MODULE 2.0: NUCLEAR CRITICALITY SAFETY STANDARDS

Introduction

Welcome to Module 2.0 of the Nuclear Criticality Safety Directed Self-Study Course! This is the second of five modules in this directed self-study course. The purpose of this module is to assist you by providing an introduction to the regulatory requirements and industrial standards associated with nuclear criticality safety.

This directed self-study module is designed to assist you in accomplishing the learning objectives listed at the beginning of the module. The module has self-check questions and activities to help you assess your understanding of the concepts presented in the module.

Before You Begin

It is recommended that you have access to the following material:

- ☐ Trainee Guide
- ☐ Regulatory Guide 3.71, Nuclear Criticality Safety Standards for Fuels and Material Facilities*

* The excerpt is included at the end of this module.

Complete the following prerequisite(s):

- ☐ Module 1.0 NRC's Nuclear Criticality Safety Mission

How to Complete this Module

1. Review the learning objectives.
2. Read each section within the module in sequential order.
3. Complete the self-check questions and activities within this module.
4. Check off the tracking form as you complete the self-check questions and/or activities within the module.
5. Contact your administrator as prompted for a progress review meeting.
6. Contact your administrator as prompted for any additional materials and/or specific assignments.
7. Complete all assignments related to this module. If no other materials or assignments are given to you by your administrator, you have completed this module.
8. Ensure that you and your administrator have dated and initialed your progress on the tracking form.
9. Go to the next assigned module.

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Learning Objectives

2.1 Upon completion of this module, you will be able to compare the nuclear criticality safety requirements provided in federal law, NRC guides, and industry standards.

2.1.1 Identify the nuclear criticality safety requirements stated in the 10 CFR series.

2.1.2 Identify the nuclear criticality safety requirements provided in selected ANSI/ANS Standards and related NRC regulatory guides.

- ANSI/ANS 8.1, 1983 (Reaffirmed in 1988), "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors"
- ANSI/ANS 8.3, 1997 "Criticality Accident Alarm System"
- ANSI/ANS 8.5, 1996, "Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material"
- ANSI/ANS 8.7, 1975, (Reaffirmed in 1987), "Guide for Nuclear Criticality Safety in the Storage of Fissile Materials"
- ANSI/ANS 8.17, 1984 (Reaffirmed in 1997), "Criticality Safety Criteria for the Handling, Storage, and Transportation of LWR Fuel Outside Reactors"
- ANSI/ANS 8.19, 1996, "Administrative Practices for Nuclear Criticality Safety"
- ANSI/ANS 8.20, 1991, "Nuclear Criticality Safety Training"
- ANSI/ANS 8.21, 1995, "Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors"

2.1.3 Match ANSI/ANS Standard requirements to examples of implementation methods/practices.

Learning Objective

When you finish this section, you will be able to:

2.1.1 Identify the nuclear criticality safety requirements stated in the 10 CFR series.

DEVELOPMENT OF INDUSTRIAL NUCLEAR CRITICALITY SAFETY STANDARDS

Code of Federal Regulations (CFR)

All federal regulations are contained in the Code of Federal Regulations (CFR). The CFR is divided into sections called titles. The regulations that concern the NRC are found in the Title 10 Energy series.

There are many parts to Title 10 CFR. Selected parts of 10 CFR that apply to the NRC are listed in Table 2-1. The parts listed were selected for their relevance to nuclear criticality. Parts directly applicable to the Department of Energy begin with 200 and are extensive because they cover all other energy sources, in addition to nuclear energy.

The CFR contains requirements that must be followed, unless the NRC grants an exemption in the license or technical specifications.

Table 2-1. Selected 10 CFR Parts That Apply to the NRC

Part	Subject
0	Conduct of employees
1	Statement of organization and general information
2	Rules of practice for domestic licensing proceedings and issuances of orders
20	Standards for protection against radiation
40	Domestic licensing of source material
50	Domestic licensing of production and utilization facilities
51	Environmental protection regulations for domestic licensing and related regulatory functions

Table 2-1. Selected 10 CFR Parts that Apply to the NRC (Continued)

Part	Subject
55	Operators' licenses
60	Disposal of high-level radioactive wastes in geologic repositories
61	Licensing requirements for land disposal of radioactive waste
62	Criteria and procedures for emergency access to nonfederal and regional low-level waste disposal facilities
63	Disposal of high-level radioactive wastes in a geologic repository at Yucca Mountain, Nevada
70	Domestic licensing of special nuclear material
71	Packaging and transportation of radioactive material
72	Licensing requirements for the independent storage of spent nuclear fuel and high-level radioactive waste
73	Physical protection of plants and materials
74	Material control and accounting of special nuclear material
75	Safeguards on nuclear material - implementation of the US/International Atomic Energy Agency (IAEA) agreement
76	Certification of gaseous diffusion plants
110	Export and import of nuclear equipment and material

10 CFR Part 1

10 CFR Part 1, Statement of Organization and General Information, states:

- "The [Nuclear Regulatory] Commission is responsible for licensing and regulating nuclear facilities and materials and for conducting research in support of the licensing and regulatory process, as mandated by the Atomic Energy Act of 1954, as amended; the Energy Reorganization Act of 1974, as amended; and the Nuclear Nonproliferation Act of 1978; and in accordance with the National Environmental Policy Act of 1969, as amended, and other applicable statutes."

- "These responsibilities include protecting public health and safety, protecting the environment, protecting and safeguarding nuclear materials and nuclear power plants in the interest of national security, and assuring conformity with antitrust laws."

- "Agency functions are performed through standards setting and rulemaking; technical reviews and studies; conduct of public

hearings; issuance of authorizations, permits, and licenses; inspection, investigation, and enforcement; evaluation of operating experience; and confirmatory research."

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10 CFR Part 20

10 CFR Part 20, Standards for Protection Against Radiation, states:

- "The regulations in this part establish standards for protection against ionizing radiation resulting from activities conducted under licenses issued by the Nuclear Regulatory Commission. These regulations are issued under the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, as amended."
- "It is the purpose of the regulations in this part to control the receipt, possession, use, transfer, and disposal of licensed material by any licensee in such a manner that the total dose to an individual (including doses resulting from licensed and unlicensed radioactive material and from radiation sources other than background radiation) does not exceed the standards for protection against radiation prescribed in the regulations in this part."
- "However, nothing in this part shall be construed as limiting actions that may be necessary to protect health and safety."

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10 CFR Part 70

10 CFR Part 70, Domestic licensing of special nuclear material, establishes procedures and criteria for the issuance of licenses to receive title to, own, acquire, deliver, receive, possess, use, and transfer special nuclear material; and establishes and provides for the terms and conditions upon which the Nuclear Regulatory Commission will issue such licenses. The regulations contained in this part are issued pursuant to the Atomic Energy Act of 1954, as amended, and Title II of the Energy Reorganization Act of 1974.

As provided in the Atomic Energy Act of 1954, as amended, the regulations in 10 CFR Part 70 establish requirements, procedures, and criteria for the issuance of licenses to uranium enrichment facilities.

Major topic areas addressed in 10 CFR Part 70 are:

- Subpart A-General Provisions
- Subpart B-Exemptions
- Subpart C-General Licenses
- Subpart D-License Applications

- Subpart E-Licenses
- Subpart F-Acquisition, Use, and Transfer of Special Nuclear Material, Creditors' Rights
- Subpart G-Special Nuclear Material Control, Records, Reports and Inspections
- Subpart H-Additional Requirements for Certain Licensees Authorized to Possess a Critical Mass of Special Nuclear Material
- Subpart I-Modification and Revocation of Licenses
- Subpart J-Enforcement, Violations, and Criminal Penalties

10 CFR Part 70 also details the requirements of a nuclear criticality safety training program. Part 70.61 (Subpart H) addresses performance requirements that include an assessment of risk of nuclear criticality accidents. Preventive controls and measures are the primary means of protection (70.61 (d)).

Part 70.64 requires prospective applicants or licensees to address basic design criteria in the design of new facilities that provide for criticality control (70.64 (a) (9).

Part 70.24 (Subpart D) addresses criticality accident requirements.

A specific discussion of criticality alarm requirements from 10 CFR Part 70 is addressed in Module 4.0, Nuclear Criticality Safety Controls.

10 CFR Part 76

10 CFR Part 76, Certification of gaseous diffusion plants, establishes requirements that will govern the operation of those portions of the Portsmouth and Paducah Gaseous Diffusion Plants located in Piketon, Ohio, and Paducah, Kentucky, respectively, that are leased by the United States Enrichment Corporation. These requirements are promulgated to protect the public health and safety from radiological hazards and provide for the common defense and security. Additionally, these requirements establish the certification process that will be used to ensure compliance with the established requirements.

The regulations in 10 CFR Part 76 apply only to those portions of the Portsmouth and Paducah Gaseous Diffusion Plants leased by the Corporation, per the lease agreement between the Department of Energy and the United States Enrichment Corporation. 10 CFR Part 76 also gives notice to all persons who knowingly provide to the Corporation or any contractor, or subcontractor any components,

equipment, materials, or other goods or services that relate to the activities subject to this part that they may be individually subject to NRC enforcement action for violation of Sec. 76.10.

Major topic areas addressed in 10 CFR Part 76 are:

- Subpart A-General provisions
- Subpart B-Application
- Subpart C-Certification
- Subpart D-Safety
- Subpart E-Safeguards and security
- Subpart F-Reports and inspections
- Subpart G-Enforcement

10 CFR 76 also gives the requirements for maintaining and operating a criticality monitoring and audible alarm system.

American National Standards Institute (ANSI) Standards

In 1918, five U.S. engineering societies founded the American Engineering Standards Committee to establish material standards. Ten years later, three federal agencies joined the organization. The name was changed to the American Standards Association (ASA). The ASA grew to an organization of 100 societies and 2,300 corporate members.

