

American Nuclear Society

WITHDRAWN

February 2, 2009

ANSI/ANS-58.23-2007 (W2009)

fire PRA
methodology

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 This standard may contain outdated material or may have been superseded by another standard.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 60526 USA

ANSI/ANS-58.23-2007

**American National Standard
Fire PRA
Methodology**

Secretariat
American Nuclear Society

Prepared by the
**American Nuclear Society
Standards Committee
Working Group ANS-58.23**

Published by the
**American Nuclear Society
555 North Kensington Avenue
La Grange Park, Illinois 60526 USA**

Approved November 20, 2007
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 It may be reaffirmed, revised, or withdrawn at any time in accordance with established procedures.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 60526 USA**

Copyright © 2007 by American Nuclear Society. All rights reserved.

Any part of this standard may be quoted. Credit lines should read "Extracted from American National Standard ANSI/ANS-58.23-2007 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 Foreword is not a part of the American National Standard, “Fire PRA Methodology,” ANSI/ANS-58.23-2007)

This standard sets forth requirements for probabilistic risk assessments (PRAs) and related analysis methodologies involving internal fires (i.e., fires that could occur within the boundaries of a nuclear power plant of causes inherent to the operation of the nuclear power plant) that can be used to support risk-informed decisions for commercial nuclear power plants. This standard also prescribes a method for applying these requirements for specific applications.

This standard is intended to be used together with other PRA standards that cover different aspects of PRA scope. Specifically, this standard is intended to be used directly with the PRA standard developed by the American Society of Mechanical Engineers [“Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications,” ASME RA-S-2002 up to and including ASME RA-Sb-2005 (hereafter referred to as ASME-RA-2002/RA-Sb-2005)], which covers an Internal Events PRA for a commercial nuclear power plant operating at nominal full power. Similarly, this standard is intended to be used with two other standards: the American Nuclear Society (ANS) PRA-methodology standard covering low-power/shutdown operations (ANS-58.22, under development) and the ANS PRA-methodology standard covering accidents initiated by external events (ANSI/ANS-58.21-2007).

The scope of a PRA covered by this standard is limited to analyzing accident sequences initiated by fires that might occur while a nuclear power plant is at nominal full power. It is further limited to requirements for (a) a Level 1 analysis of the core damage frequency and (b) a limited Level 2 analysis sufficient to evaluate the large early release frequency. The scope of a Fire PRA covered by this standard is commensurate with the scope covered by the Fire PRA method produced by the Electric Power Research Institute (EPRI) and the U.S. Nuclear Regulatory Commission (NRC), jointly published as EPRI TR-1011989 and NUREG/CR-6850.

In contrast, the scope of ASME-RA-2002/RA-Sb-2005 covers internal plant initiators (except internal fires) that might occur while the nuclear power plant is at nominal full power. Accidents initiated by internal flooding are explicitly included in ASME-RA-2002/RA-Sb-2005, as are accidents initiated by a loss of off-site power (LOOP), unless the LOOP is due to a fire as covered herein that also causes other important damage to the plant, in which case analysis of the LOOP is within the scope of this standard. Therefore, this standard, ANSI/ANS-58.21-2007, and ASME-RA-2002/RA-Sb-2005, when used together, cover all potential accident initiators arising at nominal full power. The only initiators explicitly excluded are accidents resulting from purposeful human-induced security threats (e.g., sabotage).

The types of risk-informed PRA applications contemplated under this standard are very broad and include applications related to design, procurement, construction, licensing, operation, and maintenance. Both regulatory risk-informed applications involving the NRC and applications not involving those regulations are contemplated. In this regard, this standard’s approach is intended to be identical to that used in the closely related ASME-RA-2002/RA-Sb-2005, so the approach and supporting logic of ASME-RA-2002/RA-Sb-2005 are relied upon heavily in this standard’s guidance in this area.

This standard might reference documents and other standards that have been superseded or withdrawn at the time the standard is applied. A statement has

been included in the reference section that provides guidance on the use of references.

