American Nuclear Society

nuclear criticality safety control of selected actinide nuclides

an American National Standard

REAFFIRMED

September 12, 2019

ANSI/ANS-8.15-2014 (R2019)

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reviewed and reaffirmed with the recognition that it may reference other standards and documents that may have been superseded or withdrawn.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

La Grange Park, Illinois 60526 USA

ANSI/ANS-8.15-2014

ANSI/ANS-8.15-2014

American National Standard Nuclear Criticality Safety Control of Selected Actinide Nuclides

Secretariat
American Nuclear Society

Prepared by the
American Nuclear Society
Standards Committee
Working Group ANS-8.15

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

Approved October 10, 2014
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. Responses to inquiries about requirements, recommendations, and/or permissive statements (i.e., “shall,” “should,” and “may,” respectively) 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.

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

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 Web site or by contacting the ANS Standards Administrator.

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
ATTN: Standards Administrator
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 Safety Control of Selected Actinide Nuclides," ANSI/ANS-8.15-2014.)

This standard provides guidance for the prevention of criticality accidents in the handling, storing, processing, and transportation of nineteen selected actinide nuclides. The revision revises most of the subcritical limits for the original fourteen nuclides in the 1981 standard and adds five additional nuclides, bringing the total number of nuclides to nineteen. The nuclides were selected on the basis that they have half-lives greater than 45 days and it is judged there is sufficient knowledge of their physical properties to support evaluation of subcritical mass limits. The working group has elected to change the title of the standard by referring to "selected actinide nuclides" rather than "special actinide elements." This is the first revision of ANS-8.15 since its publication in 1981. ANS-8.15 is intended to be complementary to ANSI/ANS-8.1-2014 by providing technical nuclear criticality safety guidance for nuclides other than ^{233}U, ^{235}U, and ^{239}Pu.

In Footnote 5, the 1981 standard speculates that ^{232}U and ^{236}Pu may be "exceptions" to the correlation of critical mass with the even-number and odd-number neutron of the nuclide. Both nuclides are included in the scope of this revision with ^{236}Pu appearing in Table 2, clearly breaking the correlation.

No significant advancement in understanding the criticality of californium isotopes has occurred since 1981. Consequently, the water-reflected subcritical limits for the californium isotopes ^{249}Cf and ^{251}Cf are brought forward to this revision unmodified from the original standard. In addition, isotopic mixtures of plutonium, americium, and curium are not addressed in this revision. Instead, this topic has been moved from Section 6.1 of the 1981 version to an Appendix (called Appendix A). The revised standard urges users to calculate subcritical limits for mixtures using modern methods rather than use the 1981 tables.

Currently, the usage of the words fissionable and fissile within the community is not consistent (see "The Heritage and Usage of the Words Fissionable and Fissile in Criticality," Norman L. Pruvost, J. Eric Lynn and Charles D. Harmon, II, LA-UR-04-6514, Los Alamos National Laboratory, September 2004). Since ANS standards can be viewed as models of proper usage, the working group has chosen to omit these words from the revision. "Modern Fission Theory for Criticality," J. Eric Lynn, LA-14098, Los Alamos National Laboratory, February 2004, examines the understanding gained during the forty-five years since the formulation of the structure underlying the original 1981 Appendix A (primarily from "Considerations on the Probability of Nuclear Fission," R. Vandenbosch and G. T. Seaborg, *The Physical Review*, 110 (2), 507-513, April 1958) and concludes that its basis is empirical, unexplained, and "totally outmoded" (LA-14098) thus, the original 1981 Appendix A has been removed. Appendix B of the original standard was mostly composed of technical reference material and is reproduced from the original standard with no attempt to update any of the information.

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 or a graded approach to quality assurance. The user is advised that one or more of these techniques could enhance the application of this standard.

This standard was prepared by the ANS-8.15 Working Group of the American Nuclear Society. The following members contributed to the development of this standard:

C. T. Rombough, *(Chair), CTR Technical Services, Inc.*

J. Anno, *Institute of Radioprotection and Nuclear Surete-France (retired)*
R. Brewer, *Los Alamos National Laboratory*
A. Clayton, *Atomic Weapons Establishment-United Kingdom*
H. Okuno, *Japan Atomic Energy Agency*
N. L. Pruvost (former Chair), *deceased*
V. Sviridov, *IPPE-Russia*
R. M. Westfall, *Oak Ridge National Laboratory*
K. R. Yates, *Westinghouse Savannah River Company*

The membership of the ANS-8 Subcommittee at the time of its approval of this standard was as follows:

L. Paulson (Chair), *GE Hitachi Nuclear Energy*
B. O. Kidd (Vice Chair), *Babcock & Wilcox Nuclear Operations Group*
M. J. Crouse (Secretary), *Link Solutions, Inc.*

J. S. Baker, *Savannah River Nuclear Solutions, LLC*
E. P. Elliott, *Los Alamos National Laboratory*
D. G. Erickson, *Savannah River Nuclear Solutions, LLC*
A. S. Garcia, *U.S. Department of Energy*
K. Kimball, *Y-12 National Security Complex*
D. Kupferer, *Defense Nuclear Facilities Safety Board*
T. P. McLaughlin, *Individual*
S. Monahan, *Sandia National Laboratories*
J. Morman, *Argonne National Laboratory*
D. A. Reed, *Oak Ridge National Laboratory*
T. A. Reilly, *Washington Safety Management Solutions*
H. Toffer, *Fluor Enterprises Inc.*
C. S. Tripp, *U.S. Nuclear Regulatory Commission*
D. D. Winstanley, *Sallafield Ltd.*

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

R. D. Busch (Chair), *University of New Mexico*
L. L. Wetzel (Vice Chair), *Babcock & Wilcox Nuclear Operations Group*

L. J. Berg, *U.S. Department of Energy*
G. H. Bidinger, *Individual*
W. Doane, *AREVA Inc.*
R. S. Eby, *American Institute of Chemical Engineers (employed by USEC, Inc.)*
C. M. Hopper, *Individual*
R. A. Knief, *Institute of Nuclear Materials Management (employed SNL)*
T. Marenchin, *U.S. Nuclear Regulatory Commission*
L. E. Paulson, *GE Hitachi Nuclear Energy*
S. P. Murray, *Health Physics Society (employed by General Electric Co.)*
R. L. Reed, *URS Safety Management Solutions LLC*
W. R. Shackelford, *Nuclear Fuel Services, Inc.*
R. G. Taylor, *INM Nuclear Safety Services*
R. M. Westfall, *Oak Ridge National Laboratory*
R. E. Wilson, *U.S. Department of Energy*

Contents