American Nuclear Society

REAFFIRMED

February 12, 2015

ANSI/ANS-58.9-2002; R2015

REAFFIRMED

September 11, 1987

ANSI/ANS-58.9-1981 (R1987)

single failure criteria for light water reactor safety-related fluid systems

an American National Standard

ANSI/ANS-58.9-1981; R1987 and ANSI/ANS-58.9-2002 are one in the same. Because paperwork for the 2002 reaffirmation was not filed with ANSI in time, the standard had to be reapproved as a new standard and therefore was given a new designation. The standard was not reprinted with the new designation. Should you have any questions, contact the ANS Standards Department at standards@ans.org.

REAFFIRMED

February 24, 2009

ANSI/ANS-58.9-1981 (R2009)

This standard has been reviewed and reaffirmed with the recognition that it may reference other standards and documents that may have been superseded or withdrawn. The requirements of this document will be 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 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.

This 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

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Addendum to Foreword

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Single Failure Criteria for
LWR Safety-Related Fluid Systems

This standard has been reapproved 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Standards Committee (NFSC) with the recognition that it may reference other standards and documents that may have been superseded or withdrawn.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.

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American National Standard Single Failure Criteria for Light Water Reactor Safety-Related Fluid Systems

Secretariat
American Nuclear Society

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Foreword

(This Foreword is not a part of American National Standard Single Failure Criteria for Light Water Reactor Safety-Related Fluid Systems, ANSI/ANS-58.9-1981, (Revision of N658-1976/ANS-51.7).)

The General Design Criteria for Nuclear Power Plants, published by the U.S. Atomic Energy Commission[1] 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.

This standard was initially approved and issued by the American National Standards Institute (ANSI) in June 1976, as American National Standard Single Failure Criteria for Pressurized Water Reactor (PWR) Fluid Systems, N658-1976 (ANS-51.7).

In January 1978, a joint working group consisting of ANS-51.7 and ANS-52.4, was established to convert N658 (ANS-51.7) into a Light Water Reactor (LWR) Standard. The membership consisted of:

B. G. Schultz, Chairman, *Stone & Webster Engineering Corporation*
G. Fidler, *Westinghouse Electric Corporation*
G. Martine, *Bechtel Power Corporation*
J. Norberg, *Nuclear Regulatory Commission*
P. B. Stephens/A. N. Tschaeche, *General Electric Company*
R. Weir, *Tennessee Valley Authority*
G. Wrobel, *Rochester Gas and Electric Corporation*

In revising the standard to an LWR version, the working group reflected current industry practice, provided the practice was consistent with American National Standards Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants, N18.2-1973 (ANS-51.1), and Nuclear Safety Criteria for the Design of Stationary Boiling Water Reactor Plants, ANSI/ANS-52.1-1978.

There was discussion by the working group concerning the need for guidance on post-LOCA maintenance. The group concluded that such guidance was needed. The rationale is that for potential incidents that would require long recovery periods, such as a loss-of-coolant accident, the safety systems provided to mitigate their consequences must have long-term reliability. Therefore, additional requirements beyond single-failure criteria are prudent for those safety systems. To provide this added insurance of long-term performance capability, those systems shall be designed for inservice maintenance and repair. Although this requirement is not a single-failure criterion, the requirement is included in this standard to be certain it is appropriately treated in the design of the affected safety systems.

Draft 3, dated October 1978, resulted from a consensus approval ballot by working groups ANS-51 and ANS-52. This draft was forwarded for ballot to the American Nuclear Society's Nuclear Power Plant Standards Committee (NUPPSCO).

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[1] Superseded by the U.S. Nuclear Regulatory Commission (NRC) - January 1975.

The NUPPSCO ballot resulted in four negative votes. The working group met in May 1979 to resolve all NUPPSCO comments. This resulted in Draft 4, dated May 1979.

The May 1979 draft was reballoted by NUPPSCO. It resulted in eight negative votes. The working group met in February 1980 to resolve all comments.

Resolution of all ballots since January 1978 resulted in the following substantive changes:

1. Changed PWR criteria to LWR criteria with appropriate rewording.
2. Updated definitions to be consistent with NUPPSCO Policy 2.1. Substantive revisions or additions included the following:
   - Operator Error
   - Active Failure
   - Passive Failure
   - Safety Supporting Systems
   - Safe Shutdown
   - Safety Function
3. Provided exemptions for systems in accordance with NUPPSCO Policy 2.2.
4. Provided additional criteria for operator mitigation of single failures.
5. Provided additional guidance on passive failure of ventilation ductwork.
6. Revised format to reflect criteria, design requirements, and analysis requirements.
7. Modified Sections 3.1 through 3.3 to reflect NUPPSCO Policy 2.2.
8. Deleted the original Foreword from N658-1976 (ANS-51.7) and consolidated the remainder.

