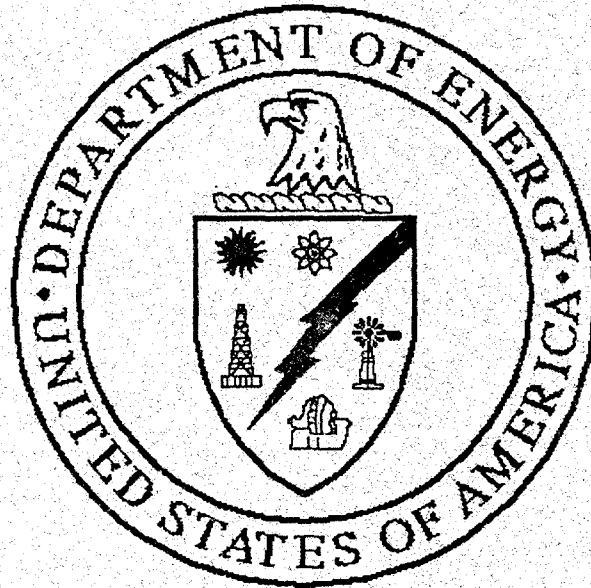


United States Department of Energy

National Spent Nuclear Fuel Program

*High Integrity Can
Design Interfaces*

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August 1998

U.S. Department of Energy
Assistant Secretary for Environmental Management
Office of Spent Fuel Management and Special Projects

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High Integrity Can Design Interfaces

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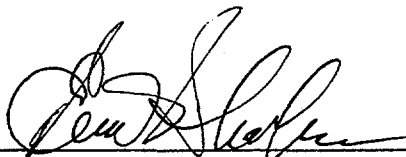
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High Integrity Can Design Interfaces

August 26, 1998

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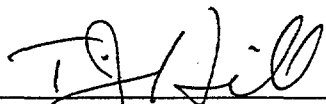

E. L. Shaber

Date: 8/26/98

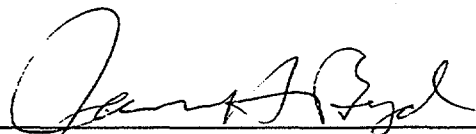
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Date: 8/31/98


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Date: 8/31/98

High Integrity Can Design Interfaces

1.0 Introduction and Scope

1.1 Basis

The National Spent Nuclear Fuel Program is chartered with facilitating the disposition of DOE-owned spent nuclear fuel to allow disposal at a geologic repository. This is done through coordination with the repository program and by assisting DOE Site owners of SNF with needed information, standardized requirements, packaging approaches, etc.

The high integrity can concept grew out of the need to manage a number of miscellaneous spent nuclear fuel items, fuels that represent very small lots, or fuel pieces that have been sectioned, damaged, or otherwise degraded. Sufficient characterization of such items to meet all repository criteria has been judged to be quite expensive and in some cases is not feasible.

The High Integrity Can (HIC) will be manufactured to provide a substitute or barrier enhancement for normal fuel geometry and cladding. The can would be nested inside the DOE standardized canister which is designed to interface with the repository waste package. The HIC approach may provide the following benefits over typical canning approaches for DOE SNF.

- It allows ready calculation and management of criticality issues for miscellaneous pieces and parts of spent fuel items.
- It segments and further isolates damaged or otherwise problem materials from normal SNF in the repository package.
- It provides a very long term corrosion barrier
- It provides an extra internal pressure barrier for particulates, gaseous fission products, hydrogen, and water vapor.
- It delays any potential release of fission products to the repository environment.
- It maintains an additional level of fuel geometry control during design basis accidents, rock-fall, and seismic events.
- When seal welded, it could provide the additional containment required for shipments involving plutonium content in excess of 20 Ci. (10 CFR 71.63.b) if integrated with an appropriate cask design.

Long term corrosion protection is central to the HIC concept. The material selected for the HIC (Hastelloy C-22) has undergone extensive testing for repository service. The most severe theoretical interactions between iron, repository water containing chlorides

and other repository construction materials have been tested. These expected chemical species have not been shown capable of corroding the selected HIC material. Therefore, the HIC should provide a significant barrier to DOE SNF dispersal long after most commercial SNF has degraded and begun moving into the repository environment.

1.2 Licensing Strategy

The HIC is being designed to ASME Section III, Division 3 (static requirements only) although only Section III, Class II and III properties are currently approved. The ASME Section III, Division I code case for Hastelloy C-22 to provide Class I values is still in development¹. The Section III requirements are being used to ensure that the can will meet the potential needs of a number of different users at DOE Sites for storage, transportation, and eventual disposal. Although specific credit as a containment for NRC licensing is not being taken during the design process, the can provides the "defense-in-depth" desired for several hard-to-manage DOE SNF materials.

For DOE Site storage, SNF may be held in NRC or DOE regulated facilities. The can will normally be used within a larger can, well, or facility SNF storage position, but it will be capable of use as a sealed containment barrier to radiological contamination if needed by the storage facility owner.

Because the can is not part of any specific cask arrangement for transport of SNF at this time, it cannot be specified as a barrier for transport during the design process. The ASME code stamped vessel, however, should allow the seal-welded can to be adopted as a barrier or secondary containment for transport at a later time if desired by cask designers.

For repository disposal, the HIC is being designed to the DOE/RW/0333P quality assurance program requirements as a quality affecting item. However, it is not expected to be used in the repository NRC License Application as an official part of the engineered barrier system. The HIC provides an additional physical separation of selected DOE SNF from the environment that eliminates the arguments that fuel damage, sectioning, or reactivity makes it unfavorably different from commercial fuel. Credit could be taken for the HIC at a later time if RW decides to assign a design life to the C-22 based on their analyses of waste package corrosion behavior.

The HIC design process, therefore, will provide the final design for a can which has the capability for use in storage, transport, and disposal situations. The design product, however will not be a "Design Specification" per ASME Section III, Division 3, paragraph WA 3111, because the NSNF Program is not the design owner. The NSNF Program will provide the design as a standard package to DOE Site user organizations to

¹ Framatome Cogema Fuels is sponsoring the ASME code case for Hastelloy C-22. It is expected to be approved about June 1999.

apply to specific fuel storage, transport and disposal situations. The Sites will verify that their use of the can is within the design envelope, verify the criticality safety of their specific application and provide a Design Specification, specific to their needs, for procurement of required HIC's.

1.3 Scope

This design interface document provides a summary of the interfaces involved in the design of a High Integrity Can for use with DOE-owned spent nuclear fuel. Where interfaces are already specified in other National SNF Program documents, the existing work is normally cited rather than copied here.

1.4 Scope of the HIC Design

The High Integrity Can program will consist of materials selection, dimensional determination, structural analysis, and criticality design of a can intended for interim storage, repository transport, and repository disposal. The can will hold spent nuclear fuel items which represent very small lots, particulate fuel materials, sectioned fuel elements, fuel samples used for post irradiation testing, unknown or otherwise uncharacterized spent fuel items, and degraded or damaged fuels. Although designed specifically for irregular SNF disposal situations, the can may also be used in some situations to obtain advantages in handling, shipping, criticality management or other benefit determined desirable by the SNF owner.

The can will be designed for dry hot cell loading in an inerted atmosphere. An alternate design lid will also be available to allow backfilling the can with an inert gas after loading for non-inerted hot cells. The lid system of the can will also be designed for sealed storage in a hot cell environment or in an interim storage configuration prior to final seal welding for disposal. A series of can lengths, designed for nesting within the standardized canister will be specified to allow can selection to maximize storage space utilization.

Although the can will be designed initially with a specific lid and lifting bail design compatible with INEEL facilities, the can may be used (potentially with an alternate lid configuration) by Hanford, SRS, the Navy, other DOE Sites, Universities, or other facilities where the fuel is currently located.

The specific design criteria, requirements and inputs for the HIC design are specified in the *High Integrity Can Design Input Document*, DOE/SNF/RD/004, Rev. 0.

2. Interfaces

2.1 Participating Organizations

The design effort will be performed by LMITCO Advanced Engineering and Development Lab (AEDL) personnel supporting Nuclear Operations as augmented staff to the National Spent Nuclear Fuel (NSNF) Program.

The current design team (subject to change) includes engineers with specific responsibility for components of the design (shown with an asterisk *) and supporting engineers who assist with analyses, checking, and internal design verification activities. This team includes:

Program Manager/Technical Lead: C. Lee Bendixsen
Work Package Manager: Eric Shaber
Quality Assurance Support Engineer: Mona Huffaker

Design Team Leader: Patrick Holmes*

Mechanical Design Engineers

John Brasier*
Wayne Shurtliff
Design Drafters
Wade Heilson
Harlan Hendricks

Software Configuration Manager

Nathan Smith*

Stress Analysis Engineers

Robert Blandford
D. Tom Clark
James Dobbins
Richard Rahl
Robert Spears
Evert Uldrich
Jack Ware*

Criticality Safety Engineers

Leland Montierth
Valerie Putman*
Paul Senteiri

Materials Selection Engineers

Ron Mizia
Eric Shaber*

Licensing Analysis & Regulatory Support

Edward Houck
Jene Kanemoto*

The INEEL Local SNF Program, SRS, Hanford, the RW M&O, and the U.S. Navy will interface with the design team during and after the design process. Interface representatives include:

Hanford: Roger McCormack
SRS: William Swift
INEEL Facilities: Eric Woolstenhume
INEEL SNF Program: Doug Toomer
U.S. Navy: Carl Detrick
RW M&O: Tom Doering

A multi-disciplined formal design review and verification process will also occur after generation of the design package. Formal verification processes are managed through the Program Manager/Technical Lead (PM/TL) for the National SNF Program, C. L. Bendixsen. It is expected that such verifications will involve the expected HIC users from other Sites, the U.S. Navy, and the RW M&O.

2.2 Interface Actions and Responsibilities

Organizations involved in the HIC design effort will have responsibilities as follows:

2.2.1 The National SNF Program

- Provide a design team composed of qualified engineering personnel to perform the design effort.
- Provide the required budget for design of the can.
- Provide design guidance and philosophy for usage of the can.
- Provide required PM/TL management and support to the design activity as required under Program Management Procedure 3.02
- Provide a Quality Assurance Support (QAS) Engineer to work with the design team in ensuring that all National SNF Program Quality requirements are met.
- Obtain a qualified design verification lead to perform required reviews of the design package.

- Ensure that interfaces for design reviews with other DOE Sites, the U. S. Navy, and the RW M&O are established and maintained.

2.2.2 The Design Team

- Perform all necessary design analysis including structural, stress, drop, criticality, and thermal (if needed).
- List and review all applicable codes and standards applicable to the design to ensure design requirements are met.
- Perform design analysis and obtain appropriate internal checks and reviews for accuracy or verifications.
- Integrate all facets of the design into one product meeting all design requirements.
- Generate all needed design drawings and specifications for the design package.
- Generate a design package which includes documents for each component of design with separate design analysis and verification check.
- Assist the PM/TL in maintaining interfaces with user organizations at the INEEL and other Sites.

2.2.4 INEEL, Hanford, SRS, RW M&O, and Naval DOE SNF Representatives

- Provide an interface representative to attend design team meetings (if desired) and coordinate on design details important to the represented facilities and their specific SNF issues.
- Provide timely review and comment input to the design process. (The representatives will be provided uncontrolled copies of draft design documents for review during the design cycle. The documents will be arranged to show the latest can design data with summaries of the results of stress analyses performed to date. Timely reviews by representatives and their respective organizations will be taken into account to the extent feasible in the design effort.)
- Participate in the formal PMP 6.01 review of the final design package. This formal review will be for applicability of the design to manage specific Site SNF issues and compatibility with Site facilities.

2.3 Information Flow and Management

After the design effort is initiated by the NSNF PM/TL, the design team leader will normally manage routine communications and interfaces within the design process. The design effort is being performed as part of the NSNF program rather than for any specific Site. The PM/TL or his designated work package manager will provide formal interface

with external organizations (the U.S. Navy, other DOE Sites, and the RW M&O through the specified representatives). However, working level discussions, interfaces, and issue resolution activities may involve direct interface between design team members and external interface representatives.

The normal modes of information transfer during the design process will include electronic mail, and telefax of preliminary draft documents such as drawings and analyses by the design team leader. All such information will be clearly marked as **"DRAFT"** to ensure such information is not used inappropriately. The design team leader, however, will normally restrict transmittal of such working level design information to those specific personnel assigned interface responsibility for the design effort. Any further distribution of preliminary design information among interfacing organizations will be the responsibility of the assigned interface representative. Informal transmittals will always be forwarded to the DCC at the time of issue and will become part of the permanent design record.

Responses, comments, and requests for design adjustments resulting from interface reviews of informal transmittals will be discussed and evaluated by the design team during regular team meetings. All adjustments or actions taken on informal comments during the design process will be documented in the regular meeting minutes which will become part of the permanent design record.

Transmittal of design documents for formal review under the QA program will be the responsibility of the NSNF PM/TL and will be managed through the PMP 6.01 review process.

3. Procedure and Requirements

3.1 Codes and Standards

The technical codes and standards to be applied to the HIC design are listed in the Design Input Document and will not be repeated here.

The HIC must perform in three different systems covered by three sets of federal regulations:

- | | |
|-----------|------------------------------------|
| 10 CFR 72 | Covering On-Site Interim Storage |
| 10 CFR 71 | Covering Inter-Site Transportation |
| 10 CFR 60 | Covering Repository Disposal |

Repository documents to implement the above codes have been drafted by the repository contractor and represent their current understanding of what is needed to implement the NRC Code of Federal Regulations requirements for the repository. Such documents

applicable to this design effort include the Interface Control Document (A000000000-01717-8100-00007), the Disposability Interface Specification (B000000000-01717-4600-00108) and the Repository Guidelines Document for Criticality (DOE/SNF/FEP-009). Although these documents cannot be finalized until after an NRC license has been issued, they will be used to provide guidance in this design effort.

3.2 Implementing Procedures

This design effort will be performed using a combination of NSNF Project Management and other Procedures. The following NSNF procedures provide the basic personnel qualification, documentation, and design environment:

- PMP 2.04 – Qualification, Indoctrination and Training
- PMP 3.01 – Design Input
- PMP 3.02 – Design Control
- PMP 6.01 – Document Preparation, Review and Distribution
- PMP 6.02 – Preparation of Technical Documents
- PMP 16.02 – Corrective Action and Stop Work
- PMP 17.01 – Quality Records Management and Control

These NSNF procedures will be supplemented with portions of TRW and LMITCO procedures for performing specific design functions. Such procedures are attached to this document. The procedures will be adopted for use with the exceptions and adjustments noted for each procedure as detailed below. The attached procedure rather than any other revision or copy of the document must be used for this design activity.

3.2.1 Software Management

The use of software products for quality-affecting analysis will be controlled using the QAP-SI-0/Rev. 3 - OCRWM Computer Software Qualification Procedure (Attachment A).

The Computer Software Qualification procedure will be used for managing software use within the design effort. The following exceptions and adjustments apply:

General: The software configuration manager will perform all duties of the SCS for this design effort except for administrative functions involving the designation of records control numbers. The software configuration manager will work with the NSNF DCC to obtain unique identifiers for individual software items.

Section 3.12 – The Contractually Designated Supervisor will be the PM/TL for this design effort.

Section 3.13, 3.15, & 3.20 – Instead of the three specific CSCI Identifiers, the NSNF DCC will issue one unique identifier for each item of software being used. The DCC identifier will be provided to the software configuration manager who will identify the unique names and numbers associated with the specific software and media as defined in the procedure.

Section 3.23 – The Responsible Manager for this design effort will be the design team leader.

Section 3.24 – The Responsible Manager's Supervisor for this design effort will be the PM/TL.

The Engineering Assurance discussed in this procedure is the Quality Assurance Support Engineer (QAS) for this design effort.

Procedural Sections 5.1, 5.3 and 5.5 are applicable to this design effort.

Section 5.4 and Section 6 and Attachment A – Records generated for software qualification and management will be managed by the NSNF DCC to PMP 6.01 and 17.01 requirements instead of the Records Processing Center.

Specific procedures for configuration control of qualified software being used for this design effort are documented internally and will be reported as part of the software qualification and management report prepared by the software configuration manager. The software qualification and management report will become part of the permanent design package.

3.2.2 MCP 2374 – Engineering Analysis

Engineering Analysis procedure MCP 2374 (Attachment B) will be used for all engineering analysis efforts in this design process.

For the purposes of this engineering analysis procedure, the design team leader will always be the requester and the assigned design team member will be the performer. The "verifier" will be a design team member not responsible for the original analysis who will perform the internal review of the analysis document for technical accuracy per Section 4.11.