In 1963, based on recommendations from the U.S. Department of Commerce, the organization was again renamed as the United States of America Standards Institute (USASI) with the goal of serving the entire U.S. economy; however, to avoid the appearance of being an entity of the federal government, the USASI was renamed the American National Standards Institute (ANSI). Within ANSI is the Nuclear Standards Board.

ANSI does not itself develop American National Standards (ANS); rather, it facilitates development by establishing consensus among qualified groups. ANSI-accredited developers are committed to supporting the development of national and, in many cases international, standards, addressing the critical trends of technological innovation, marketplace globalization, and regulatory reform.

American Nuclear Society (ANS)

The ANS is a not-for-profit, international, scientific, and educational organization. ANS was established December 11, 1954, by a group of individuals who recognized the need to unify the professional

activities within the diverse fields of nuclear science and technology. The main objective of ANS is to promote the advancement of engineering and science, relating to the atomic nucleus, and of allied sciences and arts.

Table 2-2 shows the meanings of key words used in the ANSI/ANS Standards. Table 2-3 provides a time line of ANSI/ANS standardization activities related to nuclear criticality safety.

Table 2-2. Key Words

Key Word	Meaning
“Shall”	requirement
“Should”	recommendation
“May”	permission

Table 2-3. ANSI/ANS Standardization Activities

Year	Standardization Activity
1991	ANSI/ANS 8.20 "Nuclear Criticality Safety Training" issued
1989	ANSI/ANS 8.17 (Reaffirmed)
1986	ANSI/ANS 8.3 (Revision of ANSI/ANS 8.3-1979) published
	ANSI/ANS 8.5 (Revision of ANSI/ANS 8.5-1979) published
1984	ANSI/ANS 8.17 "Criticality Safety Criteria for the Handling, Storage, and Transportation of LWR Fuel Outside Reactors" issued
	ANSI/ANS 8.19 "Admin. Practices for Nuclear Criticality Safety" issued
1983	ANSI/ANS 8.1 "Nuclear Criticality Safety in Operations With Fissionable Materials Outside Reactors: issued (Revision of ANSI N16.1)
1979	ANSI/ANS 8.3 "Criticality Accident Alarm System" published
	ANSI/ANS 8.5 "Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material" issued
1978	Revisions issued for TID-7016
1975	ANSI N16.1 revised and renamed ANSI/ANS 8.1
	ANSI/ANS 8.7 "Guide for Nuclear Criticality Safety in Storage of Fissile Materials"
1970	International Standards Organization Recommendation issued
1969	ANSI N16.1 (Rv. ASA N6.1) First nuclear ANSI Standard published by ANS
1967	Formation of ANS Nuclear Criticality Safety Technical Group
1964	ASA N6.1 (Sponsored by ANS and approved by ASA; published by ASME
1963	Principles of Criticality Safety in Handling and Processing Fissile Materials
1961	Revisions issued for TID-7016
1957	Unclassified version of the guide - TID-7016 developed
1956	Nuclear Safety Guide, LA-2063 developed
1955	Series of Industrial Criticality Safety Meetings

Self-Check Questions 2-1

Complete the following questions. The answers are located in the answer key section of the Trainee Guide.

1. Which section of the federal regulations is related to nuclear energy?

2. According to 10 CFR Part 1, what are the responsibilities of the NRC?

3. What is the purpose of the 10 CFR Part 20?

4. 10 CFR Part 70, Domestic Licensing of Special Nuclear Material, establishes procedures and criteria for the _____ to receive title to, own, acquire, deliver, receive, possess, use, and transfer special nuclear material.

5. 10 CFR Part 76, Certification of Gaseous Diffusion Plants, establishes requirements that will govern portions of the operation of two specific facilities. List them.

You have completed this section.
Please check off your progress on the tracking form.
Go to the next section.

Learning Objectives

When you finish this section, you will be able to:

2.1.2 Identify the nuclear criticality safety requirements provided in selected ANSI/ANS standards and related NRC regulatory guides.

- ANSI/ANS 8.1, 1983 (Reaffirmed in 1988), "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors"
- ANSI/ANS 8.3, 1997 "Criticality Accident Alarm System"
- ANSI/ANS 8.5, 1996, "Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material"
- ANSI/ANS 8.7, 1975 (Reaffirmed in 1987), "Guide for Nuclear Criticality Safety in the Storage of Fissile Materials"
- ANSI/ANS 8.17, 1984 (Reaffirmed in 1997), "Criticality Safety Criteria for the Handling, Storage, and Transportation of LWR Fuel Outside Reactors"
- ANSI/ANS 8.19, 1996, "Administrative Practices for Nuclear Criticality Safety"
- ANSI/ANS 8.20, 1991, "Nuclear Criticality Safety Training"
- ANSI/ANS 8.21, 1995, "Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors"

2.1.3 Match ANSI/ANS Standard requirements to examples of implementation methods/practices.

DISCUSSION OF SELECTED NRC REGULATORY GUIDES WITH CORRESPONDING ANSI/ANS STANDARDS

Background

NRC Regulatory Guides do not carry the same force as those of the CFR and executive orders. "Nuclear Regulatory Guides are issued to describe and make available to the public such information as methods acceptable to the NRC staff for implementing specific parts of the Commission's regulations...."In particular, NRC material licensees commit to certain policies and standards in their license applications, which are then incorporated into their license. They and their employees are thus required to follow these commitments; however, a licensee may deviate from these Guides by presenting alternative evidence of conformance. The difficulty then faced is convincing the NRC staff of its sufficiency.

If a licensee follows an NRC Regulatory Guide in meeting a requirement in 10 CFR, the Commission staff will regard this as acceptable evidence of conformance. With respect to criticality safety, the relevant ANSI standards are implemented within the NRC Regulatory Guides. In addition, a particular licensee may have committed to follow a particular ANSI standard as a condition of application approval. In this case, adhering to the ANSI standard is no longer optional but required by regulation and enforceable.

The message is that standards, guides, and orders are to help not hinder you. It is much easier to comply than to seek a variance that may be needed for a special purpose.

In this module, excerpts from each of the selected ANSI/ANS Standards listed in the learning objectives of this module have been extracted from the American National Standards and included in this module with permission of the publisher.

Regulatory Guide 3.71, Nuclear Criticality Safety Standards for Fuels and Material Facilities, endorses the ANSI/ANS–8 nuclear criticality safety standards, but also points out that the use of these standards are not a substitute for detailed nuclear criticality safety analyses for specific operations. When an applicant or licensee commits to the ANSI/ANS–8 national standards cited in Regulatory Guide 3.71, all operations must be performed in accordance with the requirements stated in the national standards but not necessarily with its recommendations. Recommendations given in ANSI/ANS–8 national standards may be followed unless an exception is stated in the regulatory guide or otherwise specified in 10 CFR Part 70 or Part 76, or addressed by other acceptable methods.

ANSI/ANS 8.1-1983 (R1988*) NUCLEAR CRITICALITY SAFETY IN OPERATIONS WITH FISSIONABLE MATERIALS OUTSIDE REACTORS*

Scope

- Applies to operations with fissionable materials outside nuclear reactors, except the assembly of materials under controlled conditions, such as in critical experiments.
- Provides generalized basic criteria and limits for some single fissionable units of simple shape containing ^{233}U, ^{235}U, or ^{239}Pu, but not for multi-unit arrays.
- States requirements for establishing the validity and areas of applicability of any calculational method used in assessing nuclear criticality safety.

Content Outline

Nuclear Criticality Safety Practices
- Administrative Practices
  - Responsibilities
  - Process Analysis
  - Written Procedures
  - Materials Control
  - Operational Control
  - Operational Reviews
  - Emergency Procedures
- Technical Practices
  - Controlling Factors
  - Double Contingency Principle
  - Geometry Control
  - Neutron Absorbers
  - Subcritical Limits
- Validation of a Calculational Method
  - Establishing bias
  - Area(s) of applicability of a calculational method
  - Margin
  - Method involves a computer program
  - Nuclear properties
  - Written report

Single-Parameter Limits for Fissile Nuclides
- Uniform Aqueous Solutions
- Aqueous Mixtures
  - Enrichment Limits

- Metallic Units
- Oxides

Multiparameter Control
- Uranium Metal- and Uranium Oxide-Water Mixtures at Low ^{235}U Enrichment
- Aqueous Uranium Solutions at Low ^{235}U Enrichment
- Uniform Aqueous Mixtures of Plutonium Containing ^{240}Pu
- Aqueous Mixtures of Plutonium Containing ^{240}Pu

ANSI/ANS 8.1 Requirements

Responsibility

- "Management shall clearly establish responsibility for nuclear criticality safety."

- "Management shall establish the criteria to be satisfied by nuclear criticality safety controls."

Process Analysis

- "Before a new operation with fissionable materials is begun or before an existing operation is changed, it shall be determined that the entire process will be subcritical under both normal and credible abnormal conditions."

- "Operations to which nuclear criticality safety is pertinent shall be governed by written procedures."

Materials Control

- "The movement of fissionable materials shall be controlled."

- "Appropriate materials labeling and area posting shall be maintained specifying material identification and all limits on parameters that are subjected to procedural control."

Operational Review

- "Deviations from procedures and unforeseen alterations in process conditions that affect nuclear criticality safety shall be investigated promptly. Action shall be taken to prevent a recurrence."