Working Group ANS-58.23 of the Standards Committee of the American Nuclear Society had the following membership for the original issue:

D. W. Henneke (Chair), *General Electric Corporation*

F. J. Joglar-Biloch, *Science Applications International Corporation*
M. Kazarians, *Kazarians & Associates, Inc.*
A. M. Kolaczowski, *Science Applications International Corporation*
B. Najafi, *Science Applications International Corporation*
S. P. Nowlen, *Sandia National Laboratories*
N. O. Siu, *U.S. Nuclear Regulatory Commission*
K. L. Zee, *ERIN Engineering & Research, Inc.*

This standard was processed and approved for submittal to the American National Standards Institute, Inc., by the Risk Informed Standards Committee (RISC) on ANS-58.23, "Fire PRA Methodology." Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, RISC had the following members:

W. E. Burchill (Chair), *Texas A&M University*

P. J. Amico, *Science Applications International Corporation*
R. A. Bari, *Brookhaven National Laboratory*
R. L. Black, *U.S. Department of Energy*
R. E. Bradley, *Nuclear Energy Institute*
R. J. Budnitz, *Lawrence Livermore National Laboratory*
A. L. Camp, *Sandia National Laboratories*
M. T. Drouin, *U.S. Nuclear Regulatory Commission*
F. A. Emerson, *General Electric Nuclear Energy*
D. J. Finnicum, *Westinghouse*
J. P. Gaertner, *Electric Power Research Institute*
D. W. Henneke, *General Electric*
R. A. Hill, *ERIN Engineering and Research*
W. D. Holmes, *HSB Professional Loss Control*
E. A. Hughes, *ETRANCO*
Y. F. Khalil, *Yale University*
K. L. Kiper, *Florida Power & Light Company, Seabrook Station*
S. H. Levinson, *AREVA NP*
M. K. Ravindra, *ABS Consulting, Inc.*
M. P. Rubin, *U.S. Nuclear Regulatory Commission*
J. B. Savy, *Risk Management Solutions*
D. W. Stillwell, *South Texas Project Nuclear Operating Company*

Contents	Section	Page
1	Introduction	1
1.1	Scope	1
1.2	Coordination with other PRA standards	1
1.3	Applicability	1
1.3.1	Scope: Interface with ASME-RA-2002/RA-Sb-2005 and ANSI/ANS-58.21-2007	2
1.3.2	Scope: Screening, bounding, and conservative analysis approaches	2
1.3.3	Scope: The LERF endpoint	2
1.3.4	Scope: Light water reactors in the design or construction phase	2
1.3.5	Scope: Other types of nuclear power reactors	2
1.4	Fire PRA capability categories	2
1.5	Requirements for Fire PRA elements	3
1.5.1	Fire PRA elements	3
1.5.2	High level requirements and supporting requirements	7
1.6	Fire PRA application process	7
1.7	Fire PRA configuration control	8
1.8	Peer review requirements	8
2	Acronyms and definitions	8
2.1	Acronyms	8
2.2	Definition of terms	9
3	Fire PRA application process	16
3.1	Purpose	16
3.2	Identification of application (box A)	16
3.3	Assessment of PRA for necessary scope, results, and models (box B)	16
3.3.1	Necessary scope and results	16
3.3.2	Modeling of SSCs, activities, and fire protection systems and features	16
3.4	Determination of the standard's scope and level of detail	17
3.5	Comparison of Fire PRA model to standard	17
3.6	Use of supplementary analyses/requirements	17
4	Fire PRA technical requirements	17
4.1	Purpose	17
4.2	Fire PRA process check	17
4.3	Use of expert judgment	17
4.4	Technical requirements: General	17
4.5	Plant partitioning	17
4.6	Equipment selection	22
4.7	Cable selection and location	33
4.8	Qualitative screening	37
4.9	Fire PRA plant response model	40
4.10	Fire scenario selection and analysis	46
4.11	Ignition frequency	60
4.12	Quantitative screening	64
4.13	Circuit failures	67
4.14	Human reliability analysis	68
4.15	Seismic fire	72
4.16	Fire risk quantification	74
4.17	Uncertainty and sensitivity analysis	78

5	Fire PRA configuration control	79
5.1	General requirements	79
6	Fire PRA peer review	79
6.1	Purpose	79
6.1.1	Frequency	79
6.1.2	Methodology	79
6.2	Peer review team composition and personnel qualifications	79
6.2.1	General	79
6.2.2	Specific	79
6.3	Review of Fire PRA elements to confirm the methodology	79
6.3.1	Plant partitioning	80
6.3.2	Equipment selection	80
6.3.3	Cable selection and location	80
6.3.4	Qualitative screening	80
6.3.5	Fire PRA plant response model	81
6.3.6	Fire scenario selection and analysis	81
6.3.7	Ignition frequency	81
6.3.8	Quantitative screening	81
6.3.9	Circuit failures	81
6.3.10	Human reliability analysis	82
6.3.11	Seismic fire	82
6.3.12	Fire risk quantification	82
6.3.13	Uncertainty and sensitivity	82
6.4	Expert judgment	82
6.5	Fire PRA configuration control	82
6.6	Documentation	82
7	References	83
Appendices		
Appendix A	Fire PRA Methodology (Nonmandatory)	84
Appendix B	ANS-58.23 Working Group Membership (Nonmandatory) ..	97