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**DOE-STD-1135-99
September 1999**

DOE STANDARD

GUIDANCE FOR NUCLEAR CRITICALITY SAFETY ENGINEER TRAINING AND QUALIFICATION



**U.S. Department of Energy
Washington, D.C. 20585**

AREA SAFT

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FOREWORD

This Department of Energy Standard is required for use by all DOE Contractor criticality safety personnel. It contains guidelines that should be followed for NCS training and qualification programs that are developed by DOE Contractors.

A working group with the following participants prepared this DOE Standard:

<u>PARTICIPANTS</u>	<u>AFFILIATION</u>
Dr. Jerry McKamy	DOE-EH
Roger Dintaman	DOE-DP
Dennis Cabrilla	DOE-EM
Ivon Fergus	DOE-NS
Ted Wyka	DOE-S-3.1
Adolf Garcia	DOE-ID
Calvin Hopper	ORNL
Jim Mincey	ORNL
Mike Westfall	ORNL
Tom Reilly	WSRC
Tom McLaughlin	LANL
Richard Anderson	LANL
Robert Wilson	SSOC
Jim Morman	ANL
James Felty	SAIC
John Evans	S-3.1/Vista
George Bidinger	Consultant
Gypsy Tweed	Consultant

Beneficial comments (recommendations, additions, and deletions) which may be of use in improving this document should be addressed to:

Dr. Jerry McKamy
DOE EH-34
Email: jerry.mckamy@eh.doe.gov
Phone: 301-903-8031

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Guidance for Nuclear Criticality Safety Engineer Training and Qualification

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I. Overview

Defense Nuclear Facility Safety Board Recommendation 97-2 emphasized the need for DOE guidance to train Nuclear Criticality Safety (NCS) Engineers. Contractor management is responsible for ensuring that qualified personnel perform the duties assigned to their NCS organization. The information contained in this Standard describes the requirements for Training and Qualification of Contractor NCS Engineers in the U. S. Department of Energy (DOE) complex to facilitate hiring and maintaining of trained and qualified NCS staff.

II. Scope

In order to have an effective facility NCS Program, the NCS staff must be trained and qualified in the basics of the discipline. This document contains NCS training and qualification requirements, which are divided into categories, based on typical tasks performed by NCS Engineers. This document applies to all DOE Contractors and their respective subcontractors.

Each category identifies specific competencies to be accomplished. It is not necessary that NCS Engineers be qualified in all categories; nevertheless, it is management's duty to ensure that NCS Engineers only perform work in those categories for which they are qualified. The successful completion of these competencies shall be documented, including significant interim steps. There are various tools to accomplish this training and qualification. A training resource table is included as Appendix A to assist with identification of available industry tools.

III. Definitions and Acronyms

Criticality Alarm System	CAS
Criticality Detection System	CDS
Department of Energy	DOE
Los Alamos National Laboratory	LANL
Non Destructive Assay	NDA
Nuclear Criticality Safety	NCS
Nuclear Criticality Safety Evaluation	NCSE
Nuclear Regulatory Commission	NRC
Occupational Safety and Health Administration	OSHA
On the Job Training	OJT
Safety Analysis Report	SAR
Technical Safety Requirements	TSRs
Unreviewed Safety Question Determination	USQD

Shall - Denotes a requirement.

Should - Denotes a recommendation.

May - Denotes permission, neither a requirement nor a recommendation.

IV. Training and Qualification Requirements

The qualification of Nuclear Criticality Safety Engineers requires a combination of formal education; OJT, including facility experience, continuing training, and professional development. The following sections define the areas of training required to become qualified in the discipline of criticality safety. Contractor Management may choose to categorize NCS Engineers by task assignments or levels, and therefore assign necessary training requirements for specific levels. The minimum academic requirement for the NCS qualification program is a B.S. in Nuclear Engineering, Physics, or related field.

1.0 Nuclear Theory

The basics of nuclear physics and nuclear reactor theory are mandatory for understanding the fundamentals for performing the function of a criticality safety engineer. Information below can be obtained through various tools including appropriate college textbooks. See Appendix A for available training resources.