- "Operations shall be reviewed frequently (at least annually) to ascertain that procedures are being followed and that process

conditions have not been altered so as to affect the nuclear criticality safety evaluation."

- "These reviews shall be conducted, in consultation with operating personnel, by individuals who are knowledgeable in nuclear criticality safety and who, to the extent practicable, are not immediately responsible for the operation."

Emergency Procedures

- "Emergency procedures shall be prepared and approved by management."

- "Organizations, local and offsite, that are expected to respond to emergencies shall be made aware of conditions that might be encountered, and they should be assisted in preparing suitable procedures governing their responses."

Controlling Factors

- "All controlled parameters and their limits shall be specified."

Geometry Control

- "All dimensions and nuclear properties on which reliance is placed shall be verified prior to beginning operations, and control shall be exercised to maintain them."

Neutron Absorbers

- "Control shall be exercised to maintain their continued presence with the intended distributions and concentrations."

Subcritical Limits

- "Where applicable data are available, subcritical limits shall be established on bases derived from experiments, with adequate allowance for uncertainties in the data."

Validation of a Calculational Method

- "Bias shall be established by correlating the results of criticality experiments with results obtained for these same systems by the method being validated."

- "A margin in the correlating parameter, which margin may be a function of composition and other variables, shall be prescribed that is sufficient to ensure subcriticality."

- "This margin of subcriticality shall include allowances for the uncertainty in the bias and for uncertainties due to any extensions of the area(s) of applicability."

- "If the method involves a computer program, checks shall be performed to confirm that the mathematical operations are performed as intended."

- "Any changes in the computer program shall be followed by reconfirmation that the mathematical operations are performed as intended."

- "A written report of the validation shall be prepared."

- "This report shall:

  (1) Describe the method with sufficient detail, clarity, and lack of ambiguity to allow independent duplication of results.

  (2) State computer programs used, the options, recipes for choosing mesh points where applicable, the cross section sets, and any numerical parameters necessary to describe the input.

  (3) Identify experimental data and list parameters derived therefrom for use in the validation of the method.

  (4) State the area(s) of applicability.

  (5) State the bias and the prescribed margin of subcriticality over the area(s) of applicability. State the basis for the margin."

Single-Parameter Limits for Fissile Nuclides and Multiparameter Control

- "A limit shall be applied only when surrounding materials, including other nearby fissionable materials, can be shown to increase the

  effective multiplication factor (k_{eff}) no more than does enclosing the unit by a contiguous layer of water of unlimited thickness."

- "Process specifications shall incorporate margins to protect against a limit being accidentally exceeded."

REGULATORY POSITION

- Provides procedures for nuclear criticality safety practices and the single-parameter limits for fissionable nuclides.

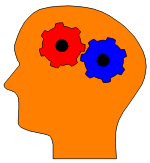
- Provides the guidance for multiparameter controls that are generally acceptable to the NRC staff for preventing accidental conditions of criticality in handling, storing, processing, and transporting special nuclear materials outside of nuclear reactors.

- The use of ANSI/ANS is not a substitute for detailed nuclear criticality safety analyses for specific operations.
- Provides a generally acceptable procedure to the NRC staff for establishing the validity and applicability of calculational methods used in assessing nuclear criticality safety. It is not sufficient merely to refer to this guide in describing the validation of a method.

- The details of validation indicated in Section 4.3.6 of the standard should be provided to demonstrate the adequacy of the margins of subcriticality relative to the bias and criticality parameters, to demonstrate that the calculations embrace the range of variables to which the method will be applied, and to demonstrate the trends in the bias upon which extension of the area of applicability will be based.

- Section 7 of ANSI/ANS-8.1-1983 lists additional documents referred to in the standard. Endorsement of ANSI/ANS-8.1-1983 does not constitute an endorsement of these documents.

Activity 1 - Reg. Guide 3.71 and ANSI/ANS 8.1



Directions: Review the scope, content outline, requirements, and regulatory position for ANSI/ANS 8.1, *Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors*. Complete the questions. Answers are located in the answer key section of the Trainee Guide.

1. When may a licensee deviate from the NRC Guides?

2. According to ANSI/ANS 8.1, what is management's responsibility for nuclear criticality safety?

3. ANSI/ANS-8.1 provides:

   - procedures for NCS practices and the single-parameter limits for _____
   - guidance for multiparameter control that are generally acceptable to the NRC staff for preventing accidental conditions of criticality in handling, storing, processing, and transporting special nuclear materials _____of nuclear reactors
   - generally acceptable procedure for establishing the validity and area of applicability of _____ used in assessing nuclear criticality safety

You have completed this section.
Please check off your progress on the tracking form.
Go to the next section.

ANSI/ANS 8.3-1997
CRITICALITY ACCIDENT ALARM SYSTEM

Scope

- Applies to operations with plutonium, ^{233}U, uranium enriched in ^{235}U, and other fissionable material in which inadvertent criticality may occur and cause the exposure of personnel to unacceptable amounts of radiation.

Content Outline

General Principles
- Coverage
- Detection
- Alarm
- Dependability

Criteria for System Design
- Reliability
- System Vulnerability
- Seismic Tolerance
- Failure Warning
- Response Time
- Detection Criterion
- Sensitivity
- Spacing

Testing
- Initial Tests
- Test Following Repairs
- Response to Radiation
- Periodic Tests
- Corrective Action
- Test Procedures
- Records

Employee Familiarization
- Posted Instructions
- Training
- Evacuation Drills

ANSI/ANS 8.3 Requirements

General

- "Alarm systems shall be provided wherever it is deemed that they will result in a reduction in total risk."

- "Consideration shall be given to hazards that may result from false alarms."

Coverage

- "The need for criticality alarm systems shall be evaluated for all

activities in which the inventory of fissionable materials in individual unrelated areas exceeds 700 g of ^{235}U, 520 g of ^{233}U, or 450 g of ^{239}Pu or 450 g of any combination of these three isotopes."

- "Evaluation shall be made whenever quantities exceed the safe limits specified in American National Standard Nuclear Criticality Control of Special Actinide Elements, ANSI/ANS-8.5-1981."

- "Special attention shall be given to all processes in which neutron moderators or reflectors more effective than water are present."

Detection

- "In areas in which criticality alarm coverage is required, a means shall be provided to detect excessive amounts or intensities of radiation and to signal personnel evacuation."

Alarm

- "The alarm signal shall be for immediate evacuation purposes only and of sufficient volume and coverage to be heard in all areas that are to be evacuated."

- "The signal shall be a mid-frequency complex sound wave that may be amplitude modulated at a subsonic frequency."

- "The signal-generating system(s) shall be automatically actuated by an initiating event without requiring human action."

- "The level shall be set low enough to detect the minimum accident of concern."

- "Evacuation shall be signaled promptly upon detection of an accident."

- "After initiation, the signal shall continue to sound as required by emergency procedures, even though the radiation falls below the alarm point."

Dependability

- "Consideration shall be given to the avoidance of false alarms."

- "In redundant systems, failure of any single channel shall not prevent compliance with the detection criterion specified in 5.6 [of this standard]."

- "The system shall be returned to operating condition immediately following tests."

- "Process areas in which activities will continue during a power outage shall have emergency power supplies for alarm systems or such activities shall be monitored continuously with portable instruments."

- "Detectors shall not fail to initiate an alarm when subjected to a radiation field of at least 10 rad/s."

Criteria for System Design

- "The system shall be designed for high reliability and should utilize components which do not require frequent servicing such as lubrication or cleaning."

- "The design and installation of the system shall be such as to resist earthquake damage."

- "The system shall not produce an evacuation signal due to component failure; however, a visible or audible warning signal shall be provided at some normally occupied location to indicate system malfunction or the loss of primary power."

- "The system shall be designed to produce the desired signal within one-half second of activation by the minimum accident of concern."

- "Criticality alarm systems shall be designed to detect immediately the minimum accident of concern."

- "The alarm signal shall activate promptly when the dose rate at the detectors equals or exceeds a value equivalent to 20 rad/min at 2 m from the reacting material."

- "Systems shall be designed so that instrument response and alarm latching shall occur as a result of transients of 1 ms duration."

- "The spacing of detectors shall be consistent with the selected alarm trip point and with the detection criterion."

Testing

- "Initial tests, inspections, and checks of the system shall verify that the fabrication and installation were made in accordance with design plans and specifications."

- "Following significant modification or repair to a system, there shall be tests and checks equivalent to the initial installation tests."
- "System response to radiation shall be measured periodically to confirm continuing instrument performance."
- "Records of tests shall be maintained."
- "The entire alarm system shall be tested periodically."
- "Field observations shall establish that the signal is audible above background throughout all areas to be evacuated."
- "All personnel in affected areas shall be notified in advance of an audible test."
- "When tests reveal inadequate performance, corrective action shall be taken without unnecessary delay."
- "Procedures shall be formulated to minimize false alarms which may be caused by testing and to return the system to normal operation immediately following the test."
- "All tests and corrective actions shall be recorded in a logbook maintained for each system."

Employee Familiarization

- "Instructions regarding response to signals shall be posted throughout the area from which there is provision for evacuation."
- “All employees whose work may necessitate their presence in an area covered by the signal shall be made familiar with the sound of the signal.”
- “Before placing the system into operation, all employees normally working in the area shall be acquainted with the signal by actual demonstration at their work locations.”
- “To refresh memories and acquaint new employees and transferees into an area, the signal should be sounded during working hours at least once quarterly after notifying all concerned. Non-regular-shift employees shall be included.”
- “Evacuation drills shall be conducted at least annually, and should be preceded by written notice, posted signs, or voice announcement over a public address system.”

- "Surprise test evacuations shall not be employed because of the possibility that accident or injury may result."

