This is a preview of "ANSI/ANS-8.9-1987 (R...". Click here to purchase the full version from the ANSI store.

American Nuclear Society

REAFFIRMED
May 13, 1987
ANSI/ANS-8.9-1987

nuclear criticality safety criteria for steel-pipe intersections containing aqueous solutions of fissile material

WITHDRAWN
May 13, 1997
ANSI/ANS-8.9-1987

an American National Standard

No longer being maintained as an American National Standard. This standard may contain outdated material or may have been superseded by another standard. Please contact the ANS Standards Administrator for details.

published by the
American Nuclear Society
555 North Kensington Avenue
La Grange Park, Illinois 60525 USA

This is a preview of "ANSI/ANS-8.9-1987 (R...". Click here to purchase the full version from the ANSI store.

ANSI/ANS-8.9-1987
Revision of
ANSI/ANS-8.9-1978

American National Standard
Nuclear Criticality Safety Criteria for Steel-Pipe Intersections Containing Aqueous Solutions of Fissile Materials

Secretariat
American Nuclear Society

Prepared by the
American Nuclear Society
Standards Committee
Working Group ANS-8.9

Published by the
American Nuclear Society
555 North Kensington Avenue
La Grange Park, Illinois 60525 USA

Approved April 3, 1987
by the
American National Standards Institute, Inc.

This is a preview of "ANSI/ANS-8.9-1987 (R...". Click here to purchase the full version from the ANSI store.

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 assure 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 60525 USA

Copyright © 1987 by American Nuclear Society.

Any part of this standard may be quoted. Credit lines should read "Extracted from American National Standard ANSI/ANS-8.9-1987 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

This is a preview of "ANSI/ANS-8.9-1987 (R...". Click here to purchase the full version from the ANSI store.

Foreword

(This Foreword is not a part of American National Standard Nuclear Criticality Safety Criteria for Steel-Pipe Intersections Containing Aqueous Solutions of Fissile Materials, ANSI/ANS-8.9-1987.)

Basic parameters and practices for nuclear criticality control outside reactors are described in American National Standard for Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors, ANSI/ANS-8.1-1983, and in documents referenced therein. However, for the most part, the data in that standard are single parameter limits.

In the past there has been a paucity of experimental and calculated data for geometric arrangements, such as crosses, ells, and tees, for storage and processing of aqueous solutions of fissile materials in pipes. This situation resulted in overly conservative applications which became evident soon after Work Group 8.9 undertook the drafting of a standard on this subject in 1968. Over the succeeding years, additional experimental data and advanced computational technology became available and now provide the means to reduce the conservatism in industrial practice and permit greater flexibility in process applications. The American National Standard Nuclear Criticality Safety for Pipe Intersections Containing Aqueous Solutions of Enriched Uranyl Nitrate, ANSI/ANS-8.9-1978, has been extended to include typical aqueous solutions of fissile materials and, in particular, uranium containing no more than 5 wt% ^{235}U. Acceptable configurations are presented as standard schedule pipe sizes for a variety of parameters.

In order to facilitate the applicability of this standard allowances have been made for situations which cannot be known or controlled absolutely. The specifications given in this standard are based upon validated calculations in which consideration of an adequate margin of subcriticality included variations in chemical concentrations ($k_{eff} \sim 0.03$), a bias in calculations of solution systems ($k_{eff} \sim 0.02$), the influence of container materials ($k_{eff} \sim 0.05$), and a minimum margin of subcriticality ($k_{eff} \sim 0.05$). Thus, the systems as specified have a nominal k_{eff} of 0.85. Submerged intersections have a nominal k_{eff} of 0.90. Generally, fissile and other materials will be present in addition to aqueous fissile solutions contained in piping. It will be necessary for a safety specialist to evaluate their reactivity contribution to proposed pipe intersections in order to confirm compliance with requirements of the standard. It would be unusual for a design not to require review by a safety specialist.

This standard was prepared by Work Group ANS-8.9, under the guidance of American Nuclear Society Standards Subcommittee 8. The Work Group, chaired by J. T. Thomas, was comprised of the members of the Subcommittee 8 and J. E. Bigelow, Oak Ridge National Laboratory.

The membership of Subcommittee 8, Fissionable Materials Outside Reactors, at the time of preparation and approval of this revision was:

J. T. Thomas, Chairman, *Martin Marietta Energy Systems, Inc.*
E. B. Johnson, Secretary, *Oak Ridge National Laboratory*
F. M. Alcorn, *Babcock and Wilcox Company*
H. K. Clark, *Savannah River Laboratory*
E. D. Clayton, *Battelle Pacific Northwest Laboratories*
D. M. Dawson, *Battelle Memorial Institute*
M. C. Evans, *British Nuclear Fuels plc*
N. Ketzlach, *U. S. Nuclear Regulatory Commission*
R. Kiyose, *University of Tokyo*
W. G. Morrison, *Exxon Nuclear Idaho Co., Inc. (Retired)*
D. R. Smith, *Los Alamos National Laboratory*
G. E. Whitesides, *Martin Marietta Energy Systems, Inc.*
F. E. Woltz, *Goodyear Atomic Corporation*

This is a preview of "ANSI/ANS-8.9-1987 (R...". Click here to purchase the full version from the ANSI store.

