



Nuclear Criticality Accident Emergency Planning and Response

REAFFIRMED

February 29, 2024

ANSI/ANS-8.23-2019 (R2024)

An American National Standard

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reviewed and reaffirmed with the recognition that it may reference other standards and documents that may have been superseded or withdrawn.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.

Published by the
American Nuclear Society
555 N. Kensington Ave
La Grange Park, IL 60526



ANSI/ANS-8.23-2019

**American National Standard
Nuclear Criticality Accident
Emergency Planning and
Response**

Secretariat
American Nuclear Society

Prepared by the
**American Nuclear Society
Standards Committee
Working Group ANS-8.23**

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

Approved September 16, 2019
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 the 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. Inquiries about requirements, recommendations, and/or permissive statements (i.e., “shall,” “should,” and “may,” respectively) should be sent to the Publications and Standards Department at Society Headquarters. Action will be taken to provide appropriate response in accordance with established procedures that ensure consensus.

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



This document is copyright protected.

Copyright © 2019 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-8.23-2019 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

Inquiry Requests

The American Nuclear Society (ANS) Standards Committee will provide responses to inquiries about requirements, recommendations, and/or permissive statements (i.e., “shall,” “should,” and “may,” respectively) in American National Standards that are developed and approved by ANS. Responses to inquiries will be provided according to the Policy Manual for the ANS Standards Committee. Nonrelevant inquiries or those concerning unrelated subjects will be returned with appropriate explanation. ANS does not develop case interpretations of requirements in a standard that are applicable to a specific design, operation, facility, or other unique situation only and therefore is not intended for generic application.

Responses to inquiries on standards are published in ANS’s magazine, *Nuclear News*, and are available publicly on the ANS website or by contacting the Publications and Standards Department.

Inquiry Format

Inquiry requests shall include the following:

- (1) the name, company name if applicable, mailing address, and telephone number of the inquirer;
- (2) reference to the applicable standard edition, section, paragraph, figure, and/or table;
- (3) the purpose(s) of the inquiry;
- (4) the inquiry stated in a clear, concise manner;
- (5) a proposed reply, if the inquirer is in a position to offer one.

Inquiries should be addressed to

American Nuclear Society
Publications and Standards Department
555 N. Kensington Avenue
La Grange Park, IL 60526

or standards@ans.org

Foreword (This foreword is not a part of American National Standard “Nuclear Criticality Accident Emergency Planning and Response,” ANSI/ANS-8.23-2019, but is included for informational purposes only.)

This standard provides criteria for emergency planning and response to a nuclear criticality accident for facilities outside reactors that process, store, or handle fissionable material. This standard focuses on those elements of planning and response needed specifically in the event of a criticality accident. It is not a general emergency planning and response standard.

This revision removes the assumption from the previous editions [ANS-8.23-1997 and ANS-8.23-2007 (R2012)], that user facilities have an alarm system that complies with ANSI/ANS-8.3-1997 (R2017), “Criticality Accident Alarm System.” Elements of this standard might be appropriate for certain facilities that are not using an alarm system compliant with ANSI/ANS-8.3-1997 (R2017) yet have credible and non-trivial hazards from a criticality accident. This revision emphasizes that an immediate evacuation zone should be established based on multiple factors and not solely based on dose estimates. The recent update of ANSI N13.3-2013 (R2019), “Dosimetry for Criticality Accidents,” for criticality accident dosimetry is included, and a few additional clarifications have been made. Appendix C now includes references to additional methods for estimating fission yield for a criticality accident. Users should understand the assumptions and limitations of these methods and use them only where applicable. Appendix C is not intended to be a tutorial on the complex topic of criticality accident analysis. Appendix D is added to help users select a dose criterion that corresponds to radiation levels immediately dangerous to life and health.

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 references section that provides guidance on the use of references.

This standard was prepared by the ANS-8.23 Working Group of the American Nuclear Society. The following members contributed to this standard:

J. S. Baker (Chair), *Spectra Tech, Inc.*
P. L. Angelo, *Y-12 Consolidated Nuclear Security, LLC*
K. M. Casanova (Associate Member), *Idaho National Laboratory*
T. E. Cutler, *Los Alamos National Laboratory*
M. Duluc, *Institut de Radioprotection et de Sûreté Nucléaire*
E. Fillastre, *CEA—France*
N. Harris, *UK National Nuclear Laboratory*
J. E. Hicks (Liaison), *Individual*
P. S. Moss, *National Nuclear Security Administration*
B. M. O’Donnell, *BWX Technologies, Inc.*
B. A. Rice, *Nuclear Fuel Services, Inc.*
E. M. Saylor, *Oak Ridge National Laboratory*
J. Wang, *Canadian Nuclear Laboratories*
R. Winiarski, *Paschal Solutions, LLC*
D. D. Winstanley (Observer), *Sellafield, Ltd.*

