American Nuclear Society

REAFFIRMED
June 29, 2016
ANSI/ANS-8.14-2004 (R2016)
November 16, 2011
ANSI/ANS-8.14-2004 (R2011)

use of soluble neutron absorbers in nuclear facilities outside reactors

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reviewed and reaffirmed with the recognition that it may reference other standards and documents that may have been superseded or withdrawn.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 North Kensington Avenue
La Grange Park, Illinois 60526 USA

American National Standard Use of Soluble Neutron Absorbers in Nuclear Facilities Outside Reactors

Secretariat
American Nuclear Society

Prepared by the
American Nuclear Society
Standards Committee
Working Group ANS-8.14

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

Approved May 25, 2004
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

Printed in the United States of America

Foreword

(This foreword is not part of American National Standard "Use of Soluble Neutron Absorbers in Nuclear Facilities Outside Reactors," ANSI/ANS-8.14-2004)

This standard provides guidance for the use of soluble neutron absorbers for process and handling operations in which solutions of neutron absorbers are used for criticality control. This standard supplements the provisions for "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors," ANSI/ANS-8.1-1998, in providing more detailed guidance for the use of soluble neutron absorbers. Soluble neutron absorbers can be used as a primary means of criticality safety control or as defense in depth to provide an additional safety margin and as such make the safety of the system more robust. As with any parameter controlled for criticality safety, and particularly important with soluble neutron absorbers, one must ensure that the controlled parameter is maintained within the range that has been shown by experiment or evaluation to maintain subcriticality.

This standard prepared by Working Group ANS-8.14 was composed of the following members:

T. A. Reilly (Chairman), *Westinghouse Safety Management Solutions, LLC*

R. D. Carter (Past Chairman), *Individual*

L. J. Berg, *U.S. Nuclear Regulatory Commission*
A. S. Garcia, *U.S. Department of Energy, Idaho*
R. A. Knief, *XE Corporation*
R. C. McBroom, *U.S. Department of Energy, Oak Ridge Operations Office*
L. M. Montierth, *Idaho National Engineering and Environmental Laboratory*
J. A. Morman, *Argonne National Laboratory*
V. L. Risner, *USEC*
S. K. Skiles, *NuclearSafety Associates*
R. E. Wilson, *U.S. Department of Energy, Rocky Flats Environmental Technology Site*

This standard was prepared under the guidance of Subcommittee 8, Fissionable Materials Outside Reactors, of the American Nuclear Society. Subcommittee 8 at the time of initial ballot was composed of the following members:

T. P. McLaughlin (Chairman), *Los Alamos National Laboratory*
J. A. Schlesser (Secretary), *Westinghouse Safety Management Solutions, LLC*

F. M. Alcorn, *Individual*
E. D. Clayton, *Individual*
A. S. Garcia, *U.S. Department of Energy, Idaho*
N. Harris, *BNFL*
C. M. Hopper, *Oak Ridge National Laboratory*
R. Kiyose, *Individual*
R. A. Libby, *Pacific Northwest National Laboratory*
D. A. Reed, *Oak Ridge National Laboratory*
T. A. Reilly, *Westinghouse Safety Management Solutions, LLC*
H. Toffer, *Fluor Federal Services*
G. E. Whitesides, *Individual*

Consensus Committee N16, Nuclear Criticality Safety, was composed of the following members at the time of approval:

C. M. Hopper (Chairman), *Oak Ridge National Laboratory*
R. A. Knief (Vice-Chairman), *XE Corporation*

G. H. Bidinger, *Individual*
R. D. Busch, *University of New Mexico*
M. S. Chatterton, *U.S. Nuclear Regulatory Commission*
H. L. Dodds, Jr., *University of Tennessee*
R. S. Eby, *American Institute of Chemical Engineers*
C. D. Manning, *Framatome ANP*
B. McLeod, *Institute of Nuclear Materials Management*
S. P. Murray, *Health Physics Society*

H. C. Paxton, *Individual*
R. L. Reed, *Westinghouse Safety Management Solutions, LLC*
B. M. Rothleder, *U.S. Department of Energy*
F. W. Sanders, *Individual*
D. R. Smith, *Individual*
R. G. Taylor, *Individual*
J. T. Thomas, *Individual*
R. M. Westfall, *Oak Ridge National Laboratory*

Contents

Section		Page
1	Introduction	1
2	Scope	1
3	Definitions	1
3.1	Limitations	1
3.2	Shall, Should, May	1
3.3	Glossary of Terms	1
4	Administrative Requirements and Guidance	2
4.1	Neutron Absorber Selection	2
4.2	System Design and System Modifications	2
4.3	Criticality Safety Evaluations	2
4.4	Quality Control Program	3
4.5	Facility Operation with Soluble Absorbers	3
5	References	3

Use of Soluble Neutron Absorbers in Nuclear Facilities Outside Reactors

1 Introduction

Guidance for criticality control in process and handling operations with fissile material is presented in American National Standard "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors," ANSI/ANS-8.1-1998 [1].[1)] However, for solutions the single parameter subcritical limits on unit mass, volume, concentration, and geometric dimensions can be highly restrictive. Significantly larger limits are possible if soluble neutron absorbers[2)] are present in such solutions.

ANSI/ANS-8.1-1998 provides general guidance for the use of soluble neutron absorbers for criticality accident prevention. This standard[3)] provides specific guidance for the use of soluble neutron absorbers for criticality control. Experience has shown that operations involving the use of such absorbers can be performed both safely and economically. When soluble neutron absorbers are present, but are not required for nuclear criticality safety, their use is outside the scope of this standard. Separate standards have been developed to address specific applications of neutron absorbers. Examples are American National Standard "Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material," ANSI/ANS-8.5-1996 [2] and American National Standard "Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors," ANSI/ANS-8.21-1995 [3].

2 Scope

This standard provides guidance for the use of soluble neutron absorbers for criticality control. This standard addresses neutron absorber selection, system design and modifications, safety evaluations, and quality control programs.

3 Definitions

3.1 Limitations

The definitions given below and in Sec. 3.3, "Glossary of Terms," are of a restricted nature for the purpose of this standard. Other specialized terms are defined in *Glossary of Terms in Nuclear Science and Technology* [4] and "Glossary of Nuclear Criticality Terms" [5].

3.2 Shall, should, and may

The word "shall" is used to denote a requirement; the word "should" is used to denote a recommendation; and the word "may" is used to denote permission, neither a requirement nor a recommendation. To conform to this standard, all operations shall be performed in accordance with its requirements but not necessarily with its recommendations. When recommendations are not implemented, justification shall be documented.

3.3 Glossary of terms

neutron absorber: A neutron-capture material[4)]; also referred to as a neutron poison.

nuclear criticality safety: Protection against the consequences of a criticality accident, preferably by prevention of the accident.

soluble neutron absorber: Any neutron poison easily dispersed in liquid, solution, or

---

[1)] Numbers in brackets refer to corresponding numbers in Section 5, "References."

[2)] Strictly speaking, *absorption* is defined as "the neutron induced reaction including fission where the neutron ceases to exist as a free particle." *Capture* is "neutron absorption not leading to fission or other production." However, by nuclear criticality safety convention, use of the terms *absorption* or *absorber* in the sense of this standard denotes the *capture* process.

[3)] The current standard, ANSI/ANS-8.14-2004, is herein referred to as "this standard."

[4)] As applied in nuclear criticality safety, *absorber* implies *nonfission* absorption that is *capture*. (See also footnote 2 above.)