REGULATORY POSITION

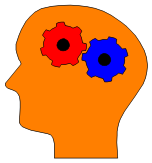
Guidance is generally acceptable to the NRC staff, subject to the following limitations:

- Section 70.24 of 10 CFR Part 70 requires alarm coverage "in each area in which special nuclear material is handled, used, or stored . . .," whereas Section 4.2.1 of the standard requires an evaluation for such areas. If such an evaluation does not determine that a potential for criticality exists, as for example where the quantities or form of special nuclear material make criticality practically impossible or where geometric spacing is used to preclude criticality, such as in some storage spaces for unirradiated nuclear power plant fuel, it is appropriate to request an exemption from Section 70.24 or Section 76.89.

- Section 70.24(a)(1) and 76.89(b) of 10 CFR Part 70 requires that each area be covered by two detectors, whereas Section 4.5.1 of the standard permits coverage by a single reliable detector.

- Finally, 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 is required by 10 CFR Part 70.24, and 10 CFR Part 76.89.

Activity 2 - Reg. Guide 3.71 and ANSI/ANS 8.3



Directions: Review the scope, content outline, requirements, and regulatory position for ANSI/ANS 8.3, *Criticality Accident Alarm System*. Answer the questions. The answers are located in the answer key section of the Trainee Guide.

1. Guidance provided in Regulatory Guide 3.71, is intended to comply with which federal regulation?

2. ANSI/ANS 8.3 applies to operations with plutonium, ^{233}U, uranium enriched in ^{235}U, and other fissionable material in which inadvertent criticality may occur and cause _____ _____ .

3. What is the purpose of the alarm signal?

4. List some of the design criteria for a criticality accident alarm system.

You have completed this section.
Please check off your progress on the tracking form.
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ANSI/ANS 8.5-1996
USE OF BOROSILICATE-GLASS RASCHIG RINGS AS A NEUTRON ABSORBER IN SOLUTIONS OF FISSILE MATERIAL

Scope

- Applies to the use of borosilicate-glass Raschig rings as a neutron absorber for primary and for secondary criticality control in packed vessels containing solutions of U235, 239Pu, or 233U.
- Specifies the chemical and physical environment, properties of the rings and packed vessels, maintenance inspection procedures, and criticality operating limits.

Content Outline

General Specifications and Criteria
- Chemical Environment
  - Acidic and Neutron Environment
  - Basic Environment
- Physical Environment
  - Mechanical Environment
  - Radiation Environment

Specifications for Rings
- Composition
  - Glass Density
  - Boron Content
  - ^{10}B Content
- Chemical Acceptance Test
  - Nitric Acid Test
  - Sodium Hydroxide Test
  - Hydrogen Fluoride Test
- Ring Dimensions
- Surface Finish
- Mechanical Shock-Resistance Test

Specifications for Packed Vessels
- Unpacked Piping in Vessels
- Determination of Level of the Rings
- Allowable Volume of Solution in a Vessel Packed with Rings
- Vessel Leakage
- Determination of Glass Volume Fraction
- Installation of Rings

Maintenance Inspection
- Settling
- Solids Accumulation
  - Fissile Material Balance
  - Determination of Fissile Solids on Rings
  - Nonfissile Solids in the Vessel
- Physical Properties
  - Applications Involving Agitation of Rings
  - Applications Involving No Agitation of Rings
  - Volume Determination
- Boron Content of Rings
  - Primary Test
  - Alternate Test
- Inspection Intervals
  - Primary Criticality Control
  - Secondary Criticality Control
  - Special Inspections

Maximum Specified Concentrations of Fissile Solutions

ANSI/ANS 8.5 Requirements

General Specifications

The general specifications and criteria set forth in ANSI/ANS 8.5 are:

- "The borosilicate glass shall be of the low-expansion, corrosion-resistant type that is conventionally used for chemical laboratory glassware as specified in Standard Specification for Glasses in Laboratory Apparatus, ASTM E 438-83."

- "The glass shall be compatible with the chemical and physical environment in which it is to be used."

- "When used as either a primary or secondary criticality control, in an acidic or neutral solution, the following restrictions shall apply:

  (1) pH less than or equal to 7.0,
  (2) temperature no greater than 120°C,
  (3) hydrogen fluoride concentration no greater than 0.0001 molar unless compatibility is established according to 4.2.3 and 6.5.3, and
  (4) phosphate ion concentration no greater than 1 molar."

- "When utilized in a basic solution, the rings shall not be used as a primary criticality control."

- "The basic solutions to which the rings are exposed shall have either:

(1) sodium, potassium, or ammonium hydroxide concentration no greater than 0.5 normal at a temperature less than 38°C or
(2) a pH less than 9 at a temperature less than 120°C."

- "Thermally tempered rings shall be used where applications involve agitation of the rings or where the rings may be subjected to accidental agitation."

- "Rings shall not be used in fields of intense ionizing radiation."

- "The maximum radiation dose rates to which rings shall be exposed are as follows:

Gamma	- 10^8 rad/yr
Beta	- 10^9 rad/yr from beta rays having energy no greater than 0.05 MeV
Beta	- 10^8 rad/yr from beta rays having energy greater than 0.05 MeV
Neutron	- 5×10^4 rad/yr
Alpha	equivalent to exposure rate from solution in which 2 watts/liter are generated due to the absorption of energy from alpha particles."

Specifications for Rings

- "The density of the glass shall not be less than 2.22 g/cm^3 at 25°C."

- "The density shall be determined by the ASTM Standard Method of Test for Density of Glass by Buoyancy, ASTM C 693-74(5) or by a method shown by comparison to have equivalent accuracy and precision."

- "The glass shall contain 3.66 to 4.28 wt% boron (11.8 to 13.8 wt% B_2O_3)."

- "The boron content shall be determined by the American National Standard Method for Chemical Analysis of Soda-Lime and Borosilicate Glass, ANSI/ASTM C 169-80(6), or by a method shown by comparison to have equivalent accuracy and precision."

- "The boron in the glass shall contain a concentration of the ^{10}B isotope such that the ^{10}B:^{11}B atom ratio is not less than 0.240."

Nitric Acid Test

- "If the rings are to be used in acidic solutions other than those of HF or H_3PO_4, the nitric acid test shall be performed. A random

sampling of ten clean, dry rings shall be weighed to 0.001 g accuracy and charged into a stainless steel vessel of 2 R capacity fitted with a reflux condenser."

- "One liter of 7.0 N nitric acid shall be introduced and the contents maintained at a temperature of 95°C for a period of 48 h."
- "The rings shall then be rinsed with distilled water, dried 1 h at 105°C, and reweighed to a 0.001 g accuracy."
- "The weight loss of the ten-ring sample shall not exceed 0.010%."

Sodium Hydroxide Test

- "A random sampling of ten clean, dry rings shall be weighed to 0.001 g accuracy and charged into a stainless steel vessel of 2 R capacity fitted with a reflux condenser."
- "One liter of 1.0 N sodium hydroxide shall be introduced and the contents maintained at a temperature of 95°C for a period of 6 h."
- "The rings shall then be rinsed with distilled water, dried 1 h at 105°C, and reweighed to a 0.001 g accuracy."
- "The weight loss of the ten-ring sample shall not exceed 0.20%."

Hydrogen Fluoride Test

- "If the rings are to be used in an acidic or neutral environment containing a hydrogen fluoride concentration greater than 0.0001 molar, a test appropriate to anticipated process conditions shall be performed."
- "In addition, frequent inspections and tests shall be made to ensure that the integrity of the rings is maintained in this more corrosive environment."

Ring Dimensions

- "The rings shall have an outside diameter no greater than 3.8 cm (1.5 in.) unless an appropriate criticality evaluation demonstrates the acceptability of larger rings that otherwise conform to the standard."

Surface Finish

- "All external surfaces of the finished rings shall be smooth and free of sharp edges."

Mechanical Shock-Resistance Test

- "Rings to be used in applications where they may be agitated or where they may be subjected to accidental agitation (e.g., where an earthquake may agitate the rings) shall be tempered and shall pass a mechanical shock-resistance test."
- "This test shall be carried out in a horizontal cylindrical tumbler drum with a spline described in Fig. 1 [of this standard]."
- "A random sample of ten clean, dry rings shall be placed in the dry tumbler drum. The drum shall be rotated about its axis at a uniform speed of approximately 10 rpm. After five revolutions (about 30 s), the tumbler shall be stopped and the contents inspected."
- "Any broken glass shall be removed and a count shall be made of those rings still intact."
- "The drum shall then be rotated another five revolutions."
- "The rings shall be considered satisfactory if 70% of those charged are still intact."
- "This test, using additional samples, shall be repeated as necessary to establish a statistically representative sample of the rings to be installed."

Specifications for Packed Vessels

- "Vessels to be packed with rings shall be designed and fabricated with suitable access and fixtures to facilitate addition and removal of solution and rings, removal of representative samples of solution and of rings, measurement of the volume of the solution and the level of the rings, and cleaning of the vessel and rings."
- "There shall be assurance that rings removed for inspection were not replacements added as the result of some previous inspection."
- "Solution withdrawal pipes shall be designed and installed to prevent removal of intact rings (e.g., installation of a screen to prevent ring removal while pumping out solution)."

- "There shall be provision for the installation and removal of all the ring samples required for inspection during the anticipated life of the ring charge and there shall be assurance that rings removed for inspection were not replacements added as the result of some previous inspection."

Determination of Level of the Rings

- "If a visual method is to be used to inspect the level of the rings, sufficient ports or sight glasses shall be provided to allow inspection of the upper surface of the assemblage of rings for the particular purpose of detecting gross depressions or unevenness in that surface."