1.1 Fission Process

The individual should be able to:

- a. Define the following terms: Excitation energy, Cross Section, Fissile material, Fissionable material, Fertile material.
- b. Sketch the fission cross section for both U-235 and Pu-239 as a function of neutron energy. Label each significant energy region and explain the implications of the shape of the curves for criticality safety.
- c. Explain why only the heaviest radioactive nuclei are easily fissioned.
- d. Explain why uranium-235 fissions with thermal neutrons and uranium-238 fissions only with fast neutrons.
- e. Characterize the fission products in terms of mass groupings and radioactivity.
- f. Define sub-critical, critical, super-critical, nu, and beta.
- g. Define reactivity and describe how it is measured.
- h. Explain the Six-Factor formula and the terms used therein.
- i. Explain how delayed neutrons affect reactivity.
- j. Explain the effects of the following factors relevant to criticality safety of operations: Mass, Interaction, Geometry, Moderation, Reflection, Concentration, Volume, Neutron absorbers and Enrichment.

1.2 Various Types of Radiation Interaction with Matter

The individual should be able to:

- a. Describe the interactions of the following with matter: Alpha particle, Beta particle, Positron, and Neutron.
- b. Describe the following ways that gamma radiation interacts with matter: Compton scattering, Photoelectric effect, Pair production

1.3 Neutron Absorbers

The individual should be able to:

- a. Describe the use of neutron poisons.
- b. Explain the absorption characteristics of the following elements in terms of their cross-sections: cadmium, boron, chlorine, gadolinium, and hydrogen.
- c. Explain the purpose and use of Raschig Rings as a neutron poison.

2.0 Computational Methods

Various calculational methods are used depending on the complexity of the problem being evaluated. This information can be obtained through various Monte Carlo classes, short courses, or college classes. See Appendix A for available training resources.

The individual should be able to:

- a. Identify and discuss the application of several common hand calculation methods.
- b. Select one hand calculation technique (buckling method, solid angle, or areal density) and prepare an example of its use.
- c. Develop input model for one of the criticality safety codes (i.e., MONK, VIM, KENO/SCALE, MCNP, DANTSYS, ANISN, COG).
- d. Describe how cross section data impact Monte Carlo and deterministic codes.
- e. Describe the importance of validation of computer codes and how it is accomplished.
- f. Describe the methodology supporting Monte Carlo codes and deterministic codes.
- g. Describe pitfalls of Monte Carlo calculations.
- h. Discuss the strengths and weaknesses of Monte Carlo and Discrete Ordinants codes.
- i. The diffusion theory model is not strictly valid for treating fissile systems in which neutron absorption, voids, and/or material boundaries are present. In the context of these limitations, identify a fissile system for which a diffusion theory solution would be adequate.

3.0 Critical Experiments and Data

The purpose of this competency is to ensure that the individual has the familiarity with critical and subcritical experiments and the use of the resulting data. The individual shall be able to give examples of critical and subcritical experiments, explain what the data from these experiments are used for, and describe the parameters involved in a solution and metal criticality accident. This knowledge is necessary to determine the applicability of experimental data to normal and abnormal process conditions addressed by NCS Evaluations and to utilize existing kinetics experiments and accident data that characterize the physics and consequences of criticality. The individual should also be aware of situations where little or no experimental data exists.

Hands-on training with critical experiments is covered in Section 9.0.

This information can be obtained from various textbooks or Criticality Safety Short Courses. See Appendix A for available training resources.

The individual should be able to:

- a. Describe the types of data derived from critical experiments and their use in criticality safety.
- b. Participate in a criticality experiment or subcritical experiment demonstration.
- c. Discuss previous criticality accidents and their causal factors.