PMP 3.01 rather than MCP 2371 will be used for controlling design inputs discussed in this procedure. In Sections 4.9 – 4.17 any mention of MCP's and the specific forms within them will be interpreted to mean PMP 6.01, 6.02, 17.01 and their attendant forms of similar name.

This design effort is quality affecting per DOE/RW/0333P and will supercede references to risk levels in this procedure. All analyses for this design effort will follow the requirements of "high-risk" analysis.

Section 4.6 qualification of computer programs will be performed. All engineering analyses will be interpreted as quality affecting per DOE/RW/0333P. (See process described in 3.2.1 above).

Section 4.7 will not be performed as stated. The DAR (See PMP 6.01 & 6.02) will be used and the analysis report will be an NSNF document.

Section 5. Records, will not apply. The NSNF DCC will manage the reports generated through this process as lifetime records using the procedures in PMP 17.01.

3.2.3 MCP 2377 – Preparing, Reviewing, and Approving Drawings

MCP 2377 for preparation and management of design drawings (Attachment C) will be used to manage all design drawings generated as part of this design effort.

This procedure will be applied to all drawings for this design effort. The NSNF DCC will assign a separate document number to each drawing in addition to the drawing number applied per MCP 2377.

Section 3: The Project Manager/Technical Lead will define the minimum review, approval, signatures, and distribution for drawings involved in this design effort. Sections 3.2 and 3.3 are not applicable.

The "engineer" and "drafter" discussed in this procedure are members of the design team. The "Professional Engineer", if used will be the design team leader.

The "authorized checker" will be a member of the design team, qualified to perform the checking task but independent of the engineer and drafter who generated the drawings.

Section 4.3: For this design effort, drawings will be reviewed as documents, and comments provided per the requirements of PMP 6.01.

Section 4.5 and 4.8 and 4.9, 4.10, and 5.0 will not apply.

Section 4.6: The "Drafting Organization" duties in this procedure will be performed by the NSNF DCC. Drawing Release authorization will be managed according to PMP 6.01 protocols. Once drawings are approved per PMP 6.01, the DCC will utilize the DMCS and LMITCO processes for maintaining drawing originals, and providing controlled copies. However, the DCC will retain an official approved file copy of all drawings.

3.2.4 MCP 3006 – Performing and Reviewing Criticality Safety Evaluations

Criticality safety evaluations are highly specialized within the DOE complex and represent advanced techniques for performing complicated analysis under a wide variety of conditions. Criticality requirements in 10 CFR 60, 71, and 72 and the criticality safety criteria in the Repository Guidelines Document for Criticality are based on the ANSI/ANS standards for criticality analysis. The Disposability Interface Specification is also expected to adopt these standards. The Criticality Safety Program Requirements Manual, Attachment E, provides and details the ANSI/ANS standards for LMITCO use in performing criticality analysis.

Because of the advanced nature of DOE analysis capability, LMITCO criticality procedures will be applied to criticality scoping calculations performed using qualified software transferred from the OCRWM M&O and the requirements of MCP-3006 and PRD-112 (Attachment D and E). The following adjustments are required for MCP-3006:

Section 4.1 and 4.2.4– To initiate a CSE, the criticality safety engineer will generate a document action request per NSNF PMP 6.01. The DAR will assign an external report number from the document control coordinator (DCC) for use in the CSE.

Section 4.3 – 4.5 – Not applicable. Document approvals, revisions, and sign-off will follow the requirements in NSNF PMP 6.01.

Section 5.0 – The records will be managed by the NSNF DCC.

3.2.5 PRD 112 – Criticality Safety Program Requirements Manual

The document will be used along with MCP 3006 for performing criticality scoping analyses for this design effort with the following adjustments:

Sections 3.1 and 3.2 are not applicable as they relate to actions outside the criticality analysis design activity.

For Section 3.3 the Criticality Safety Staff is considered any one or all of the criticality safety engineers assigned to this design effort.

3.3 QA and Records Management Requirements

The RW Quality Assurance Requirements and Description, DOE/RW/0333P will apply to this design activity.

The HIC design will be performed on the basis that the can is a quality affecting item for the repository. The intent is to design the can such that later credit for the can may be

taken as an engineered barrier to the release of fission products to the repository environment.

Records will be managed through the NSNF Document Control Coordinator (DCC). The DCC will provide individual document numbers according to standard PMP 6.01 procedures for all formal HIC design documents. The DCC will also provide a HIC design file to protect and secure informal transmittals, meeting minutes, analyses, and independent checks of design work performed as part of the design effort which may become QA records (PMP 17.01.4.a.(6) and 4.b.(1)). The DCC, in coordination with the Design Team Leader and QAS will define records lifetimes and finalize/disposition QA Records per PMP 17.01.4a-d at the completion of the design effort.

4. Budget and Schedule

4.1 Funding Levels

Funding was originally provided for feasibility studies and the preliminary design of a high integrity can within the National SNF FY-98 "Plus-Up" Materials Analysis Work Package 1.7.02.1.T0.030, activity 60. Additionally design support to Site programs for design interface and package materials was budgeted in the same package under activity 40. The INEEL SNF program was originally funded for work on a standard can and lift fixture in work package 1.4.01.4.03.010, activity 3. The scope of the Materials Analysis work package design activity was modified to include the full design effort on May 29, 1998. No funding was added to the package, but the scope of the preliminary design activity was reduced and a portion of the design effort may continue to be funded from the INEEL SNF program work package.

The draft high integrity can feasibility study is currently complete. Review comments will be incorporated and the document finalized for record. A draft design input document was generated for the INEL SNF standard can which is being modified to become the design input document for the HIC.

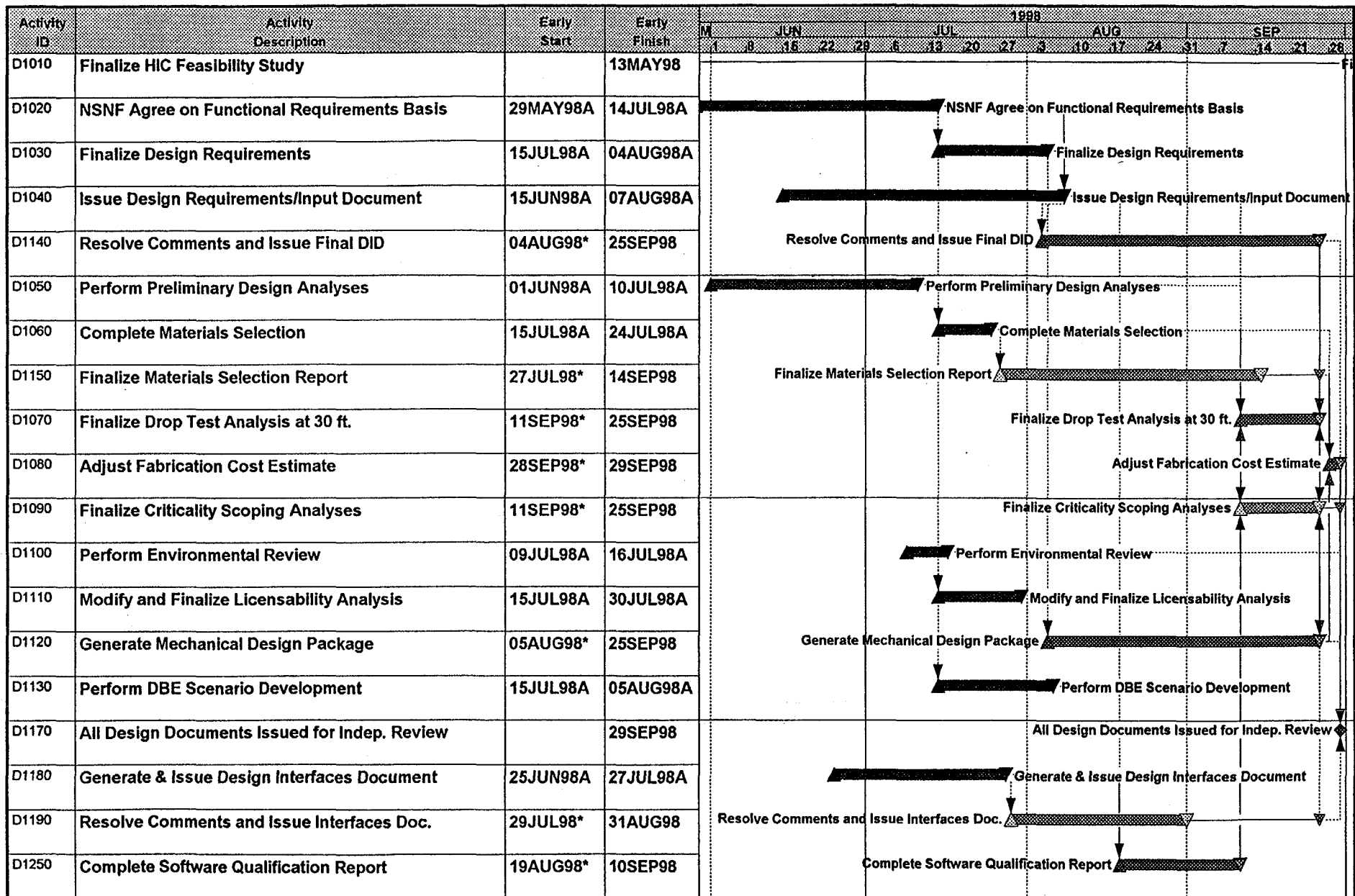
4.2 Schedule

The schedule for the HIC program is shown as Figure 1.

4.3 Deliverables

The deliverables for this program include the completion of the following documents:

1. Feasibility Study for the High Integrity Can
2. High Integrity Can Design Input Document
3. High Integrity Can Design Package



Project Start 14MAY98
 Project Finish 29SEP98
 Data Date 14MAY98
 Run Date 24AUG98

Early Bar
 Float Bar
 Progress Bar
 Critical Activity

HIC2

FIGURE 1
High Integrity Can
Design Schedule

Sheet 1 of 1

**Civilian Radioactive Waste
Management System**

QA: L

Management & Operating
Contractor

ATTACHMENT A

QUALITY ADMINISTRATIVE PROCEDURE

Title: **COMPUTER SOFTWARE QUALIFICATION**

Procedure Number: **QAP-SI-0**

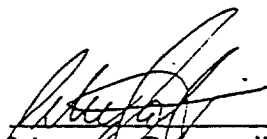
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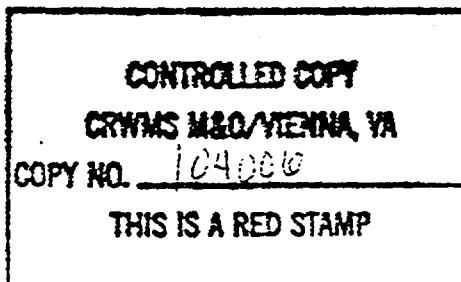
Effective Date: **December 8, 1997**

Author: **G. N. Bowman, G. P. Carlisle**

Responsible Manager: **C. R. Hastings**

Approvals:


Manager, Responsible Organization



26 Nov 97
Approval Date


General Manager, CRWMS M&O

2 DEC 97
Approval Date

CHANGE HISTORY

<u>Revision Number</u>	<u>Effective Date</u>	<u>Description of and Reason for Revision</u>
0	1/31/95	Initial issue
1	10/14/96	Complete rewrite to incorporate requirements of DOE/RW-0333P Revision 5, <i>Quality Assurance Requirements and Description</i> (QARD) and to consolidate QAP-SI-0, Revision 0, <i>Scientific and Engineering Software</i> , QAP-SI-1, Revision 0, <i>Acquired Scientific and Engineering Software</i> , and QAP-SI-2, Revision 0, <i>Developed Scientific and Engineering Software</i> , into a single procedure under a new title, QAP-SI-0, Revision 1, <i>Computer Software Qualification</i> .
2	6/02/97	Address the QA Transition. Change Quality Assurance Manager to Engineering Assurance. Change reference from QAP-17-1 to AP-17.1Q.
3	12/08/97	Add a process for handling software qualified by the National Laboratories or USGS and now used by other non-Laboratory M&O organizations. Clarify the process for getting the initial software identification numbers from the Software Configuration Secretary (SCS). Remove the grandfathering clause to the old QAP-SI-0, QAP-SI-1, QAP-SI-2, QAP-SI-3 procedure suite. Clarify the process for handling qualification of software routines. Clarify the definition and use of the term Responsible Manager. Clarify the Scope section.

1. PURPOSE

This procedure establishes the responsibilities and process for the qualification of computer software used by the Civilian Radioactive Waste Management System Management and Operating Contractor (M&O) to perform work subject to the *Quality Assurance Requirements and Description* (QARD), DOE/RW-0333P.

2. SCOPE

This procedure applies to all Civilian Radioactive Waste Management M&O organizations, except as noted below, tasked by the Office of Civilian Radioactive Waste Management (OCRWM) to perform design or analysis activities that are subject to the QARD, and involve the use of computer software for the performance of those activities or the generation of inputs for those activities. M&O organizations (such as the National Laboratories) that have their own OCRWM-approved software procedures may use those procedures to qualify computer software in lieu of QAP-SI-0.

This procedure applies to computer software that is used as the controlled source of information for design analysis, process control, scientific investigation, and other activities subject to the QARD. Generally, this procedure does not apply to software that performs a support function, such as operating systems; administrative and management software; system utilities; compilers and their associated libraries; and word processors. Industry standard software such as database managers; graphing and visual display systems; spreadsheet programs; and statistical analysis tools are also excluded. However, software routines and macros written for use within these types of industry standard software need to be qualified under this procedure if they are used as a controlled source of information for design analysis, process control, scientific investigation, and other activities that are subject to the QARD. Software that is acquired as an integral part of measuring and test equipment, and has not been developed or modified by the Affected Organization, is controlled by QAP-12-1, *Control of Measuring and Test Equipment and Calibration Standards*, and is also exempt from this procedure.

Computer software previously qualified by M&O organizations (such as the National Laboratories) under their procedures and in accordance with the QARD (especially Supplement I), that is transferred and used without modification by non-Laboratory M&O organizations, must comply with Subsection 5.5, Transferred Software.

3. APPLICABLE DEFINITIONS

References to other defined terms contained within a definition are displayed in *italics*. Definitions extracted from the QARD and other procedures are so noted.

- 3.1 **Acquired Software**—*Computer software* that is acquired from a source outside an M&O organization and was neither developed nor modified (see *Software Modification*) by an M&O organization or by an external organization acting under an M&O contractual or procurement document.
- 3.2 **Administrative and Management Software**—Software that provides tracking, monitoring, retrieving, sorting, or other function and does not serve as the controlled source of quality information used in design analysis, process control, or scientific investigation. Such software may support activities subject to the QARD, but does not require the controls of Supplement I (QARD).
- 3.3 **Affected Organization**—An organization performing Program work subject to QARD requirements whose organizational relationships are defined in OCRWM [Office of Civilian Radioactive Waste Management] Program documents (QARD).
- 3.4 **Alternate Calculations**—Calculations that are made with alternate methods to verify correctness of the original calculation (QARD).
- 3.5 **Approval**—The documented determination by a responsible organization that work is suitable for the intended purpose and shall be used as required (QARD).
- 3.6 **Baseline Element (Software)**—An individual component of a *software baseline* (QARD).
- 3.7 **Code Listing**—An ordered display or printout of program statements (QARD).
- 3.8 **Computational Support Software**—See *software routines*.
- 3.9 **Computer Program**—A sequence of instructions suitable for processing by a computer (QARD).
- 3.10 **Computer Software**—Executable *computer program* files, data files essential for running the software, and related documentation or support material that function as a single unit. It may include *stand-alone software* and *software routines*. Generally, *computer software* also includes source code, object code, job control code, and control data.
- 3.11 **Computer Software Configuration Item (CSCI)**—*Computer software* that satisfies an end use function and is designated for configuration control. Each CSCI is assigned a unique

- alphanumeric character set used to identify it and link it to its related documentation. The CSCI is a *software baseline element* (see *Baseline Element [Software]*) (QAP-SI-3).
- 3.12 **Contractually Designated Supervisor**—The individual to whom the *Responsible Manager* reports as designated by an M&O contractual or procurement document.
- 3.13 **CSCI Identifier**—A unique alphanumeric character set assigned by *Software Configuration Management* to identify a *computer software configuration item* and link it to its related documentation (QAP-SI-3).
- 3.14 **Developed Software**—*Computer software* that is developed or modified (see *Software Modification*) by an M&O organization or by an external organization acting under an M&O contractual or procurement document.
- 3.15 **Document Identifier (DI)**—A unique identifier assigned by *Software Configuration Management* to identify *software documentation* associated with *computer software*. *Software documentation* identified with a DI is a *software baseline element* (see *Baseline Element [Software]*) (QAP-SI-3).
- 3.16 **Functional Requirement**—A description of the overall nature and purpose of the *computer software* and the requirements for its intended use. Each functional requirement is a statement that captures a user need in terms of an observable behavior of the software and may include, for example, a description of the problem to be solved, the calculations to be performed, the data to be manipulated, the algorithms and numerical methods to be employed, the output to be generated (e.g., reports and data files), and the range of operation to be validated.
- 3.17 **Installation Testing**—Test runs with representative test data sets to ensure the computer software is operating as expected.
- 3.18 **Mandatory Comment**—A documented comment provided by the assigned comment due date that requires resolution prior to document approval and identifies an issue that does not meet specified review criteria (QAP-5-1).
- 3.19 **Measuring and Test Equipment**—Devices or systems used to calibrate, measure, gage, test, or inspect in order to control or acquire data to verify conformance to specified requirements (QARD).
- 3.20 **Media Identifier (MI)**—A unique identifier assigned by *Software Configuration Management* to identify *software media* associated with *computer software*. *Software media* identified with an MI is a *software baseline element* (see *Baseline Element [Software]*) (QAP-SI-3).

