American Nuclear Society

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nuclear criticality safety in the storage of fissile materials

an American National Standard

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Foreword

(This Foreword is not part of American National Standard for Nuclear Criticality Safety in the Storage of Fissile Materials, ANSI/ANS-8.7-1998.)

As with many standards and guides, the direct solution to a specific 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 contingencies attendant to handling massive pieces, to deviations from established procedures, or to those perturbations or mishaps commonly encountered in storage areas. This standard should be considered not 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 standard is an extension of American National Standard for Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors, ANSI/ANS-8.1-1998. Attention to details of possible single-unit criticality is, therefore, presumed. The information presented in this standard is primarily directed to criticality safety and is based on validated Monte Carlo calculations. Water is adopted as a standard reflector for storage arrays; because of the variety and thicknesses of concretes that may occur in the more usual conditions of storage, an unambiguous presentation of information is difficult.

This standard provides an orientation and direction to nuclear criticality safety practices. Individual safety groups concerned with specific problems are encouraged to publish solutions to these problems, detailing the bases. Future reviews and revisions of this standard may make use of the information to expand the areas of applicability.

Working 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 standard. One draft underwent a one-year trial use and comment period in 1973. This standard was approved by the American National Standards Institute in 1975 as ANSI N16.5-1975 and was reaffirmed in 1987 as ANSI/ANS-8.7-1975 (R1987). This revision includes several textual enhancements and tabulated changes resulting from confirmatory evaluations by Working Group members Kimball and Vessard, and by individuals in industry: Russell L. Bowden of BNFL Consultancy Services, David Hanlon of AEA Technology, E. Fitz Trumble of Westinghouse Savannah River Company, and M. Wesley Waddell of the Oak Ridge Y-12 Plant. These researchers determined that uncertainties associated with the calculated values were larger than previously evaluated. Therefore, this revision includes removal of Table 5.12, Unit Mass Limit in Kilograms of Uranium-233 per Cell in Water-Reflected Storage Arrays, for oxides with H/U $\leq$ 3, 10, and 20, and the removal of limited portions of Tables 5.2, 5.5, and 5.6, Unit Mass Limit in Kilograms of Uranium per Cell in Water-Reflected Storage Arrays, for oxides at 93.2 wt-%, 50 wt-%, and 30 wt-%.

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Contents

Section — Page

1. Introduction 1

2. Scope 1

3. Definitions 1
   3.1 Limitations 1
   3.2 Shall, Should, and May 1
   3.3 Glossary of Terms 1

4. Nuclear Criticality Safety Practices 1
   4.1 Administrative Practices 1
   4.2 Technical Practices 2

5. Parameters, Limits, and Conditions 2
   5.1 Unit Mass Limits 3
   5.2 Moderation 3
   5.3 Position of Unit in Cell 3
   5.4 Other Reflectors 3
   5.5 Double Batching 3
   5.6 Vault Pairs 3
   5.7 Reduction Factors 3
   5.8 Aisles 4
   5.9 Fissile Material Containment and Shelving Materials 4
   5.10 Unit Subcriticality 4
   5.11 Unit Spacing 4
   5.12 Unit Shape 4

6. Other Applications 4
   6.1 Commingling of Dissimilar Cells 4
   6.2 Interpolation 4
   6.3 Noncubic Cells 4
   6.4 Position of Unit in Cell 4
   6.5 Array Shape 4
   6.6 Plutonium-238 4

7. References 4

Tables

Table 5.1 Unit Mass Limit in Kilograms of Uranium per Cell in Water-Reflected Storage Arrays: Metal 6

Table 5.2 Unit Mass Limit in Kilograms of Uranium per Cell in Water-Reflected Storage Arrays: Oxides, 93.2 wt-% ^{235}U, 6.8 wt-% ^{238}U 7

Table 5.3 Unit Mass Limit in Kilograms of Uranium per Cell in Water-Reflected Storage Arrays: Oxides, 80 wt-% ^{235}U, 20 wt-% ^{238}U 8

Table 5.4 Unit Mass Limit in Kilograms of Uranium per Cell in Water-Reflected Storage Arrays: Oxides, 70 wt-% ^{235}U, 30 wt-% ^{238}U 9
Table 5.5 Unit Mass Limit in Kilograms of Uranium per Cell in Water-Reflected Storage Arrays: Oxides, 50 wt-% ^{235}U, 50 wt-% ^{238}U 10
Table 5.6 Unit Mass Limit in Kilograms of Uranium per Cell in Water-Reflected Storage Arrays: Oxides, 30 wt-% ^{235}U, 70 wt-% ^{238}U 11
Table 5.7 Unit Mass Limit in Kilograms of Plutonium per Cell in Water-Reflected Storage Arrays: Metal, 100 wt-% ^{239}Pu 12
Table 5.8 Unit Mass Limit in Kilograms of Plutonium per Cell in Water-Reflected Storage Arrays: Oxides, 100 wt-% ^{239}Pu 13
Table 5.9 Unit Mass Limit in Kilograms of Plutonium per Cell in Water-Reflected Storage Arrays: Metal and Oxides, 94.8 wt-% ^{239}Pu, 5.2 wt-% ^{240}Pu 14
Table 5.10 Unit Mass Limit in Kilograms of Plutonium per Cell in Water-Reflected Storage Arrays: Metal and Oxides, 80 wt-% ^{239}Pu, 20 wt-% ^{240}Pu 15
Table 5.11 Unit Mass Limit in Kilograms of Uranium-233 per Cell in Water-Reflected Storage Arrays 16

Nuclear Criticality Safety in the Storage of Fissile Materials

1. Introduction

Many current storage arrangements for fissile materials, while safe, are wasteful of storage capacity. Experiments with arrays of fissile materials (see References [1] and [2])[1] have provided a means of validating computations, and have demonstrated the safety of mass limits and storage area spacings that are less restrictive than those now in use. This standard 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 standard are for idealized storage configurations. While these configurations may not be commonly encountered in practice, they do provide bases for establishing safe storage arrays. Because this standard cannot effectively cover all conditions of interest, the use of supplementary information (see References [3], [4], and [5]) is encouraged. For example, subcriticality of arrays not specified in this standard may be confirmed by conducting neutron source multiplication measurements as described in American National Standard for Safety in Conducting Subcritical Neutron Multiplication Measurements In Situ, ANSI/ANS-8.6-1983 (R1995) [6].

2. Scope

This standard 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.

3. Definitions

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

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

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

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.

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

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

validated computational technique. A calculational technique that has been validated in conformance with American National Standard for Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors, ANSI/ANS-8.1-1998 [7].

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 ANS-8.1 [7]. This standard is intended to supplement 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 shall be familiar with these procedures. Limits for storage shall be posted.

4.1.3 Management shall provide for inspections to verify compliance with established procedures.

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