4.0 Rules, Standards and Guides

Various laws, standards, and guides have been written which direct the performance of criticality safety across the complex. These are the references used in development of this Standard. In order to provide consistent understanding of the policies and rules governing the function of criticality safety, the individual shall demonstrate familiarity with the following rules, standards, and guides:

- ANSI/ANS-8.1, *Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors.*
- ANSI/ANS-8.3, (ANSI N-16.2), *Criticality Accident Alarm System*
- ANSI/ANS-8.5, (ANSI N-16.4), *Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material.*
- ANSI/ANS-8.6, *Safety in Conducting Subcritical Neutron-Multiplication Measurements In Situ.*
- ANSI/ANS-8.7, *Guide for Nuclear Criticality Safety in the Storage of Fissile Materials.*
- ANSI/ANS-8.9, *Nuclear Criticality Safety Criteria for Steel-Pipe Intersections Containing Aqueous Solutions of Fissile Materials.*
- ANSI/ANS-8.10, *Criteria for Nuclear Criticality Safety Controls in Operations With Shielding and Confinement.*
- ANSI/ANS-8.12, *Nuclear Criticality Control and Safety of Plutonium-Uranium Fuel Mixtures Outside Reactors.*
- ANSI/ANS-8.15, *Nuclear Criticality Control of Special Actinide Elements.*
- ANSI/ANS-8.17, *Criticality Safety Criteria for the Handling, Storage and Transportation of LWR Fuel Outside Reactors.*
- ANSI/ANS-8.19, *Administrative Practices for Nuclear Criticality Safety.*
- ANSI/ANS-8.20, *Nuclear Criticality Safety Training.*
- ANSI/ANS-8.21, *Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors.*
- ANSI/ANS-8.22, *Nuclear Criticality Safety Based on Limiting and Controlling Moderators.*
- ANSI/ANS-8.23, *Nuclear Criticality Accident Emergency Planning and Response.*
- ANSI/ANS-13.3, *Dosimetry for Criticality Accidents.*

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- DOE G 421.1-1, *Criticality Safety Good Practices Program Guide for DOE Non-Reactor Nuclear Facilities*.
- DOE G 450.4, *Integrated Safety Management System Guide*.
- DOE/NCT-04, *A Review of Criticality Accidents*, March 1989.
- DOE Order 420.1, *FACILITY SAFETY*, Section 4.3, Nuclear Criticality Safety (supersedes DOE Order 5480.24)
- DOE Order 5480.21, *Unreviewed Safety Questions*.
- DOE Order 5480.22, *Technical Safety Requirements*.
- DOE Order 5480.23, *Nuclear Safety Analysis Reports*.
- DOE Order 5480.31/425.1, *Start-up and Restart of Nuclear Facilities*.
- DOE Policy 450.4, *Safety Management System Policy*.
- DOE-STD-3007-93 (Change Notice No. 1, September, 1998), *Guidelines for Preparing Criticality Safety Evaluations at Department of Energy Non-Reactor Nuclear Facilities*.
- DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*.
- DOE-STD-3011-94, *Guidance for Preparation of DOE Order 5480.22 (TSR) and DOE Order 5480.23 (SAR) Implementation Plans*.
- LA-10860-MS, *Critical Dimensions of Systems Containing U235, Pu239, and U233*, 1986.
- Reg Guide 3.71, *Nuclear Criticality Safety Standards for Fuels and Material Facilities*.
- TID-7016, *The Nuclear Safety Guide*, June 1978.

Training on these documents should be obtained by OJT combined with mentoring from a qualified NCS Engineer. However, the various Criticality Safety Short Courses offer sessions on review and use of these documents. See Appendix A for recommended standards, guides and handbooks.

5.0 Nuclear Criticality Safety Evaluations

An important function of a criticality safety engineer is effective preparation of NCS Evaluations. NCS Evaluations are performed to technically demonstrate the subcriticality of fissionable material processes, operations, and situation for transportation and storage under all normal and credible abnormal conditions. Evaluators should use configuration controlled, verified, and validated software and data sets; handbook techniques and data shown to be valid; or direct comparisons with critical and subcritical experiment data. The NCS Engineer shall prepare Nuclear Criticality Safety Evaluation in accordance with the guidance in DOE-STD-3007-93.

The results from the evaluations will be categorized as passive-engineered (i.e., geometry), active-engineered, or administrative controls (i.e., procedures). The preferred method of control is by passive engineered equipment design features. When engineered methods of control are not practical, administrative control methods may be used. When establishing NCS controls, the NCS Engineer shall

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consult with operations personnel and should be familiar with other programs that directly relate to criticality safety such as human factors, fire safety, safeguards, and Radiological Control.