Civilian Radioactive Waste Management System

Management & Operating Contractor

- 3.21 **Regression Testing**—Selective retesting of a system or component to verify that modifications have not caused unintended effects and that the system or component still complies with its specified requirements (QARD).
- 3.22 **Release (Software)**—The formal notification and distribution of approved software (QARD).
- 3.23 **Responsible Manager**—The M&O manager with functional responsibility for an item or activity (QAP-5-1).
- 3.24 **Responsible Manager's Supervisor**—The M&O manager to whom the *Responsible Manager* reports in accordance with the M&O line organization.
- 3.25 **Retirement (Software)**—The termination of technical support and *Software Configuration Management* controls for a specific baselined *computer software* or software component for work subject to the QARD (QAP-SI-3).
- 3.26 **Software Baseline**—(1) A specification or product that has been formally reviewed and agreed upon, that thereafter is the basis for further development, and that can be changed only through formal change procedures. (2) A document, a set of documents, or a product formally designated and controlled at a specific time during the *software life cycle* (QARD). (3) A collection of *baseline elements* (QAP-SI-3).
- 3.27 **Software Configuration Management**—The process of establishing procedures for and performing configuration identification, configuration control, configuration status accounting, defect reporting and resolution, retirement, and withdrawal for *computer software*.
- 3.28 **Software Configuration Secretary (SCS)**—The individual responsible for providing *Software Configuration Management* administrative support and service, assigning configuration identification numbers, configuration change, problem reporting, configuration status accounting and reporting, defect reporting, and resolution (QAP-SI-3).
- 3.29 **Software Control Point**—Milestones in the *software life cycle* when controls are applied to the *software baselines* (QARD).
- 3.30 **Software Design**—The data structures and procedural flow (preliminary design) and the operational detail (detail design) of a *computer program*.
- 3.31 **Software Documentation**—Documentation that accompanies *computer software* and may include a description of the mathematical model and numerical solution technique, installation manual, user's manual, tutorial, and other specific manuals to aid in the use of the software.

- | 3.32 **Software Life Cycle**—A series of activities that begins when software planning is initiated and ends when the software is no longer available for use (QARD).
- | 3.33 **Software Media**—Magnetic tape, floppy disks, CD-ROM [compact disk-read only memory], or other electronic, magnetic, or optical storage devices that contain *computer software* files for backup or storage.
- | 3.34 **Software Modification**—Changes to *computer software* that affect the calculational structure or flow, data flow, and logic and mathematical algorithms. The following are not considered modifications subject to the provisions of this procedure: 1) changes that are necessary to install as-received software or to port the as-received software between computer platforms; 2) changes that result from (re)compilation, (re)linking, or adaptation of computer system-dependent functions such as time, date, input/output port addresses, and system access routines; or 3) changes that result from modifications in the computer operating environment.
- | 3.35 **Software Qualification**—The process of approving *computer software* or software components for support of work that is subject to the QARD.
- | 3.36 **Software Qualification Report (SQR)**—A report that documents the *software validation* for *acquired software* and the *software verification and validation* for *developed software*.
- | 3.37 **Software Requirement**—Specifics imposed by QARD Supplement I with respect to *software life cycle* planning, verification, validation, documentation, configuration management, defect reporting and resolution, and use control.
- | 3.38 **Software Routine**—A computer macro, script file, spreadsheet application, or other software application (either *acquired software* or *developed software*) that generally operates within another program, such as a spreadsheet; and *stand-alone software* that can be verified by visual inspection and/or hand calculations.
- | 3.39 **Software Routine Report (SRR)**—A report that describes one or more *software routines*, including testing that the calculations are correct for a specified range of input parameter values.
- | 3.40 **Software Validation**—The process of evaluating a system or component during or at the end of the development process to determine whether it satisfies specified requirements (QARD).

NOTE: Defined by NUREG-0856, *Final Technical Position on Documentation of Computer Codes for High-Level Waste Management*, as "Verification - Assurance that a computer code correctly performs the operations specified in a numerical model."

NOTE: Validation involves running test cases to ensure that the computed output meets specified expectations and requirements, including numerical correctness of the results on the basis of comparisons with *alternate calculations* (such as hand

calculations, analytical solutions, and other computer codes); see the checklists in Attachment I, Instructions for Preparing Software Qualification Report for Acquired Software, and Attachment II, Instructions for Preparing Software Qualification Report for Developed Software, for additional clarification.

- 3.41 **Software Verification**—The process of determining whether the products of a given *software life cycle* phase satisfy the conditions imposed at the start of that phase (QARD).

NOTE: Verification involves the comparison of the *computer software* and software components, including associated documentation, with functional requirements and specifications for these components, to ensure that the planned equations and logic are incorporated into the software, that the documentation includes the required sections and topics, and that the software is useful and accurate for the intended applications; see the checklist in Attachment II, Instructions for Preparing Software Qualification Report for Developed Software, for additional clarification.

- 3.42 **Stand-Alone Software**—*Computer software* that can be executed without the need of other *computer software* (other than computer system files).

- 3.43 **Transferred Software**—A term used to identify software that has already been qualified by an M&O organization (such as a National Laboratory), or the USGS, under procedures subject to the QARD and is now being provided for use, without modification, to a non-Laboratory M&O organization (QAP-SI-3).

- 3.44 **User Request**—An administrative request (Lotus Notes or memorandum) made to the *Software Configuration Secretary* to obtain a copy of the *Software Configuration Management* controlled and approved *software baseline* or *Transferred Software* package from the *Software Configuration Secretary* for installation on a specified computer (QAP-SI-3).

4. RESPONSIBILITIES

- 4.1 The Nevada Site Systems Engineering Manager is responsible for the preparation and maintenance of this procedure.
- 4.2 The following have responsibilities for implementing this procedure:
- A. Responsible Manager
 - B. Responsible Manager's Supervisor
 - C. Contractually Designated Supervisor
 - D. Engineering Assurance (EA)

5. PROCEDURE

If an individual is performing work that is subject to this procedure and cannot accomplish that work in full compliance with this procedure, the individual shall suspend work and shall resume work only after this procedure has been revised to correct the affected work practices. Process steps applicable to the given activity are to be accomplished sequentially unless otherwise indicated.

5.0 PROCESS OUTLINE

	Page
5.1 ACQUIRED SOFTWARE	7
5.2 DEVELOPED SOFTWARE	9
5.3 SOFTWARE ROUTINES	11
5.4 REVIEW, APPROVAL, AND SUBMITTAL OF RECORDS (EXCEPT TRANSFERRED SOFTWARE)	13
5.5 TRANSFERRED SOFTWARE	15

For a given computer software or software component, Subsection 5.1, 5.2, or 5.3 applies, as indicated by the section titles. Subsection 5.4 applies to all computer software or software components, except software routines that are described in SQRs of related acquired or developed software, or that are described in documents that include the analyses for which they are used.

5.1 ACQUIRED SOFTWARE

NOTE: Subsection 5.1, Subsection 5.4, and Attachment I, Instructions for Preparing Software Qualification Report for Acquired Software, constitute the approved process for conducting, documenting, reviewing, and approving the validation of acquired software. The steps in Subsection 5.1 include software acquisition; approval if validation needs to be performed by an individual who directed the software development; installation and validation; and preparation of an SQR, which documents the installation and validation. The qualification steps, except for the SQR, are performed in sequence and each step is considered to be a control point to ensure adherence to the procedure. The SQR may be prepared concurrently with the other steps, because input to the SQR will be developed throughout the qualification process. Updates of previously baselined software may be documented in a new SQR or in revisions or addenda to the existing baselined documentation. Software licensed for use on more than one computer needs to be validated on one computer only, but installation testing is performed before the software is used on other computers with different operating environments.

5.1.1 For acquisition, the Responsible Manager shall:

A. acquire the software in accordance with applicable procurement procedures;

- B. obtain sufficient copies of the software documentation and a waiver of copyright to meet the needs of records submittal in Section 6 and of regulatory requirements for records processing (which include providing images of textual material to outside parties); and
- C. contact the SCS to obtain CSCI Identifiers, DIs, and MIs for the software and software components in accordance with QAP-SI-3.

5.1.2 If necessary to justify the lack of independence, the Responsible Manager's Supervisor or the Contractually Designated Supervisor shall:

- A. approve the performance of the validation by individuals who directed the development work; and
- B. document the approval and justification in a memorandum to the Responsible Manager.

5.1.3 For installation and validation, the Responsible Manager shall:

- A. perform the validation, including software installation and installation testing, with independent individuals who did not work on the original software development (the person who directed the development work may perform the validation with a higher level of management approval and documented justification—see 5.1.2);
- B. in those cases where the entire software cannot be validated prior to the software release, identify the portions of the software that have not been validated and state the reasons and justification for the exclusions from the qualification in the SQR, to ensure appropriate control in accordance with QAP-SI-3, *Software Configuration Management*;
- C. prepare additional software documentation if the existing software documentation does not contain information similar to that listed for developed software in Attachment III, Instructions for Preparing Software Documentation for Developed Software, Items 2 and 3 (except 3.d.vi) ; and
- D. review and approve the additional software documentation, if any, including any revision of previously approved documentation, in accordance with Subsection 5.4.

5.1.4 For preparation of the SQR, the Responsible Manager shall:

- A. document the installation results and validation in an SQR in accordance with the instructions in Attachment I, Instructions for Preparing Software Qualification Report for Acquired Software, with supporting documentation as needed; and

- B. review and approve the SQR and any supporting documentation, including any revision of a previously approved SQR and documentation, in accordance with Subsection 5.4, prior to the software release.

5.2 DEVELOPED SOFTWARE

NOTE: This section applies to new software to be developed, existing acquired or developed software to be modified, and software that was developed and documented prior to the effective date of this procedure without compliance with the QARD. Developed software is qualified according to the steps in this section and in Subsection 5.4. The steps in Subsection 5.2 consist of preparation of a Life Cycle Plan (LCP); software installation if there is a change in operating environment; software development, modification, and documentation; preparation of a Verification and Validation (V&V) Plan; and V&V, which includes preparation of an SQR. Modifications of previously baselined software may be documented in new documentation or in revisions or addenda to the existing baselined documentation.

5.2.1 For preparation of the LCP, the Responsible Manager shall:

- A. contact the SCS to obtain CSCI Identifiers, DIs, and MIs for the planned computer software or software components in accordance with QAP-SI-3;
- B. prepare an LCP in accordance with the instructions for Attachment IV, Instructions for Preparing Life Cycle Plan for Developed Software, prior to development of new software; modification of a previously qualified software or software component; or qualification of developed software not previously qualified for work subject to the QARD;
- C. revise the LCP if requirements cannot be performed as specified in the LCP; and
- D. review and approve the LCP, including any revision of a previously approved LCP, in accordance with Subsection 5.4, prior to the start of work under Paragraphs 5.2.2 through 5.2.5.

5.2.2 For installation, if any of the activities of Paragraphs 5.2.3 and 5.2.6 involve a change of the operating environment, the Responsible Manager shall:

- A. perform brief and random testing of the installed software; and
- B. describe the results of the testing, including any discrepancies between the existing and new software and hardware platform, in the affected documents (e.g., the software documentation in Paragraph 5.2.3 or the SQR in Paragraph 5.2.6) using Attachment III, Instructions for Preparing Software Documentation for Developed

Software, Item 3.c; or Attachment II, Instructions for Preparing Software Qualification Report for Developed Software, Item 3; as applicable, for guidance.

5.2.3 For development, modification, and documentation, the **Responsible Manager** shall:

- A. as applicable, develop new software, modify previously qualified software or software components , or process previously developed unqualified software in accordance with the LCP;
- B. prepare software documentation (e.g., user's manual and description of mathematical models and numerical methods) in accordance with the LCP and the instructions of Attachment III, Instructions for Preparing Software Documentation for Developed Software; and
- C. review and approve the software documentation, including any revision of previously approved documentation, in accordance with Subsection 5.4, at the control points specified in the LCP.

5.2.4 If necessary to justify the lack of independence, the **Responsible Manager's Supervisor** or the **Contractually Designated Supervisor** shall:

- A. approve the preparation of the V&V Plan and/or the performance of the V&V by individuals who directed the development or modification work; and
- B. document the approval and justification in a memorandum to the Responsible Manager.

5.2.5 For preparation of the V&V Plan, the **Responsible Manager** shall:

- A. prepare a V&V Plan in accordance with the instructions of Attachment V, Instructions for Preparing Verification and Validation Plan for Developed Software;
- B. prepare the V&V Plan with independent individuals who did not work on the original software development or modification (the person who directed the development or modification may prepare the V&V Plan with a higher level of management approval and documented justification—see 5.2.4);
- C. revise the V&V Plan if the V&V cannot be performed as specified in the V&V Plan; and

- D. review and approve the V&V Plan, including any revision of a previously approved V&V Plan, in accordance with Subsection 5.4, prior to the start of the V&V at the control point specified in the LCP.

NOTE: The V&V Plan may be prepared prior to the completion of the software development and the approval of the software documentation, but may have to be revised to correspond with the approved software documentation.

5.2.6 For V&V, the Responsible Manager shall :

- A. perform the V&V in accordance with the V&V Plan with independent individuals who did not work on the original software development or modification (the person who directed the development or modification may perform the V&V with a higher level of management approval and documented justification—see 5.2.4);
- B. in those cases where the entire software cannot be verified and validated prior to the software release, identify the portions of the software that have not been verified and validated, and state the reasons and justification for the exclusions from the qualification in the SQR, to ensure appropriate control in accordance with QAP-SI-3;
- C. document the V&V in an SQR in accordance with the instructions in Attachment II, Instructions for Preparing Software Qualification Report for Developed Software, with supporting documentation as needed; and
- D. review and approve the SQR and any supporting documentation, including any revision of a previously approved SQR and documentation, in accordance with Subsection 5.4, prior to the software release at the control points specified in the LCP.

NOTE: The V&V may start prior to the completion of the software development and the approval of the software documentation, but the V&V is not completed and the SQR is not approved prior to the approval of the software documentation.

5.3 SOFTWARE ROUTINES

NOTE: Computer software routines are qualified according to the steps in this section. If an SRR is prepared, it is reviewed and approved in accordance with Subsection 5.4. Software routines are typically developed to accomplish specific tasks and usually operate within a spreadsheet program, although they may also be simple stand-alone computer programs. By their own nature, they typically have very limited application and are under continual modification to address additional needs or improve on their operation. Qualification of software routines, therefore, must

address this special need that is different from acquired or developed software. The software routine information is covered either in the document that includes the analyses for which the software routine is used, in an SQR for related acquired or developed software, or in a separate SRR. An SRR may be preferred if the same software routine(s) could be used for several activities without modification. A set of software routines may be covered in a single document for any of these options. Modifications of previously baselined software routines may be documented in new documentation or in revisions or addenda to the existing baselined documentation.

5.3.1 If necessary to justify the lack of independence, the Responsible Manager's Supervisor or the Contractually Designated Supervisor shall:

- A. approve the performance of the qualification activities by individuals who directed the development or modification work; and
- B. document the approval and justification in a memorandum to the Responsible Manager.