The Fissionable Materials Outside Reactors Subcommittee, ANS-8, had the following membership at the time of its approval of this standard:

D. G. Bowen (Chair), *Oak Ridge National Laboratory*
K. H. Reynolds (Vice Chair), *Consolidated Nuclear Security, LLC*
M. J. Crouse (Secretary), *Consolidated Nuclear Security, LLC*

J. S. Baker, *Savannah River Nuclear Solutions, LLC*
M. Barnett, *URS Professional Solutions, LLC (an AECOM Company)*

N. W. Brown, *Nuclear Fuel Services, Inc.*
E. P. Elliott, *Los Alamos National Laboratory*
D. G. Erickson, *Savannah River Nuclear Solutions*
T. P. McLaughlin, *Individual*
J. A. Morman, *Argonne National Laboratory*
L. E. Paulson, *GE Hitachi Nuclear Energy*
A. W. Prichard, *Pacific Northwest National Laboratory*
C. S. Tripp, *U.S. Nuclear Regulatory Commission*
D. D. Winstanley, *Sellafield Ltd.*

The Nuclear Criticality Safety Consensus Committee had the following membership at the time of its approval of this standard:

L. L. Wetzel (Chair), *BWX Technologies, Inc.*
W. R. Shackelford (Vice Chair), *Nuclear Fuel Services, Inc.*

R. W. Bartholomay, *C.S. Engineering, Inc.*
L. J. Berg, *U.S. Department of Energy*
D. G. Bowen, *Oak Ridge National Laboratory*
R. D. Busch, *University of New Mexico*
W. L. Doane, *Framatome Inc.*
R. S. Eby, *AIChE Rep. (Employed by Navarro Research & Engineering)*
C. M. Hopper, *Individual*
K. D. Kimball, *Consolidated Nuclear Security, LLC*
R. A. Knief, *INMM Rep. (Employed by Sandia National Laboratories)*
T. Marenchin, *U.S. Nuclear Regulatory Commission*
J. A. Miller, *Sandia National Laboratories*
S. P. Murray, *HPS Rep. (Employed by General Electric)*
R. G. Taylor, *C.S. Engineering, Inc.*
R. M. Westfall (Observer), *Individual*
R. E. Wilson, *U.S. Department of Energy*

Contents

Section	Page
1 Introduction	1
2 Scope	1
3 Definitions	1
3.1 Limitations.....	1
3.2 Shall, should, and may.....	1
3.3 Glossary of terms.....	1
4 Responsibilities.....	2
4.1 Management responsibilities	2
4.2 Technical staff responsibilities	2
4.2.1 Planning.....	2
4.2.2 Emergency response.....	3
5 Emergency response planning.....	3
5.1 Evaluation.....	3
5.2 Emergency response plan.....	3
5.3 Equipment	4
6 Evacuation	4
7 Reentry, rescue, and stabilization.....	5
8 Classroom training, exercises, and evacuation drills	6
8.1 Classroom training.....	6
8.2 Exercises.....	7
8.3 Evacuation drills.....	7
9 References.....	8

Appendices

Appendix A	Selection and Use of Radiation Protection Instrumentation for Emergency Response to a Nuclear Criticality Accident.....	9
Appendix B	Criticality Specialist Emergency Response Resources	14
Appendix C	Nuclear Criticality Accident Emergency Response Exercises	15
Appendix D	Guidance for the Use of Radiation Dose Units and Determination of a Maximum Acceptable Value of Absorbed Dose at the Immediate Evacuation Zone Boundary.....	28
Appendix E	Bibliography.....	31

Tables

Table C.1	Dose estimates to personnel (rad or cGy).....	22
-----------	---	----

Figures

Figure C.1	Specific fissions in first spike as a function of reactor period.....	16
Figure C.2	Maximum specific fission yield resulting from criticality solution excursions in CRAC and SILENE	17

Figure C.3	Hypothetical facility, accident location, and evacuation routes	18
Figure C.4	Fission rate versus time	20
Figure C.5	Integrated specific fission yield versus time	21
Figure C.6	Gamma dose rate at the security portal and assembly station versus time after first pulse	23