



# REGULATORY GUIDE

## OFFICE OF NUCLEAR REGULATORY RESEARCH

### REGULATORY GUIDE 3.71

(Draft was issued as DG-3023, dated May 2005)

## NUCLEAR CRITICALITY SAFETY STANDARDS FOR FUELS AND MATERIAL FACILITIES

### A. INTRODUCTION

This revised regulatory guide provides licensees and applicants with updated guidance concerning criticality safety standards that the U.S. Nuclear Regulatory Commission (NRC) has endorsed for use with nuclear fuels and material facilities. As such, this guide describes methods that the NRC staff considers acceptable for complying with the NRC's regulations in Title 10, Parts 70 and 76, of the *Code of Federal Regulations* (10 CFR Parts 70 and 76).

In 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material," Section 70.20, "General License To Own Special Nuclear Material," states that a specific license is required to acquire, deliver, receive, possess, use, transfer, import, or export special nuclear material. According to 10 CFR 70.22, "Contents of Applications," each application for such a license must contain proposed procedures to avoid nuclear criticality accidents. In 10 CFR Part 76, "Certification of Gaseous Diffusion Plants," Section 76.87, "Technical Safety Requirements," states that the technical safety requirements should reference procedures and equipment that are applicable to criticality prevention.

The NRC staff has developed this regulatory guide to provide guidance on complying with these portions of the NRC's regulations by describing procedures for preventing nuclear criticality accidents in operations that involve handling, processing, storing, and/or transporting special nuclear material at fuel and material facilities. This regulatory guide endorses specific nuclear criticality safety standards developed by the American Nuclear Society's Standards Subcommittee 8 (ANS-8), "Operations with Fissionable Materials Outside Reactors." This guide is not intended to be used by nuclear reactor licensees.

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The U.S. Nuclear Regulatory Commission (NRC) issues regulatory guides to describe and make available to the public methods that the NRC staff considers acceptable for use in implementing specific parts of the agency's regulations, techniques that the staff uses in evaluating specific problems or postulated accidents, and data that the staff need in reviewing applications for permits and licenses. Regulatory guides are not substitutes for regulations, and compliance with them is not required. Methods and solutions that differ from those set forth in regulatory guides will be deemed acceptable if they provide a basis for the findings required for the issuance or continuance of a permit or license by the Commission.

This guide was issued after consideration of comments received from the public. The NRC staff encourages and welcomes comments and suggestions in connection with improvements to published regulatory guides, as well as items for inclusion in regulatory guides that are currently being developed. The NRC staff will revise existing guides, as appropriate, to accommodate comments and to reflect new information or experience. Written comments may be submitted to the Rules and Directives Branch, Office of Administration, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001.

Regulatory guides are issued in 10 broad divisions: 1, Power Reactors; 2, Research and Test Reactors; 3, Fuels and Materials Facilities; 4, Environmental and Siting; 5, Materials and Plant Protection; 6, Products; 7, Transportation; 8, Occupational Health; 9, Antitrust and Financial Review; and 10, General.

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This regulatory guide contains information collections that are covered by the requirements of 10 CFR Part 70, which the Office of Management and Budget (OMB) approved under OMB control number 3150-0009. The NRC may neither conduct nor sponsor, and a person is not required to respond to, an information collection request or requirement unless the requesting document displays a currently valid OMB control number. However, this regulatory guide contains additional information collections that are covered by the requirements of 10 CFR 76.8, "Information collection requirements: OMB approval not required," which apply to a wholly-owned instrumentality of the United States and affect fewer than 10 respondents. As a result, OMB clearance is not required pursuant to the Paperwork Reduction Act (44 U.S.C. 3501, et seq.).