In agreement with the July 1979 meeting minutes from NUPPSCO, it is considered that any additional impacts on this standard due to the TMI-2 (Three Mile Island-2) accident will fall in the area of requirements in addition to or coincidental with the single failure criteria, not with the implementation of the single failure criteria. Such additional requirements are presently being evaluated by the ANS-58.5 Working Group.

Nothing in this standard is intended to imply that the use of the single failure criterion, by itself, is sufficient to characterize the required reliability of components or systems.

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

J. F. Mallay, Chairman
M. D. Weber, Secretary

Name of Representative	*Organization Represented*
G. A. Arlotto	*U.S. Nuclear Regulatory Commission*
R. E. Basso	*Catalytic, Inc.*
R. G. Benham	*General Atomic Company*
	(for the Institute of Electrical and Electronics Engineers, Inc.)
O. W. Bilharz, Jr. (Alt.)	*Knolls Atomic Power Laboratory*
	(for the Institute of Electrical and Electronics Engineers, Inc.)
R. V. Bettinger	*Pacific Gas and Electric Company*
P. Bradbury	*Westinghouse Advanced Reactor Division*
D. A. Campbell	*Westinghouse Electric Corporation*
C. O. Coffer	*Kaiser Engineers*
L. J. Cooper	*Nebraska Public Power District*
W. H. D'Ardenne	*General Electric Company*
F. X. Gavigan	*U.S. Department of Energy*
C. J. Gill	*Bechtel Power Corporation*
H. J. Green	*Tennessee Valley Authority*
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R. W. Keaten	*GPU Services Corporation*
D. M. Leppke	*Fluor Power Services, Inc.*
J. F. Mallay	*Babcock & Wilcox Company*
	(for the American Nuclear Society)
A. T. Molin	*United Engineers and Constructors*
E. P. O'Donnell	*Ebasco Services, Inc.*
	(for the Atomic Industrial Forum)
T. J. Pashos	*Quadrex/Nuclear Services Corporation*
M. E. Remley	*Rockwell International*
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J. E. Ward	*Sargent & Lundy*
G. L. Wessman	*General Atomic Company*
J. E. Windhorst	*Southern Company Services, Inc.*
	(for the American Society of Mechanical Engineers)
E. R. Wiot	*NUS Corporation*

Contents

Single Failure Criteria for Light Water Reactor Safety-Related Fluid Systems

1. Scope

This standard provides criteria for the designer which interpret the requirements of Title 10, Code of Federal Regulations, Part 50, "Licensing of Production and Utilization Facilities," Appendix A, "General Design Criteria for Nuclear Power Plants," with respect to design against single failures in safety-related Light Water Reactor (LWR) fluid systems [1][2]. Means of treating both active and passive failures are addressed for safety-related fluid systems following various initiating events. Current acceptable practice is used as a basis for these criteria.

Failure criteria for the electric power systems and the protection systems are provided in IEEE Std 308-1980 "IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations", IEEE Std 279-1971 "IEEE Standard Criteria for Protection Systems for Nuclear Power Generating Stations" (N42.7-1972), IEEE Std 379-1977 "IEEE Standard for Application of the Single-Failure Criterion to Nuclear Power Generating Station Class IE Systems", and IEEE Std 603-1980 "Standard Criteria for Safety Systems for Nuclear Power Generating Stations." [2, 3, 4, 5] Failures of structural components, such as braces, supports, or restraints, as well as occurrences involving common mode failures, are excluded.

2. Definitions

active failure. An active failure is a malfunction, excluding passive failures, of a component that relies on mechanical movement to complete its intended function upon demand.

Examples of active failures include the failure of a powered valve or a check valve to move to its correct position, or the failure of a pump, fan, or diesel generator to start.

Spurious operation of a powered component due to a failure originating within its automatic actuation or control systems shall be regarded as an active failure unless specific features or operating restrictions (such as "racking out" a breaker to a motor-operated valve) are incorporated to prevent such spurious operation. An example of spurious operation is the unintended energizing of a powered valve to open or close.

initiating event. An initiating event is a single occurrence, including its consequential effects, that places the plant or some portion of the plant in an off-normal condition. An initiating event and its resulting occurrences are not the single failure defined herein. An initiating event can be a single equipment failure, natural phenomenon, or external man-made hazard.

long term. The long term is defined as that period of safety-related fluid system operation following the short term, during which the safety function of the system is required.

operator error. An operator error is a single incorrect or omitted action by a human operator attempting to perform a safety-related manipulation.

An example of an operator error is operation of the wrong switch while responding to an initiating event.

passive failure. A passive failure is a failure of a component to maintain its structural integrity or the blockage of a process flow path. Blockage of a process flow path could occur, for example, due to separation of a valve disc from its stem.

safety supporting systems. Safety supporting systems are those systems which provide the services necessary to a safety-related fluid system to enable that system to complete its intended safety function.

Examples of safety supporting systems for the emergency core cooling system include the component and process cooling system, the electric power supply system, and the emergency core cooling system equipment ventilation system.

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