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reviewed and reaffirmed with the recognition that it may reference other standards and documents that may have been superseded or withdrawn.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.
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 It may be reaffirmed, revised, or withdrawn at any time in accordance with established procedures.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 © 1997 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-8.3-1997 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 part of American National Standard Criticality Accident Alarm System, ANSI/ANS-8.3-1997.)

The usefulness and protective features of criticality accident alarm systems have been demonstrated in instances of accidental criticality that have occurred during the processing of fissionable materials. This standard provides guidance for the establishment and maintenance of an alarm system to initiate personnel protective actions in the event of inadvertent criticality.


Most of the changes incorporated into this revision of ANS-8.3 are oriented towards clarification, rather than change, of existing standard requirements and recommendations. Where concern exists for accidents of smaller magnitude than alarm systems have traditionally been designed to detect, additional guidance is now provided.

Use of portable instruments to augment an installed accident alarm system is now more specifically addressed. The term “immediate evacuation” has been replaced with “personnel protective action” since for some shielded facilities or locations, proper immediate response by some personnel may be to remain at their current location rather than to evacuate.

This standard is compatible with ISO 7753, *Nuclear energy—Performance and testing requirements for criticality detection and alarm systems*, IEC 860, *Warning equipment for criticality accidents*, contains useful information regarding electrical characteristics and testing procedures for alarm equipment.

Appendix B has been extensively revised to provide analytical methods and example applications for determining detector placement.

Working Group ANS-8.3, which revised this document, had the following membership:

D. A. Reed, Chairman, *Oak Ridge National Laboratory*
R. E. Anderson, *Los Alamos National Laboratory*
W. A. Blyckert, *Mohr & Associates*
L. C. Davenport, *Mohr & Associates*
B. L. Lee, Jr., * Battelle Oak Ridge Operations*
S. P. Monahan, *Los Alamos National Laboratory*
V. L. Putman, *Lockheed Martin Idaho Technologies*
S. R. Salaymeh, *Westinghouse Savannah River Company*
J. A. Schlesser, *Los Alamos National Laboratory*
R. L. Webb, *Westinghouse Savannah River Company*
This standard was prepared under the direction of Subcommittee ANS-8, Fissionable Materials Outside Reactors, of the Standards Committee of the American Nuclear Society. The membership of ANS-8 at the time of draft preparation and approval was:

T. P. McLaughlin, Chairman, Los Alamos National Laboratory
J. A. Schlesser, Secretary, Los Alamos National Laboratory
F. M. Alcorn, The Babcock & Wilcox Company
K. E. Bhanot, British Nuclear Fuels Limited
E. D. Clayton, Individual
D. M. Dawson, Transnuclear, Inc.
A. S. Garcia, U. S. Department of Energy
C. M. Hopper, Oak Ridge National Laboratory
N. Ketlach, Individual
R. Kiyose, Individual
R. A. Libby, Battelle-Pacific Northwest National Laboratory
J. F. Mincey, Oak Ridge National Laboratory
W. G. Morrison, Individual
D. A. Reed, Oak Ridge National Laboratory
T. A. Reilly, Westinghouse Savannah River Company
H. Toffer, Safe Sites of Colorado
G. E. Whitesides, Individual

Consensus Committee N16, Nuclear Criticality Safety, had the following membership at the time of its approval of this standard:

D. R. Smith, Chairman
R. A. Knief, Vice-Chairman

G. H. Bidinger ........................................................ Individual
R. D. Busch ........................................................ University of New Mexico
S. P. Congdon ......................................................... GE Nuclear Energy
H. L. Dodds, Jr. ......................................................... University of Tennessee
R. A. Knief ........................................................ Ogden Environmental Services
J. R. LaRiviere ......................................................... American Institute of Chemical Engineers
C. D. Manning ......................................................... Siemens Nuclear Power Corporation
S. P. Murray ........................................................ Health Physics Society
H. C. Paxton ........................................................ Individual
R. L. Reed ........................................................ Westinghouse Savannah River Company
B. M. Rothleder ......................................................... U. S. Department of Energy
F. W. Sanders ........................................................ Individual
D. R. Smith ........................................................ American Nuclear Society
J. T. Thomas ........................................................ Individual
Contents

