American Nuclear Society

REAFFIRMED

May 31, 2012

ANSI/ANS-8.26-2007 (R2012)

# criticality safety engineer training and qualification program

an American National Standard

This standard has been reviewed and reaffirmed with the recognition that it may reference other standards and documents that may have been superseded or withdrawn. The requirements of this document will be met by using the version of the standards and documents referenced herein. It is the responsibility of the user to review each of the references and to determine whether the use of the original references or more recent versions is appropriate for the facility. Variations from the standards and documents referenced in this standard should be evaluated and documented.
This standard does not necessarily reflect recent industry initiatives for risk informed decision-making or a graded approach to quality assurance. Users should consider the use of these industry initiatives in the application of this standard.

ANSI/ANS-8.26-2007

published by the
American Nuclear Society
555 North Kensington Avenue
La Grange Park, Illinois 60526 USA

**ANSI/ANS-8.26-2007**

# American National Standard
# Criticality Safety Engineer Training and Qualification Program

Secretariat
**American Nuclear Society**

Prepared by the
**American Nuclear Society**
**Standards Committee**
**Working Group ANS-8.26**

Published by the
**American Nuclear Society**
**555 North Kensington Avenue**
**La Grange Park, Illinois 60526 USA**

Approved June 20, 2007
by the
**American National Standards Institute, Inc.**

## 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 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 ensure 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 60526 USA**



Printed in the United States of America

# Foreword

(This Foreword is not a part of American National Standard, "Criticality Safety Engineer Training and Qualification Program," ANSI/ANS-8.26-2007.)

Appendix A of ANSI/ANS-8.1-1998 (R2007) reminds us that the few criticality accidents that occurred worldwide resulted from a failure to anticipate the unexpected in fissionable material handling and processing operations. To be a criticality safety engineer, one must not only be familiar with nuclear criticality and the factors that influence it but also recognize that criticality safety is only meaningful within the context of fissionable material operations. Minimizing the risk of a criticality accident to an acceptable level within the scope of operations is the basic function of every person who works in the field of criticality safety. This requires personnel who are thoroughly familiar with fissionable material processes and who work in close cooperation with operations personnel and management. The goal of the criticality safety engineer is to assist operating personnel in the conduct of safe and efficient operations while maintaining an acceptably low risk of a criticality accident.

The art and science of nuclear criticality safety are complex. In addition to nuclear physics, an effective criticality safety engineer develops a multidisciplinary understanding of electrical (software, hardware), chemical, mechanical (structural, heat transfer), material, industrial (procedural, ergonomic), human performance (behavioral), and economic issues related to fissionable material process control.

Key elements of an effective training program include an understanding of the impact of controlled parameters on the reactivity of a defined system and an ability to effectively predict the reactivity of a system or process. A careful review of lessons learned from previous criticality accidents and other site-specific nonconformances can also be considered.

Training to the program content elements in this standard can enable criticality safety engineers to become effective advocates to foster a nuclear safety–conscious workforce and sound nuclear safety practices in support of facility operations personnel. One key element of the training program is practical experience with the parameters that affect the neutron multiplication of fissionable material systems. This experience can be achieved through hands-on criticality safety courses, conduct of experiments in a research reactor environment, or participation in critical experiments.

This standard provides guidance for the *content* of training programs for nuclear criticality safety specialists who are responsible for developing the analyses, controls, and safety documentation required for the safe handling of fissionable materials. This standard presents a matrix of training and qualification criteria based on education and experience combined with individual job functions and provides for qualification of experienced staff by documentation. This standard stresses the necessity to integrate standard training subjects with operational experience in order to qualify as a criticality safety engineer.

This standard *does not specify how* to develop or execute these training and qualification programs; it provides only the elements that should be included in the programs. It is not intended that these programs lead to any professional engineer certification, only that they create a common basis for criticality safety engineer qualification across the diverse organizations that rely on these specialists. Standard criteria for establishing scopes, functions, and levels of competence for safety professionals are available in ASSE/ANSI Z590.2-2003 and ASSE/ANSI Z590.1-200X, published or in draft form by the American Society of Safety Engineers.

This standard was prepared by the ANS-8.26 Working Group, which had the following membership at the time of publication:

J. A. Morman (Chair), *Argonne National Laboratory*

W. A. Blyckert, *Mohr and Associates*
K. J. Carroll, *BWXT Y-12*
M. R. Crowell, *Individual*
J. R. Felty, *Science Applications International Corporation*
A. S. Garcia, *U.S. Department of Energy*
C. M. Hopper, *Oak Ridge National Laboratory*
S. F. Kessler, *Lawrence Livermore National Laboratory*
R. A. Knief, *XE Corporation*
B. L. Lee, *BWXT Y-12*
J. N. McKamy, *National Nuclear Security Administration*
L. E. Paulson, *GE/Global Nuclear Fuel–Americas*
R. E. Pevey, *University of Tennessee*
C. L. Pope, *Idaho National Laboratory*
T. D. Powell, *U.S. Nuclear Regulatory Commission*
C. E. Reed, *BWX Technologies, Inc.*
K. H. Reynolds, *BWXT Y-12*
B. J. Rumble, *NISYS Corporation*
N. F. Schwers, *Sandia National Laboratories*
J. T. Stewart, *Department for Transport—United Kingdom*
F. E. Trumble, *Washington Safety Management Solutions, LLC*
R. E. Wilson, *U.S. Department of Energy*

