



# Validation of Neutron Transport Methods for Nuclear Criticality Safety Calculations

An American National Standard

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**American National Standard  
Validation of Neutron Transport Methods  
for Nuclear Criticality Safety Calculations**

Secretariat  
**American Nuclear Society**

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**Foreword** (This foreword is not a part of American National Standard “Validation of Neutron Transport Methods for Nuclear Criticality Safety Calculations,” ANSI/ANS-8.24-2017, but is included for informational purposes.)

This standard provides additional details beyond those contained in ANSI/ANS-8.1-1998 (R2007) (W2014), “Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors,” concerning validation of computer-based neutron transport methods used in nuclear criticality safety analyses. A standard on validation for nuclear criticality safety was originally issued as ANSI N16.9/ANS-8.11-1975 (W1983), “Validation of Calculational Methods for Nuclear Criticality Safety.” Upon its withdrawal, the guidance of this standard was subsumed into ANSI/ANS-8.1-1983 (R1988) (W1998), “Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors.” Due to a greater reliance on computer calculations in criticality safety applications in recent years, a separate standard describing the requirements for the validation of computer-based neutron transport methods was again deemed needed. This need led to the development of ANSI/ANS-8.24-2007 (R2012) (W2017), and detailed guidance on validation was removed from ANSI/ANS-8.1 upon its revision as ANSI/ANS-8.1-2014.

The existing database of critical experiments used in validation was developed largely in a period when the fissile material operations and technical criteria were different from many of the current and planned operations involving fissile material. As the number of experiments that focus on current and planned operations has decreased, the industry need to optimize operations and reduce unnecessary conservatism has increased. Thus, the scrutiny and importance placed on validation has increased in recent years. This standard provides requirements and recommendations on proper validation processes and techniques for computer-based neutron transport calculational methods. The ANS-8.24 working group has used its experience, results of conferences on area of applicability and validation, and outside experts to expand on the concepts identified in ANSI/ANS-8.1-1998 (R2007) (W2014). The current revision incorporates user feedback received since the initial issuance in 2007 and comments received during its 2012 reaffirmation. Specific changes include addressing the situation where few or no critical benchmark experiments are available and the potential need for the use of other data beyond critical and exponential experiments, clarifying definitions of bias and other terms, the treatment of apparent outliers, the use of sensitivity/uncertainty methodology in justifying subcritical margin, and the use of correlated experiments. The appendices and references have also been updated.

ANSI/ANS-8.1-2014, “Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors,” describes in Sec. 4.3 the necessity for validation. For validation of neutron transport methods, ANSI/ANS-8.1-2014 defers to ANSI/ANS-8.24-2007 (R2012) (W2017).

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# Validation of Neutron Transport Methods for Nuclear Criticality Safety Calculations

## 1 Introduction

This standard<sup>1)</sup> amplifies the basic requirements and recommendations for validation as described in ANSI/ANS-8.1-2014, “Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors” [1],<sup>2)</sup> as applied to computer-based neutron transport calculational methods. Requirements and recommendations for the validation of neutron transport calculational methods applied to nuclear criticality safety analyses are provided in this standard. In particular, this standard provides requirements and recommendations for selecting benchmarks; estimating the bias and bias uncertainty; selecting appropriate margins, both within and beyond the benchmark applicability; and documenting the validation. To satisfy certain requirements like matching of benchmarks to process systems, an iterative approach may be needed.

This standard uses  $k$ -effective, but other parameters that determine subcriticality can be used.

## 2 Scope

This standard provides requirements and recommendations for validation, including establishing applicability, of neutron transport calculational methods used in determining critical or subcritical conditions for nuclear criticality safety analyses.

## 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* [2] and in “Glossary of Nuclear Criticality Terms” [3].

### 3.2 Shall, should, and may

**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

**benchmark:** A representation of an experiment evaluated for use in validation. The experiment may be critical or slightly subcritical (also called exponential experiment).

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<sup>1)</sup> The current standard, ANSI/ANS-8.24-2017, is hereinafter referred to as “this standard.”

<sup>2)</sup> Numbers in brackets refer to corresponding numbers in Sec. 9, “References.”