American Nuclear Society

WITHDRAWN

July 23, 2012

ANSI/ANS-58.11-1995 (R2002)

design criteria for safe shutdown following selected design basis events in light water reactors

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 This standard may contain outdated material or may have been superseded by another standard.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

American National Standard Design Criteria for Safe Shutdown Following Selected Design Basis Events in Light Water Reactors

Secretariat
American Nuclear Society

Prepared by the
American Nuclear Society
Standards Committee
Working Group ANS-58.11

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

Approved July 10, 1995
by the
American National Standards Institute, Inc.

American National Standard

Designation of this document as an American National Standard attests that the principles of openness and due process have been followed in the approval procedure and that a consensus of those directly and materially affected by the standard has been achieved.

This standard was developed under procedures of the Standards Committee of the American Nuclear Society; these procedures are accredited by the American National Standards Institute, Inc., as meeting the criteria for American National Standards. The consensus committee that approved the standard was balanced to ensure that competent, concerned, and varied interests have had an opportunity to participate.

An American National Standard is intended to aid industry, consumers, governmental agencies, and general interest groups. Its use is entirely voluntary. The existence of an American National Standard, in and of itself, does not preclude anyone from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standard.

By publication of this standard, the American Nuclear Society does not insure anyone utilizing the standard against liability allegedly arising from or after its use. The content of this standard reflects acceptable practice at the time of its approval and publication. Changes, if any, occurring through developments in the state of the art, may be considered at the time that the standard is subjected to periodic review. It may be reaffirmed, revised, or withdrawn at any time in accordance with established procedures. Users of this standard are cautioned to determine the validity of copies in their possession and to establish that they are of the latest issue.

The American Nuclear Society accepts no responsibility for interpretations of this standard made by any individual or by any ad hoc group of individuals. Requests for interpretation should be sent to the Standards Department at Society Headquarters. Action will be taken to provide appropriate response in accordance with established procedures that ensure consensus on the interpretation.

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

Published by

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

Printed in the United States of America

Addendum to Foreword

ANSI/ANS-58.11-1995; R2002

Design Criteria for Safe Shutdown Following Selected Design Basis Events in Light Water Reactors

---

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 superseded or withdrawn. The requirements of this document are 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 cited 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.

The 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.

Foreword

(This Foreword is not a part of American National Standard Design Criteria for Safe Shutdown Following Selected Design Basis Events in Light Water Reactors, ANSI/ANS-58.11-1995.)

Background

This standard provides guidance to the plant designer regarding the means to shut down a reactor and maintain it in a safe shutdown condition, including plant cooldown to a cold shutdown condition. The standard also recognizes that it might not be prudent to deliberately impose reactivity, temperature, and pressure transients on the plant, by proceeding to the cold shutdown condition, following every transient which requires a shutdown of the reactor.

Development

The original version of this standard was issued in 1983. This standard was subsequently re-affirmed in 1988. The re-affirmation process identified 28 comments, which have been addressed in this revision. In addition to the re-affirmation comments, this standard has undergone a general revision to make it consistent with other newer ANS Standards, and to address industry work on evolutionary and advanced light water reactors, including designs with passive engineered safety features. The previous versions of this standard provided design criteria for plant cooldown from hot to cold shutdown conditions. This revision expands the scope of the standard to provide design criteria for plant safe shutdown. The safe shutdown design criteria include criteria to shut down the reactor and maintain it in a long term safe shutdown condition, which is defined to include plant cooldown from hot conditions to cold shutdown conditions within 36 hours following initiation of a design basis event. Alternative design criteria are included to permit the designer to select an alternative, higher end point cooldown temperature for maintenance of a long-term safe shutdown condition.

From an historical perspective, there was significant guidance provided during the early development of nuclear plant designs with respect to design basis accidents. This guidance is contained in numerous NRC regulations and other ANS standards. However, until the latter part of the 1970s, there was little guidance available regarding the need to shut down a plant safely after an incident that was not one of the "classical" Final Safety Analysis Report (FSAR) type accidents. From this need, ANS-58.11 was developed. Therefore, this standard excludes explicit consideration of these classical accidents, as stated in Section 1 of the standard.

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. This standard references other standards that provide design criteria applicable to safe shutdown systems.

A designer is not restricted by this standard from proposing or using alternate criteria to ensure nuclear safety. Frequently, a desirable overall result can be obtained by any of several design concepts. The designer can 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.

This standard was prepared by Working Group ANS-58.11 with assistance of the LWR Criteria Management Committee MC-1. This standard was approved by NUPPSCO in 1995.

This standard is intended for prospective use only.

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 LWR Criteria Management Committee MC-1 meets periodically to consider revisions or modifications to this standard.

