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American Nuclear Society

REAFFIRMED

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use of borosilicate-glass Raschig rings as a neutron absorber in solutions of fissile material

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reviewed and reaffirmed with the recognition that it may reference other standards and documents that may have been superseded or withdrawn.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

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American National Standard
Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material

Secretariat
American Nuclear Society

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American National Standard

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Foreword

(This Foreword is not a part of American National Standard Use of Borosilicate Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material, ANSI/ANS-8.5-1996.)

This standard provides guidance for the use of borosilicate-glass Raschig rings as a neutron absorber for criticality control in plants processing fissile materials. It also specifies maximum concentrations of homogeneous solutions of uranium and plutonium in vessels of unlimited size when packed with rings.

This standard was first approved as N16.4-1971, revised as ANSI/ANS-8.5-1979, and again revised as ANSI/ANS-8.5-1986, as a result of the prescribed periodic review. Although the general use of neutron absorbers, including Raschig rings, for criticality control dates back to 1958, some applications were recorded as early as the mid-1940s.

The early experimental data forming the basis for some of the specifications in this standard and a review of the early experience with Raschig rings were reported by Nichols et.al.* before the first publication of this standard. Additional data that provides bases for other portions of this standard have also been published.**

Changes in this revision of the standard are primarily in two areas. First, references to specific methods of analysis of Raschig ring properties have been removed and collected in the Appendix, to illustrate suggested methods which may be used. Whatever methods are used must be documented and independently reviewed. Second, emphasis has been placed on the use of control Raschig rings and trends in their (non-destructively) measured properties to determine the frequency of maintenance tests. Both of these reflect up-to-date concepts in assuring that the properties needed for criticality safety actually exist, and continue to exist, during service in vessels packed with Raschig rings.

Working Group ANS-8.5 had the following membership during the creation of this revision:

N. Ketzlach, Chairman, *Individual*
D. R. Finch, *Westinghouse Savannah River Company*
R. E. Rothe, *Individual*

Also contributing to this revision were:

P. B. Adams, *Precision Analytical*
F. M. Alcorn, *The Babcock & Wilcox Company*
B. B. Ernst, *American Nuclear Insurers*
J. E. Hicks, *Rocky Flats Plant*
J. D. McCarthy, *Individual*
R. E. Wilson, *Rocky Flats Plant*

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* J. P. Nichols, C. L. Schuske, and D. W. Magnuson, *Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material*, Y-DCD-8, Oak Ridge Y-12 Plant, Oak Ridge, TN, 1971.

** P.B. Adams, "Glass Containers for Ultrapure Solutions," Chapter 14 in *Ultrapurity*, edited by M. Zieff and R. Speights, Marcel Dekker, Inc., New York, 1972; and N. Ketzlach, "Proposed Extension of Raschig Ring Standard to Low Enriched Uranium Fuels," *Nuclear Technology*, 42, 65, 1979.

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The development of the standard and its maintenance were performed under Subcommittee ANS-8, Fissionable Materials Outside Reactors, of the Standards Committee of the American Nuclear Society. At the time of approval of the revision ANS-8 had the following membership:

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J. C. Schlesser, Secretary, *Los Alamos National Laboratory*
F. M. Alcorn, *The Babcock & Wilcox Company*
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D. R. Smith, *Individual*
J. T. Thomas, *Individual*
H. Toffer, *Westinghouse Hanford Company*
G. E. Whitesides, *Oak Ridge National Laboratory*

Consensus Committee N16, Nuclear Criticality Safety, had the following membership when it reviewed and approved this standard:

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Elizabeth B. Johnson, Secretary

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R. D. Busch ..... University of New Mexico
S. P. Congdon ..... ASTM (GE Nuclear Energy)
H. L. Dodds, Jr. ..... University of Tennessee
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F. W. Sanders ..... Individual
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Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material

1. Scope

This standard provides guidance for the use of borosilicate-glass Raschig rings as a neutron absorber for criticality control in ring-packed vessels containing solutions of ^{235}U, ^{239}Pu, or ^{233}U. The chemical and physical environment, properties of the rings and packed vessels, maintenance inspection procedures, and operating guidelines are specified.

2. Definitions

2.1 Limitations. The definitions given below are of a restricted nature for the purposes of this standard. Other specialized terms are defined in the American Nuclear Society's publication, *Glossary of Terms in Nuclear Science and Technology* [1].[1]

2.2 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.

2.3 Glossary of Terms

agitation. The physical movement of the glass rings relative to one another that may cause breakage or gravitational settling.

control Raschig rings (controlled sample). Raschig rings that are periodically removed from service for scheduled measurements, and then are returned to service after these short test periods.

glass volume fraction. The fraction of the interior volume of a Raschig ring-filled vessel that is occupied by the glass in the rings.

Raschig ring (ring). A small, hollow, borosilicate-glass cylinder having approximately equal length and diameter.

solution. Liquid containing dissolved fissile material, or a suspension of that fissile material in the liquid. This includes aqueous (water based) solutions but excludes those where the hydrogen is replaced by either deuterium or tritium. It also includes organic liquids, provided that their hydrogen content falls within the range specified in the note in Section 6 (see page 4).

sparging. The act of flowing air, gas, or steam through liquid in a vessel.

trending. The extrapolation of data from periodic non-destructive measurements of a control Raschig ring's physical and chemical properties, and from certain properties of the vessel, to predict changes with time in the properties measured.[2]

vessel. A container designed to hold solution. This includes any volume within which criticality control is provided by Raschig rings.

3. General Requirements

The purpose of Raschig rings in criticality safety applications is to assure subcriticality for normal and credible abnormal operating conditions over the operating life of a vessel. General requirements for use of Raschig rings for criticality control are:

(1) The nuclear criticality safety criteria of the current version of American National Standard Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors, ANSI/

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

[2] Industrial experience shows that very benign applications have much less impact upon the chemical and physical properties of Raschig rings. Therefore, rings used in such applications need not be subject to the same inspection frequency as for more hostile environments. The trending analysis allows for that real situation and still covers the worst-case conditions covered by this standard.