The training process for this competency is most effective when completed at the Engineer's facility with the aid of a qualified NCS Engineer.

The individual should be able to:

- a. Develop contingency analysis, limits and controls.
- b. Describe key personnel needed to assist in preparation of criticality safety evaluations and determination of process upsets.
- c. Describe how subcritical margins and limits are determined.
- d. Describe when validation and bias estimates must be considered.
- e. Describe typical criteria to consider when evaluating various fissile processes, including common process upsets: Aqueous, Metal, Recovery, Fabrication/Foundry, Mixed Waste.
- f. Describe criteria to consider for evaluating material storage: Pits, Waste, Fuel elements, Solutions, Metal parts.
- g. Discuss the industry reference material used in determination of critical mass: LA-10860, LA 12808, and TID 7016.
- h. Describe elements to consider when preparing a Safety Analysis Report for Packaging (SARP).
- i. Discuss the effects and applications of the following factors relevant to criticality safety of operations: Mass, Interaction, Geometry, Moderation, Reflection, Concentration, Volume, Neutron absorbers, and Enrichment.
- j. Discuss the influence of the presence of non-fissionable materials mixed with, or in contact with, fissionable material on nuclear criticality safety.
- k. Discuss the concept of contingencies for checking the validity of criticality safety limits and controls.
- l. Discuss the methods used in the calculation of criticality safety, source term, environmental transport, and dose assessment activities including commonly used computer models.
- m. Demonstrate familiarity with the published histories of criticality accidents with emphasis on the control failures, terminating mechanisms, and resulting radiation hazards/health consequences to nearby personnel.

6.0 Safety Analysis and Control

When significant quantities of fissile material are handled or stored in a facility, the criticality safety program is an integral part of the facility safety authorization basis. Facility safety analyses typically contain information to demonstrate compliance with applicable requirements for the prevention of inadvertent criticality and mitigation of consequences from a criticality accident. The analyses of natural phenomenon events create a common interface between NCS and the SAR. In addition, the analyses typically contain information assessing the risk for postulated criticality accidents providing the bases for Unreviewed Safety Question Determinations (USQDs).

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Another essential element of the safety authorization basis is effective configuration control of facility modifications and items that impact nuclear safety. An entire chapter in the SAR is dedicated to “Prevention of Inadvertent Criticality”(see DOE-STD-3009-94).

There are many training classes for preparation of safety analysis reports, technical safety requirements and hazard classification. See Appendix A for training resources.

The individual should be able to:

- a. Identify and discuss essential elements of deterministic and probabilistic risk assessment techniques.
- b. Identify and discuss the methods used to determine and analyze failure modes.
- c. Discuss the methods used to identify and categorize the hazards associated with DOE nuclear systems.
- d. Define the following terms with respect to probabilistic risk assessments: Probability, Reliability, Availability, Unavailability, Risk, Safety, Accident sequence, Dominant contributors, and Minimal cut set.
- e. Define the following terms and differentiate between the associated processes: Event tree and Fault tree.
- f. Describe the content of the sections of a safety analysis report (SAR) per the local DOE site office expectations.
- g. Explain a hazard analysis technique and how Technical Safety Requirements (TSRs) are derived.
- h. Identify criticality safety controls that are required by the facility safety authorization basis documents.
- i. Explain Threshold values and the Graded Approach used in hazard classification.
- j. Explain how natural phenomenon events are evaluated in NCS.

7.0 Criticality Alarm Systems (CAS) and Criticality Detection Systems (CDS)

Each Contractor typically has a documented process for evaluating CAS or CDS placement and coverage. There are several industry documents which provide guidance related to criticality accident alarm and detection systems. ANSI/ANS 8.3 is the most commonly used and most complete resource for this competency.

The individual should be able to:

- a. Perform an evaluation of placement and determine coverage area for a CAS or CDS at their facility.
- b. Define the following terms: Criticality accident, Minimum accident of concern, and Process area.
- c. Discuss the general principles associated with the use of criticality alarm/detection systems including: Installation, Coverage, Detection, Alarms, Dependability, Surveillance, and Maintenance.
- d. Discuss the requirements for testing the criticality alarm/detection system.