Consensus Committee N16, Nuclear Criticality Safety, which reviewed and approved this standard in 1985, had the following membership:

Dixon Callihan, Chairman
E. B. Johnson, Secretary

Alex F. Perge ..... American Institute of Chemical Enginers
Dixon Callihan ..... American Nuclear Society
Ricardo Artigas ..... American Society for Testing and Materials (Liaison only)
D. Frank Cronin ..... Atomic Industrial Forum
Leo E. Hansen ..... Exxon Nuclear Company, Inc.
Representative not Assigned ..... Health Physics Society
C. Leslie Brown ..... Institute of Nuclear Materials Management
William T. Mee, alt.
William R. Waltz ..... Savannah River Laboratory
Blake P. Brown ..... U.S. Department of Energy
George H. Bidinger ..... U.S. Nuclear Regulatory Commission
Elizabeth B. Johnson, Individual
Hugh C. Paxton, Individual
Fred W. Sanders, Individual

This is a preview of "ANSI/ANS-8.9-1987 (R...". Click here to purchase the full version from the ANSI store.

Contents

This is a preview of "ANSI/ANS-8.9-1987 (R...". Click here to purchase the full version from the ANSI store.

This is a preview of "ANSI/ANS-8.9-1987 (R...". Click here to purchase the full version from the ANSI store.

Nuclear Criticality Safety Criteria for Steel-Pipe Intersections Containing Aqueous Solutions of Fissile Materials

1. Introduction

This standard provides criteria and data based on criticality experiments and validated calculations[1-6] which are generally applicable to homogeneous aqueous solutions of fissile materials. It includes specific information on fissile solutions containing uranium highly enriched in the ^{235}U or ^{233}U isotope, plutonium, and uranium solutions having a ^{235}U content not exceeding 5 wt% of the total uranium.

2. Scope

This standard is applicable to the storage, transfer, and processing of homogeneous aqueous solutions of uranium and plutonium in intersecting schedule 10, or heavier, steel pipes. No information is included on specific chemical and mechanical technology, on fluid dynamics, or on other engineering fundamentals also required in safe design of process equipment.

3. Definitions

3.1 Limitations. The definitions given below are restricted to the purposes of this standard. Other specialized terms are defined in the Glossary of Terms in Nuclear Science and Technology [1].[7]

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

area of intersection. The area of the solution within an arm which intersects a plane tangent to the column at the point where the axis of the arm intersects the surface of the column. (See Fig. 1.)

arm. Any pipe intersecting a column.

column. The pipe of largest diameter in a system of intersecting pipes.

environmental factors. Conditions of the environment, usually not directly related to the process, that may affect the margin of subcriticality of a system and that could be subject to change.

full reflector. A closely fitting, effectively infinite thickness of water, or its equivalent, surrounding the system of pipes.

intermediate reflector. A neutron reflector that contributes reactivity to a column with intersecting arms not exceeding that reactivity corresponding to the presence of a concrete wall in contact with the column and arms in a 2-m-square room having 30-cm-thick concrete walls and floor. (See Fig. 2.)

---

[1]J. T. Thomas, "Reflectors, Infinite Cylinders, Intersecting Cylinders, and Nuclear Criticality," *Nucl. Sci. Eng.*, **67**, 279 (1978).

[2]N. F. Cross, G. E. Whitesides, and R. J. Hinton, "Monte Carlo Analysis of Experimentally Critical Pipe Intersections," *Trans. Am. Nucl. Soc.*, **17**, 268 (1973).

[3]Deanne Dickinson, "Calculations for Pipe Intersections Containing Fissile Solution," RFP-1499, Dow Chemical U.S.A., Rocky Flats Division (1970).

[4]B. B. Ernst and C. L. Schuske, "Empirical Method for Calculating Pipe Intersections Containing Fissile Solutions," RFP-1197, Dow Chemical U.S.A., Rocky Flats Division (1968).

[5]J. K. Fox, L. W. Gilley, and D. Callihan, "Critical Mass Studies, Part IX, Aqueous ^{235}U Solutions," ORNL-2367, Oak Ridge National Laboratory (1958).

[6]E. B. Johnson, "The Nuclear Criticality of Intersecting Cylinders of Uranyl Fluoride Solutions," Y-DR-129, Oak Ridge Y-12 Plant (1974).

[7]Numbers in brackets refer to corresponding numbers in Section 7, References.