## B. DISCUSSION

The NRC initially issued Regulatory Guide 3.71 in 1998 to provide guidance concerning procedures that the staff considered acceptable for complying with the agency's regulatory requirements in 10 CFR 70.20, 70.22 and 76.87. Toward that end, the original guide endorsed specific safety standards that ANS-8 developed to provide guidance, criteria, and best practices for use in preventing and mitigating criticality accidents during operations that involve handling, processing, storing, and/or transporting special nuclear material at fuel and material facilities. The original guide also took exceptions to certain portions of individual ANSI/ANS-8 standards. In addition, the original guide consolidated and replaced a number of earlier NRC regulatory guides, thereby providing all of the relevant guidance in a single document.

The ANS-8 standards endorsed in Regulatory Guide 3.71 were approved by the American Nuclear Society's Consensus Committee N16 on Nuclear Criticality Safety, as well as the American National Standards Institute (ANSI). Nonetheless, each ANSI/ANS-8 standard is reviewed every 5 years by a working group of expert practitioners in the area so that it can be revised, reaffirmed, or withdrawn, as appropriate, to reflect the current state of the art. (This time can be extended to as long as 10 years or more under special circumstances.) New standards are also added when the need arises. Since the timing and issuance of individual standards is independent of the other standards, the list of current standards and their respective dates of issuance is constantly changing.

As a result, since the NRC published Regulatory Guide 3.71 in 1998, several ANSI/ANS-8 nuclear criticality safety standards have been added, reaffirmed, revised, or withdrawn. Consequently, the NRC staff decided to update this guide to clarify which standards the agency endorses and to clearly state exceptions to individual standards. Toward that end, the staff issued this revised regulatory guide as Draft Regulatory Guide DG-3023, with a *Federal Register* notice (70 FR 25128), dated May 12, 2005, to solicit stakeholder comments. The public comment period closed on June 20, 2005, without the submission of any stakeholder comments; however, the NRC staff further revised RG 3.71 based on review of additional changes to the consensus standards in the guide. This revision does not change any of the guidance provided in the initial issuance of Regulatory Guide 3.71; rather, it provides guidance concerning changes that have occurred since the NRC published the original guide in 1998. For completeness, this guide restates the endorsements and exceptions stated in Regulatory Guide 3.71, as applicable, while identifying endorsements of or exceptions to new or modified standards. Since the ANSI/ANS-8 standards are constantly being issued, revised, reaffirmed, or withdrawn, the NRC staff plans to revise this guide on a regular basis.

## C. REGULATORY POSITION

The ANSI/ANS-8 nuclear criticality safety standards provide procedures and methodologies that the NRC staff considers generally acceptable for use in preventing and mitigating nuclear criticality accidents. However, use of the ANSI/ANS-8 nuclear criticality safety standards is not a substitute for detailed nuclear criticality safety analyses for specific operations. In addition, inclusion of a reference to another standard in an endorsed standard does not imply NRC endorsement of the referenced standard.

The NRC staff will follow the requirements denoted in the ANSI/ANS-8 standards. The word “shall” in an ANSI/ANS-8 standard denotes a requirement, the word “should” denotes a recommendation, and the word “may” denotes permission (neither a requirement nor a recommendation). When a licensee or applicant commits to an ANSI/ANS-8 standard cited in this regulatory guide, the licensee or applicant must perform all operations in accordance with the requirements stated in that standard, but not necessarily with its recommendations. Licensees or applicants may follow the recommendations given in the ANSI/ANS-8 standards unless an exception is stated in this regulatory guide, is otherwise specified in 10 CFR Parts 70 or 76, or can be shown to be addressed by other acceptable methods.