Allowable Volume of Solution in a Vessel Packed with Rings

- "There shall be provision to protect against an accumulation of solution in a ring-free region that will be formed should the rings settle."

- "If such a positive method is not applicable to the vessel involved, the vessel may be equipped with a liquid-level indicating device which shall be augmented by an appropriate alarm system and by stringent operating procedures whereby the solution content of the vessel does not exceed 80% of its capacity when packed with rings."

Vessel Leakage

- "In installations where rings are installed as the primary criticality control, provision shall be made to protect against criticality occurring as the result of leakage of fissile solution from a vessel."

Determination of Glass Volume Fraction

- "The capacity of a vessel in the absence of rings shall be measured or calculated. The capacity of the vessel containing rings shall be determined from the measured volume of liquid required to fill it."

Installation of Rings

- "The rings shall be installed in such a manner as to ensure that the vessel is filled with a fluid arrangement of randomly oriented

rings. Complete filling and fluidity of the packing in the vicinity of corners, of enclosed piping, and of other obstructions shall be assured."

- "The rings shall be compacted by a method demonstrated to be satisfactory, such as by raking, stirring, or sparging."

Maintenance Inspection

- "The rings shall be periodically inspected to determine whether they have settled, whether solids have accumulated, and whether there have been changes in their physical and chemical properties."

- "A record of the results of inspections of installed rings shall be maintained for each packed vessel."

- "The level of rings in the vessel shall be determined either visually or by remote methods."

- "If settling is detected, rings shall be added to restore the specified packing."

- "The volume or the number of rings added and other appropriate comments shall be entered on the Vessel Inspection Form."

- "The rings charged to a vessel shall be replaced when the required cumulative addition will become equal to 10% of the original loading."

- "If the rate of settling indicates there will be no rings in the upper 5% of the vessel before the next inspection, rings shall be added to restore the specified packing condition."

Fissile Material Balance

- "At the time of inspection the volume of solution in the packed vessel shall be determined and a representative sample of the solution shall be analyzed for fissile material content."

- "A fissile material balance shall be established for each packed vessel on a regular schedule."

- "If a discrepancy exceeding 1000 g of fissile material is indicated (or a larger value justified by appropriate criticality safety analysis), the tank and rings shall be cleaned to the extent necessary to resolve the discrepancy."

Determination of Fissile Solids on Rings

- "Rings shall be removed from representative regions of the vessel and any solids deposited on their surface shall be analyzed for uranium or plutonium."

- "The rings in the vessel shall be cleaned if the deposited solids contain more than 50 g of uranium or of plutonium per liter of glass."

- "If the ^{235}U content of the uranium is $\leq$ 5.0 wt%, the rings shall be cleaned when the concentration reaches 50 g ^{235}U per liter of glass."

Nonfissile Solids in the Vessel

- "The presence of significant quantities of nonfissile solids, including glass corrosion products, shall be determined."

- "These solids shall be removed as soon as there is indication that they interfere with mixing the solution, with measurement of the volume of the solution, or with removal of the solution from the vessel."

Physical Properties

- "Rings shall be inspected for their physical properties by performing visual inspections or mechanical tests on a representative sample. Procedures shall prevent the inclusion in the sample of rings previously added, which may be atypical."

- "The mechanical shock-resistance test (4.5) shall be applied to samples of tempered rings that have been used in environments where the rings were subject to agitation. If the rings of the sample do not meet the requirements of 4.5, all the rings in the vessel shall be replaced."

- "Qualitative tests shall be applied to rings that are used in environments where agitation is no more than that caused by mixing the solution with an air sparge at a rate of approximately 5×10^{-3} standard cubic meters/second/square meter (1 standard cubic foot/minute/square foot) of sectional area."

- "The required tests shall consist of first visual inspection of the rings for chipped edges, crazing, cracks, and scratches, all of which may affect the mechanical strength."

- "An additional examination shall be simple drop tests on the used

rings followed by a comparison of the observed breakage rate with that of unused rings under the same test conditions. Conclusive evidence shall be cause for their replacement."

- "The loss of glass volume in the tank shall be determined in addition to the apparent volume decrease due to settling and breakage (see 6.1) [in this standard] through examination of control rings from representative regions of the tank at specified intervals."

- "The volume of each control ring shall be determined from its weight and density. The following equation shall be used to determine the acceptability of the rings:

$$\frac{V^1 V_0 >}{V V_t}$$

volume fraction occupied by rings required for solutions of the maximum allowable uranium or plutonium concentration where

V_0 = original volume fraction of vessel occupied by glass
V_t = (see 5.5 [of this standard])

V = original volume of control ring
V^1 = volume of control ring at time of test"

- "If any of the control rings does not meet the above criterion, the rings in the tank shall be replaced or it shall be independently determined that the minimum allowable volume fraction occupied by glass prevails throughout the tank. Control rings shall remain in the tank except for test periods not exceeding two weeks per test or a total of four weeks per year."

Boron Content of Rings

- "Rings from representative regions within the tank shall be analyzed for their boron content. If the result is less than 11.8 wt% B_2O_3, the rings shall be replaced. Procedures shall prevent the inclusion in the sample of rings previously added, which may be atypical."

- "A decrease in the density of the control rings shall be attributed to removal of B_2O_3 unless shown otherwise by chemical analysis. Rings shall be replaced when the boron content, either inferred from the density or chemically determined, becomes less than the minimum specified in 4.1.2 [of this standard]."

Inspection Intervals

- "In installations of rings for primary criticality control, the interval between inspections of the rings for settling (6.1), for solids accumulation (6.2), for determination of physical properties (6.3), and for boron content (6.4) shall not exceed 13 months for those applications in which (1) there is no agitation of the rings, and (2) the rate at which the solution is concentrated by evaporation does not exceed 10% per year."

- "For those applications in which the rings are agitated, the interval between inspections for settling (6.1) shall not exceed seven months."

- "For those applications in which the fissile solution is concentrated by evaporation at a rate exceeding 10% per year, the interval between inspections for solids accumulation (6.2) shall not exceed seven months."

- "When the rings are exposed to solutions in which the hydrogen fluoride concentration is greater than 0.0001 molar, a frequency of inspection shall be established to ensure that the rings retain the chemical and mechanical properties specified in Section 4, Specifications for Rings."

Maximum Specified Concentration of Fissile Solutions

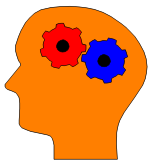
- "The density of hydrogen in the solution shall be not less than 75 g/liter and not greater than 115 g/liter."

REGULATORY POSITION

- Provides procedures generally acceptable to the NRC staff for the prevention of accidental conditions on criticality.

- Lists additional documents referred to in the standard. The specific applicability or acceptability of these listed documents will be covered separately in other regulatory guides, where appropriate.

Activity 3 - Reg. Guide 3.71 and ANSI/ANS 8.5



Directions: Review the scope, content outline, requirements, and regulatory position for ANSI/ANS 8.5, *Use of Borosilicate-Glass Raschig Rings as A Neutron Absorber in Solutions of Fissile Material*. Complete the questions. The answers are located in the answer key section of the Trainee Guide.

1. ANSI/ANS 8.5, *Use of Borosilicate-Glass Raschig Rings as A Neutron Absorber in Solutions of Fissile Material*, applies to the use of borosilicate-glass Raschig rings as a neutron absorber for _____ in packed vessels containing solutions of ^{235}U, ^{239}Pu, or ^{233}U.

2. As a general specification, the borosilicate-glass must be compatible with the _____ and _____ environment in which it is to be used.

3. When using borosilicate-glass as either a primary or secondary criticality control in an acidic or neutral solution, what is the maximum temperature allowed?

4. Rings shall not be used in fields of _____ .

5. What are the maximum radiation dose rates to which rings shall be exposed?

6. Describe the external surface of finished rings.

7. Identify similarities and the differences in criteria of the nitric acid test and the sodium hydroxide test.

8. The rings shall be cleaned if the deposited solids contain more than _____ of uranium or of plutonium per liter of glass.

9. Given the following equation for determining the volume fraction occupied by rings required for solutions of the maximum allowable uranium or plutonium concentration, identify each factor.

$$\frac{V^1 V_0 >}{V V_t}$$

You have completed this section.
Please check off your progress on the tracking form.
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ANSI 8.7-1975 (R1987) GUIDE FOR NUCLEAR CRITICALITY SAFETY IN THE STORAGE OF FISSILE MATERIALS

ANSI N16.5-1975, *Guide for Nuclear Criticality Safety in the Storage of Fissile Materials*, was reaffirmed and reissued as ANSI/ANS 8.7-1987.

Scope

- Applies to the storage of fissile materials.
- Provides mass and spacing limit tabulations for uranium containing greater than 30 wt% ^{235}U and ^{233}U and for plutonium as metals and oxides.
- Provides criteria for the range of application of the limits.

Content Outline

Nuclear Criticality Safety Practices
- Administrative Practices
- Technical Practices

Parameters, Limits, and Conditions
- Unit Mass Limits
- Moderation
- Position of Unit in Cell
- Other Reflectors
- Double Batching
- Vault Pairs
- Reduction Factors
- Aisles
- Container and Shelving Materials
- Unit Subcriticality
- Unit Spacing
- Unit Shape

Other Applications
- Commingling of Dissimilar Cells
- Interpolation
- Noncubic Cells
- Position of Unit in Cell
- Array Shape
- Plutonium-238

ANSI/ANS 8.7 Requirements

Administrative Practices

- "All operations with fissile material, including storage, shall be conducted in accordance with American National Standard for Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors, N16.1-1975/ANSI-8.1."
- "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."
- "Management shall provide for inspections to verify compliance with established procedures."
- "Access in storage areas shall be controlled."