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. General Principles ................................................... 1
   4.1 General ........................................................ 1
   4.2 Coverage ....................................................... 1
   4.3 Criticality Alarm ................................................ 2
   4.4 Dependability ................................................... 2
5. Criteria for System Design ............................................ 3
   5.1 Reliability ...................................................... 3
   5.2 System Vulnerability ............................................. 3
   5.3 Seismic Tolerance ................................................ 3
   5.4 Failure Warning ................................................ 3
   5.5 Response Time .................................................. 3
   5.6 Detection Criterion .............................................. 3
   5.7 Sensitivity ...................................................... 3
   5.8 Spacing ........................................................ 3
6. Testing ............................................................. 4
   6.1 Initial Tests ..................................................... 4
   6.2 Special Tests .................................................... 4
   6.3 Response to Radiation ............................................ 4
   6.4 Periodic Tests ................................................... 4
   6.5 Corrective Action ................................................ 4
   6.6 Test Procedures ................................................. 4
   6.7 Records ......................................................... 4
7. Employee Familiarization ............................................. 4
   7.1 Posted Instructions .............................................. 4
   7.2 Training and Criticality Alarm Drills ......................... 4
8. References .......................................................... 4

Appendices
   Appendix A Characterization of a Minimum Accident of Concern ......... 5
   Appendix B Detector Placement ...................................... 9
   Appendix C Signal Characteristics and Sound Levels ................... 19

Tables
   Table B.1 Moderated Assembly n/γ Dose Ratio Comparison .......... 10
   Table B.2 Unmoderated Assembly n/γ Dose Ratio Comparison .......... 11
   Table B.3 Integrated Quantities for a 25 g/l Pu (95/5)
       Solution Criticality .............................................. 15
   Table B.4 Thermal Neutron Fluence Detector Response ............... 16
Table B.5  Gamma Ray Dose Rate Detector Response  ................. 17

Figures
Figure A.1  Energy Release During Initial Spike of Criticality Events
            in Process and Handling Operations  ....................... 6
Figure B.1  Gamma Ray Dose Rate versus Distance, Based
            on a Total Dose of 0.20 Gy at 2 Meters  .................... 13
Figure B.2  An Example of a One-Dimensional Computational Model  ...... 15
Criticality Accident Alarm System

1. Introduction

Guidance for the prevention of criticality accidents in the handling, storing, processing, and transporting of fissionable materials is presented in American National Standard for Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors, ANSI/ANS-8.1-1983 (R1988) [1]. In most operations with fissionable materials the risk of inadvertent criticality is very low; however, this risk cannot be eliminated. Where a criticality accident may lead to an excessive radiation dose, it is important to provide a means of alerting personnel and a procedure for their prompt evacuation, or other protective actions to limit their exposure to radiation.

2. Scope

This standard is applicable to all operations involving fissionable materials in which inadvertent criticality can occur and cause personnel to receive unacceptable exposure to radiation.

This standard is not applicable to detection of criticality events where no excessive exposure to personnel is credible, nor to nuclear reactors or critical experiments. This standard does not include details of administrative actions or of emergency response actions that occur after alarm activation.

3. Definitions

3.1 Limitations. The following definitions are of a restricted nature for the purpose of this standard. Other specialized terms are defined in the Glossary of Terms in Nuclear Science and Technology [2].

3.2 Shall, Should, and May. The word “shall” is used to denote a requirement, the word “should” to denote a recommendation, and the word “may” to denote permission, neither a requirement nor a recommendation. To conform with this standard, all operations shall be performed in accordance with its requirements but not necessarily with its recommendations.

3.3 Glossary of Terms

criticality accident. The release of energy as a result of accidental production of a self-sustaining or divergent neutron chain reaction.

excessive radiation dose. Any dose to personnel corresponding to an absorbed dose from neutrons and gamma rays equal to or greater than 0.12 Gy (12 rad) in free air.

minimum accident of concern. The smallest accident, in terms of fission yield and dose rate, that a criticality alarm system is required to detect.

4. General Principles

4.1 General


4.1.2. Process equipment used in areas from which immediate evacuation is required should be so designed that leaving the equipment will not introduce significant risk.

4.1.3. The purpose of an alarm system is to reduce risk to personnel. Evaluation of the overall risk should recognize that hazards may result from false alarms and subsequent sudden interruption of operations and relocation of personnel.

4.2 Coverage

4.2.1. The need for criticality alarm systems shall be evaluated for all activities in which the inventory of fissionable materials in individual unrelated areas exceeds 700 g of U-235, 500 g of U-233, 450 g of Pu-239, or 450 g of any com-

1 Numbers in brackets refer to corresponding numbers in Section 8, References.