### 1. ANSI/ANS-8 Nuclear Criticality Safety Standards Endorsed by the NRC

The NRC endorses the following ANSI/ANS-8 nuclear criticality safety standards:

- ANSI/ANS-8.5-1996 (Reaffirmed in 2002), “Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material”
- ANSI/ANS-8.6-1983 (Reaffirmed in 2001), “Safety in Conducting Subcritical Neutron-Multiplication Measurements In Situ”
- ANSI/ANS-8.7-1998, “Nuclear Criticality Safety in the Storage of Fissile Materials”
- ANSI/ANS-8.12-1987 (Reaffirmed in 2002), “Nuclear Criticality Control and Safety of Plutonium-Uranium Fuel Mixtures Outside Reactors”
- ANSI/ANS-8.14-2004, “Use of Soluble Neutron Absorbers in Nuclear Facilities Outside Reactors”
- ANSI/ANS-8.15-1981 (Reaffirmed in 1995), “Nuclear Criticality Control of Special Actinide Elements”
- ANSI/ANS-8.19-2005, “Administrative Practices for Nuclear Criticality Safety”
- ANSI/ANS-8.20-1991 (Reaffirmed in 1999), “Nuclear Criticality Safety Training”
- ANSI/ANS-8.21-1995 (Reaffirmed in 2001), “Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors”
- ANSI/ANS-8.22-1997, “Nuclear Criticality Safety Based on Limiting and Controlling Moderators”
- ANSI/ANS-8.23-1997, “Nuclear Criticality Accident Emergency Planning and Response”

## 2. ANSI/ANS-8 Nuclear Criticality Safety Standards Endorsed by the NRC with Exceptions

The NRC endorses the following ANSI/ANS-8 nuclear criticality safety standards, but takes exception to certain sections, as follows:

- ANSI/ANS-8.1-1998, “Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors”

The guidance on validating calculational methods for nuclear criticality safety, as specified in ANSI/ANS-8.1-1998, provides a procedure that is acceptable to the NRC staff for establishing the validity and applicability of calculational methods used in assessing nuclear criticality safety. However, it is not sufficient to merely refer to this standard in describing the validation of a method. Rather, a licensee or applicant should provide the details of validation (as stated in Section 4.3.6 of the standard) to (1) demonstrate the adequacy of the margins of subcriticality relative to the bias and criticality parameters, (2) demonstrate that the calculations embrace the range of variables to which the method will be applied, and (3) demonstrate the trends in the bias upon which the licensee or applicant will base the extension of the area of applicability. In addition, the details of validation should state computer codes used, operations, recipes for choosing code options (where applicable), cross-section sets, and any numerical parameters necessary to describe the input.

- ANSI/ANS-8.3-1997 (Reaffirmed in 2003), “Criticality Accident Alarm System”

The guidance on criticality accident alarm systems, as specified in ANSI/ANS-8.3-1997 (reaffirmed in 2003), is generally acceptable to the NRC staff. An exception is that 10 CFR 70.24, “Criticality Accident Requirements,” requires criticality alarm systems in each area in which special nuclear material is handled, used, or stored, whereas Section 4.2.1 of the standard merely requires an evaluation for such areas. Another exception is that 10 CFR 70.24 and 10 CFR 76.89, “Criticality Accident Requirements,” require that each area must be covered by two detectors, whereas Section 4.4.1 of the standard permits coverage by a single reliable detector. Finally, 10 CFR 70.24 and 10 CFR 76.89 require a monitoring system capable of detecting a nuclear criticality that produces an absorbed dose in soft tissue of 20 rads of combined neutron and gamma radiation at an unshielded distance of 2 meters from the reacting material within 1 minute.

- ANSI/ANS-8.10-1983 (Reaffirmed in 2005), “Criteria for Nuclear Criticality Safety Controls in Operations With Shielding and Confinement”

The guidance on using shielding and confinement as a nuclear criticality safety control, as specified in ANSI/ANS-8.10-1983 (reaffirmed in 2005), is generally accepted by the NRC staff. An exception to Section 4.2.1 of the standard is the assumption that the radiation source strengths and releases from a nuclear criticality accident arise from an excursion occurring in an unfavorable geometry containing a solution of 400 g/L of uranium enriched in U-235. The excursion produces an initial burst of  $1 \times 10^{18}$  fissions in 0.5 second, followed successively at 10-minute intervals by 47 bursts of  $1.9 \times 10^{17}$  fissions, for a total of  $1 \times 10^{19}$  fissions in 8 hours. The excursion is assumed to be terminated by evaporation of 100 liters of the solution. Licensees and applicants may use a less-conservative nuclear criticality accident condition if detailed analyses of credible nuclear criticality accidents are performed and shown to be applicable to the conditions being evaluated.