5.3.2 For software routine qualification, the Responsible Manager shall:

- A. perform the qualification activities with independent individuals who did not work on the original software routine development or modification (the person who directed the development or modification may perform the qualification activities with a higher level of management approval and documented justification—see 5.3.1);
- B. test the software routine by visual inspection of outputs (in the case of maps or graphs) and/or alternate calculations (such as hand calculations) to verify that the software routine gives the correct response for a specified range of input parameter values;
- C. document the software routine information (listed in Attachment VI, Instructions for Preparing Software Routine Information) using one of the following options:
 - in the document reporting the analyses for which the software routine is used;
 - in an SQR for related acquired or developed software;
 - in a separate SRR;
- D. if an SRR (option 5.3.2.C third bullet) is prepared, contact the SCS to obtain a DI for the SRR and CSCI identifiers for the software routine and any components in accordance with QAP-SI-3;

- E. prepare the software routine information (for any option chosen in Paragraph 5.3.2.C) in accordance with the instructions in Attachment VI, Instructions for Preparing Software Routine Information; and
- F. if the software routine information is included in an analysis document, review and approve that document in accordance with the procedure(s) applying to that document; or
- G. if an SRR is prepared, review and approve it and any supporting documentation, including any revision of a previously approved SRR and documentation, in accordance with Subsection 5.4, prior to the software routine release.

5.4 REVIEW, APPROVAL, AND SUBMITTAL OF RECORDS (EXCEPT TRANSFERRED SOFTWARE)

5.4.1 If necessary to justify the lack of independence, the Responsible Manager's Supervisor or the Contractually Designated Supervisor shall:

- A. approve the review of a V&V Plan, SQR, or SRR by individuals who directed the development or modification work; and
- B. document the approval and justification in a memorandum to the Responsible Manager.

5.4.2 For review, the Responsible Manager qualifying the software shall:

- A. identify the Affected Organization(s) for the review (including EA for requirements incorporation for the LCP, V&V Plan, SQR, and SRR), consulting with the Software Configuration Manager;
- B. specify the manner in which mandatory comments and their resolution shall be documented;
- C. specify the review criteria, using the checklist in the applicable attachment as guidance;
- D. provide records listed in Subsections 6.1 and 6.2 for review by the Affected Organizations using the specified review criteria;
- E. ensure that the V&V Plan, SQR, or SRR are reviewed by independent individuals who did not work on the original software development or modification (the person who directed the development or modification may review these documents with a higher level of management approval and documented justification—see 5.4.1);

- F. revise the documentation if necessary; and
- G. if the reviewed documentation is an LCP, V&V Plan, SQR, or SRR, forward it to EA for concurrence.

5.4.3 For concurrence, EA shall:

- A. indicate concurrence that the LCP, V&V Plan, SQR, or SRR contains the information specified in Attachments IV, Instructions for Preparing Life Cycle Plan for Developed Software; V, Instructions for Preparing Verification and Validation Plan for Developed Software; II, Instructions for Preparing Software Qualification Report for Developed Software; and VI, Instructions for Preparing Software Routine Information, respectively, by signing and dating the document; and
- B. return the document to the Responsible Manager.

5.4.4 For approval, records submittal, and configuration management submittal, the Responsible Manager qualifying the software shall:

- A. sign and date the documentation to indicate approval after ensuring that:
 - documentation meets the requirements specified in the applicable checklists;
 - documentation of developed software was prepared in accordance with the LCP;
 - V&V was performed in accordance with the V&V Plan;
 - reviews of the documentation were performed and documented as specified;
- B. submit lifetime and nonpermanent QA (QA: L, QA: N) records to the Records Processing Center in accordance with Subsections 6.1 and 6.2 of this procedure, after approval of each software record, several software records, the SQR, or SRR; and
- C. along with the submittal to the Records Processing Center, submit a copy of each record to the Software Configuration Manager, and notify the SCS of the accession or batch number of each record after it becomes available.

NOTE: The computer software or software components are not released for work subject to the QARD until approved by the Software Configuration Manager in accordance with QAP-SI-3. Following approval, all uses of the computer software or software

components for work subject to the QARD will be controlled by the Software Configuration Management in accordance with QAP-SI-3.

5.5 TRANSFERRED SOFTWARE

This subsection applies only to software previously qualified by M&O organizations (such as the National Laboratories), under their own OCRWM-approved procedures, that is now being transferred for use without modification by non-laboratory M&O organizations. This subsection stands alone unless a reference to another section of this procedure is explicitly stated.

There can be more than one requesting Responsible Manager within an organization depending on how responsibilities are assigned for transferring specific software packages. For any transferred software package, the requesting Responsible Manager's duties for that package extend only to use of that package within their own organization (e.g., Waste Package, Design, Scientific Programs, or Performance Assessment).

Only those modules or aspects of a software package that have been fully validated and/or verified can be used in an activity subject to the QARD. It is the function of the requesting Responsible Manager to determine applicability of qualified or non-qualified modules or aspects of the software package being transferred based on materials received from the providing organization, through the SCS.

The Responsible Manager shall:

- A. to obtain transferred software, send a User Request (in free-form format by Lotus Notes or memorandum) to the SCS in accordance with Subsection 5.10 of QAP-SI-3;
- B. to install transferred software, upon receipt of the transferred software and supporting materials from the SCS (or an approval, in writing, allowing electronic transfer of the files), perform the following:
 1. develop an installation and testing report based on the software documentation that provides the installation plan/checklist, the strategy for testing the software, and the criteria for acceptance of correct installation on the designated hardware/software platform;
 2. ensure the report generated in Paragraph 5.5.B.1:
 - contains a description of the computer on which the transferred software was installed/tested (such as the central processing unit), chip type, memory capacity, operating system, and the M&O 6-digit bar-coded identification number of the CPU);

- is signed by the preparer;
 - is independently reviewed and signed by a technically qualified person indicating the report strategy tests the installation adequately for the intended use of the software;
 - is signed by the requesting Responsible Manager to indicate approval;
3. ensure the software is installed and tested according to the report generated in Paragraph 5.5.B.5;
 4. ensure the acceptance criteria are properly applied to the test results;
 5. ensure the process of installation and testing and the test results are documented in a memorandum that contains:
 - an evaluation of the test results;

NOTE: The evaluation should include any problems encountered during installation and the steps taken to remedy them. If there are indications of differences by electronic comparison between these test results and the expected outputs justification for why the differences are acceptable should also be included.

- the signed installation and test report as an attachment to the memorandum;
6. ensure a copy of the memorandum with attachment is transmitted to the Records Processing Center and a copy is provided to the SCS;
 7. ensure that the transferred media is returned to the SCS after installation, unless it was transferred electronically; and

NOTE: If software was originally transferred electronically, then there are no media to return to the SCS.

8. ensure that if, after installation of the transferred software, the Central Processing Unit or operating system on which the transferred software was installed is changed, the steps in Paragraph 5.5.A and 5.5.B are repeated.
- C. for withdrawal of transferred software, prepare a Withdrawal Memorandum in accordance with Subsection 5.10 of QAP-SI-3, *Software Configuration Management*; and

- D. upon discovery of an error or defect in a transferred software package, or upon receipt of an error report or QA notice from the providing organization, prepare an Error and Defect Memorandum in accordance with Subsection 5.10 of QAP-SI-3.

6. RECORDS

The following QA: L and QA: N records generated as a result of this procedure shall be collected (as applicable) and submitted to the Records Processing Center in accordance with AP-17.1Q, *Record Source Responsibilities for Inclusionary Records*.

NOTE: The record source providing input to the SCS from this procedure, should transmit the batch number or, if available, the accession number of the records submitted to the Records Processing Center as these numbers become available. This includes record(s) submitted that were associated with an existing records package or individual records. The SCS will reference those batch numbers or accession numbers on documentation maintained by M&O Configuration Management, thus associating all Records Processing Center-submitted records within a given software qualification package.

6.1 Records to be assembled into QA records packages include:

A. Acquired Software Records Package

QA: L - SQR, software documentation, software media, and records identified as lifetime QA records in the SQR. If applicable, memoranda on the lack of independence between software development and validation and/or document review are included.

QA: N - Records identified in the SQR as nonpermanent QA records.

B. Developed Software Records Package

QA: L - The LCP, V&V Plan, SQR, software documentation, source code listing, software media; and records identified in the LCP, V&V Plan, and SQR as lifetime QA records. If applicable, memoranda on the lack of independence between software development or modification and V&V and/or document review are included.

QA: N - records identified in the LCP, V&V Plan, or SQR as nonpermanent QA records.

C. Software Routine Records Package

NOTE: This section applies only if an SRR is prepared. No records are produced under this section for software routines described in SQRs of related acquired or developed software, or in documents that include the analyses for which they are used.

QA: L - The SRR, source code listing (if available), software media, and records identified in the SRR as lifetime QA records. If applicable, memoranda on the lack of independence between software routine development or modification and testing and/or document review, are included.

QA: N - Records identified in the SRR as nonpermanent QA records.

D. Transferred Software Records Package

QA: L - Memorandum documenting software installation and testing, Installation and Testing Report.

QA: N - None

6.2 Individual QA records include:

Because of the long time periods sometimes required for software development and qualification, the records listed in Subsection 6.1 may also be submitted as individual QA records as they are approved by the Responsible Manager.

7. ATTACHMENTS

The attachments listed below shall be used with this QAP.

ATTACHMENT

TITLE

- | | |
|-----|--|
| I | Instructions for Preparing Software Qualification Report for Acquired Software |
| II | Instructions for Preparing Software Qualification Report for Developed Software |
| III | Instructions for Preparing Software Documentation for Developed Software |
| IV | Instructions for Preparing Life Cycle Plan for Developed Software |
| V | Instructions for Preparing Verification and Validation Plan for Developed Software |
| VI | Instructions for Preparing Software Routine Information |

INSTRUCTIONS FOR PREPARING SOFTWARE QUALIFICATION REPORT FOR ACQUIRED SOFTWARE

The following checklist identifies the minimum content of the SQR for acquired software. If the validation is for a new version of previously baselined software, a new SQR or a revision or addendum to the existing baselined documentation may be prepared. Software components that do not generate data subject to the QARD, such as display or graphing, do not need to be validated.

The checklist may be used during the preparation and review of a new or revised SQR to ensure that all required information is included. The SQR may be organized as suggested by the checklist.

The status column is intended to help the user of the checklist track progress for each listed item. The user may enter whatever is useful; examples of entries are "requested on (date)," "completed on (date)," "documented in (document name)," "assigned to on (date)," or simply a checkmark when the work is completed.

Checklist for Software Qualification Report for Acquired Software	
Software name & version:	Doc. ID:
Preparer name:	Date doc. initiated:
Content	Status
1. Title Page	
a. Name and version of the software or software components	
b. CSCI Identifier, DI, and MI	
c. QA designation of the SQR as L	
d. Preparer's signature and date of completion	
e. EA's signature and date of concurrence	
f. Responsible Manager's signature and date of approval	
2. Introduction or Summary	
a. Overall nature and purpose of the software	
b. Description of software, including summary of mathematical models and numerical methods	
c. Summary of functional requirements for the intended use of the software	
d. A description of the tasks, methods, implementing documents, and acceptance criteria for accomplishing the software validation	
e. Identification of additional software documentation to be generated	
3. Installation	
a. Describe installation procedure	
b. Describe tests used to verify installation	
c. Describe results of installation tests	
d. List executable files and supporting data files that are to be baselined	
4. Validation	
a. Describe tests used to validate software, including:	
i. Test cases developed independently of the software developer	
ii. Supplementary test cases provided by the developer (include justification for their use)	
iii. Regression testing of previously baselined software	

Checklist for Software Qualification Report for Acquired Software	
Content	Status
iv. A record of the results of the execution of the planned software validation, including the extent to which the results agree with the specified acceptance criteria	
b. Summary and evaluation of results, including description of software limitations determined by the test runs	
c. Reference list of all documentation relevant to the qualification	
d. Computer listing of test data input and output, identifying software name and version number (may be handwritten if not automatic)	
5. Recommendation	
a. List of software elements included in the validation	
b. Identification of components of software that were not or could not be validated	
c. Recommendation for software or software components to be qualified	

INSTRUCTIONS FOR PREPARING SOFTWARE QUALIFICATION REPORT FOR DEVELOPED SOFTWARE

The following checklist identifies the minimum content of the SQR for developed software. If the verification and validation is for a new version of a previously baselined software, then a new SQR or a revision or addendum to the existing SQR may be prepared. Software components that do not generate data subject to the QARD, such as display or graphing, do not need to be verified and validated.

The checklist may be used during the preparation and review of a new or revised SQR to ensure that all required information is included. The SQR may be organized as suggested by the checklist.

The status column is intended to help the user of the checklist to track progress for each listed item. The user may enter whatever is useful; examples of entries are "requested on (date)," "completed on (date)," "documented in (document name)," "assigned to on (date)," or simply a checkmark when the work is completed.

Checklist for Software Qualification Report for Developed Software	
Software name & version:	Doc. ID:
Preparer name:	Date doc. initiated:
Content	Status
1. Title Page	
a. Name and version of the software or software components	
b. CSCI Identifier, DI, and MI	
c. QA designation of the SQR as L	
d. Preparer's signature and date of completion	
e. EA's signature and date of concurrence	
f. Responsible Manager's signature and date of approval	
2. Introduction or Summary	
a. Overall nature and purpose of the software	
b. Description of software, including summary of mathematical models and numerical methods	
c. Summary of functional requirements for the intended use of the software (from LCP or V&V Plan)	
d. A description of the tasks, methods, implementing documents, and acceptance criteria for accomplishing the software V&V (from the V&V Plan)	
3. Installation (required only if the V&V will be performed on a different operating system and hardware than the software development or modification)	
a. Describe installation procedure	
b. Describe tests used to verify installation	
c. Describe results of installation tests	
d. List source files and executable files and supporting data files that are to be baselined	
4. Verification and Validation	
a. Describe tests used to verify and validate software, including:	
i. Test cases developed independently of the software developer	

Checklist for Software Qualification Report for Developed Software	
Content	Status
ii. Supplementary test cases provided by the developer (include justification for their use)	
iii. Regression testing of previously baselined software	
b. Address the V&V requirements (established by the V&V Plan), including:	
i. Verification that the software baseline elements meet the requirements	
ii. A record of the results of the execution of the planned software V&V, including the extent to which the results agree with the acceptance criteria	
c. Summary and evaluation of results, including description of software limitations determined by the test runs	
d. Reference list of all documentation relevant to the qualification	
e. Computer listing of test data input and output, identifying software name and version number	
5. Recommendation	
a. List of software components included in the V&V	
b. Identification of components of software that were not or could not be verified and validated	
c. Recommendation for software or software components to be qualified	

INSTRUCTIONS FOR PREPARING SOFTWARE DOCUMENTATION FOR DEVELOPED SOFTWARE

The following checklist identifies the minimum content for the documentation of mathematical models, numerical methods, and user instructions for developed software. If the planned software development is a modification of baselined software, then new documentation or a revision or addendum to the existing documentation may be prepared. The software documentation shall be sufficient to demonstrate the ability of the software to meet the needs of the Affected Organization.

The checklist may be used during the preparation and review of new or revised software documentation to ensure that all required information is included. The software documentation may be organized as suggested by the checklist. Items 2 and 3 (except 3.e) provide guidance for evaluating the adequacy of documentation for acquired software and for filling gaps in that documentation.

The status column is intended to help the user of the checklist to track progress for each listed item. The user may enter whatever is useful; examples of entries are "requested on (date)," "completed on (date)," "documented in (document name)," "assigned to on (date)," or simply a checkmark when the work is completed.

Checklist for Computer Software Documentation	
Software name & version:	Doc. ID:
Preparer name:	Date doc. initiated:
Content	Status
1. Title Page	
a. Name and version of the software or software components	
b. CSCI Identifier, DI, and MI	
c. QA designation of documentation containing the requirements of this attachment as L	
d. Preparer's signature and date of completion	
e. EA's signature and date of concurrence	
f. Responsible Manager's signature and date of approval	
2. Mathematical Models and Numerical Methods	
a. Overall nature and purpose of the software	
b. Intended use and associated requirements	
c. Description and equations of mathematical models	
d. Identification of input and output parameters	
e. Experimental and observational basis of mathematical models	
f. Description and mathematical formulations of numerical methods	
g. Assumptions, limitations, and restrictions	
h. Numerical stability and accuracy	
i. Overall performance of the software, based on software testing	
3. User Information	
a. Description of how to use the software including:	
i. Input and output options	
ii. Data files, input and output data, defaults, and file formats	
iii. Allowable and tolerable ranges for inputs and outputs	
iv. Expected errors and how the user can respond	
v. Hardware and software environments	

Checklist for Computer Software Documentation	
Content	Status
b. Sample problems, including input data listing (or magnetic media files) and corresponding output printout (including graphics if applicable)	
c. Installation (items ii. and iii. are only required for documenting or modifying previously documented or qualified software if there is a change in the operating software or hardware system):	
i. Describe installation procedure	
ii. Describe test cases for verifying installation	
iii. Describe results of installation tests	
d. Requirements and design information:	
i. Performance requirements and design constraints	
ii. Interfaces with external data, hardware, or other software	
iii. Software and hardware operation aspects, including programming languages and versions, portability, maintainability, reliability, and efficiency	
iv. Description of each software or software component as it relates to the functional requirements	
v. Description of the software structure including software internal interfaces, control logic, and data structure and flow	
vi. Source code listing or magnetic media files	

INSTRUCTIONS FOR PREPARING LIFE CYCLE PLAN FOR DEVELOPED SOFTWARE

The following checklist identifies the minimum content of the LCP for developed software. If the planned software development is a modification of baselined acquired or developed software, a new LCP or a revision or addendum to the existing LCP may be prepared.