- e. Discuss how an exemption for CAS/CDS must be prepared.
- f. Discuss facility emergency response procedures and activities.

8.0 Accountability Practices

Material tracking and accountability is a key element in an effective criticality safety program. Confidence in the facility sampling and NDA techniques is necessary when establishing NCS controls on transfer of material. There are several courses offered in this area. See Appendix A for training resources.

The individual should be able to:

- a. Explain how nuclear materials accountability relates to criticality safety.
- b. Discuss how the accountability system is conducted at their facility.
- c. Discuss Non Destructive Assay (NDA) and sampling techniques used at their facility including the limitations and pitfalls of the methods relative to criticality safety.
- d. Discuss container and material labeling practices and fissile material area postings.

9.0 Hands on Experimental Training

This competency is included to facilitate familiarity with the factors contributing to criticality, the physical behavior of systems at and near criticality, and a theoretical understanding of neutron multiplication processes in critical and subcritical systems. If the individual does not have previous experience in critical experiments, then they shall participate in the LANL Advanced Five-Day Course. There are limited resources to cover this competency.

10.0 Process/Facility Knowledge

The following facility specific training is typically required for access to protected areas, to provide information on applicable hazards and emergency procedures associated with the facility.

- General Employee Training
- Radiation Worker Training
- Fissile Worker Training
- Emergency Preparedness Training
- Conduct of Operations Training
- OSHA Training
- Hazardous Waste Operations Training
- Building Specific Training

In order to perform the tasks of a criticality safety engineer, familiarity with the facility including operations and equipment knowledge and safety authorization basis is required. This information can be obtained through facility walkdowns, operating procedures, engineering drawings, interviews with operators, review of applicable

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occurrence reports, process/system descriptions and study of the facility safety basis documents. Each individual shall be required to spend a predetermined amount of time in the facility to meet this competency. NCS Engineers shall demonstrate familiarity with specific facilities and processes for which they produce criticality safety evaluations.

The individual should be able to:

- a. Describe the physical system/facility.
- b. Describe the material flow and throughput.
- c. Describe the normal operating conditions.
- d. Describe credible abnormal conditions.
- e. Describe interfaces and interactions with other processes/facilities.

See Appendix A for recommended facility specific areas of training and associated training resources.

V. Documentation Requirements

The Contractor shall document successful completion of each competency via written exam or oral board. Each individual in performing the duties of an NCS Engineer shall have a Training and Qualification Card. The Training and Qualification Card shall be signed by both the qualifying individual and the assigned facility qualifying official. Any competencies used in lieu of the above requirements for experienced personnel shall be specifically documented on a Training and Qualification Card.

VI. Re-qualification Requirements

A periodic re-qualification is required to address any NCS Engineers that may have been assigned to other tasks for an extended period of time. The Contractor shall document the periodicity and process for re-qualification.

VII. Guidelines for Initial Qualification of Experienced Staff

Past experience in the field of criticality safety may be used to qualify individuals with at least 3 years of criticality safety experience at the discretion of the Contractor Management and shall be documented on a Training and Qualification Card. Experience with different facilities/processes other than the one(s) to which the engineer is currently assigned should not be used to meet the requirements of Section 10.0 of this Standard.

VIII. Continuing Training Requirements

Each Contractor shall document their requirements for NCS Engineer continuing training and professional development. Continued participation by NCS staff in professional activities such as ANS conferences, ANSI standards committees and criticality safety workshops shall be an element of the Contractor continuing training program to maintain proficiency in the discipline.

IX. Training Related Reference Documents

Training programs should provide consistent and effective training for personnel at any nuclear facility. Minimum requirements for training and qualification programs are found in the references listed below. The requirements included are based on DOE, NRC and related industry standards.

1. DOE Order 5480.20A, "Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities."
2. ANSI/ANS-8.20-1991, "Nuclear Criticality Safety Training." (fissile material handlers)

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Appendix A

Training Resource Matrix

This matrix was developed to provide training resources for the areas required in this Standard. It is understood that this list is not all inclusive. Individuals are encouraged to seek out the best tool for their needs.