Technical Practices

- "Limits for the storage of fissile material shall be based on experimental data or the results of validated computational techniques."
- "Storage facilities and structures shall be designed, fabricated, and maintained in accordance with good engineering practices."
- "Storage of fissile materials shall be such as to obviate concern with accidental nuclear criticality in the event of fire, flood, earthquake, or other natural calamities."
- "Shelving shall be sturdy and noncombustible."
- "Where the presence of significant quantities of combustibles cannot be avoided, as in the storage of combustible scrap, a fire protection system shall be installed."
- "Containers of fissile materials in areas with sprinkler systems shall be designed to prevent accumulation of water."
- "Where sprinkler systems are installed in fissile material storage areas, consideration shall be given to the possibility of criticality occurring in an accumulation of runoff water."
- "A criticality alarm shall be provided as appropriate."

- "Good housekeeping shall be incorporated as an important part of nuclear criticality safety practices."

Parameters, Limits, and Conditions

- "In the application of limits for uranium enriched in ^{235}U, isotopes other than ^{238}U shall be considered as ^{235}U and there shall not be more than 1 wt% ^{233}U. In limits applicable to ^{233}U, other isotopes of uranium shall be considered as ^{233}U. Isotopes of plutonium, other than ^{240}Pu, shall be considered as ^{239}Pu."

- "The mass of the units shall not exceed the values in Tables 5.1 through 5.12." [Note: See ANSI/ANS 8.7 for table information.]

- "The units shall be centered to within 10% of the cell dimension. This restriction may be relaxed to permit freedom of horizontal position provided the unit mass limit is reduced to 60% of the stated value. If this reduced value exceeds 20% of the unreflected spherical critical mass, the minimum unit surface separation shall be 152mm (6 in.)."

- "The mass limits shall be reduced to 75% of stated values for a concrete reflector of 203mm (8 in.) and to 60% for greater thicknesses."

- "Double batching shall be considered in storage safety analyses and in the establishment of operating procedures."

- "The tabulated mass limits shall be reduced to 55% of stated values for two contiguous vaults where the concrete walls separating and surrounding the storage areas have the same thickness; this factor is sufficient to include the effect of concrete as a reflector."

- "Effects of greater thicknesses of iron or of other materials shall be investigated experimentally or by validated computational techniques."

- "The contents of each storage cell shall be subcritical if submerged."

- "Unit surface separations shall be at least 152mm (6 in.) where flooding is credible."

Other Applications

- "Units placed in noncubic cells shall be centered to within 10% of the smallest cell dimension. The restriction may be relaxed to

permit freedom of horizontal position provided the mass limit is reduced to 60% of the stated value. If this reduced value exceeds 20% of the unreflected spherical critical mass, the minimum unit surface separation shall be 152mm (6 in.)."

REGULATORY POSITION

- Provides procedures generally acceptable to the NRC staff for nuclear criticality safety practices, limits, and conditions for the storage of fissile material and the guidance for other storage configurations subject to the following:

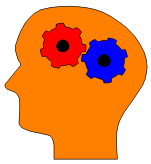
  1. Use of standard is not a substitute for detailed nuclear criticality safety analyses for specific storage arrangements for fissile materials.

  2. The mass limits tabulated in the standard that are marked by a superscript "a" to show that they exceed 90 percent of the critical mass of a water-reflected sphere should not be used unless it can be demonstrated that their use could not result in criticality under conditions involving errors or accidents, such as double batching or water immersion.

  3. The tabulated masses in the standard are not acceptable without all of the appropriate adjustments called for by the standard. Licensee applicants wanting to use the standard should, among other things, demonstrate that the requirements of paragraphs 5.3 through 5.6 of the standard have been met.

  4. Section 7 of the standard lists additional documents referred to in the standard. The specific applicability or acceptability of these listed documents will be covered separately in other regulatory guides, where appropriate.

Activity 4 - Reg. Guide 3.71 and ANSI/ANS 8.7



Directions: Review the scope, content outline, requirements, and regulatory position for ANSI/ANS 8.7, *Guide for Nuclear Criticality Safety in Storage of Fissile Materials*. Complete the questions. The answers are located in the answer key section of the Trainee Guide.

1. What is the basis for establishing limits for the storage of fissile material?

2. Identify some NCS considerations for areas where sprinkler systems are installed and where fissile materials are located.

3. The tabulated mass limits shall be reduced to 55% of stated values for two contiguous vaults where the concrete walls separating and surrounding the storage areas have the same thickness; this factor is sufficient to include the effect of concrete as a _____ ___.

4. What should be the effect of submerging the contents of a storage cell?

5. Units placed in noncubic cells shall be _____ to within 10% of the smallest cell dimension.

You have completed this section.
Please check off your progress on the tracking form.
Go to the next section.

ANSI/ANS 8.17-1984 (R1997)
CRITICALITY SAFETY CRITERIA FOR THE HANDLING, STORAGE AND TRANSPORTATION OF LWR FUEL OUTSIDE REACTORS

Scope

- Provides nuclear criticality safety criteria for the handling, storage, and transportation of LWR fuel rods and units outside reactor cores.
- Provides additional guidance applicable to handling, storage, and transportation of LWR nuclear fuel units in any phase of the fuel cycle outside the reactor core.

Content Outline

General Safety Criteria
Criteria to Establish Subcriticality

ANSI/ANS 8.17 Requirements

General Safety Criteria

- "Methods used to calculate subcriticality shall be validated in accordance with ANSI/ANS 8.1-1983 [1]."
- "Prior to first use of, or before implementing changes to, any operation or system involving handling, storage, or transportation of fuel units or rods, a criticality safety evaluation shall be performed for all normal and credible abnormal conditions to determine that the entire operation or system will be subcritical based on the criteria contained in Section 5, Criteria to Establish Subcriticality."
- "The criticality safety evaluation shall explicitly identify the controlled parameters and their design and operating limits upon which nuclear criticality safety depends."
- "The criticality safety evaluation shall be documented with sufficient detail, clarity, and lack of ambiguity to allow independent judgment of results."
- "Prior to commencing an operation, there shall be an independent assessment that confirms the adequacy of the evaluation required by 4.4 [of this standard]."

- "Prior to commencing operation, the operating organization shall verify that the as-built conditions conform with the design limits specified in 4.4 [of this standard]."

- "However, when reliance is placed on neutron-absorbing materials, control shall be exercised to maintain their continued presence with the intended distributions and concentrations."

- "In performing the criticality safety evaluation, the composition and nuclear characteristics of the fuel shall be those resulting in the maximum neutron multiplication factor of the system."

- "Consideration shall be given to the axial distribution of burnup in the fuel unit."

Criteria to Establish Subcriticality

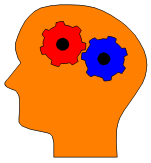
- "Where methods of analysis are used to predict neutron multiplication factors, the calculated multiplication factor, k_s, shall be equal to or less than an established allowable neutron multiplication factor."

- "If the calculated k_{eff}s for the criticality experiments exhibits a trend with a parameter, then k_c shall be determined by extrapolation on the basis of a best fit to the calculated values."

REGULATORY POSITION

- Provides procedures acceptable to the NRC staff for preventing accidental conditions of criticality in handling, storing, and transporting fuel assemblies at fuels and material facilities. The only exception is that credit for fuel burn-up may be taken only when the amount of burn-up is confirmed by physical measurements that are appropriate for each type of fuel assemble in the environment in which it is to be stored.

Activity 5 - Reg. Guide 3.71 and ANSI/ANS 8.17



Directions: Review the scope, content outline, requirements, and regulatory position for ANSI/ANS 8.17, *Criticality Safety Criteria for the Handling, Storage and Transportation of LWR Fuel Outside Reactors*. Complete the questions. The answers are located in the answer key section of the Trainee Guide.

1. What is the regulatory position for ANSI/ANS 8.17?

2. According to ANSI/ANS 8.17, what is the guidance for calculating subcriticality?

3. When is a criticality safety evaluation required?

4. Where methods of analysis are used to predict neutron multiplication factors, what is the allowable limit of the calculated multiplication factor, k_s?

You have completed this section.
Please check off your progress on the tracking form.
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ANSI/ANS 8.19-1996
ADMINISTRATIVE PRACTICES FOR NUCLEAR CRITICALITY SAFETY

Scope

- Provides criteria for the administration of a nuclear criticality safety program for operations outside of reactors in which there exists a potential for criticality accidents.
- Addresses the responsibilities of management, supervisors, and Nuclear Criticality Safety staff.
- Provides objectives and characteristics of operating and emergency procedures.

Content Outline

Management Responsibilities
Supervisory Responsibilities
Nuclear Criticality Safety Staff Responsibilities
Operating Procedures
Process Evaluation for Nuclear Criticality
Safety Materials Control
Planned Response to Nuclear Criticality Accidents

ANSI/ANS 8.19 Requirements

Management Responsibilities

- "Management shall accept overall responsibility for safety of operations."
- "Management shall formulate nuclear criticality safety policy and make it known to all employees involved in operations with fissile materials."
- "Management shall assign responsibility and delegate commensurate authority to implement established policy."
- "Management shall provide personnel familiar with the physics of nuclear criticality and with associated safety practices to furnish technical guidance appropriate to the scope of operations."
- "Management shall establish a means for monitoring the nuclear criticality safety program."
- "Management shall periodically participate in auditing the overall effectiveness of the nuclear criticality safety program."

