hazifotis, *General Electric Company*
P. Ibanez, *Applied Nucleonics Company, Incorporated*
P. S. Klasky, *Teledyne Geotech*
C. Lin, *Westinghouse Electric Corporation*
W. J. Lindblad, *Pacific Gas & Electric Company*
D. S. Mehta, *Bechtel Power Corporation*
D. K. Ostrom, *Southern California Edison Company*
H. Polk, *U.S. Nuclear Regulatory Commission*
R. Srinivasan, *Sargent & Lundy*
L. White, *Stone & Webster Engineering Corporation*

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

R. V. Bettinger, Chairman, *Pacific Gas & Electric Company*
A. Brearley, *Sargent & Lundy*
L. E. Escalante, *Los Angeles Department of Water and Power*
J. A. Fisher, *Dames and Moore*
M. I. Goldman, Sc.D.,*NUS Corporation*
W. W. Hays, *U.S. Geological Survey*
G. E. Heim, *Sargent & Lundy*
G. Hunt, *Southern California Edison Company*
D. H. Johns, *Southern California Edison Company*
U. Kappus, *Dames and Moore*
R. E. Keever, *Nuclear Technology Incorporated*
E. J. Keith, *EDS Nuclear Inc.*
C. R. McClure, *Bechtel Corporation*
S. Milioti, *American Electric Power Service Corporation*
G. W. Nicholas, *Dames and Moore*
R. Noble, *Dames and Moore*
T. Pickel, *Oak Ridge National Laboratory*
I. Craig Roberts, *U.S. Nuclear Regulatory Commission*
P. J. Ryan, *Bechtel Corporation*
J. M. Smith, *General Electric Company*
I. Spickler, *Dames and Moore*
J. D. Stevenson, *J. D. Stevenson Consultants, Div. of Arthur G. McKee & Company*
S. Tucker, *Florida Power and Light Company*
A. K. Vaish, *EDS Nuclear Inc.*
N. R. Wallace, *Bechtel Corporation*
K. Weidner, *Bechtel Power Corporation*

The American National Standards Committee N18 had the following membership at the time it reviewed and approved this standard:

L. J. Koch, Chairman
C. B. Zitek, Secretary

Organization Represented	*Name of Representatives*
American Chemical Society	C. E. Stevenson
	P. L. Roggenkamp (Alt)
American Concrete Institute	P. E. Mast
American Nuclear Society	L. J. Koch
American Society of Civil Engineers	M. I. Goldman
	C. Gogolick (Alt)
American Society of Mechanical Engineers	J. S. Bitel
	R. H. Holyoak (Alt)
American Public Health Assoiation, Inc.	J. R. Coleman
American Welding Society	J. R. McGuffey
Atomic Industrial Forum	G. G. Sherwood
Electric Light & Power Group	J. E. Howard
	J. E. Sohngen (Alt)
Federal Power Commission	A. P. Donnell
	B. P. Chew (Alt)
Health Physics Society	J. M. Smith, Jr.
	R. L. Clark (Alt)
Institute of Electrical & Electronics Engineers	R. G. Benham
	O. W. Bilharz, Jr. (Alt)
Institute of Nuclear Materials Management	J. Arendt
	L. A. Strom (Alt)
Nuclear Energy Liability & Property Insurance Association	F. Catudal
U.S. Energy Research & Development Admin.	F. X. Gavigan
U.S. Environmental Protection Agency	R. Sullivan
	G. Burley (Alt)
U.S. Nuclear Regulatory Commission	C. A. Arlotto
	M. Kehnemuyi (Alt)
Individual Members	E. N. Cramer
	R. J. Creagan
	J. F. Gibbons
	T. D. Jones
	T. J. Pashos
	D. Patterson
	A. H. Redding
	G. C. Robinson
	R. P. Schmitz
	G. L. Wessman
	J. F. West
	C. B. Zitek

Contents