

American National Standard

**single failure criteria for
pwr fluid systems**



published by the
American Nuclear Society
244 East Ogden Avenue
Hinsdale, Illinois 60521, USA

American National Standard
Single Failure Criteria for
PWR Fluid Systems

Secretariat
American Nuclear Society

Prepared by the
American Nuclear Society
Standards Committee
Working Group ANS-51.7

Published by the
American Nuclear Society
244 East Ogden Avenue
Hinsdale, Illinois 60521

Approved June 21, 1976
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CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time.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
244 East Ogden Avenue, Hinsdale, Illinois 60521**

Price: \$8.00

Copyright © 1977 by American Nuclear Society.

Any part of this Standard may be quoted. Credit lines should read "Extracted from American National Standard N658-1976 (ANS-51.7) with permission of the publisher, the American Nuclear Society." Reproduction prohibited under copyright convention unless written permission is granted by the American Nuclear Society.

Printed in the United States of America

Foreword

(This Forward is not a part of American National Standard Single Failure Criteria for PWR Fluid Systems, N658-1976/ANS-51.7)

The General Design Criteria for Nuclear Power Plants, published by the U.S. Atomic Energy Commission¹ in Title 10, Code of Federal Regulations, Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," effective May 21, 1971, requires that certain fluid systems important to safety be designed as follows:

Suitable redundancy in components and features . . . shall be provided to assure that . . . the system safety function can be accomplished, assuming a single failure.

It was pointed out in the preface to the General Design Criteria that:

The conditions under which a single failure of a passive component in a fluid system shall be considered in designing the system against a single failure are under development.

Subsequent to publication of these criteria, considerable confusion has arisen as to which systems (components) require single failure design, what are the various accidents which should be considered, what is a passive failure, etc.

To resolve the various conflicting interpretations of the intent of the General Design Criteria, subcommittee ANS-51 (formerly ANS-21) was assigned the development of the standard "Single Failure Criteria for PWR Fluid Systems." Beginning in late 1971 a subcommittee working group was formed with the goal of producing a fundamental guide for designers which would be consistent with present accepted practice and which would provide a sound basis for future design considerations.

The technical content of the document has been very difficult and time consuming to develop within the committee, and reflects the results of detailed discussions with the U.S. Nuclear Regulatory Commission (NRC).

Consensus was difficult to achieve over the use of two definitions for the short term (wherein passive failures are exempted). However, the final accepted version, which defines the short term as the initiation of the recirculation mode for the Emergency Core Cooling System (ECCS) functions, and 24 hours for other events, was proposed by members of the NRC and was acceptable to the majority of the membership.

We have been advised that the NRC will probably take a more conservative regulatory position on the use of the "limited leak" for passive failures as may be allowed under 3.6 of the following standard. However, it has been pointed out that: the postulation of limited passive failures has been found technically acceptable in past applications for special components; the burden of support and analysis is placed on the designer in analyzing such limited leakage criteria; and the degree of conservatism remains subject to regulatory review.

Within the subcommittee, criticism was raised over the fact that the single failure criteria in itself is not sufficient in complex systems in that it does not allow for differentiating between the reliability of, say a pipe and an electronic component, nor in assessing the probabilities and consequences of different types of failures. The criteria does, in fact, recognize different applications for active and passive failures and for condition II, III, and IV events (See American National Standard Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants, N18.2-1973/ANS-51.1, N18.2a-1975/ANS-51.8), but further consideration of multiple failures or failure tree analyses is not within its scope.

Another concern raised was that passive failures should not be excluded during the short term. However, as noted above, this consideration has the backing of current acceptable practice, represents licensing acceptance over the past 8 years, and has been approved without comment by all but one of the members.

¹Superseded by the U.S. Nuclear Regulatory Commission (NRC) — January, 1975.

It should be noted that this Standard covers a single nuclear unit, as do General Design Criteria 34, 35, 38, 41 and 44. Consideration of Criterion 5 "Sharing of Structures, Systems, and Components" is outside its scope and should be the subject of a separate standard covering protection criteria for multi-unit plants.

Subcommittee ANS-51 approved a draft standard on the third ballot in May, 1974 and approval was obtained by ANS-50 in July, 1974. Subsequently, that draft was distributed for public comment by the American National Standard Institute and balloted by American National Standard Committees N 18 and N 45 in November, 1974. Comments received by these ballots were considered, suitable revisions incorporated, and subsequently reballoted by N 18 in August, 1975 receiving one negative ballot out of thirteen ballots cast. The single negative ballot received during this review was based on the inclusion of "spurious operation" in the definition of a "Single Active Failure." The reviewer stated: "Industry studies have shown this of such low probability that it should not be a design requirement." The committee believes that this concern is covered by 4.1 of the following standard which allows such relief recognizing that there is ongoing work in developing probabilistic assessments of accidents, equipment failure, and operator action and that the definition should stand as is. This latest draft was approved by Subcommittee ANS-51 in October, 1975.

This Standard was developed by Working Group ANS-51.7 of the American Nuclear Society which had the following membership at the time this Standard was approved:

H. J. Cordle, Chairman (through 1973) *Westinghouse Electric*
J. H. Blasingame, Chairman, *Bechtel Power*
W. G. Bingham, *Bechtel Power*
K. Schroeder, *Babcock & Wilcox*

The membership of Subcommittee ANS-51 at the time of final ballot in May, 1974 on this Standard was:

J. D. Crawford, Chairman, <i>Combustion Engineering</i>	G. L. Koppel, <i>Stone and Webster</i>
G. Beatty, <i>Florida Power</i>	D. E. Nunn, <i>Southern California Edison</i>
W. G. Bingham, <i>Bechtel Power</i>	H. G. O'Brien, <i>Tennessee Valley Authority</i>
J. H. Blasingame, <i>Bechtel Power</i>	E. P. O'Donnell, <i>Ebasco Services</i>
T. W. Burnett, <i>Westinghouse Electric</i>	H. Oslick, <i>Ebasco Services</i>
R. W. Fleming, <i>Westinghouse Electric</i>	C. L. Sansbury, <i>Duke Power</i>
J. L. Frewing, <i>Portland General Electric</i>	K. Schroeder, <i>Babcock & Wilcox</i>
E. W. Hewitt, <i>Combustion Engineering</i>	E. W. Swanson, <i>Babcock & Wilcox</i>
C. A. Hunt, <i>Consumers Power</i>	K. R. Wichman, <i>Nuclear Regulatory Commission</i>

The American National Standard Committee N18, Nuclear Design Criteria, which reviewed and approved this Standard in 1975, had the following membership:

L. J. Koch, Chairman

C. B. Zitek, Secretary

<i>Organization Represented</i>	<i>Name of Representative</i>
American Chemical Society	J. William Morris C. E. Stevenson (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 Association, Inc.	J. R. Coleman
American Welding Society	J. R. McGuffey
Atomic Industrial Forum	I. F. Stuart
Electric Light & Power Group	J. E. Howard G. E. Olson (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 Franklin Chin (Alt)
U.S. Energy Research & Development Administration	W. H. Hannum
U.S. Environmental Protection Agency	R. Sullivan G. Burley (Alt)
U.S. Nuclear Regulatory Commission	R. B. Minogue G. A. Arlotto (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

Section	Page
1. Scope	1
2. Definitions.....	1
3. Rules for Application of the Single Failure Criteria	2
4. Exemptions.....	3
5. References.....	3