Working Group ANS-58.11, of the Standards Committee of the American Nuclear Society, had the following membership at the time it developed this standard:

E. C. Arnold, Chairman, *Westinghouse Electric Corporation*
L. F. Pabst, *Florida Power & Light Company*

At the time of its approval of this standard, Committee MC-1 had the following membership:

J. T. Luke, Chairman, *Florida Power & Light Company*
J. C. Dempsey, *Pacific Nuclear*
L. A. Ettlinger, *Defense Nuclear Facilities Safety Board*
J. C. Glynn, *U.S. Nuclear Regulatory Commission*
P. H. Hepner, *ABB/Combustion Engineering Nuclear Power*
R. A. Hill, *GE Nuclear Energy*
L. A. Klosowski, *Niagara Mohawk Power Corporation*
G. B. Locklear, *Brunswick Steam Electric Plant*
S. A. Nass, *Duquesne Light Company*
N. Prillaman, *The Babcock & Wilcox Company*
H. C. Shaffer, *Yankee Atomic Electric Company*
S. A. Shuman, *Stone & Webster Engineering Corporation*
M. D. Smith, *Bechtel Corporation*
R. C. Surman, *Westinghouse Electric Corporation*

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

W. H. D'Ardenne, Chairman
M. D. Weber, Secretary

R. E. Allen ..... UE&C Nuclear
(for the Institute of Electrical and Electronics Engineers, Inc.)
P. Ballinger ..... Nebraska Public Power District
F. Boorboor ..... Nuclear Placement Services, Inc.
J. C. Bradford ..... Bechtel National, Inc.
T. W. Burnett ..... Westinghouse Electric Corporation
J. D. Cohen ..... Westinghouse Savannah River Company
J. D. Cotton ..... Philadelphia Electric Company
T. A. Daniels ..... Rochester Gas & Electric Corporation
W. H. D'Ardenne ..... GE Nuclear Energy
(for the American Nuclear Society)
L. E. Davis ..... Commonwealth Edison Company
S. B. Gerges ..... NUS Corporation, Inc.
D. L. Gillispie ..... Institute of Nuclear Power Operations
R. W. Hardy ..... GE Nuclear Energy
P. H. Hepner ..... ABB/Combustion Engineering Nuclear Power
C. E. Johnson, Jr. ..... U.S. Nuclear Regulatory Commission
J. T. Luke ..... Florida Power & Light Company
J. F. Mallay ..... Liberty Consulting Group
J. A. Nevshemal ..... Raytheon UE&C
W. B. Reuland ..... Electric Power Research Institute
T. T. Robin ..... Southern Company Services, Inc.
J. C. Saldarini ..... Ebasco Services, Inc.
R. E. Scott ..... Scott Enterprises
D. J. Spellman ..... Oak Ridge National Laboratories
S. L. Stamm ..... Stone & Webster Engineering Corporation
J. D. Stevenson ..... Stevenson & Associates
C. D. Thomas, Jr. ..... Yankee Atomic Electric Company
G. P. Wagner ..... Commonwealth Edison Company
N. Weber ..... Sargent & Lundy
R. Weir ..... Tennessee Valley Authority

Contents

Design Criteria for Safe Shutdown Following Selected Design Basis Events in Light Water Reactors

1. Scope

This standard provides design criteria for systems that perform the safety-related functions necessary to shut down a reactor and maintain it in a safe shutdown condition for selected design basis events; i.e., any design basis events that do not require operation of engineered safety features. For design basis events that require operation of engineered safety features, this standard can be selectively applied because of plant features specifically designed for these conditions. For systems that serve multiple functions, the design criteria associated with the most limiting function shall be applied.

The following safety-related functions are required for safe shutdown and are addressed in this standard:

(1) Reactor core reactivity control
(2) Reactor core heat removal
(3) Reactor coolant pressure boundary integrity provided by:
    (a) Temperature control
    (b) Pressure control, and
    (c) Inventory control.

2. Definitions

active component. A component in which mechanical movement or change of state must occur to accomplish the function of the component.

active failure. A malfunction of a component that prevents the component's mechanical movement or change of state required to accomplish its function upon demand.

active function. A function that requires mechanical motion or a change of state (e.g., the closing of a valve or relay or the change in state of a transistor).[1]

cold shutdown. The condition, consistent with technical specifications, in which the reactor is subcritical and the reactor coolant system average temperature is below the temperature specified in the technical specifications (e.g., 200 °F for PWRs and 212 °F for BWRs).

component. An item that performs a specific function within a system (usually has a component-level plant-unique identification code) and can be either an assembly of interconnected parts or a single part.

design basis event (DBE). An event that is a condition of normal operation (including an anticipated operational occurrence); a design basis accident (or transient); an external event; or a natural phenomenon for which the plant must be designed to ensure that the three basic safety-related functions are achievable. (See Title 10, "Energy," Code of Federal Regulations, Part 50, "Domestic Licensing of Production and Utilization Facilities," (10 CFR 50), Section 50.49 [1][2])

engineered safety feature (ESF). A structure, system, or component that is relied upon during or following design basis events to ensure the capability to prevent or mitigate the consequences of those design basis events that could result in potential off-site exposures comparable to the guideline exposures of Title 10, "Energy," Code of Federal Regulations, Part 100, "Reactor Site Criteria," (10 CFR 100) Section 100.11 [2], excluding reactor coolant

[1] In passive ALWR designs, passive engineered safety features are those that rely on passive means to provide their functions. Passive means are natural forces (e.g., gravity and natural circulation), stored energy (e.g., batteries, rotating inertia, and compressed fluid), energy inherent to the system (e.g., check valves), and non-cycling valves. Passive means do not rely on large, continuously rotating machinery; multiple acting valves; or ac powered divisions of electrical power. Active functions can be either safety-related, supplemented grade, or non-safety-related. See B.6 in Appendix B of American National Standard Safety and Pressure Integrity Classification Criteria for Light Water Reactors, ANSI/ANS-58.14-1993.

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