American Nuclear Society

WITHDRAWN

nuclear criticality control and safety of homogeneous plutonium-uranium fuel mixtures outside reactors

an American National Standard



published by the American Nuclear Society 555 North Kensington Avenue La Grange Park, Illinois 60525 USA American National Standard for Nuclear Criticality Control and Safety of Homogeneous Plutonium-Uranium Fuel Mixtures Outside Reactors

Secretariat American Nuclear Society

Prepared by the American Nuclear Society Standards Committee Work Group ANS-8.12

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

Approved July 17, 1978 by the American National Standards Institute, Inc.

American National Standard

An American National Standard implies a consensus of those substantially concerned with its scope and provisions. An American National Standard is intended as a guide to aid the manufacturer, the consumer, and the general public. The existence of an American National Standard does not in any respect preclude anyone, whether he has approved the standard or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standard. American National Standards are subject to periodic review and users are cautioned to obtain the latest editions.

CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken to reaffirm, revise, or withdraw this Standard no later than five years from the date of publication. Purchasers of this Standard may receive current information, including interpretation, on all standards published by the American Nuclear Society by calling or writing to the Society.

Published by

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

Price: \$22.00

Copyright [®] 1978 by American Nuclear Society.

Any part of this Standard may be quoted. Credit lines should read "Extracted from American National Standard ANSI/ANS-8.12-1978, 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

Foreword

(This Foreword is not a part of American National Standard for Nuclear Criticality Control and Safety of Homogeneous Plutonium-Uranium Fuel Mixtures Outside Reactors, ANSI/ANS-8.12-1978.)

This standard provides guidance for the prevention of criticality accidents in the handling, storing, processing, and transporting of plutonium-uranium fuel mixtures outside reactors and is applicable to all operations involving homogeneous mixtures of plutonium and natural uranium. It constitutes an extension of the American National Standard for Nuclear Criticality Safety in Operations With Fissionable Materials Outside Reactors, N16.1-1975/ANS-8.1.

This standard was prepared by Work Group ANS-8.12 of Subcommittee 8 of the Standards Committee of the American Nuclear Society. The data serving as the bases of the subcritical limits for the Standard have been summarized in a paper entitled "Basis for Subcritical Limits in Proposed Criticality Safety Standard for Mixed Oxides", *Nucl. Technol.*, 35, 97 (1977) authored by the ANS-8.12 Work Group members. The Work Group was composed of:

- E. D. Clayton, Chairman, Battelle-Pacific Northwest Laboratories
- R. Artigas, General Electric Company
- C. L. Brown, Battelle-Pacific Northwest Laboratories
- J. H. Chalmers, Health and Safety Executive, U. K. Nuclear Installations Inspectorate
- H. K. Clark, Savannah River Laboratory
- N. Ketzlach, U. S. Nuclear Regulatory Commission
- R. Kiyose, University of Tokyo
- D. W. Magnuson, Oak Ridge Gaseous Diffusion Plant
- D. R. Smith, Los Alamos Scientific Laboratory
- G. Walker, U. K. Atomic Energy Authority

Subcommittee 8, Fissionable Materials Outside Reactors, of the Standards Committee of the American Nuclear Society, had the following members at the time this standard was approved:

- J. D. McLendon, Chairman, Union Carbide Corp., Nuclear Division, Oak Ridge Y-12 Plant
- F. M. Alcorn, Babcock and Wilcox Company
- H. K. Clark, Savannah River Laboratory
- E. D. Clayton, Battelle-Pacific Northwest Laboratories
- D. M. Dawson, General Electric Company
- E. B. Johnson, Secretary, Oak Ridge National Laboratory
- W. A. Johnson, U. S. Energy Research and Development Administration
- W. G. Morrison, Allied Chemical Corporation
- N. Ketzlach, U. S. Nuclear Regulatory Commission
- D. R. Smith, Los Alamos Scientific Laboratory
- J. T. Thomas, Oak Ridge National Laboratory
- G. E. Whitesides, Oak Ridge National Laboratory
- F. E. Woltz, Goodyear Atomic Corporation

The American National Standard Committee N16, Nuclear Criticality Safety, which reviewed and approved this Standard in 1977, had the following membership:

Dixon Callihan, Chairman E. B. Johnson, Secretary

Organization Members

Name of Representative

H. C. Paxton

American Institute of Chemical Engineers American Nuclear Society	A. F. Perge
American Society for Testing and Materials	A. N. Tschaeche
	J. H. Bystrom (Alt)
Atomic Industrial Forum, Incorporated	
Health Physics Society	
	F. F. Haywood (Alt)
Institute of Nuclear Materials Management	C. L. Brown
	George Wuller (Alt)
U. S. Energy Research and Development Administration	W. C. McCluggage
U. S. Nuclear Regulatory Commission	
U. S. Public Health Service	
Individual Members	E. B. Johnson

Contents	Se	ction	F	Page
	1.	Introduc	tion	1
	2.	Scope		1
	3.	3.1 Lim 3.2 Sha	ons nitations Il, Should, and May ssary of Terms	1
	4.	Nuclear 4.1 Adı	Criticality Safety Practices	2
	5.	5.1 Hor5.2 Var5.3 Dry5.4 LinMix	cal Limits for Plutonium-Uranium Mixtures mogeneous Aqueous Mixtures riation of Subcritical Limits with PuO ₂ Content and Damp Mixed-Oxide Powders niting Concentrations of Plutonium in Unrestricted Quantities of the Oxides and Nitrates of Plutonium and Natural	2
	6.		es	
		Table 1	Subcritical Limits for Uniform Aqueous Mixtures of the Oxides of Plutonium and Natural Uranium	4
		Table 2	Subcritical Mass Limits for Single Units of Homogeneously Mixe Oxides of Plutonium and Natural Uranium at Low Moderation .	
		Table 3	Subcritical Concentration Limits for Plutonium in Homogeneous Mixtures of Plutonium and Natural Uranium of Unlimited Mass	6
		Fig. 1	Limiting Mass of Mixtures of the Oxides of Plutonium and Natural Uranium as a Function of the Plutonium Oxide Content with All Other Parameters Optimized	7
		Fig. 2	Limiting Volume of the Oxides of Plutonium and Natural Uranium as a Function of the Plutonium Oxide Content with All Other Parameters Optimized	8
		Fig. 3	Limiting Diameter of an Infinitely Long Cylinder of the Oxides of Plutonium and Natural Uranium as a Function of the Plutonium Oxide Content with All Other Parameters Optimized.	9
		Fig. 4	Limiting Thickness of an Infinite Slab of the Oxides of Plutonium and Natural Uranium as a Function of the Plutonium Oxide Content with All Other Parameters Optimized.	10
		Fig. 5	Limiting Areal Density of the Oxides of Plutonium and Natural	

Uranium as a Function of the Plutonium Oxide Content

References to Criticality Data on Plutonium-Uranium

Appendix

with All Other Parameters Optimized11

Fuel Mixtures......12