Legend:

UT - University of Tennessee Short Course
 UNM - University of New Mexico Short Course
 GT - Georgia Tech University
 LANL - Los Alamos 5-Day Class
 *NCSET - Nuclear Criticality Safety Engineer
 Training (revised SOLCET)

Category	Sub-category	Training Resources
Academic		
	Nuclear Reactor Theory	UT, UNM, LANL, GT, NCSET Module I&II
	Fundamentals of chain reactions	UT, UNM, LANL, NCSET Module I
	Neutron balance	UT, UNM, LANL, NCSET Module II
	Criticality and Anomalies	PNL Criticality Anomalies
	Calculational Methods	UT, UNM, GT, LANL
	Model development	UT, UNM, LANL
	Hand calculations	Nuclear Tech 8/76, Vol. 30, NCSET Module III
	Computer code usage	UT, UNM, LANL
	Neutron Multiplication Factor	UT, UNM, LANL
	Cross sections	UT, UNM, LANL
	Monte Carlo codes	DANTSYS Courses
	MCNP	MCNP Primer
	KENO/SCALE	SCALE Course
	Diffusion and transport codes	UT, UNM, LANL
	Validation of calculations	UT, UNM, LANL, NCSET Module 4
	Deep Penetration Calculations (CAS coverage)	Shielding for Nuclear Engrs (Textbook)

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Category	Sub-category	Training Resources
	Experiments	LANL, Knief Book, LA 3366, Paxton Docs,
	Critical and subcritical experiments	Tuscon Workshop Proceedings
	Accident simulations	UT, UNM, LANL
	Criticality data (i.e., ICSBEP, YCDC-12)	UT, UNM, LANL
	Identification/proposal of new experiments	LA Forecast of Experimental Needs
	Rules, Standards and Guides	UT, UNM, NRC, DOE
	DOE Orders 5480.24, 5480.23, 5480.22, 5480.21, 5480.20, 420.1	UT, UNM, NRC, DOE
	ANSI/ANS 8 criticality safety Standards	UT, UNM, NRC, DOE
	Criticality safety handbooks and guides (LA 12808, LA 10860, TID 7016, DOE-STD-3007-93, DOE-STD-3009-92, ICSBEP, YCDC-12, LA Paxton's Glossary, DOE Guide 421.1-1)	UT, UNM, NRC, DOE
	NRC Reg. Guides	UT, UNM, NRC, DOE
	Applicable CFRs (e.g., 10CFR, 49CFR, 10CFR830.120)	UT, UNM, NRC, DOE
	Criticality Safety Evaluations	UNM, GT, LANL Adv., UT
	Requirements	DOE-STD-3007-93
	Process analysis	UT, UNM, NRC, DOE
	Subcritical margins and limits	UT, UNM, NRC, DOE
	Controls and operating rules	UT, UNM, NRC, DOE
	Validations and bias estimates	K. Disney
	Safety Analysis and Control	JB Fussel Text and Course
	Analysis skills	DOE courses
	Hazop	DOE courses
	Event Tree/Fault Tree methods	DOE courses
	What-if methods	DOE courses
	MORT	DOE courses
	PRA basis	JBF
	Root Cause methods	DOE courses