Supervisory Responsibilities

- "Each supervisor shall accept responsibility for the safety of operations under his control."
- "Each supervisor shall be knowledgeable in those aspects of nuclear criticality safety relevant to operations under his control."
- "Each supervisor shall provide training and shall require that the personnel under his supervision have an understanding of procedures and safety considerations such that they may be expected to perform their functions without undue risk."
- "Records of training activities and verification of personnel understanding shall be maintained."
- "Supervisors shall develop or participate in the development of written procedures applicable to the operation under their control. Maintenance of these procedures to reflect changes in operations shall be a continuing supervisory responsibility."
- "Supervisors shall verify compliance with nuclear criticality safety specifications for new or modified equipment before its use."
- "Each supervisor shall require conformance with good safety practices including unambiguous identification of fissile materials and good housekeeping."

Nuclear Criticality Safety Staff Responsibilities

- "The nuclear criticality safety staff shall provide technical guidance for the design of equipment processes and for the development of operating procedures."
- "The staff shall maintain familiarity with current developments in nuclear criticality safety standards, guides, and codes."
- "The staff shall maintain familiarity with all operations within the organization requiring nuclear criticality safety controls."
- "The staff shall assist supervision, on request, in training personnel."
- "The staff shall conduct or participate in audits of criticality practices and compliance with procedures as directed by management."
- "The staff shall examine reports of procedural violations and other

deficiencies for possible improvement of safety practices and procedural requirements, and shall report their findings to management."

Operating Procedures

- "Procedures shall include those controls and limits significant to the nuclear criticality safety of the operation."
- "Supplementing and revising procedures as improvements become desirable shall be facilitated."
- "Active procedures shall be revised periodically by supervision."
- "New or revised procedures impacting nuclear criticality safety shall be reviewed by the nuclear criticality safety staff."
- "Deviations from operating procedures and unforeseen alterations in process conditions that affect nuclear criticality safety shall be documented, reported to management, and investigated promptly. Action shall be taken to prevent a recurrence."
- "Operations shall be reviewed frequently (at least annually) to ascertain that procedures are being followed and that process conditions have not been altered so as to affect the nuclear criticality safety evaluation."

Process Evaluation for Nuclear Criticality Safety

- "Before starting a new operation with fissile materials or before an existing operation is changed, it shall be determined that the entire process will be subcritical under both normal and credible abnormal conditions."
- "The nuclear criticality safety evaluation shall determine and explicitly identify the controlled parameters and their associated limits upon which nuclear criticality safety depends."
- "The nuclear criticality safety evaluation shall be documented with sufficient detail, clarity and lack of ambiguity to allow independent judgement of results."
- "Before starting operation, there shall be an independent assessment that confirms the adequacy of the nuclear criticality safety evaluation."

Materials Control

- "The movement of fissionable materials shall be controlled."
- "Appropriate materials labeling and area posting shall be maintained specifying material identification and all limits on parameters that are subject to procedural control."
- "If reliance is placed on neutron absorbing materials that are incorporated into process materials or equipment, control shall be exercised to maintain their continued presence with the intended distributions and concentrations."
- "Access to areas where fissile material is handled, processed, or stored shall be controlled."
- "Control of spacing, mass, density, and geometry of fissile material shall be maintained to assure subcriticality under all normal and credible abnormal conditions."

Planned Response to Nuclear Criticality Accidents

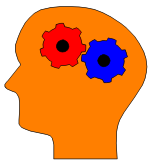
- "Emergency procedures shall be prepared and approved by management."
- "Organizations, on and off-site, that are expected to provide assistance during emergencies shall be informed of conditions that might be encountered."
- "Emergency procedures shall clearly designate evacuation routes. These routes shall be clearly identified and should avoid recognized areas of higher risk."
- "Personnel assembly stations, outside the areas to be evacuated, shall be designated."
- "Means to account for personnel shall be established."
- "Personnel in the area to be evacuated shall be trained in evacuation methods and informed of routes and assembly stations."
- "Provisions shall be made for the evacuation of transient personnel."
- "Drills shall be performed at least annually to maintain familiarity with the emergency procedures. Drills shall be announced in advance."

- "Arrangements shall be made in advance for the care and treatment of injured and exposed persons. The possibility of personnel contamination by radioactive materials shall be considered."
- "Planning shall include a program for the immediate identification of exposed individuals and should include personnel dosimetry."
- "Instrumentation and procedures shall be provided for determining the radiation at the assembly area and in the evacuated area following a criticality accident."
- "Emergency procedures shall address re-entry procedures and the membership of response teams."

REGULATORY POSITION

- Describes practices generally acceptable to the NRC staff for administration of a nuclear criticality safety program for operation with fissionable materials at fuels and materials facilities in which there exists a potential for criticality accidents.
- Section 11 of the standard lists additional documents referred to in the standard. Endorsement of this standard does not constitute an endorsement of these documents.

Activity 6 - Reg. Guide 3.71 and ANSI/ANS 8.19



Directions: Review the scope, content outline, requirements, and regulatory position for ANSI/ANS 8.19, *Administrative Practices for Nuclear Criticality Safety*. Complete the questions. The answers are located in the answer key section of the Trainee Guide.

1. The responsibility for the safety of operations belongs to _____.

2. Who has responsibility for the safety of operations under his control? _____

3. When complying with ANSI/ANS 8.19, *Administrative Practices for Nuclear Criticality Safety*, list at least four products that might be generated.

4. As a minimum, what is the frequency for conducting drills to maintain familiarity with the emergency procedures?

5. Suggest actions that you might take as an inspector to ensure requirements are met.

You have completed this section.
Please check off your progress on the tracking form.
Go to the next section.

ANSI/ANS 8.20-1991 *NUCLEAR CRITICALITY SAFETY TRAINING*

Nuclear Criticality Safety Training, ANSI/ANS 8.20-1991, provides criteria for nuclear criticality safety training for personnel associated with operations outside reactors where a potential exists for criticality accidents.

ANSI/ANS-8.20-1991, "Nuclear Criticality Safety Training," was prepared by Subcommittee 8, "Fissionable Materials Outside Reactors," of the Standards Committee of the American Nuclear Society; it provides a framework and criteria for training employees associated with fissionable material operations outside reactors when a potential exists for criticality accidents.

Program Requirements

- "Management shall establish a nuclear criticality safety training program that provides confidence in the continuing proficiency of personnel."
- "Supervisors shall ensure that their staffs are suitably trained."
- "Nuclear criticality safety staff shall participate in the development of the training program and should participate in its implementation and the evaluation of its effectiveness."

Program Structure

- "Training requirements shall be determined and documented. The content of the training program shall be tailored to job responsibilities and shall support the conduct of the job."
- "Refresher training requirements shall be determined and documented. Such training shall be provided at least every two years."

Program Content

ANSI/ANS-8.20-1991 presents a training outline, procedures, and responsibilities for providing nuclear criticality safety training for employees associated with fissile material operations outside reactors that is generally acceptable to the NRC staff. The standard includes provisions for the establishment of training objectives, the designation of personnel requiring training, a skeletal framework of training program content, and criteria for documentation and evaluation.

The content areas to be included in the training program are:
- Fission Chain Reactions and Accident Consequences
- Neutron Behavior in Fissioning Systems

- Criticality Accident History
- Response to Criticality Alarm Signals
- Control Parameters
- Policy and Procedures

Some of the specific topics to be presented in the training are:

- "Health effects of criticality accidents shall be discussed."

- "Training shall be provided in the recognition of and in response to criticality alarms in accordance with ANSI/ANS-8.3-1986 [3]."

- "An example of the reduction in the received dose as a function of distance, time, and shielding shall be given to emphasize the need for prompt evacuation."

- "The effects and applications of the following factors that are relevant to criticality safety of operations in the facility shall be explained and illustrated:

  (1) mass
  (2) shape
  (3) interaction and separation
  (4) moderation
  (5) reflection
  (6) concentration
  (7) volume
  (8) density
  (9) neutron absorbers
  (10) heterogeneity
  (11) enrichment."

- "Single parameter limits appropriate to the facility shall be discussed."

- "The concept of nuclear criticality shall be illustrated by examples appropriate to the facility."

- "The concept of contingencies for checking the validity of criticality safety limits shall be discussed."

- "The facility management's nuclear criticality safety policy shall be described."

- "The facility policy for the use of check lists, sign-off sheets, and documentation in the execution of procedures that are pertinent to criticality safety shall be explained."

- "Relevant procedures that pertain to criticality shall be discussed. Emphasis shall be given to criticality safety limits, controls, and emergency procedures."

- "The policy that relates to situations not covered by procedures and to situations in which the safety of the operation is in question shall be described."

- "Employees shall be informed of their right to question any operations that they believe may not be safe."

Evaluation

- "The criticality safety training program of an organization shall be evaluated periodically. The evaluation process should provide confidence in the adequacy of the total training program. The evaluation process and the evaluations shall be documented."

- "Satisfactory completion of training shall be based upon predetermined performance criteria. Identified weaknesses shall be addressed by additional training. Acceptance of the adequacy of the individual's total training record shall be the responsibility of the immediate supervisor and any other organizational units designated by management."

- "The employee's training record shall be documented and retained for a minimum of four years or longer as required by management."

REGULATORY POSITION

Provides guidance on an appropriate NCS training program for the use of SNM, especially the prevention of criticality accidents, license applicants and all members of the staffs associated with operations. It is not adequate for training for the nuclear criticality staff. The information collections contained in Regulatory Guide 3.71 are covered by the requirements in 10 CFR Part 70.

1. "The general outline and content for a nuclear criticality safety training program described in ANSI/ANS-8.20-1991 is generally acceptable to the NRC staff for meeting the requirements in 10 CFR Part 70 and Part 76 for a nuclear criticality safety training program for personnel associated with operations outside of reactors."