- ANSI/ANS-8.17-2004, “Criticality Safety Criteria for the Handling, Storage, and Transportation of LWR Fuel Outside Reactors”

The general safety criteria and criteria to establish subcriticality, as specified in ANSI/ANS-8.17-2004, provide guidance that is acceptable to the NRC staff for preventing nuclear criticality accidents in handling, storing, and transporting fuel assemblies at fuel and material facilities. The only exception is that licensees and applicants may take credit for fuel burnup only when the amount of burnup is confirmed by physical measurements that are appropriate for each type of fuel assembly in the environment in which it is to be stored.

### **3. ANSI/ANS-8 Nuclear Criticality Safety Standards Withdrawn by the NRC**

The NRC has withdrawn its endorsement of ANSI/ANS-8.9-1987 (reaffirmed in 1995), “Nuclear Criticality Safety Criteria for Steel-Pipe Intersections Containing Aqueous Solutions of Fissile Materials.” This standard, which was listed in Regulatory Guide 3.71-1998, has subsequently been withdrawn by ANS (i.e., it is a historical standard). Although the NRC has withdrawn its endorsement of the standard, *there is nothing technically wrong with this standard and it would be acceptable for licensees and applicants to use it.*

## **D. IMPLEMENTATION**

The purpose of this section is to provide information to applicants and licensees regarding the NRC staff’s plans for using this regulatory guide. No backfitting is intended or approved in connection with the issuance of this guide. Except when an applicant or licensee proposes or has previously established an acceptable alternative method for complying with specified portions of the NRC’s regulations, the methods described in this guide will be used in evaluating submittals in connection with license applications submitted under 10 CFR Part 70, “Domestic Licensing of Special Nuclear Material,” and 10 CFR Part 76, “Certification of Gaseous Diffusion Plants.”

## **REGULATORY ANALYSIS**

The NRC published a draft regulatory analysis when the agency issued the original draft of this guide (as DG-3013) for public comment in January 1998. Since that time, several ANSI/ANS-8 nuclear criticality safety standards have been added, reaffirmed, revised, or withdrawn. Consequently, the NRC staff decided to update this guide to clarify which standards the agency endorses and to clearly state exceptions to individual standards. However, this revision does not change any of the guidance provided in Regulatory Guide 3.71; rather, it provides guidance concerning changes that have occurred since the NRC published the original guide 1998. Consequently, the NRC staff has not prepared a separate regulatory analysis for this regulatory guide. The original regulatory analysis for DG-3013 is available for inspection or copying (for a fee) in the NRC’s Public Document Room (PDR), which is located at 11555 Rockville Pike, Rockville, Maryland. The PDR’s mailing address is USNRC PDR, Washington, DC 20555-0001. The PDR can also be reached by telephone at (301) 415-4737 or (800) 397-4205, by fax at (301) 415-3548, and by email to [PDR@nrc.gov](mailto:PDR@nrc.gov).

## **BACKFIT ANALYSIS**

This revision of Regulatory Guide 3.71 did not require a backfit analysis, as described in 10 CFR 70.76(b) and 10 CFR 76.76(b), because it did not impose a new or amended provision in the Commission's rules or a regulatory staff position interpreting the Commission's rules that is either new or different from a previous applicable staff position. In addition, this regulatory guide did not require modification or addition to structures, systems, components, or design of a facility or the procedures or organization required to design, construct, or operate a facility. Rather, a licensee or applicant is free to select a preferred method for achieving compliance with a license or the Commission's rules (as described in 10 CFR Parts 70 and 76) or orders.