



Nuclear Criticality Safety in the Storage of Fissile Materials

An American National Standard

ANSI/ANS-8.7-2022

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



Documents

Document Sharing Hub

ANSI/ANS-8.7-2022

**American National Standard
Nuclear Criticality Safety
in the Storage
of Fissile Materials**

Secretariat
American Nuclear Society

Prepared by the
**American Nuclear Society
Standards Committee
Working Group ANS-8.7**

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

Approved May 6, 2022
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 It may be reaffirmed, revised, or withdrawn at any time in accordance with established procedures.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 Society headquarters, ATTN: Standards or to standards@ans.org. 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 © 2022 by American Nuclear Society. All rights reserved.

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 at www.ans.org or by contacting standards@ans.org.

Inquiry Format

Inquiry requests shall be submitted on the Standards Inquiry Submittal Form available at <https://ans.org/standards/docs/inquiry-submittal-form.pdf>. 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
ATTN: Standards
555 N. Kensington Avenue
La Grange Park, IL 60526

or standards@ans.org

Foreword

(This foreword does not contain any requirements of American National Standard “Nuclear Criticality Safety in the Storage of Fissile Materials,” ANSI/ANS-8.7-2022, but is included for informational purposes.)

As is the case with many standards and guides, the direct solution to a specific problem may not be immediately evident in these pages. When dealing with fissile material, the application of some of the mass limits and allowances permitted in storage arrangements requires groups, or individuals, experienced in nuclear criticality safety to examine the contingencies attendant to handling massive pieces, to deviations from established procedures, or to those perturbations or mishaps commonly encountered in storage areas. This standard should be considered not as a substitute for detailed safety analyses, but rather as an integral part of the analysis for the attainment of a sound nuclear criticality safety program.

This standard is an extension of ANSI/ANS-8.1-2014 (R2018), “Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors.” Attention to details of possible single-unit criticality accidents is, therefore, presumed. The information presented in this standard is primarily directed to nuclear criticality safety and is based on validated Monte Carlo calculations. Water is adopted as a standard reflector for storage arrays; because of the variety and thicknesses of concretes that may occur in the more usual conditions of storage, an unambiguous presentation of information is difficult.

This standard provides an orientation and direction to nuclear criticality safety practices. Individual safety groups concerned with specific problems are encouraged to publish solutions to these problems, detailing the bases. Future reviews and revisions of this standard may make use of the information to expand the areas of applicability.

The ANS-8.7 Working Group under the Fissionable Material Outside Reactors Subcommittee (ANS-8) of the American Nuclear Society (ANS) was established in November 1967 and has prepared a number of drafts of this standard. One draft underwent a one-year trial use and comment period in 1973. This standard was approved by the American National Standards Institute (ANSI) in 1975 as ANSI N16.5-1975 and was reaffirmed in 1987 as ANSI/ANS-8.7-1975 (R1987). In 1998, a revision was made to include several textual enhancements and tabulated changes resulting from confirmatory evaluations. The 1998 revision removed the table of unit mass limits of uranium-233 per cell in water-reflected storage arrays for oxides with $H/U \leq 3$, 10, and 20 and removed limited portions of tables for unit mass limits of uranium per cell in water-reflected storage arrays for oxides at 93.2 wt%, 50 wt%, and 30 wt%, because of identified uncertainties associated with the calculated values. This revision makes textual enhancements to bring consistency between this standard and the current series of ANS-8 standards. No changes to the calculation limits have been made.

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 does not incorporate the concepts of generating risk-informed insights, performance-based requirements, or a graded approach to quality assurance. The user is advised that one or more of these methods could enhance the application of this standard.