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Category	Sub-category	Training Resources
	Control Methods and Evaluation	DOE Guide 421.1-1, LA 3366, DOE-STD-3007
	DOE Site Process Overview	Alb. Weapons Course
	Review of process accidents	NCT-04
	Criticality Alarm & Detection Systems	ANS 8.3, ANS/NCSD Workshops (2)
	Requirements	ANS 8.3, ANS/NCSD Workshops (2)
	Determining coverage	ANS 8.3, ANS/NCSD Workshops (2)
	Exclusion analysis for CAS	ANS 8.3, ANS/NCSD Workshops (2)
	Accountability Practices	Principles of NDA Nu Reg.
	Measurement (NDA) techniques	Basics of MC&A Measurements, MCA-140 (Central Training Academy)
	Sampling and Analysis failure modes	Basics of MC&A Measurements, MCA-140 (Central Training Academy)
	Use and Abuse of Statistics	Basics of MC&A Measurements, MCA-140 (Central Training Academy)
Experimental (Hands-On)		
	LANL 5-day introductory criticality safety course	LANL
	LANL 5-day advanced criticality safety course	LANL
	participation in critical mass experiments	LANL Critical Experiments Facility
Operational		
	site specific accident and incident experience	Site specific training
	process safety documentation and control	
	preparation and review of facility SARs, TSRs, USQ determinations, hazard analyses and transportation requirements	DOE courses, Site specific training
	preparation and review of criticality safety evaluations, determination of safety margins and operating limits	Site specific procedures and manuals
	preparation of facility procedures and postings	Site specific training, DOE Guide 421.1-1
	on-the-job experience, including assessing conformance to the site NCS program	Site specific training

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Category	Sub-category	Training Resources
	operations and equipment knowledge	
	process equipment and hardware (e.g., HEPA filter characteristics for fissile material collection and water retention, mechanical designs for backflow prevention)	Site specific training, Nuclear Fuel Reprocessing (J. A. Long), Nuclear Chemical Engr
	types and nature of fissile material (e.g., isotopics, hygroscopic, deliquescent) used in typical fissile material processes	Site specific training, Pu (Wick), U (Googan)
	typical chemical, physico-chemical, electro-chemical and metallurgical processes used in fissile material operations and typical off-normal conditions of such processes that can potentially impact the safety basis of a NCS evaluation	Site specific training
	typical passive and active detection and control devices used in fissile material processing	Principles of NDA, DOE Guide 421.1-1
	site-specific equipment, materials and processes	Site specific training
	other on-site activities that could impact facility NCS	Site specific training
	fire safety systems	NFPA course, Site specific procedures, Holmes document
	safeguards and security	DOE course, site specific process
	Conflict between other programs that impact NCS (i.e., Rad Con, Waste Mngmt)	Site specific, UT, GT, UNM, LANL
	OSHA programs	DOE course, site specific training
	conduct of operations	DOE course, site specific training
	standard conduct of operations principles as applied to NCS	Site Specific Con Ops training
	Event response	Site specific training, LANL, UNM
	infraction grading	Site specific training
	lessons learned	DOE course, site specific process
	occurrence reporting	DOE Occurrence Reporting Courses

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Category	Sub-category	Training Resources
	administrative practices	LANL, UNM, Site specific
	configuration management and control (hardware, software, documents)	Site specific
	surveillance and audit activities	Site specific, UT, UNM, DOE Lead Auditor course
	emergency preparedness	Site specific, Nu Reg/CR-6504
	independent safety review process	Site specific
	human factors	INEL course, JBF course, UNM, UT, Nu Regs
	liaison for management, operators and operations staff	Covey, Myers-Briggs
	training support	Site specific
	postings and procedures	LLNL Audit Manuals, UT
	operational aspects affecting job performance	Site specific
	communications and interpersonal skills	Site specific
	materials control and accountability	Materials Accounting for Nuclear Safeguards, MCA-111, LANL Nondestructive Assay Techniques for Safeguards Practitioners, MCA-241, LANL
	accountability practices (inventories, material balance areas, etc.)	Introduction to MC&A, MCA-101 (Central Training Academy)
	SNM measurement techniques (NDA and analytical methods)	Basics of MC&A Measurements, MCA-140 (Central Training Academy)
	holdup measurements	Nondestructive Assay of SNM Holdup, MCA-243, LANL

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CONCLUDING MATERIAL

Review Activity:

Preparing Activity: EH-34

Project Number: SAFT-0070

DOE

DP-13
DP-20
EH-22
EH-31
EH-32
EH-34
EM-65

Field Offices

AL
ID
ORO
RL

National Laboratories

ANL
LANL
LLNL
ORNL
PNNL

Others

B&W Hanford
Bechtel-Jacobs
Consultant
DNFSB Staff
FDH
FDNW
Georgia Tech University
LMITCO Hanford
NISYS Corp.
SAIC Richland
WSRC