American Nuclear Society

WITHDRAWN
May 13, 1997
ANSI/ANS-8.7
ANSI N16.5-1975 (R1987)

guide for nuclear criticality safety in the storage of fissile materials

an American National Standard

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

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American National Standard Guide for Nuclear Criticality Safety in the Storage of Fissile Materials

Secretariat
American Nuclear Society

Prepared by the
American Nuclear Society
Standards Committee
Working Group ANS-8.7

Published by the
American Nuclear Society
555 North Kensington Avenue
LaGrange Park, Illinios 60525

Approved April 12, 1975
by the
American National Standards Institute, Inc.

Reaffirmed
May 13, 1987

American National Standard

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Published by

American Nuclear Society
244 East Ogden Avenue, Hinsdale, Illinois 60521

Printed in the United States of America

Foreword

(This Foreword is not part of American National Standard Guide for Nuclear Criticality Safety in the Storage of Fissile Materials, N16.5-1975/ANS-8.7.)

As with many standards and guides, the direct solution to a particular problem may not be immediately evident in these pages. The application of some of the mass limits and allowances permitted in storage arrangements requires groups, or individuals, experienced in criticality to examine the possible contingencies attendant to handling massive pieces, to deviations from established procedures, or to those perturbances or mishaps commonly encountered in the use of storage areas. This Guide should not be considered as a substitute for detailed safety analyses, but rather as an integral part of the analysis for the attainment of a sound criticality safety program.

This Guide is an extension of the American National Standard for Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors, N16.1-1975/ANS-8.1. Attention to details of possible single unit criticality is, therefore, presumed. The information presented in this Guide is primarily directed to criticality safety and is based upon validated Monte Carlo calculations. Water is adopted as a standard reflector for storage arrays; because of the variety of concretes and thicknesses that may be experienced in the more usual conditions of storage, an unambiguous presentation of information is difficult.

Issuance of the Guide will provide an orientation and direction to nuclear criticality safety practices. Individual safety groups concerned with specific problems are encouraged to publish solutions to the problems, detailing the bases. In this manner, future reviews and revisions of the Guide may make use of the information to expand the areas of applicability.

Work Group ANS-8.7 of Subcommittee 8 of the American Nuclear Society Standards Committee was established in November, 1967 and prepared a number of drafts of this Guide. One draft experienced a one-year trial use and comment period in 1973. The Guide was approved by the American National Standards Committee N16 in 1974.

The membership of the Work Group ANS-8.7 that originated this document was:

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E. C. Crume, *Oak Ridge National Laboratory*
D. M. Dawson, *General Electric Company*
K. R. Ridgway, *U.S. Nuclear Regulatory Commission*
D. R. Smith, *Los Alamos Scientific Laboratory*

This Guide was prepared under the direction of Subcommittee 8, Fissionable Materials Outside Reactors, of the American Nuclear Society Standards Committee. The membership of this Subcommittee is:

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American National Standards Committee N16, Nuclear Criticality Safety, which reviewed and approved this Standard in 1974, had the following membership:

Dixon Callihan, Chairman
E. B. Johnson, Secretary

Organization Represented	*Name of Representative*
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American Nuclear Society	Dixon Callihan
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Contents

Guide for Nuclear Criticality Safety in the Storage of Fissile Materials

1. Introduction

Current storage arrangements for fissile materials, while safe, are frequently wasteful of storage capacity. Experiments[1,2] with arrays of fissile materials have provided a means of validating computations and have demonstrated the safety of less restrictive mass limits and spacings for storage areas. This Guide is intended to provide general storage criteria based on validated calculations and includes some engineering and administrative practices appropriate to the storage of fissile material.

The tabulated mass limits presented in this Guide are for idealized storage configurations that may not be commonly encountered in practice, but they do provide bases for establishing safe storage arrays. Because this Guide cannot effectively cover all conditions of interest, the use of supplementary information is encouraged.[3] For example, subcriticality of arrays not specified in this Guide may be confirmed by conducting neutron source multiplication measurements described in American National Standard for Safety in Conducting Subcritical Neutron Multiplication Measurements In Situ, N16.3-1975/ANS-8.6.

2. Scope

This Guide is applicable to the storage of fissile materials. Mass and spacing limits are tabulated for uranium containing greater than 30 wt % ^{235}U, for ^{233}U and for plutonium as metals and oxides. Criteria for the range of application of these limits are provided.

[1]J. T. THOMAS, "Critical Three-Dimensional Arrays of U(93.2)-Metal Cylinders," *Nuclear Science and Engineering* 52, 350 (1973).

[2]FINN, H.; PRUVOST, N. L.; KOLAR, O. C.; and PIERCE, G. A., "Summary of Experimentally Determined Plutonium Array Critical Configurations," UCRL-51041, Lawrence Livermore Laboratory, Livermore, California (1971).

[3]Additional guidance may be found in *Nuclear Safety Guide*, TID-7016, Rev. 1, U.S. Atomic Energy Commission, 1961; H. C. Paxton, J. T. Thomas, D. Callihan, and E. B. Johnson, "Critical Dimensions of Systems Containing ^{235}U, ^{239}Pu, and ^{233}U," TID-7028, U.S. Atomic Energy Commission, 1964; H. C. Paxton, "Criticality Control in Operations with Fissile Material," LA-3366, Rev. 1, Los Alamos Scientific Laboratory, Los Alamos, New Mexico, 1972.

3. Definitions

3.1 Limitations. The definitions given below are restricted to the purpose of this Guide.

3.2 Glossary of Terms

3.2.1 shall, should, 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 Guide, all operations shall be performed in accordance with its requirements but not necessarily with its recommendations.

3.2.2 fissile material. A material, other than natural uranium, that is capable of sustaining a neutron chain reaction.

3.2.3 storage unit (unit). A mass of fissile material considered as an entity. The material may be of any shape, and a unit may consist of separate pieces.

3.2.4 storage cell (cell). A volume having defined boundaries within which a storage unit is positioned.

3.2.5 storage array (array). A regular arrangement of storage cells.

3.2.6 validated computational techniques. A calculational method that has been tested, by comparison with experiment, to establish the reliability of results when the method is applied to conditions of interest.

4. Nuclear Criticality Safety Practices

4.1 Administrative Practices

4.1.1 All operations with fissile material, including storage, shall be conducted in accordance with American National Standard for Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors, N16.1-1975/ANS-8.1. This Guide is intended to supplement N16.1-1975/ANS-8.1 by providing storage criteria applicable to many fissile materials.

4.1.2 Methods of storage control and operational practices approved by management shall be described in written procedures. Persons participating in the transfer and storage of material