2. "The nuclear criticality safety training program should be developed with the cooperative involvement of management, supervision, and the criticality safety staff."

3. "The nuclear criticality safety training program should include

specific learning objectives, program structure, program content, and program evaluation, established through a systematic approach to training that includes:

3.1 Analysis of jobs and tasks to determine what a worker must know to be able to perform effectively;

3.2 Design and development of learning objectives based on the analysis of jobs and tasks that reflect the knowledge, skills, and abilities needed by the worker;

3.3 Development of instructional materials based on the learning objectives;

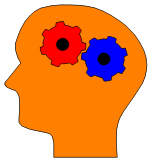
3.4 Implementation of the training program to achieve the performance objectives identified in the analysis and design phase of the facility, and

3.5 Evaluation and, as appropriate, revision of the training program based on internal and external audits and results obtained from written, oral, and operational examinations."

4. "The nuclear criticality safety training program should include instruction concerning implementation of revised or temporary operating procedures."

5. "NUREG-1220, 'Training Review Criteria and Procedures' (Revision 1, January 1993) contains methods acceptable to the NRC staff for evaluating the development and implementation of a training program and is a useful tool for quality control of the program."

Activity 7 - Reg. Guide 3.71 and ANSI/ANS 8.20



Directions: Review the scope, content outline, requirements, and regulatory position for ANSI/ANS 8.20, *Nuclear Criticality Safety Training*. Complete the questions. The answers are located in the answer key section of the Trainee Guide.

1. What is the regulatory position for ANSI/ANS 8.20?

2. Management shall establish a nuclear criticality safety training program that provides confidence in the _____ of personnel.

3. What responsibility does nuclear criticality safety staff have for training?

4. To what is the content of a nuclear criticality safety training program tailored?

5. How often is nuclear criticality safety refresher training required?

6. What is the basis of satisfactory completion of nuclear criticality safety training?

You have completed this section.
Please check off your progress on the tracking form.
Go to the next section.

ANSI/ANS 8.21-1995 *USE OF FIXED NEUTRON ABSORBERS IN NUCLEAR FACILITIES OUTSIDE REACTORS*

ANSI/ANS-8.21-1995, *Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors*, was prepared by Subcommittee ANS-8, Fissionable Materials Outside Reactors, of the American Nuclear Society Standards Committee. ANSI/ANS-8.21-1995 was approved by the American National Standards Committee N16, Nuclear Criticality Safety, and by ANSI in 1995.

ANSI/ANS-8.21-1995 provides guidance for using fixed neutron absorbers as an integral part of operations to prevent criticality accidents in operations involving handling, processing, storing, and transporting SNM at fuels and materials facilities. The design, safety evaluations, and verification and inspection requirements for the use of fixed neutron absorbers for criticality safety control are specified in the standard.

Scope

(Not available)

Outline

(Not available)

REGULATORY POSITION

ANSI/ANS-8.21-1995, *Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors*, provides procedures acceptable to the NRC staff for the use of fixed neutron absorbers in handling, processing, storing, and transporting special nuclear material at fuels and materials facilities to avoid criticality accidents. Use of ANSI/ANS-8.21-1995, however, is not a substitute for the licensee's preparation of and NRC's approval of detailed nuclear criticality safety analyses for specific operations.

Section 6 of ANSI/ANS-8.21-1995 lists additional documents referred to in the standard.

Regulatory Guide 3.71, Nuclear Criticality Safety Standards For Fuels and Material Facilities, endorses ANSI/ANS-8.21-1995, *Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors*. Issuing this regulatory guide is consistent with the NRC policy of evaluating the latest national consensus standards in terms of their suitability for endorsement by regulatory guide. The methods described in this guide were applied to a number of specific cases during reviews and selected licensing actions. These methods reflect the latest general NRC approach to criticality safety in operations involving the use of fixed neutron absorbers at fuels and materials facilities.

The value to NRC operations and industry is that there would be:

(1) a systematic method for specifying and reviewing technical specifications on allowable fixed neutron absorbers,

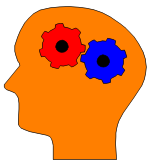
(2) more established methods for specifying technical specifications,

(3) guidance on design, evaluation, verification, and inspection of fixed neutron absorbers, and

(4) less chance for unwarranted criticality accidents.

ANSI/ANS-8.21-1995, *Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors*, provides more specific guidance on establishing and using fixed neutron absorbers. It does not provide any new methodology for establishing the use of fixed neutron absorbers than is presently required in 10 CFR Part 70. Thus, the incremental cost should be negligible (or at most marginal) if an applicant or licensee follows the guidance in ANSI/ANS-8.21-1995 as opposed to not following this standard.

Activity 8 - Reg. Guide 3.71 and ANSI/ANS 8.21



Directions: Review the scope, content outline, requirements, and regulatory position for ANSI/ANS 8.21, *Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors*. Complete the statement. The answer is located in the answer key section of the Trainee Guide.

1. ANSI/ANS 8.21, *Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors*, provides guidance for using fixed neutron absorbers as an integral part of operations to _____ criticality accidents in operations involving handling, processing, storing, and transporting special nuclear materials at fuels and materials facilities.

You have completed this section.
Please check off your progress on the tracking form.
Go to the next section.

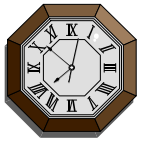
Self-Check Questions 2-2

Match the ANSI/ANS Standard in Column A with its associated Purpose in Column B. The answers are located in the answer key section of the Trainee Guide.

	Column A NRC Reg. Guide	Column B Purpose
____ 1.	8.5 Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material	A. Provides procedures generally acceptable to the NRC staff for nuclear criticality safety practices, limits, and conditions for the storage of fissile material and the guidance for other storage configurations
_____ 2.	Guide for Nuclear Criticality Safety in the Storage of Fissile Materials	B. Describes practices generally acceptable to the NRC staff for administration of a nuclear criticality safety program for operation with fissionable materials at fuels and material facilities in which there exists a potential for criticality accidents
_____ 3.	8.19 Administrative Practices for Nuclear Criticality Safety	C. Specifies the chemical and physical environment, properties of the rings and packed vessels, maintenance inspection procedures, and criticality operating limits
_____ 4.	8.17 Criticality Safety Criteria for the Handling, Storage, and Transportation of LWR Fuel Outside Reactors	D. Provides details directed principally toward gamma-radiation rate-sensing systems.
_____ 5.	8.20 Nuclear Criticality Safety Training	E. Provides procedures acceptable to the NRC staff for preventing accidental conditions of criticality in handling, storing, and transporting fuel assemblies at fuels and material facilities.

____ 6.	8.21 Use of Fixed Neutron Absorbers in Nuclear Facilities outside reactors	F. Provides guidance on an appropriate nuclear criticality safety training program for the use of special nuclear material, especially the prevention of criticality accidents, license applicants and all members of the staffs associated with operations.
____ 7.	8.3 Criticality Accident Alarm System	G. Provides guidance for using fixed neutron absorbers as an integral part of operations to prevent criticality accidents in operations involving handling, processing, storing, and transporting special nuclear materials at fuels and materials facilities.

It's time to schedule a progress meeting with your administrator. Review the progress meeting form on the next page. In Part III, As a Regulator, write your specific questions to discuss with the administrator.



Progress Review Meeting Form

Date Scheduled:_____ **Location:**_____

I. The following suggested items should be discussed with the administrator as to how they pertain to your current position:

- ANSI/ANS Standards:
  - 3.1, Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material
  - 3.4, Nuclear Criticality Safety in Operations with Fissionable Materials at Fuels and Materials Facilities
  - 3.43, Nuclear Criticality Safety in the Storage of Fissile Materials
  - 3.57, Administrative Practices for Nuclear Criticality Safety at Fuels and Materials Facilities
  - 3.58, Criticality Safety for Handling, Storing, and Transporting LWR Fuel at Fuels and Materials Facilities
  - 3.68, Nuclear Criticality Safety Training
  - 3.70, Use of Fixed Neutron Absorbers at Fuels and Materials Facilities
  - 8.12, Criticality Accident Alarm System

II. Use the space below to take notes during your meeting.

III. As a Regulator:

- Determine whether there have been past operational events that required implementation of the site emergency plan. If so, determine whether there were any problems or deficiencies associated with the emergency plan and that the licensee has corrected those deficiencies.
- Verify that the licensee has provisions for updating the emergency plan based on the incorporation of management-approved recommendations from audits, drills, actual events, and training.
- Review the prefire plan to assure that it is current and reflects any special considerations, such as unique chemical hazards or areas where water must be excluded for fire fighting due to criticality concerns.
- Confirm that a monitoring/alarm system is provided for all fissionable material areas and that the system is tested to confirm reliability and operability.
- Confirm that NCS staff inspects process operations and audit performance for NCS and that procedural violations, equipment, or system failures related to NCS are reported and reviewed and that resolutions are tracked.
- Confirm that documents defining system configuration, operation, and maintenance are maintained and accessible and that NCS evaluations are included in the configuration control system.

  Use the space below to write your specific questions.

IV. Further assignments? If yes, please note and complete. If no, initial completion of progress meeting on tracking form.

Ensure that you and your administrator have dated and initialed your progress on your tracking form for this module. Go to the module summary.

MODULE SUMMARY In summary, selected nuclear criticality safety standards presented in this module include:

- Requirements from the 10 CFR series
- Development of industrial nuclear criticality safety standards
- Selected ANSI/ANS standards

Congratulations! You are ready to go to the next assigned module.