Software life cycle activities may be performed in a sequential or iterative manner, to be specified in the LCP.

An abbreviated LCP may be prepared if the software has been developed and documented prior to the effective date of this procedure without compliance with the QARD. This LCP shall identify those aspects that are not in compliance with the QARD and this procedure, using the list below and Attachments II, III, and V for guidance, and specify a plan for bringing the software into compliance. This may require repeating any software V&V if independence between software development and V&V did not occur. This repetition may not be necessary if the LCP can justify that the lack of independence does not compromise the V&V of the software.

The checklist may be used during the preparation and review of a new or revised LCP to ensure that all required information is included. The LCP may be organized as suggested by the checklist.

The status column is intended to help the user of the checklist track progress for each listed item. The user may enter whatever is useful; examples of entries are "requested on (date)," "completed on (date)," "documented in (document name)," "assigned to on (date)," or simply a checkmark when the work is completed.

Checklist for Developed Software Life Cycle Plan	
Software name & version:	Doc. ID:
Preparer name:	Date doc. initiated:
Content	Status
1. Title Page	
a. Name and version of the software or software components	
b. CSCI Identifier, DI, and MI	
c. QA designation of the LCP as L	
d. Preparer's signature and date of completion	
e. EA's signature and date of concurrence	
f. Responsible Manager's signature and date of approval	
2. Introduction or Summary	
a. Overall nature and purpose of the software	
b. Summary of functional requirements for the intended use of the software	
3. Software Requirements	
a. Functional requirements for the intended use of the software	
b. Planned mathematical models and numerical methods	
c. Performance requirements with respect to range of applicability and accuracy	
d. Planned software language and version	
e. Planned computer operating system and hardware	
f. List of references to support information above	
4. Life Cycle Phases and Control Points	
a. Definition and purpose of each phase, including software installation (for existing software being ported to a different software operating or hardware system), development, preparation of V&V Plan, V&V, and retirement	
b. Activities to be performed during each phase and for each control point	
c. Activities which must be performed prior to the software release	

Checklist for Developed Software Life Cycle Plan	
Content	Status
d. Baseline elements to be developed, documented, reviewed, and approved at each control point	
e. Contents of individual baseline elements to be developed during each phase	
f. Relationship between individual phases and control points and whether they will be performed in a sequential or iterative manner	
5. Planned Documents	
a. Mathematical models and numerical methods	
b. User information (may be combined with above)	
c. V&V Plan	
d. SQR	
e. Others as needed (list):	

INSTRUCTIONS FOR PREPARING VERIFICATION AND VALIDATION PLAN FOR DEVELOPED SOFTWARE

The following checklist identifies the minimum content of the V&V Plan for developed software. If the planned software development is a modification of baselined, developed software, a new V&V Plan or a revision or addendum to the existing V&V Plan may be prepared. The V&V Plan has to reflect the requirements, including V&V phases and control points, defined by the approved LCP. Software components that do not generate data subject to the QARD, such as display or graphing, do not need to be verified and validated.

The checklist may be used during the preparation and review of a new or revised V&V Plan to ensure that all required information is included. The V&V Plan may be organized as suggested by the checklist.

The status column is intended to help the user of the checklist to track progress for each listed item. The user may enter whatever is useful; examples of entries are "requested on (date)," "completed on (date)," "documented in (document name)," "assigned to on (date)," or simply a checkmark when the work is completed.

Checklist for Developed Software Verification and Validation Plan	
Software name & version:	Doc. ID:
Preparer name:	Date doc. initiated:
Content	Status
1. Title Page	
a. Name and version of the software or software components	
b. CSCI Identifier, DI, and MI	
c. QA designation of the V&V Plan as L	
d. Preparer's signature and date of completion	
e. EA's signature and date of concurrence	
f. Responsible Manager's signature and date of approval	
2. Introduction or Summary	
a. Purpose of V&V	
b. Appropriate background information	
c. Description of software, including summary of mathematical models and numerical methods	
d. Description and purpose of each V&V phase and control point (based on LCP for developed software)	
e. Identification of individual documents to be produced for each V&V phase and control point	
3. Functional Requirements	
a. General need that this software or software components are to satisfy	
b. Functional requirements for the software or software components, including, for example, hardware suitability, performance requirements, precision, ranges, models, numerical methods, and interfaces with external hardware, software, or data	
c. Description of how the software or software components satisfy the functional requirements	
4. Installation (required only if the V&V will be performed on a different operating system and hardware than the development or modification)	
a. Describe how the installation will be performed	

Civilian Radioactive Waste Management System

Management & Operating Contractor

Checklist for Developed Software Verification and Validation Plan	
Content	Status
b. Identify the computer platform on which the software will be installed	
c. Describe the installation procedures	
d. Describe how the installation will be verified	
5. Verification and Validation	
a. Address the functional requirements defined in the LCP and previously in this document	
b. Define an approach to performing the V&V activities that is:	
i. Consistent with the nature, purpose, and complexity of the software and its intended use	
ii. Integrated with the phases, documents, and control points of the software life cycle (based on the LCP)	
iii. Completed prior to the software release for work subject to the QARD	
c. Identify the specific software components to be verified and validated	
d. Identify the specific hardware configuration planned for performing the V&V	
e. Describe the specific means of performing the individual V&V activities for each V&V phase and control point, including:	
i. Describe for each V&V activity:	
(1) The V&V requirements established for each life cycle phase, including the life-cycle products and the baseline elements being verified and the functional and software requirements being validated	
(2) The acceptance criteria for each life-cycle product, baseline element, functional requirement, and software requirement, as applicable	
(3) The method of validating each functional and software requirement, including the reliance on testing as the primary method of validation or the reliance on demonstration, analysis, inspection, or review where testing is documented as either not feasible or inappropriate	

Checklist for Developed Software Verification and Validation Plan	
Content	Status
(4) The method of verifying each life-cycle product and baseline element including the reliance on demonstration, analysis, inspection, review, and testing	
ii. Identify any implementing documents, including unique plans and procedures, that are required to support the V&V activities	
iii. For each validation activity involving modification of released software or software components, describe the regression testing to be performed	
f. If the software or software components will result from changes to released software or software components:	
i. Identify the role of regression testing in the V&V process	
ii. Ensure that the V&V approach addresses changes to software documentation	
g. Describe test cases developed independently of the software developer and provide input data	
h. Describe test cases provided by the software developer to supplement the V&V process and justify their use	
i. Provide a reference list of all documentation relevant to the V&V Plan	

INSTRUCTIONS FOR PREPARING SOFTWARE ROUTINE INFORMATION

The following checklist identifies the minimum information for software routines in either 1) documents that include the analyses for which the routines are used, 2) in an SQR of related software, or 3) in a separate SRR. A set of software routines may be covered in a single document for any of these options. If the software routines are modifications of previously baselined software routines, then the required information may be provided in new documentation or in revisions of previous documentation.

The checklist may be used during the preparation and review of a new or revised SRR or of the software routine information described in analysis reports to ensure that all required information is included. The SRR may be organized as suggested by the checklist.

The status column is intended to help the user of the checklist to track progress for each listed item. The user may enter whatever is useful; examples of entries are "requested on (date)," "completed on (date)," "documented in (document name)," "assigned to on (date)," or simply a checkmark when the work is completed.

Checklist for Software Routine Information	
Software name & version:	Doc. ID:
Preparer name:	Date doc. initiated:
Content	Status
1. Identification and Signoff (if an SRR is not prepared, Document Identifier, signatures and dates in accordance with procedure applicable to the other type of document)	
a. Name and version of software routine or software routine set	
b. CSCI Identifier and if an SRR is prepared, DI	
c. For SRR, QA designation of the SRR documentation as L	
d. For SRR, preparer's signature and date of completion	
e. For SRR, EA's signature and date of concurrence	
f. For SRR, Responsible Manager's signature and date of approval	
2. Description and Testing	
a. Description and equations of mathematical models, algorithms, and numerical solution techniques, as applicable	
b. Description of software routine including the execution environment	
c. Description of test cases	
d. Description of test results	
e. Range of input parameter values for which results were verified	
f. Identification of any limitations on software routine applications or validity	
g. Reference list of all documentation relevant to the qualification	
h. Directory listing of executable and data files	
i. Computer listing of source code, if available	
j. Computer listing of test data input and output, identifying software routine name and version number (may be handwritten if not automatic for acquired software routines)	

Management Control Procedure	ENGINEERING ANALYSIS	Identifier: MCP-2374
Company-wide		Revision: 1
		Page: 16

PURPOSE

Engineering analysis is used to determine if designs, equipment, and facilities will perform their required functions, and to optimize those designs, equipment, or facilities. Engineering analysis also supports studies that affect facility operations and management.

SCOPE AND APPLICABILITY

This procedure provides instruction to all Lockheed Martin Idaho Technologies Company (LMITCO) personnel in performing engineering analyses that are to be retained to document design adequacy or to support safe and economical decision making concerning facility operation or modification.

This procedure applies to all engineering analyses used to demonstrate that equipment or processes present acceptable risks associated with public safety, worker safety, environmental protection, Federal and State laws, DOE orders, regulations, mission impact, investment protection, and public perception.

- 2.3 This procedure covers activities ranging from the identification of requirements applicable to an analysis through analysis documentation, release and control.
- 2.4 This procedure is not mandatory for preliminary or scoping calculations that are to be superseded with later analyses.
- 2.5 This procedure does not apply to the preparation of Safety Analysis Reports. Safety Analysis Reports are prepared in accordance with other procedures and typically reference analyses prepared in accordance with this Engineering Analysis MCP.

PREREQUISITES

None

Management Control Procedure	ENGINEERING ANALYSIS	Identifier: MCP-2374
		Revision: 1
Company-wide		Page: 17

INSTRUCTIONS

Requester (See def.): Arrange for analyst (performer) support in accordance with the scope, cost, and schedule requirements for the analysis activity.

Requester and Performer: Determine whether the analysis is high- or low-risk (see def.) using the methods defined in MCP-2371, Design Input Document Preparation.

- 4.3 Performer and Requester with support from others as required: Develop and document the analysis plan in a form suitable for retention with design records.

NOTE: *If the design activity is low risk and the design engineer performs multiple analyses in the development of the design, it is acceptable to establish a single plan covering the analyses provided the items identified in 4.3.1 are ultimately included in the analysis report(s).*

- 4.3.1 Include in the plan, as a minimum, the following:
- A. identification of the requester, performing organization, and performer responsible for the analysis.
 - B. deliverables and personnel to whom they will be provided
 - C. purpose of the analysis
 - D. description of the item(s) and processes to be analyzed
 - E. identification of applicable documents including those containing information derived from applicable experience.
 - F. identification of design requirements and design bases (and sources of these requirements where applicable) including system or process operating conditions and assumptions, the service environment, applicable codes, standards, regulatory requirements, and quality and ES&H requirements.
 - G. description of safety significance or category
- 4.3.2 If the analysis is high-risk, include the following additional information in the analysis plan:
- A. method(s) to be used to verify the analysis
 - B. analysis cost and schedule

Management Control Procedure	ENGINEERING ANALYSIS	Identifier: MCP-2374
Company-wide		Revision: 1
		Page: 18

- C. document control and change control systems to be used for the plan, analysis report, and any computer programs used.

- 4.4 Requester: Sign the analysis plan indicating that the planned analysis will meet the requester's needs.

NOTE: Additional concurrence signatures may be obtained at the discretion of the requester.

- 4.5 Requester: Ensure any changes to the analysis plan are developed and documented with a degree of rigor comparable to that applied to the original input and approved by the same organizations that reviewed and approved the original plan.

- 4.6 Performer: Ensure computer programs used in Quality Level 1 and 2 analyses are verified.

4.6.1 If the program was previously verified, review the verification records to ensure the previous verification adequately bounds the capabilities required for the present application.

4.6.2 If the program was not previously verified, or if the previous verification does not bound the capabilities required for the present application, develop and perform test problem(s) whose solutions can be compared to results obtained through an independent method such as hand calculations or use of a separate, verified computer program.

NOTE: This verification may be accomplished either by a general verification performed and documented for generic application of the computer program, or may be performed on a case-by-case basis to support the specific application of interest.

4.6.3 If the program version or platform configuration (processor model or operating system version) used for the analysis differs from that covered by the previous verification, re-verify the program in accordance with Step 4.6.2.

4.6.4 Document the verification or the confirmation that existing program verification is adequate in a form suitable for retention, reference, and retrieval.

- 4.7 Performer: Obtain a Calculations and Analysis document identifier (see MCP-118, *Identifying DMCS Documents*) from the DMCS location where the analysis will be controlled.

- 4.8 Performer: Conduct the engineering analysis in accordance with the requirements contained in the analysis plan.

- 4.9 Performer: Document the analysis in an Analysis Report.

Attachment BINEL FORM L-0412.9#
(08-96 - Rev. #00)

Management Control Procedure	ENGINEERING ANALYSIS	Identifier: MCP-2374
		Revision: 1
Company-wide		Page: 19

- 4.9.1 Ensure the report is legible and in a form suitable for reproduction, filing, and retrieval.
- 4.9.2 Ensure the analysis report is sufficiently detailed that the verifier can understand and verify its adequacy without recourse to the performer.
- 4.9.3 Include in the report, as a minimum, the following:
 - A. controlled document cover, Form 412.14#
 - B. identification of author, verifier, and approver of analysis
 - C. table of contents (if body of the report exceeds 10 pages)
 - D. analysis purpose and objectives
 - E. results of applicable literature and background data searches
 - F. analysis input (append a copy of the analysis plan or other approved input document)
 - G. analysis method(s)
 - H. assumptions and identification of those assumptions that must be verified as the design proceeds
 - I. identification of units of measurement used
 - J. calculations by subject (including the item to which the calculation applies)
 - K. analysis results (and summary, at the discretion of the analyst)
 - L. Identification of any computer calculations including computer type, computer program (for example, program name), revision identification, inputs, outputs, and the bases (or reference thereto) supporting application of the computer program to the specific physical problem.
 - M. Documentation of, or reference to the record of computer program verification.
 - N. references

Management Control Procedure	ENGINEERING ANALYSIS	Identifier: MCP-2374 Revision: 1 Page: 20
Company-wide		

- O. traceability to the requesting organization, project, and work package.

- 4.10 Performer and Requester: Submit the analysis document for review by an independent analysis verifier who has sufficient skill to have performed the analysis.
- 4.11 Verifier: Review the completed engineering analysis to ensure the following:
- A. it is valid for the final product (design, process, study)
 - B. the assumptions are valid
 - C. the computer programs and the inputs to computer programs are appropriate
 - D. the computer programs used have been adequately tested to confirm the reported results are acceptable, and the testing has been documented or referenced.
 - E. the analysis is technically correct and complies with the analysis plan
 - F. the analysis meets the analysis objectives.
- 4.12 Verifier: Provide the review comments, on Form 412.13#, *DMCS Review Record* or other appropriate format, to the performer for resolution.
- 4.13 Performer: Resolve comments and, revise the analysis report as necessary.
- 4.14 Verifier: If Form 412.15#, *Document Approval Sheet*, is included with the analysis report, sign and date it,
OR
Sign Form 412.11#, *Document Action Request (DAR)*, signifying that the review criteria in Step 4.11 have been met.
- 4.15 Requester: Approve the analysis by signing the Document Approval Sheet or DAR (reference the DAR on the Document Approval Sheet) to signify the following:
- A. the operational assumptions are correct
 - B. the scope is satisfactory
 - C. review comments have been adequately resolved

Attachment BINEL FORM L-0412.9#
(08-96 - Rev. #00)

Management Control Procedure	ENGINEERING ANALYSIS	Identifier: MCP-2374 Revision: 1 Page: 21
Company-wide		

- D. the results and conclusions satisfy the objectives and the performance requirements for the items being analyzed.
- 4.16 Requester: Submit or ensure the submittal of the analysis report and case file to the appropriate DMCS location for release and distribution in accordance with MCP-109, *Releasing DMCS Documents*.
- 4.17 Requester or Performer: If a change to a released Analysis Report is required, initiate a new analysis effort and revise the report in accordance with MCP-135, *Proposing, Evaluating, and Planning a DMCS Change*.

