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Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants

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Foreword

(This Foreword is not a part of American National Standards Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants, ANSI/ANS-51.1-1983(R1988).)

This standard is a complete revision and combination of N18.2-1973/ANS-51.1 and N18.2a-1975/ANS-51.8. It has been prepared by Subcommittee ANS-51, Pressurized Water Reactor Criteria, to incorporate additional requirements for the design of pressurized water reactor (PWR) nuclear power plants and to address three major areas:

1. **Safety Classes**

   The results of the ANS Nuclear Power Plant Standards Committee (NUPPSCO) Ad Hoc Committee and NUPPSCO Coordinating Working Group 3 on Equipment Classification are incorporated. These results define Safety Classes and specify requirements for all equipment and structures in a stationary nuclear power plant having a nuclear safety function. A methodology is given to classify all equipment into one of three Safety Classes according to its importance to nuclear safety and its capability for maintenance, surveillance testing, and inspection, or into a Non-Nuclear Safety Class. In addition, classification interface criteria are defined.

2. **Plant Conditions**

   The results of the NUPPSCO Coordinating Working Group 2 have been incorporated. The concept of Plant Conditions is developed that includes individual process conditions, combinations of process conditions, and the combinations of process conditions and external hazards that could result in simultaneous effects on plant equipment. Probability of occurrence is the unifying basis for the categorization of Plant Conditions.

3. **Design Requirements**

   This standard provides a set of design requirements for all Safety Classes and Non-Nuclear Safety Class in terms of industry codes and standards for each category of Plant Conditions. The design requirements reference specific standards and ensure substantial interrelationship with other codes and standards.

The content of this standard reflects an attempt to achieve the following objectives:

a. To establish a consistent set of requirements for light water reactor nuclear power plants;

b. To establish a disciplined, systematic method for defining nuclear safety requirements for nuclear power plants;

c. To establish and delineate the functional nuclear safety requirements for the design of nuclear power plants;

d. To be responsive to both the regulatory requirements of the Nuclear Regulatory Commission and the design and technical requirements of industry codes and standards;

e. To provide a framework for augmenting these criteria as additional standards are developed within the nuclear industry; and

f. To provide a uniform basis for design safety requirements which may be reflected in regulatory documents.

The existence of unique plant or site characteristics might require the consideration of alternate design concepts. This standard has been developed along functional lines to permit this flexibility. The standard has, however, cited many standards, some of which were still in draft form at the time this document was published. Provisions contained in any draft standard should be considered and used with great discretion. It is strongly suggested that the prospective user fully understand the present status of the referenced standard and major factors on why it might be still in draft form; for example, controversial issues should be recognized.

A number of considerations under development concurrent with the preparation of this standard are not addressed in this standard. Examples of these considerations include: human factors engineering (HFE), probabilistic risk assessment (PRA), systems interaction, diversity, plant security, emergency response facilities, degraded core, minimizing challenges to engineered safety features, safety goals and consideration of cost/benefit analysis, and anticipated transients without scram. Subsequent revisions of this standard will address these considerations as appropriate when they become adequately defined.

A designer is not restricted by this standard from proposing or using alternate criteria to ensure adequate nuclear safety. Frequently, a desirable overall result can be obtained by any of several design concepts. The designer may choose from several alternatives in satisfying the specifics of this standard by the proper consideration of the interrelationship of components and systems within the plant. For example, the PRA approach may be used as an alternative method to evaluate plant design; however, its usefulness is somewhat limited without safety goals that are currently under development.

Portions of this standard were prepared separately under ANS-50 Nuclear Power Plant Systems Engineering and were reviewed individually by ANS-51, ANS-50, and NUPPSCO which replaced ANS-50 during this time. The separate documents that have been incorporated into this standard include the Glossary (CWG-1), Conditions of Design (CWG-2), and Equipment Classification (Ad Hoc Committee on Equipment Classification). The structure of this standard is based on the standard format guide (CWG-4). This standard was approved by NUPPSCO in 1982.

This standard and all other ANS standards have been written for prospective use.

Continuing efforts will be required to augment or modify the criteria in this standard to implement changing licensing requirements, to achieve standardization among the various industry criteria and standards currently being developed, and to provide additional clarification or interpretation as appropriate. The ANS-51 PWR Criteria Committee meets periodically to consider revisions or modifications to this standard.