This standard was prepared under the guidance of Subcommittee 8, Fissionable Materials Outside Reactors, of the American Nuclear Society. Subcommittee 8 had the following membership at the time this standard was approved:

T. P. McLaughlin (Chair), *Los Alamos National Laboratory*
J. A. Schlesser (Secretary), *Washington Safety Management Solutions, LLC*

F. M. Alcorn, *Individual*
H. D. Felsher, *U.S. Nuclear Regulatory Commission*
A. S. Garcia, *U.S. Department of Energy*
N. Harris, *British Nuclear Fuels, PLC*
B. O. Kidd, *BWXT Y-12*
R. A. Libby, *Pacific Northwest National Laboratory*
D. A. Reed, *Oak Ridge National Laboratory*
T. A. Reilly, *Individual*
H. Toffer, *Fluor Federal Services*
G. E. Whitesides, *Individual*

Consensus Committee N16, Nuclear Criticality Safety, had the following membership at the time of approval:

C. M. Hopper (Chair), *Oak Ridge National Laboratory*
R. A. Knief (Vice-Chair), *XE Corporation*

G. H. Bidinger, *Individual*
R. D. Busch, *University of New Mexico*
R. S. Eby, *American Institute of Chemical Engineers*
M. A. Galloway, *U.S. Nuclear Regulatory Commission*
C. D. Manning, *AREVA NP*
S. P. Murray, *Health Physics Society*
R. E. Pevey, *University of Tennessee*
R. L. Reed, *Washington Safety Management Solutions, LLC*
B. M. Rothleder, *U.S. Department of Energy*
W. R. Shackelford, *Nuclear Fuel Services, Inc.*
R. G. Taylor, *Individual*
R. M. Westfall, *Oak Ridge National Laboratory*
L. L. Wetzel, *BWX Technologies, Inc.*
R. E. Wilson, *U.S. Department of Energy*

# Contents

# Criticality Safety Engineer Training and Qualification Program

## 1 Introduction

Both ANSI/ANS-8.1-1998 (R2007) [1][1)] and ANSI/ANS-8.19-2005 [2] require that management provide personnel who are skilled in the interpretation of data and analyses pertinent to nuclear criticality safety and who are familiar with operations to provide technical advice. This standard defines and presents guidelines for the content of a training and qualification program for nuclear criticality safety engineers.

This standard defines three categories of criticality safety engineers and differentiates the categories by experience and knowledge. For each of these categories, general guidance is provided in the form of essential competencies that address the broad classes of functions typically carried out by the nuclear criticality safety staff. This standard presents only content elements. It is left to management to create and implement specific training programs to ensure that the nuclear criticality safety staff is vested with the necessary knowledge and experience for specific job tasks.

## 2 Scope

This standard presents the fundamental content elements of a training and qualification program for individuals with responsibilities for performing the various technical aspects of criticality safety engineering. The standard presents a flexible array of competencies for use by management to develop tailored training and qualification programs applicable to site-specific job functions, facilities, and operations.

## 3 Definitions

### 3.1 Limitations

The definitions given below are of a restricted nature for the purpose of this standard. Other specialized terms are defined in *Glossary of Terms in Nuclear Science and Technology* [3].

### 3.2 Shall, should, and may

The word "shall" is used to denote a requirement; the word "should" is used to denote a recommendation; and the word "may" is used to denote permission, neither a requirement nor a recommendation.

### 3.3 Glossary of terms

**criticality safety staff:** The collection of criticality safety engineers, senior criticality safety engineers, criticality safety engineers in training, and other criticality safety technical support personnel.

**facility:** This word is used throughout the standard in a manner consistent with existing, operating facilities; however, it is also intended to apply to facilities that have ceased operations (i.e., in the decommissioning phase), facilities that have not yet been built (i.e., in the design stage), operations with fissionable materials outside structures (e.g., below-grade storage and disposal sites), and the movement of materials between on-site facilities.

**nuclear criticality safety:** Protection against the consequences of a criticality accident, preferably by prevention of the accident.

**nuclear criticality safety evaluation** (NCSE): A formal, technically reviewed analysis that establishes the technical bases, limits, and controls for the nuclear criticality safety of a given operation.

## 4 Management responsibilities

### 4.1 Training and qualification program

ANSI/ANS-8.19-2005 [2] requires management to establish a training and qualification program for nuclear criticality safety staff. The program shall include requirements for demon-

---

[1)] Numbers in brackets refer to corresponding numbers in Sec. 9, "References."