RECORDS

Record Description	Uniform Code	Disposition Authority	Retention Period/ Storage Location
Analysis Plan			Retain until the analysis is approved
Analysis Report		U14-1-C-5	To be determined based on content

DEFINITIONS

Requester. The individual representing the owner of a program, project, facility, system, structure, or component in the interface with the performer, and assigned the responsibility for ensuring the appropriateness and adequacy of the requested engineering activities.

Risk, high or low. A quantitative descriptor of the probability and consequences of deficiencies occurring in an activity, process, or item determined in accordance with MCP-2371, *Design Input Document Preparation*.

REFERENCES

See procedure basis, Appendix A

APPENDICES

Appendix A, Procedure Basis

PROCEDURE BASIS

Procedure Basis for MCP-2374 Engineering Analysis			
Step No.	Basis	Source	Comments
General	Implement the requirements of PRD-101, Section 8.2.3	PRD-101/ NQA-1	
4.3	Perform the analysis in a planned manner, and through a graded approach.	PRD-101, 8.2.3.1	
4.3.1, 4.3.2	Identify analysis inputs.	PRD-101, 8.2.3.1, 8.2.3.3	
4.6	Ensure computer codes used for high risk analyses are V&V'd	PRD-101, 8.2.3.4	
4.9	Document the analysis in a way that allows it to be adequately verified and retrieved in the future.	PRD-101, 8.2.3.3	
4.11	Obtain independent technical review of the analysis.	PRD-101, 8.2.3.1, 8.2.3.3, 8.2.4.7, 8.2.5.1	

Management Control Procedure Category 3 Companywide	PREPARING, REVIEWING, AND APPROVING DRAWINGS	Identifier: MCP-2377 Revision: 2 Page: 1 of 14
Document Control Center (208) 526-1202	Document Owner/Approver: Chief Engineer	Effective Date: 11/03/97

Manual: 10A - Engineering & Research

DAR Number: 10469

NOTICE: The LMITCO intranet version of this document is the current revision.

Attachment C

1. PURPOSE

Drawings are prepared, reviewed, and approved to present design-related information that is technically correct and accepted by the appropriate authorities.

2. SCOPE AND APPLICABILITY

This procedure provides instructions for the preparation, review, and approval of drawings and provides additional detail for applying, to drawings, the instructions contained in MCP-135, *Proposing, Evaluating, and Planning a DMCS Change*, and MCP-108, *Verifying, Validating, and Approving a DMCS Change*. When questions of interpretation arise related to the preparation, review, and approval of drawings, MCP-2377 is the governing document.

This procedure covers the following drawing categories: (1) *Architectural Engineering (A-E) drawings* (see def.), (2) *Engineering drawings* (see def.), (3) Non-Company drawings (Contract and Vendor drawings), (4) *Interim drawings* (see def.), and (5) *Special Purpose drawings* (see def.).

This procedure applies to all personnel who prepare, review, or approve drawings that are to be entered into the Lockheed Martin Idaho Technologies Company (LMITCO) Document Management Control System (DMCS).

Non-LMITCO customer requests for an alternate format or process for the development and control of drawings applicable to their projects take precedence over this procedure.

Management Control Procedure Category 3 Companywide	PREPARING, REVIEWING, AND APPROVING DRAWINGS	Identifier: MCP-2377 Revision: 2 Page: 2 of 14
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3. PREREQUISITES

- 3.1. Program/Project/Facility management has defined the minimum review, approval, signature, and distribution requirements for their drawings.
- 3.2. Program/Project/Facility management has defined the criteria for selection and established a list of *essential drawings* (see def.).
- 3.3. Program/Project/Facility management has established a process for tracking the status and ensuring closure of drawing field changes before making such changes.

Management Control Procedure Category 3 Companywide	PREPARING, REVIEWING, AND APPROVING DRAWINGS	Identifier: MCP-2377 Revision: 2 Page: 3 of 14
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4. INSTRUCTIONS

4.1. Preparing New Drawings

- 4.1.1 Engineer (see def.): Obtain authorization from the appropriate program/project/facility representative to initiate the preparation of a new drawing. This authorization may be contained in a work request, work agreement, Engineering Initiation Request (EIR) (see def.), Field Change Notice (FCN) (see def.), Engineering Change Request (ECR), or may be documented on Form 412.11#, Document Action Request (DAR).
- 4.1.2 Engineer: With consultation and concurrence of the drafting supervisor, determine the type of drawing that is needed: A-E drawing, Engineering drawing, Interim drawing, or Special Purpose drawing.
- 4.1.3 Engineer: Furnish to the Drafting Organization drawing preparation guidance through sketches, layouts, or other forms of communication that provide the information necessary to prepare the drawing.
- 4.1.4 Engineer: If the drawing requires the seal of a *professional engineer* (see def.), request that an electronic reproduction of the engineer's seal be placed on the drawing, or that space be left where the engineer's manual seal can be placed.
- 4.1.5 Drafter: Prepare the drawing in accordance with the information provided by the requester, following the formatting instructions contained in STD-11, *Drawing Requirements Standard*, and any program/project/facility-specific requirements.
- 4.1.6 Engineer: Review the drawing to confirm that the technical information is accurately depicted.

4.2. Checking New Drawings and Drawing Revisions

- 4.2.1 Authorized Checker (see def.): Provide an independent review of the drawing to ensure clarity, completeness, and accuracy of drawing information, and to ensure compliance with STD-11.
- 4.2.2 Authorized Checker: Resolve checking-related design or drafting issues with the Engineer and the Drafter.

Management Control Procedure Category 3 Companywide	PREPARING, REVIEWING, AND APPROVING DRAWINGS	Identifier: MCP-2377 Revision: 2 Page: 4 of 14
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4.3. Reviewing New Drawings and Drawing Revisions

4.3.1 Engineer: If the review is being conducted of a drawing revision, ensure the reviewers include personnel from the same or commensurate organizations that performed the original review and concurrence, unless the changes do not affect areas covered by the expertise of that organization.

4.3.2 Engineer: Obtain a review of the drawing by disciplines judged to be appropriate, ensuring minimum reviews specified for the affected program/project/facility are met.

NOTE 1: *Based on lessons learned from INEEL experience, it is highly recommended that representatives from Quality and applicable ES&H disciplines be included in the review of drawings for high risk (see def.) designs.*

NOTE 2: *The means for obtaining the review of new and revised drawings is left to the discretion of the Engineer. Alternatives include distributing copies of the drawing to reviewers, meeting with individual or collective reviewers, and reviewing during design reviews.*

4.3.3 Reviewers: Review the drawing to verify accuracy and completeness in areas related to the expertise of the reviewer, recording comments on a marked print of the drawing or on Form 412.13#, Review Record Form.

4.3.4 Engineer: Consulting with the reviewers and others as needed, resolve the comments provided by the reviewers and provide to the Drafter a marked print or other clear identification of changes required as a result of the drawing review.

4.3.5 Drafter: Incorporate the requested changes, working with the Engineer to ensure accurate interpretation of the change information.

4.3.6 Authorized Checker: Perform a final check of the drawing to ensure any changes made subsequent to the prior check are consistent with the direction contained in 4.2.1, above.

Management Control Procedure Category 3 Companywide	PREPARING, REVIEWING, AND APPROVING DRAWINGS	Identifier: MCP-2377 Revision: 2 Page: 5 of 14
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4.4. ~~Documenting Approval of~~ Approving New Drawings and Drawing Revisions

- 4.4.1 Drafter: If obtaining approval of SMC drawings, go to step 4.5.
- 4.4.2 Engineer: If a DAR has not yet been prepared, prepare one in accordance with its instructions through block 10, and list the appropriate drawing reviewers in block 11.
- 4.4.3 Engineer: Sign the DAR form in block 11 signifying confirmation of technical correctness.
- 4.4.4 Engineer: Obtain the review/concurrence of the reviewers identified and secure their signatures on the DAR form.
- 4.4.5 Program/Project/Manager or designee: Sign the DAR form (Block 12, Final Document Approval) to signify Program/Project/Facility acceptance.
- 4.4.6 Engineer: Deliver the signed DAR form to the Drafting Organization.
- 4.4.7 Drafter: If the drawing is new, enter the following information on the drawing title block and electronic file:
 - A. DAR number
 - B. DRAWN: Name of the drafter who prepared the drawing
 - C. DESIGN: name of the Engineer responsible for the design of the depicted system, structure, or component
 - D. REQUESTER: Name of the document owner (typically this will be the person who signed block 12 on the DAR form)
 - E. EFFECTIVE DATE: (as defined in block 13 of the DAR)
- 4.4.8 Drafter: If the drawing is being revised, enter the DAR number and the effective date in the drawing revision history column and electronic file.
- 4.4.9 Drafter: Prepare a hard copy plot of the final drawing.

Management Control Procedure Category 3 Companywide	PREPARING, REVIEWING, AND APPROVING DRAWINGS	Identifier: MCP-2377 Revision: 2 Page: 6 of 14
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4.4.10 Professional Engineer: If the drawing requires the seal of a professional engineer, sign the PE seal placed electronically on the drawing or place and sign the manual seal.

4.4.11 Drafter: If the drawing contains the seal of a professional engineer, revise the electronic file of the drawing to replace the electronic seal (if included) or occupy the space reserved for the manual seal, with the following:

“Revision ____ of this drawing originally issued and sealed by (name of sealer), P.E. (Registration Number) or P. LS. No. (Registration Number) on (date of sealing). This copy should not be considered a certified document.”

4.4.12 Drafter: Provide the DAR form and hard copy plot of the final drawing to the authorized checker for release authorization in accordance with step 4.6.

4.5. Approving New Drawings and Drawing Revisions (SMC)

NOTE: The review and approval signatures for SMC drawings are recorded directly on the face of the drawing. Authorization for drawing preparation or revision is documented on the EIR form.

4.5.1 Drafter: Provide a hard copy of the drawing for approval.

4.5.2 Authorized Checker: Sign and date the drawing to indicate completion of the drafting effort.

4.5.3 Engineer: Sign the drawing in the indicated space in the title block or revision column to signify confirmation of technical correctness.

4.5.4 Engineer: Obtain the review/concurrence of the reviewers identified and secure their signatures on the drawing.

4.5.5 Professional Engineer: If the drawing requires the seal of a professional engineer, sign the PE seal placed electronically on the drawing or place and sign the manual seal.

4.5.6 Program/Project/Manager/ or designee: Sign the release block on the drawing to signify program/project/manager approval.

Management Control Procedure Category 3 Companywide	PREPARING, REVIEWING, AND APPROVING DRAWINGS	Identifier: MCP-2377 Revision: 2 Page: 7 of 14
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- 4.5.7 Engineer: Deliver the signed drawing to the Drafting organization.
- 4.5.8 Drafter: If the drawing contains the seal of a professional engineer, revise the electronic file of the drawing to replace the electronic seal (if included) or occupy the space reserved for the manual seal, with the following:

“Revision _____ of this drawing originally issued and sealed by (name of sealer), P.E. (Registration Number) or P. L.S. No. (Registration Number) on (date of sealing). This copy should not be considered a certified document.”

- 4.5.9 Drafter: If the drawing is new, enter the names and dates of the original signers into the drawing title block of the electronic file.
- 4.5.10 Drafter: If the drawing is being revised, enter the names and dates of the signers onto the electronic file.

4.6. Authorizing Release of New Drawings and Drawing Revisions

- 4.6.1 Engineer: If copies of the drawing or drawing revision are required before the drawing is released by Document Control in accordance with MCP-109, submit a request for copies to the Drafting organization. Identify whether the copy is to be marked as “Pre-released, For Information Only” or “Pre-released, for use with (applicable activity or document, such as ~~SWR~~ or a Work Order).”
- 4.6.2 Drafting Organization: Mark the copies of the pre-released drawing in accordance with the Engineer’s instructions and deliver to the engineer requested copies of the drawing or drawing revision.
- 4.6.3 Drafting Organization: If authorizing release of an SMC drawing, go to step 4.6.6.
- 4.6.4 Authorized Checker: Sign and date the DAR in Block 11, entering “Checking” in the “Discipline/Org No.” column. This signature indicates that the drawing is authorized for release.
- 4.6.5 Drafting Organization: Deliver the signed DAR form, final plot of the drawing, an electronic file copy of the final drawing, and the A-E specification (if applicable) to the appropriate DMCS location for release in

Management Control Procedure Category 3 Companywide	PREPARING, REVIEWING, AND APPROVING DRAWINGS	Identifier: MCP-2377 Revision: 2 Page: 8 of 14
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accordance with MCP-109, Releasing DMCS Documents. EXIT THIS SECTION.

4.6.6 Drafting Organization: For an SMC drawing, deliver the signed drawing and the A-E specification (if applicable) to the appropriate DMCS for release in accordance with MCP-109, Releasing DMCS Documents.

4.6.7 Drafter: Transfer the electronic file copy(ies) to SMC archive release.

4.6.8 Archive System Manager: Transfer electronic files to the SMC controlled archive data base.

4.7. **Revising Drawings--*Direct Drawing Change* (see def.)**

4.7.1 Engineer: Obtain authorization from the appropriate program/project/facility representative to initiate the drawing change. Authorization should normally be documented on the DAR. An acceptable alternative is a global authorization (such as "revise affected drawings") contained in a work agreement or ECR that is followed up during the drawing approval process through completion of the DAR(s). SMC drawing revision authorization is documented on an EIR or FCN.

4.7.2 Engineer: Provide evidence of authorization for the drawing change to the drafting supervisor.

4.7.3 Requester, Drafter, Authorized Checker: If the items or hardware described through a Special Purpose drawing are intended for installation into an SSC requiring configuration management, upgrade the Special Purpose drawing to, or replace with an Engineering drawing.

4.7.4 Engineer and Drafting Supervisor: Determine whether the change will be made through use of an *Interim drawing* (see def.) or a direct drawing change.

4.7.5 Engineer: If the drawing to be revised is an Essential drawing and the change is not an *as-built* (see def.), or if the drawing is to be maintained in the as-built condition (as might be the case for a *Master Facility Drawing* (see def.), go to step 4.87 and revise the drawing through use of an Interim Drawing.

Management Control Procedure Category 3 Companywide	PREPARING, REVIEWING, AND APPROVING DRAWINGS	Identifier: MCP-2377 Revision: 2 Page: 9 of 14
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- 4.7.6 Engineer: Provide information to the drafting organization through sketches, layouts, marked prints, or other forms of communication that will facilitate preparation of the drawing revision.
- 4.7.7 Drafter: Obtain access to the drawing from the appropriate DMCS location. If the drawing is an SMC project drawing, obtain the hard copy original drawing from the SMC DMCS and obtain the electronic file from the SMC controlled archive data base.
- 4.7.8 Drafter: Revise the drawing in accordance with the information provided by the Engineer.
- 4.7.9 Authorized Checker, Engineer, Drafter, Program/Project/Facility Manager or Designee: Check, review, approve, and authorize for release the revised drawing in accordance with Steps 4.2 through 4.65.
- 4.7.10 Drafter (for SMC drawings only): If the original drawing is in hard copy form and is superseded with a new hard copy, mark the face of the original drawing with the notation "HISTORICAL" and include in the applicable project file.

4.8. Revising Drawings--Using Interim Drawings

- 4.8.1 Engineer: Obtain authorization from the appropriate program/project/facility representative to initiate the drawing change. Authorization should normally be documented on a DAR. An acceptable alternative is a global authorization (such as "revise affected drawings") contained in a work agreement that is followed up during the drawing approval process through completion of DAR(s). SMC drawing revision authorization is documented on an EIR or FCN.
- 4.8.2 Engineer: Provide evidence of authorization for the drawing change to the drafting supervisor.
- 4.8.3 Engineer: Provide information to the Drafting Organization through sketches, layouts, or other forms of communication that will facilitate preparation of the Interim drawing.
- 4.8.4 Drafter: Prepare an interim drawing against the *parent drawing* (see def.), in accordance with the information provided by the Engineer.