Comments, suggestions, and requests for interpretations should be addressed to the Chairman, ANS-51 PWR Criteria Committee, American Nuclear Society, 555 North Kensington Avenue, La Grange Park, Ill. 60525.

Working Group ANS-51.1 of the Standards Committee of the American Nuclear Society, had the following membership at the time it developed this standard:

G. A. Zimmerman, Chairman, *Portland General Electric Company*
R. C. Surman, *Westinghouse Electric Corporation*

At the time of its approval of this standard, Subcommittee ANS-51 had the following membership:

C. J. Gill, Chairman, *Bechtel Power Corporation*
R. Bone, *Stone & Webster Engineering Corporation*
V. M. Callaghan, *Combustion Engineering, Inc.*
R. W. Fleming, *Westinghouse Electric Corporation*
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E. W. Swanson, *Babcock & Wilcox Company*
G. A. Zimmerman, *Portland General Electric Company*

The American Nuclear Society's Nuclear Power Plant Standards Committee (NUPPSCO) had the following membership at the time of its approval of this standard.

L. J. Cooper, Chairman
M. D. Weber, Secretary

Name of Representative	Organization Represented
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B. M. Rice (Alt.)	Duke Power Company (for the Institute of Electrical and Electronics Engineers, Inc.)
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S. L. Stamm	Stone & Webster Engineering Corporation
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C. D. Thomas	Science Applications, Inc.
G. P. Wagner	Commonwealth Edison Company
G. L. Wessman	Torrey Pines Technology
J. E. Windhorst	Individual

*Formerly with Babcock & Wilcox Company

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Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants

1. Introduction

1.1 Scope. This standard establishes the nuclear safety criteria and functional design requirements of structures, systems, and components of stationary pressurized water reactor (PWR) power plants. Operations, maintenance, and testing requirements are covered only to the extent that they affect design provisions.

A methodology is given for classifying all equipment into one of three Safety Classes according to its importance to nuclear safety or into a Non-Nuclear Safety Class. Another methodology is given for identifying and categorizing into one of five Plant Conditions the normal operations and events for which the plant shall be designed. Acceptance criteria are given for each Plant Condition.

Specific design requirements are given for each major system in a typical plant. These requirements are related to other, more specific design standards and are intended to amplify the criteria given in the Code of Federal Regulations, Title 10, "Energy," Part 50, "Licensing of Production and Utilization Facilities," Appendix A, "General Design Criteria for Nuclear Power Plants" [1].[1]

1.2 Purpose. Incorporating the requirements of this standard provides a degree of assurance that, in their entirety, plants are designed and constructed so that they can be operated without undue risk to the health and safety of the public. It is intended that this standard lead to attainment of this objective by defining existing practices that are consistent with the licensing requirements of the U.S. Nuclear Regulatory Commission (NRC), appropriate industry codes, and good engineering practice. References to regulations, codes, and other standards are included where appropriate.

A designer of a plant has a responsibility, even at the design stage, going beyond conformance to the criteria defined in this standard. In addition to considering this standard, the NRC regulations, and other published guidance, the designer must ensure that the design bases and expected operational characteristics are supported, to the extent practical, by design analyses, experimental verifications, and comparisons to accepted designs or experience gained from similar designs.

Consideration of alternate or additional criteria and requirements may be necessary to accommodate unique site characteristics.

This standard is written specifically for a PWR nuclear power plant. A PWR plant is based on closed-cycle circuits, utilizing two separate fluid systems that interface at two or more heat exchangers called steam generators. These circuits are known as the reactor coolant (or primary) system and the power conversion (or secondary) system. The reactor coolant system contains the reactor core, a water-cooled and water-moderated nuclear assembly that utilizes fissionable fuel. Heat is transferred by the reactor coolant system from the reactor core to the power conversion system at the steam generators. The power conversion system converts thermal energy into electrical energy by means of a turbine generator. Both the reactor coolant system and the power conversion system are provided with a number of auxiliary systems that supply, service, and control circulated fluids, processes and environmental conditions, and remove undesirable by-products, distribute power, and ensure safe conditions, during normal or accident conditions. A number of structures are provided to house, contain, protect, and shield both equipment and personnel. For the purpose of this standard, a PWR plant has the following characteristics:

a. Solid ceramic fuel enclosed in metallic cladding,

b. Fixed geometry for the fuel and coolant (which acts as the moderator),

[1]Numbers in brackets refer to corresponding numbers in Section 5, References.