ANSI/ANS-8.1-1983

Revision of
ANSI N16.1-1975

American Nuclear Society

REAFFIRMED
November 30, 1988
ANSI/ANS-8.1-1983

WITHDRAWN
September 9, 1998
ANSI/ANS-8.1-1983

nuclear criticality safety in operations with fissionable materials outside reactors

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 This standard may contain outdated material or may have been superseded by another standard.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

ANSI/ANS-8.1-1983

ANSI/ANS-8.1-1983
Revision of
ANSI N16.1-1975

American National Standard for Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors

Secretariat
American Nuclear Society

Prepared by the
American Nuclear Society
Standards Committee
Subcommittee ANS-8

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

Approved October 7, 1983
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CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time.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

Printed in the United States of America

Foreword

(This Foreword is not a part of American National Standard for Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors, ANSI/ANS-8.1-1983.)

This standard provides guidance for the prevention of criticality accidents in the handling, storing, processing, and transporting of fissionable material. It was first approved as American Standard N6.1-1964. A substantial revision that included the specification of subcritical limits applicable to process variables was approved as American National Standard N16.1-1969 and was reaffirmed, with minor revisions, as American National Standard N16.1-1975/ANS-8.1, under the prescribed five-year review. It was subsequently supplemented by American National Standard for Validation of Calculational Methods for Nuclear Criticality Safety, ANSI N16.9-1975/ ANS-8.11. To lessen the proliferation of nuclear criticality safety standards, the two standards have been consolidated in the present prescribed five-year review.

An important part of the present review was the examination of subcritical limits in the standard. In a few cases limits have been increased where the margin of subcriticality seemed unnecessarily large. In other cases, where subcriticality appeared doubtful, the limits have been reduced. Additional limits have been provided where they seemed likely to be useful. The limits make no allowance for operating contingencies (e.g., double batching) or for inaccurate knowledge of process variables (e.g., concentrations, masses, dimensions) and are "maximum subcritical limits." That is, under the stated conditions, the limits are close enough to critical to provide little incentive for attempting to justify slightly larger values, but, concomitantly, they are confidently expected actually to be subcritical. The stated conditions (infinitely long cylinders, absence of neutron-absorbing vessel walls, plutonium solutions without free nitric acid, etc.) are unlikely to be approached in practice; hence if a limit is reached, there will ordinarily be a larger margin of subcriticality than the minimal value used in its derivation. However, no account was taken of this unlikelihood in setting the limits. It is legitimate for the user of the standard, if he so chooses, (conservatively) to make adjustments in the limits to take advantage of the extent to which credible potential conditions may deviate from stated conditions, e.g., to increase a cylinder diameter limit to take advantage of a finite height and of neutron absorption in steel walls.

The prescribed five-year review of American National Standards N16.1-1975/ANS-8.1 and N16.9-1975/ANS-8.11 was performed by Subcommittee 8 of the Standards Committee of the American Nuclear Society, with Dr. H. K. Clark assuming principal responsibility for the revision. Limits were derived in accordance with the standard. The derivations have been reviewed by the subcommittee and have been published, largely in the open literature.

This revised standard was prepared under the guidance of ANS Subcommittee 8, Fissionable Materials Outside Reactors, which had the following membership at the time of its approval of this revision:

American National Standards Committee N16, Nuclear Criticality Safety, which reviewed and approved this revision in 1982, had the following membership:

Dixon Callihan, Chairman
Elizabeth B. Johnson, Secretary

Organization Represented	*Representative*
Allied-General Nuclear Services	William R. Waltz
American Institute of Chemical Engineers	Alex F. Perge
American Nuclear Society	Dixon Callihan
American Society for Testing and Materials (Liaison only)	Ricardo Artigas
Atomic Industrial Forum, Inc.	D. Frank Cronin
Exxon Nuclear Company	Leo E. Hansen
Health Physics Society	Fred W. Sanders
	Norman C. Dyer (Alt.)
Institute of Nuclear Materials Management	Leo E. Hansen
U. S. Department of Energy	Lorin C. Brinkerhoff
U. S. Nuclear Regulatory Commission	George H. Bidinger
Individual Members	C. Leslie Brown
	Elizabeth B. Johnson
	Hugh C. Paxton

Contents

Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors

1. Introduction

Operations with some fissionable materials introduce risks of a criticality accident resulting in a release of radiation that may be lethal to nearby personnel. However, experience has shown that extensive operations can be performed safely and economically when proper precautions are exercised. The few criticality accidents that have occurred show frequency and severity rates far below those typical of nonnuclear accidents. This favorable record can be maintained only by continued adherence to good operating practices such as are embodied in this standard; however, the standard, by itself, cannot establish safe processes in an absolute sense. Good safety practices must recognize economic considerations, but the protection of operating personnel[1] and the public must be the dominant consideration.

2. Scope

This standard is applicable to operations with fissionable materials outside nuclear reactors, except the assembly of these materials under controlled conditions, such as in critical experiments. Generalized basic criteria are presented and limits are specified for some single fissionable units of simple shape containing ^{233}U, ^{235}U, or ^{239}Pu, but not for multiunit arrays.[2] Requirements are stated for establishing the validity and areas of applicability of any calculational method used in assessing nuclear criticality safety. This standard does not include the details of administrative controls, the design of processes or equipment, the description of instrumentation for process control, or detailed criteria to be met in transporting fissionable materials.

[1]Guidance for establishing an alarm system is contained in American National Standard Criticality Accident Alarm System, ANSI/ANS-8.3-1979.

[2]Limits for certain multiunit arrays are contained in American National Standard Guide for Nuclear Criticality Safety in the Storage of Fissile Materials, ANSI/ANS-8.7-1982.

3. Definitions

3.1 Limitations. The definitions given below are of a restricted nature for the purposes of this standard. Other specialized terms are defined in American National Standard Glossary of Terms in Nuclear Science and Technology, ANSI N1.1-1976/ANS-9 [1].[3]

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. In order 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(s) of applicability. The ranges of material compositions and geometric arrangements within which the bias of a calculational method is established.

areal density. The total mass of fissionable material per unit area projected perpendicularly onto a plane. (For an infinite, uniform slab, it is the product of the slab thickness and the concentration of fissionable material within the slab.)

bias. A measure of the systematic disagreement between the results calculated by a method and experimental data. The uncertainty in the bias is a measure of both the precision of the calculations and the accuracy of the experimental data.

calculational method (method). The mathematical equations, approximations, assumptions, associated numerical parameters (e.g., cross sections), and calculational procedures which yield the calculated results.

controlled parameter. A parameter that is kept within specified limits.

criticality accident. The release of energy as a result of accidentally producing a self-sustaining or divergent neutron chain reaction.

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