Management Control Procedure Category 3 Companywide	PREPARING, REVIEWING, AND APPROVING DRAWINGS	Identifier: MCP-2377 Revision: 2 Page: 10 of 14
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- 4.8.5 Drafter: Place status notes on the parent drawing and on the Interim drawing to provide a cross reference between the two drawings in accordance with STD-11.
- 4.8.6 Authorized Checker, Engineer, Drafter, Program/Project/Facility Manager or Designee: Check, review, approve, and authorize for release the Interim drawing in accordance with Steps 4.2 through 4.65.
- 4.8.7 Engineer: After the applicable SSC is modified in accordance with the Interim drawing, provide to the Drafting Organization the information required to as-build the parent drawing.
- 4.8.8 Drafter: Revise the parent drawing in accordance with the as-built information provided by the Engineer.
- 4.8.9 Drafter: Revise the interim and parent drawings to accurately reflect the final status (such as "superseded" or "canceled" for the interim drawing, and removal of the reference to the interim drawing from the parent drawing) in accordance with the instructions contained in STD-11.
- 4.8.10 Authorized Checker, Engineer, Drafter, Program/Project/Facility Manager or Designee: Check, review, approve, and authorize for release the revised parent drawing and Interim drawing in accordance with Steps 4.2 through 4.65.

4.9. Field Changes to Drawings

NOTE 1: *This section does not apply to A-E drawings during the constructing phase. These changes are controlled through the Construction Interface Document process.*

NOTE 2: *Field changes are made when the adverse consequences of the delay required to revise and release the drawing are greater than the increased potential for loss of configuration control.*

- 4.9.1 Engineer: Prepare a DAR form, or FCN for SMC drawings, with the required drawing field change information attached to the form.

Management Control Procedure Category 3 Companywide	PREPARING, REVIEWING, AND APPROVING DRAWINGS	Identifier: MCP-2377 Revision: 2 Page: 11 of 14
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- 4.9.2 Engineer: Obtain review signatures considered appropriate for the specific change, ensuring applicable requirements of the program/project/facility are met.
- 4.9.3 Engineer: Obtain the approval signature of the appropriate program/project/facility drawing owner.
- 4.9.4 Engineer: Retain the signed DAR or FCN with attachment, and provide a copy to the organization using the drawing.
- 4.9.5 Engineer: Within 5 working days:
- 4.9.5.1 Provide the DAR or FCN and attachment to the Drafting Organization to revise the affected drawing
 - 4.9.5.2 Provide a copy of the DAR or FCN and attachment to the organization assigned the responsibility for tracking the status and ensuring closure.
- 4.9.6 Engineer: Ensure the applicable steps of 4.1 through 4.87 are completed and a copy of the revised drawing is issued to the drawing user. This should be completed within 30 days following step 4.98.5.

4.10. Preparing Non-company Drawings for Release

- 4.10.1 Engineer: If it is anticipated that the Company will be making changes to vendor drawings, or if the vendor drawings affect facility configuration, initiate the release of the vendor drawings into the appropriate DMCS Location through preparation of a DAR or, for SMC drawings, an EIR.
- 4.10.2 Engineer: Deliver to the Drafting Organization the supplier-furnished drawings that are to be retained in the DMCS.
- 4.10.3 Drafter: Ensure proper format of the drawings provided by the Engineer:
- 4.10.3.1 Verify that supplier-furnished drawings meet the electronic file structure requirements of STD-11.

Management Control Procedure Category 3 Companywide	PREPARING, REVIEWING, AND APPROVING DRAWINGS	Identifier: MCP-2377 Revision: 2 Page: 12 of 14
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4.10.3.2 If the files do not meet the requirements of STD-11, jointly determine with the Engineer the appropriate action to be taken prior to release.

4.10.3.3 Restructure electronic files as required.

4.10.3.4 Add the Company index codes and serial number in accordance with STD-11, and applicable quality level (as specified by the Engineer).

4.10.4 Authorized Checker, Engineer, Drafter: Check, review, approve and authorize for release the drawing in accordance with steps 4.2 through 4.65.

5. RECORDS

Records generated as a result of this procedure include:

- Released Drawings (in-process record)
- DAR Form (412.11#)
- Review Record Form (412.13#)
- EIR Form (SMC-9310#)

6. DEFINITIONS

Architectural-Engineering (A-E) Drawing. Drawings used to disclose physical and functional requirements for construction contractor activities, which usually include construction of facilities or utility systems equipment.

As-built. Term applied to a drawing that describes the current configuration of the depicted equipment.

Authorized Checker. An individual designated by the Design and Drafting Manager to check and authorize release of drawings and drawing changes.

Configuration Management. An integrated management process that ensures facility configuration is established and maintained in conformance with reviewed and approved

Management Control Procedure Category 3 Companywide	PREPARING, REVIEWING, AND APPROVING DRAWINGS	Identifier: MCP-2377 Revision: 2 Page: 13 of 14
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design requirements as changes evolve over the life of the facility. In addition, the configuration management program ensures that the design requirements and physical configuration are accurately reflected on the facility operating and design documentation.

Direct Drawing Change. Changes which are added directly to an original drawing rather than through use of an interim drawing.

DMCS Location. Organizations/facilities that are identified and recognized in the Company Document Management Control System (DMCS) as having responsibility and authority for the control of released drawings through a system that imposes appropriate controls on the change, distribution, receipt, and recall of the drawings. Authorized Drawing control centers are located in the Engineering Research Office Building (EROB), Idaho Chemical Processing Plant (ICPP, building 1605), Willow Creek Building (WCB, Security Systems), and Test Area North (TAN, SMC operations).

Engineer: The person assigned the responsibility for the technical adequacy of the information included on a drawing. This is usually a design engineer but may be the facility engineer assigned to the applicable SSC.

Engineering Drawing. Drawings used to disclose physical and functional requirements for purposes other than construction contractor activities. Such purposes include:

Document the design, fabricate, procure, install, test, operate, inspect, and troubleshoot structures, systems, or components;

Establish the accept/reject criteria for the depicted item.

Engineering Initiation Request. A form (SMC-9310#) used by the Specific Manufacturing Capability Project to describe and authorize changes to configuration controlled SSCs. Prepared in accordance with SMC-MCP-1.2406.

Essential Drawing (Also referred to as Key Drawing). A drawing that is deemed by the Program/Project/Facility manager as necessary for safe and efficient operation and maintenance of facilities, structures, systems, and components. Essential Drawings are maintained in the as-built condition at all times and are normally selected and identified on the basis of their importance for emergency response; training; troubleshooting facility conditions, systems, and equipment; and as needed for safe facility or system operation and maintenance.

Management Control Procedure Category 3 Companywide	PREPARING, REVIEWING, AND APPROVING DRAWINGS	Identifier: MCP-2377 Revision: 2 Page: 14 of 14
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Field Change Notice. A form (SMC-021#) used by the Specific Manufacturing Capability Project to describe and authorize changes to in-process modifications of configuration controlled Structures, Systems, or Components.

Interim Drawing. A drawing used to portray proposed or in-process changes to existing structures, systems, or components under configuration control. The interim drawing is either a new drawing or a modified copy of the original drawing. Interim Drawings are used to maintain Essential Drawings in the as-built condition and may be used to maintain other drawings in the as-built condition during a system modification process.

Master Facility Drawing. A controlled drawing selected by the Program/Project/Facility manager or his designee for the routine operation, maintenance, safety analysis, and engineering of the facility equipment and system which depicts the as-built condition of a facility.

Original Drawing. The full size reproducible drawing on which is kept the record recognized as official (these drawings are controlled by DMCS location or Record Storage Facility).

Parent Drawing. Original drawing affected by an Interim drawing.

Professional Engineer. An individual registered or licensed by the State of Idaho to practice engineering, land surveying, or architecture.

Released Drawing. A drawing controlled by a DMCS location that has been reviewed, approved, and issued for use in accordance with the approved company procedure.

Risk, high or low. A quantitative descriptor of the probability and consequences of deficiencies occurring in an activity, process, or item determined in accordance with MCP-2371, *Design Input Document Preparation*.

Special Purpose Drawing. A drawing exempt from selected format requirements applicable to Engineering Drawings, prepared in accordance with STD-11. Special Purpose drawings may be used to document new hardware or modifications to hardware that will not be installed as part of a system, structure, or component that requires *configuration management* (see def.), is temporary, failure will not adversely affect the safety of operations or the validity of record data, and a record of the hardware configuration is desired. Special Purpose drawings are typically used to document development products, such as special instruments, fixtures, tools, and experimental assemblies and systems.

Management Control Procedure Category 3 Companywide	PREPARING, REVIEWING, AND APPROVING DRAWINGS	Identifier: MCP-2377 Revision: 2 Page: 15 of 14
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7. REFERENCES

MCP-109, Releasing DMCS Documents

Drawing Requirements Manual, STD-11

Procedure Basis (See Appendix A)

8. APPENDIX

Appendix A, Procedure Basis

Management Control Procedure Category 3 Companywide	PREPARING, REVIEWING, AND APPROVING DRAWINGS	Identifier: MCP-2377 Revision: 2 Page: A1 of A1
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APPENDIX A**Procedure Basis**

Procedure Basis for MCP-2377, Preparing, Reviewing, and Approving Drawings			
Step No.	Basis	Source	Comments
General	Establish a process to translate design inputs into drawings.	PRD-101 8.2.2.5	Many of the steps in this procedure are not specifically required by the PRD-101, but are established to implement a cohesive program that translates design inputs into design documentation (drawings).
General	Drawings shall be prepared, reviewed, issued, used, and revised to prescribe processes, specify requirements, or establish designs. They shall be reviewed for adequacy and approved for release by authorized personnel.	PRD-101 5.1 and 5.2	The Basis is a synopsis of the applicable requirements in PRD-101, Section 5.
4.3.1	Design changes must be controlled at a level commensurate with the original design.	PRD-101 8.2.2.1	
4.3.2 4.3.3	Design adequacy is to be verified by personnel other than the person who performed the design. Quality standards are to be reviewed and approved.	PRD-101 8.2.2.1 8.2.2.2	
4.3.3 4.4.42 4.5.2	Design outputs (includes drawings) are to be technically correct.	PRD-101 8.2.2.5	
4.4.64 4.5.5	Assignment of responsibility for ownership is an essential element of ensuring control of drawings	PRD-101 8.2.2.2	
4.7.56.3	Essential drawings are to be maintained	PRD-101	

Management Control Procedure Category 3 Companywide	PREPARING, REVIEWING, AND APPROVING DRAWINGS	Identifier: MCP-2377 Revision: 2 Page: A2 of A1
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APPENDIX A

<u>4.8</u>	as-built.	8.2.2.8	
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Attachment D

Lockheed Martin Idaho Technologies Company

INEL FORM L-0412.9#
(08-96 - Rev. #00)

Management Control Procedure	Performing and Reviewing Criticality Safety Evaluations	Identifier: MCP-3006 Revision: 0 Page: 1 of 6
Document Control Center (208)	Document Owner/Approver: J. T. Taylor	Effective Date: September 3, 1997

Manual: 10B Engineering and Research

DAR Number: 9947

PERFORMING AND REVIEWING CRITICALITY SAFETY EVALUATIONS

1. PURPOSE

This procedure specifies how to prepare a *Criticality Safety Evaluation (CSE; see def.)*, the internal review process, how to obtain approval and issue a CSE, and how to issue revisions to reports.

NOTE: CSEs are reports prepared in accordance with DOE specified guidelines which are used by safety analysis and operations personnel to develop the authorization basis. These evaluations are documented using experimental data and *calculational methods* (see def.) that are *validated* (see def.) to provide a basis for criticality safety for processes and equipment used in fissile material handling and storage.

2. SCOPE AND APPLICABILITY

This procedure provides instructions for Criticality Safety engineers in preparing CSEs at the Idaho National Engineering and Environmental Laboratory (INEEL) facilities managed by Lockheed Martin Idaho Technologies Company (LMITCO).

3. PREREQUISITES

None

4. INSTRUCTIONS

4.1 Prepare the CSE

- 4.1.1 Criticality Safety Engineer: Prepare the CSE per DOE-STD-3007-93, *Guidelines for Preparing Criticality Safety Evaluations at Department of Energy NonReactor Nuclear Facilities*, November 1993, to ensure consistency in format and content of the report.

NOTE: *In some cases it may not be necessary to perform calculations e.g., a previously performed CSE may apply or a basis might be formed from a handbook such as the American Nuclear Society Standards (ANSI/ANS).*

- 4.1.2 Consult others who have special expertise in related problems or particular methods of solution as applicable.

Management Control Procedure	Performing and Reviewing Criticality Safety Evaluations	Identifier: MCP-3006
Criticality Safety		Revision: Page: 23

4.2 Review the CSE

4.2.1 Criticality Safety Engineer: Request a second criticality safety engineer verify calculations and methods in the CSE for accuracy.

4.2.1.2 Resolve or modify any comments or corrections from second criticality engineer.

4.2.2 Conduct a group "round-table review" (see def.) of the completed CSE, inviting participation from other LMITCO groups as applicable.

4.2.2.1 Identify other reviewers outside of the criticality safety group.

4.2.3 Resolve all comments received from the round-table review as documented by the Criticality Manager before obtaining final sign-off of the CSE.

4.2.4 Obtain a report number from the Criticality Safety administrative assistant.

4.2.4.1 Criticality Safety Administrative Assistant: Obtain a report number from the LMITCO Technical Publishing group.

4.2.4.1.2 Determine if the report is for internal or external distribution.

NOTE: Refer to STD 7028, "Format and Style Standard for Technical Reports, Meeting Papers, and Journal Articles" for guidance on internal and external reports.

4.3 Obtain Approvals and Sign-off on CSE

4.3.1 Criticality Safety Engineer: Obtain the following signatures as appropriate and date signed on the sign-off page (see Appendix A) of the CSE:

- 1) Second Criticality Safety Engineer. This signature verifies the calculations performed in the CSE are accurate and have been checked.
- 2) Projects or Operations Department (as applicable). This signature ensures personnel from the applicable group concur with the configuration used in the report.
- 3) Safety Analysis. Review and concurrence by the appropriate safety analysis personnel is mandatory for all CSEs that will be used in the determination of safety limits.
- 4) Criticality Safety Manager. The final CSE must be approved and signed by the criticality safety manager after all other signatures are completed on the sign off page to verify peer review adequacy and conformity to DOE-STD-3007-93.

Management Control Procedure	Performing and Reviewing Criticality Safety Evaluations	Identifier: MCP-3006
Criticality Safety		Revision:
		Page: 24

4.4 Revising a CSE

4.4.1 Criticality Safety Engineer: Notify the appropriate safety analysis personnel of the pending revision to the applicable CSE.

4.4.2 Notify the Criticality Safety administrative assistant of the revision to the CSE.

4.4.2.1 Criticality Safety Administrative Assistant: Ensure the revised CSE appropriately marked with the correct revision number and the original report is filed in the Criticality Safety CSE filing system as well as the database for tracking purposes.

4.4.3 Write a "Revision Note" describing why the revision was necessary and attach it to the newly revised CSE.

4.4.4 Issue a new sign-off page (see Appendix A) complete with signatures and dates as described in 4.3.

NOTE: *It may not be necessary to obtain all signatures for sign-off of the revised CSE, e.g., if new calculations were not performed.*

4.4.5 Determine if the original report should be retained or destroyed.

4.5 Distribute and File the CSE

4.5.1 Criticality Safety Administrative Assistant: Distribute copies of the CSE to the requester, appropriate safety analyst, and other appropriate personnel.

4.5.2 File CSEs by calendar year in the appropriate book in the Criticality Safety Administrative Assistant's office.

4.5.3 Enter the CSE report number and information about the CSE in the database.

Management Control Procedure	Performing and Reviewing Criticality Safety Evaluations	Identifier: MCP-3006
Criticality Safety		Revision: Page: 25

5. RECORDS

Original CSE Reports

6. DEFINITIONS

Calculational method. The mathematical equations, approximations, assumptions, associated numerical parameters (e.g., cross sections), and calculational procedures which yield the calculated results.

Criticality Safety Evaluation (CSE). A documented evaluation of activities or equipment involving fissile material to establish a basis for criticality safety.

Round-table review. A peer review of a CSE in which the criticality safety group meets to discuss a report after individually reviewing it to ascertain that the correct methods are applied and the problem is correctly solved.

Validated computational techniques. A calculational method that has been tested by comparison with experiment to establish the reliability of results when the method is applied to conditions of interest.

7. REFERENCES

ANS/ANSI Series 8 Standards (Criticality Safety).

PRD 112, Program Requirements Document for the Criticality Safety Program Requirements Manual (CSPRM), Rev 0, dated September 1, 1995.