This standard was prepared by the ANS-8.7 Working Group of the American Nuclear Society. The following members contributed to this standard:

K. D. Kimball (Chair), *Individual*

K. A. Bunde, *U.S. Department of Energy*
J. Cole, *Sandia National Laboratories*

D. E. Edwards, *U.S. Nuclear Regulatory Commission*
C. M. Gibson, *Consolidated Nuclear Security, LLC*
J. J. Kuropatwinski, *Los Alamos National Laboratory*
E. M. Saylor, *Oak Ridge National Laboratory*
B. M. Williamson, *Spectra Tech, Inc./SRNS*
T. L. Wilson, *X-energy*

The Fissionable Material 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*
M. Crouse (Secretary), *Consolidated Nuclear Security, LLC*

J. S. Baker, *Spectra Tech, Inc.*
M. H. Barnett, *Savannah River Nuclear Solutions, LLC*
N. W. Brown, *Nuclear Fuel Services, Inc.*
D. G. Erickson, *Savannah River Nuclear Solutions, LLC*
C. F. Haught, *Consolidated Nuclear Security, LLC*
T. P. McLaughlin, *Individual*
J. A. Morman, *Argonne National Laboratory*
L. E. Paulson, *GE Hitachi/Global Nuclear Fuel-Americas*
C. G. Percher, *Lawrence Livermore National Laboratory*
A. W. Prichard, *Pacific Northwest National Laboratory*
K. Reynolds, *Consolidated Nuclear Security, LLC*
T. E. Stover, *Savannah River Nuclear Solutions, LLC*
D. D. Winstanley, *Sellafield Limited*

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.*
R. R. Shackelford (Vice Chair), *Paschal Solutions, 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. Doane, *Framatome, Inc.*
E. P. Elliott, *BWX Technologies, Inc.*
C. M. Hopper, *Individual*
K. D. Kimball, *Individual*
R. A. Knief, *INMM Representative (Employed by Sandia National Laboratories)*
J. A. Miller, *Sandia National Laboratories*
J. W. Munson, *U.S. Nuclear Regulatory Commission*
S. P. Murray, *HPS Representative (Employed by General Electric)*
R. E. Wilson, *U.S. Department of Energy*

Contents

Section	Page
1 Introduction and scope.....	1
1.1 Introduction	1
1.2 Scope	1
2 Definitions	1
2.1 Limitations.....	1
2.2 Shall, should, and may.....	1
2.3 Definitions	1
3 Nuclear criticality safety practices.....	2
3.1 Administrative practices.....	2
3.2 Technical practices	2
4 Parameters, limits, and conditions.....	3
4.1 Unit mass limits	4
4.2 Moderation.....	4
4.3 Position of unit in cell.....	4
4.4 Other reflectors	4
4.5 Over-mass conditions.....	4
4.6 Vault pairs	5
4.7 Reduction factors.....	5
4.8 Aisles.....	5
4.9 Fissile material containment and shelving material.....	5
4.10 Unit subcriticality	5
4.11 Unit spacing.....	5
4.12 Unit shape.....	5
5 Other applications.....	6
5.1 Commingling of dissimilar cells	6
5.2 Interpolation.....	6
5.3 Noncubic cells	6
5.4 Position of unit in cell.....	6
5.5 Array shape.....	6
6 References.....	16

Tables

Table 1	Unit Mass Limit in Kilograms of Uranium per Cell in Water-Reflected Storage Arrays: Metal.....	7
Table 2	Unit Mass Limit in Kilograms of Uranium per Cell in Water-Reflected Storage Arrays: Oxides, 93.2 wt% ²³⁵ U, 6.8 wt% ²³⁸ U.....	8
Table 3	Unit Mass Limit in Kilograms of Uranium per Cell in Water-Reflected Storage Arrays: Oxides, 80 wt% ²³⁵ U, 20 wt% ²³⁸ U.....	9
Table 4	Unit Mass Limit in Kilograms of Uranium per Cell in Water-Reflected Storage Arrays: Oxides, 70 wt% ²³⁵ U, 30 wt% ²³⁸ U.....	10
Table 5	Unit Mass Limit in Kilograms of Uranium per Cell in Water-Reflected Storage Arrays: Oxides, 50 wt% ²³⁵ U, 50 wt% ²³⁸ U.....	11