DOE-STD-3007-93, Guidelines for Preparing Criticality Safety Evaluations at Department of Energy NonReactor Nuclear Facilities

Management Control Procedure Criticality Safety	Performing and Reviewing Criticality Safety Evaluations	Identifier: MCP-3006 Revision: Page: 26
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APPENDIX A
Example of Sign-off page for CSE

"Title of Report"

Author's Name

Issued:

Signature

Date

Author:
(Criticality Safety Engineer)

Checked by:
(Criticality Safety Engineer)

Adequate for Facility Safety Analysis:
(Fuel Safety Analysis)

Approved by:
(Manager, Criticality Safety)

Management Control Procedure Criticality Safety	Performing and Reviewing Criticality Safety Evaluations	Identifier: MCP-3006 Revision: Page: 27
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APPENDIX B

BASIS DOCUMENT		
STEP NUMBER	STEP BASIS	SOURCE
4.1.1	Prepare CSE per DOE-STD-3007-93.	Criticality Safety Program Requirements Manual (CSPRM), Sec. 3.3.3
4.2.1	Request a second criticality safety engineer verify calculations and methods.	CSPRM, Sec. 3.3.8.6
4.3.1.3	Signature of safety analysis required on sign-off page.	CSPRM, Sec. 3.4.1

Lockheed Martin Idaho Technologies Company

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Revision: 1

IDAHO NATIONAL ENGINEERING & ENVIRONMENTAL
LABORATORY

Program Requirements Document

for

Criticality Safety Program Requirements Manual
Attachment E

41214#
03-97
Rev. #01

Attachment E412.09#
(10/20/97 - Rev. #01)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 1
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Manual: 10B – Engineering and Research

CATEGORY 2DAR Number: 13023**NOTICE:** The LMITCO intranet version of this document is the current revision.**Table of Contents**

1.	PURPOSE.....	4
2.	APPLICABILITY.....	4
3.	REQUIREMENTS AND RECOMMENDATIONS.....	5
3.1	Nuclear Operations Management Responsibilities.....	5
3.2	Facility Management Responsibilities.....	6
3.3	LMITCO Criticality Safety Staff Responsibilities.....	7
3.4	Process Analysis and Control.....	8
3.4.1	Process Analysis.....	8
3.4.2	Material Control.....	9
3.4.3	Operational Procedures.....	9
3.5	Criticality Safety Review and Assessment.....	10
3.6	Criticality Accident Emergency Response.....	10
3.7	Criticality Safety Principles and Criteria.....	12
3.7.1	Contingency Principle.....	12
3.7.2	General Criteria.....	13
3.7.3	Plant Protective Systems (PPS).....	14
3.7.4	Criticality Analyses Independent Review.....	15
3.7.5	Criticality Safety Parameters.....	15
3.7.6	Fissile Material Storage and Transport.....	22
3.8	Criticality Accident Detection System.....	23
3.8.1	Criticality Alarm System Applicability.....	23

Attachment E412.09#
(10/20/97 - Rev. #01)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 2
Document Control Center: (208) 526-1202	Document Owner/Approver: Supervisor, Criticality Safety	Effective Date: 06/01/98

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CATEGORY 2

DAR Number: 13023**NOTICE:** The LMITCO intranet version of this document is the current revision.

3.8.2 Alarm Requirements	26
3.8.3 Dependability/Reliability	27
3.8.4 Testing.....	29
3.9 Criticality Safety Training.....	30
3.9.1 Criticality Safety Training Program Requirements.....	30
3.9.2 Fissile Material Handler Requirements	31
3.10 Criticality Control Areas	33
3.11 Firefighting.....	34

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 3
---	---	---

4.	DEFINITIONS.....	35
5.	REFERENCES.....	37
6.	ATTACHMENTS	38
	ANSI/ANS 8.1 CROSS REFERENCE	38
	ANSI/ANS 8.3 CROSS REFERENCE	40
	ANSI/ANS 8.5 CROSS REFERENCE	43
	ANSI/ANS 8.6 CROSS REFERENCE	43
	ANSI/ANS 8.7 CROSS REFERENCE	43
	ANSI/ANS 8.9 CROSS REFERENCE	45
	ANSI/ANS 8.12 CROSS REFERENCE	45
	ANSI/ANS 8.15 CROSS REFERENCE	45
	ANSI/ANS 8.17 CROSS REFERENCE	45
	ANSI/ANS 8.19 CROSS REFERENCE	46
	ANSI/ANS 8.20 CROSS REFERENCE	49
	ANSI/ANS 8.21 CROSS REFERENCE	50
	DOE ORDER 420.1 CROSS REFERENCE	52
	DOE-ID NOTICE ID N 420.B CROSS REFERENCE.....	55
	DOE ORDER 5480.19 CROSS REFERENCE	56
	DOE ORDER 5480.20A CROSS REFERENCE.....	57

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 4
---	---	---

1. PURPOSE

The purpose of the *Criticality Safety* (see def.) Program is to ensure appropriate actions are taken to prevent and mitigate the consequences of a *criticality accident* (see def.).

2. APPLICABILITY

Requirements and recommendations of the Criticality Safety Program apply to the design, construction, operation, maintenance and decommissioning of all LMITCO facilities that contain or handle *fissile material* (see def.) with the exception of fissile material in nuclear reactor cores, which is exempt.

Criticality Safety Program requirements and recommendations apply to all facilities regardless of the design or modification date unless a waiver based on safety significance, cost and consequence is obtained. The complexity and type of facility will determine the applicable requirements and recommendations for each facility. The LMITCO Criticality Safety Staff is responsible for obtaining waivers and will provide interpretation of this manual.

Requirements and recommendations in this manual are based on existing DOE orders (DOE 5480.24 "Nuclear Criticality Safety" with DOE Order 420.1, section 4.3 "Nuclear Safety" as interpretive guidance) industry standards and best management practices used at the INEEL and throughout the DOE complex. Following each requirement and recommendation in this manual is a reference in parentheses listing the source document(s) or BMP for Best Management Practice. Section 6 "Attachments," contains a cross reference citing each requirement and recommendation, and its location within the text within the manual. In this manual the word "shall" denotes a requirement, the word "should" denotes a recommendation and the word "may" denotes permission, neither a requirement nor a recommendation. To comply with this manual all operations will be performed in accordance with its requirements but not necessarily with its recommendations. When recommendations are not implemented, a waiver must be obtained from the LMITCO Criticality Safety Staff.

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 5
---	---	---

3. REQUIREMENTS AND RECOMMENDATIONS

3.1 Nuclear Operations Management Responsibilities

- 3.1.1 Nuclear Operations Management shall establish a Criticality Safety Program that applies to fissile materials that pose a criticality accident *hazard* (see def.). (420.1 4.3.2.a)
- 3.1.2 Nuclear Operations Management shall establish a Criticality Safety Program that applies to fissile materials that are produced, processed, stored, transferred, disposed or otherwise handled in such a manner that the probability of a criticality accident is acceptably low. (420.1 4.3 and 4.3.2-1) (8.19 4.1-2)
- 3.1.3 Nuclear Operations Management shall establish a Criticality Safety Program that ensures to the extent practicable, the public, workers, property, both government and private, the environment and essential operations are protected from the effects of a criticality accident. (420.1 4.3.2-2)
- 3.1.4 Nuclear Operations Management should ensure the Criticality Safety Program is assigned importance in a manner compatible with all other safety disciplines and is not compromised by production and schedule or other functions. (8.1 4.1.1-2) (8.19 4.3-2)
- 3.1.5 Nuclear Operations Management shall establish a Criticality Safety Program that provides personnel skilled in the physics pertinent to criticality safety. These personnel shall, to the extent practicable, be administratively independent of process supervision. (8.1 4.1.1-4 and 4.1.1-5) (8.19 4.4-1 and 4.4-2)
- 3.1.6 Nuclear Operations Management shall establish a Criticality Safety Program that includes nuclear criticality *safety analysis* (see def.) for normal and credible abnormal conditions documenting the parameters, limits and controls required to ensure that the analyzed conditions are subcritical. (420.1 4.3.1.(i))
- 3.1.7 Nuclear Operations Management shall assign, delegate and accept overall responsibility for criticality safety. (8.1 4.1.1-1) (8.19 4.1-1 and 4.3-1)
- 3.1.8 Nuclear Operations Management shall ensure that the Criticality Safety Program is documented. (420.1 4.3.1-4)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 6
---	---	---

3.1.9 Nuclear Operations Management shall establish a means for monitoring the effectiveness of the Criticality Safety Program through periodic assessments. (420.1 4.3.1-4) (8.19 4.5)

3.1.10 Nuclear Operations Management shall periodically participate in auditing the overall effectiveness of the nuclear criticality safety program. (8.19 4.6)

3.2 Facility Management Responsibilities

3.2.1 Facility Management shall accept responsibility for the criticality safety of operations. (8.19 5.1)

3.2.2 Facility Management shall establish CCA(s) and assign custodian(s) as applicable per section 3.10 "Criticality Control Areas." (BMP)

3.2.3 Facility Management shall ensure that section 3.4 "Process Analysis and Control," of this manual is implemented and documented in a *safety analysis report* (see def.) as applicable. (See section 3.10 "Criticality Control Areas," for applicability.) (BMP)

3.2.4 Operations shall be reviewed by Facility Management (at least annually) to ascertain that procedures are being followed. (8.7 4.1.3) (8.19 7.8-1)

3.2.5 Facility Management shall require operations where criticality safety is pertinent to be governed by operating procedures. (See section 3.4.3 "Operational Procedures.") (8.1 4.1.3-1) (8.7 4.1.2-1) (8.19 5.4-2)

3.2.6 Facility Management shall be knowledgeable in those aspects of criticality safety relevant to the operation and participate in the development of *safety analysis* (see def.) for the facility. (8.19 5.2-1 and 5.4-1)

3.2.7 Facility Management shall ensure that personnel are trained on, and require that they have an understanding of, criticality safety procedures and considerations. (See section 3.9 "Criticality Safety Training.") (8.1 4.1.1-3 and 4.1.3-2) (8.7 4.1.2-2) (8.19 5.3-1 and 5.6) (8.20 5.2)

3.2.8 Facility Management shall verify that new or modified equipment is covered by the authorization basis before it is used. (8.19 5.5)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 7
---	---	---

3.3 LMITCO Criticality Safety Staff Responsibilities

- 3.3.1 The Criticality Safety Staff shall document the requirements and recommendations for the LMITCO Criticality Safety Program by developing, issuing and maintaining the Criticality Safety Program Requirements Manual (PRD-112). (8.1 4.1.1-6) (8.19 4.2)
- 3.3.2 The Criticality Safety Staff shall perform reviews of equipment and process designs, safety analyses and operating procedures. (8.19 6.1)
- 3.3.3 The Criticality Safety Staff shall document and validate criticality safety evaluations (CSEs) per DOE-STD-3007-93 to ensure sufficient detail and clarity exists to allow independent judgement of results. (8.17 4.6) (8.19 8.3)
- 3.3.4 The Criticality Safety Staff shall maintain familiarity in criticality safety standards, guides and codes. (8.19 6.2-1, 6.2-2 and 6.3)
- 3.3.5 The Criticality Safety Staff shall maintain familiarity with operations that require criticality safety controls. (8.19 6.4)
- 3.3.6 The Criticality Safety Staff shall assist Facility Management as requested in training personnel. (8.19 5.2-2 and 6.5)
- 3.3.7 The Criticality Safety Staff shall examine reports of criticality safety procedural violations and other deficiencies for possible improvement, and report findings. (8.19 6.7)
- 3.3.8 The Criticality Safety Staff shall validate criticality safety *calculational methods* (see def.) in accordance with ANSI/ANS 8.1 and as follows:
(8.17 4.2) (8.21 5.2.2-2)
- 3.3.8.1 Limits for the processing, handling and storage of fissile material shall be based on experimental data or the results of *validated computational techniques* (see def.). (8.1 4.2.5) (8.7 4.2.1) (8.21 5.2.2-1)
- 3.3.8.2 *Bias* (see def.) shall be established by comparing criticality experiments with results obtained for systems by the method being validated. (8.1 4.3.1-1)
- 3.3.8.3 Where the extension in the area of applicability is large, the method should be supplemented by other calculational methods to provide a better estimate of the bias. (8.1 4.3.2)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 8
---	---	---

- 3.3.8.4 A margin in the correlating parameter (operating limit) shall be prescribed that is sufficient to ensure subcriticality. (8.1 4.3.3-1)
- 3.3.8.5 The 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. (8.1 4.3.3-2) (8.17 5.1)
- 3.3.8.6 If the calculational method involves a computer program, checks shall be performed to confirm that the mathematical operations are performed as intended. (8.1 4.3.4-1)
- 3.3.8.7 Changes in the computer program shall be followed by reconfirmation that the mathematical operations are performed as intended. (8.1 4.3.4-2)
- 3.3.8.8 Validation of criticality safety calculational methods shall be documented and include the following: (8.1 4.3.6)
- (A) a description of the calculational method with sufficient detail and clarity to allow independent duplication of results;
 - (B) computer programs used, the options, cross section sets and any numerical parameters necessary to describe the input;
 - (C) the experimental data and parameters; and
 - (D) the bias and the area(s) of applicability.

3.4 Process Analysis and Control

3.4.1 Process Analysis

- 3.4.1.1 Safety analysis shall document that the entire process will be subcritical under both normal and credible abnormal conditions before transferring fissile material or starting a new operation (including an existing operation that has been changed). (8.1 4.1.2-1) (8.17 4.4) (8.19 8.1) (420.1 4.3.1-1)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 9
---	---	---

- 3.4.1.2 An independent assessment shall confirm the adequacy of the criticality safety analysis before starting a new operation. (8.17 4.7) (8.19 8.4)
- 3.4.1.3 The safety analysis shall determine and identify the *controlled parameters* (see def.) and limits upon which criticality safety depends. (See section 3.7 "Criticality Safety Principles and Criteria.") (8.1 4.1.2-2 and 4.2.1) (8.17 4.5) (8.19 8.2-1)
- 3.4.1.4 The safety analysis shall be sufficient to determine the effect of changes in the controlled parameters, i.e., the margin of safety or in the conditions to which they apply. (8.19 8.2-2)
- 3.4.1.5 Safety analysis shall evaluate the criticality accident hazard and document the controls necessary to mitigate consequences to personnel and property. (420.1 4.3.1-2)
- 3.4.1.6 New or revised safety analyses impacting criticality safety shall be reviewed by the Criticality Safety Staff. (8.19 7.5)

3.4.2 Material Control

- 3.4.2.1 The handling, processing and storage of fissile materials shall be controlled by operating procedures. (8.1 4.1.4-1) (8.17 4.11) (8.19 9.1)
- 3.4.2.2 Access to areas where fissile material is handled, processed or stored shall be controlled. (8.7 4.1.4) (8.19 9.4)
- 3.4.2.3 Material labeling, where practicable, that enhances the safe handling and storage of fissile materials shall be used. (8.1 4.1.4-2) (8.19 9.2)

3.4.3 Operational Procedures

- 3.4.3.1 Procedures shall include all controls and limits specified in the criticality safety analysis. (8.1 4.1.3-3) (8.19 7.2-1 and 9.5) (420.1 4.3.1.(ii))
- 3.4.3.2 Procedures shall be such that no single, inadvertent departure from a procedure can cause a criticality accident. (8.19 7.2-2)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 10
---	---	--

- 3.4.3.3 Active procedures shall be reviewed periodically and revised as necessary. (8.19 7.3 and 7.4)
- 3.4.3.4 Procedures shall be supplemented with posted criticality safety limits when the safety analysis determines these postings are an aid to operations. (8.7 4.1.2-3) (8.19 7.6) (5480.19 Chap. XVII)
- 3.4.3.5 Procedures and postings should be organized for convenient use by operators. (8.19 7.1-1 and 7.1-2)
- 3.4.3.6 Procedural violations and process conditions outside the authorization basis shall be reported to Facility Management and Criticality Safety Staff and investigated promptly. (8.1 4.1.5-1) (8.19 7.7-1)
- 3.4.3.7 Action to prevent a recurrence of violations and process conditions outside the authorization basis, shall be taken. (8.1 4.1.5-2) (8.19 7.7-2)

3.5 Criticality Safety Review and Assessment

- 3.5.1 An annual review shall be performed in consultation with operations, by the Criticality Safety Staff to ascertain that process conditions have not been altered so as to affect the criticality safety evaluations. (8.1 4.1.6-1 and 4.1.6-2) (8.19 7.8-2 and 7.8-3) (420.1 4.3.1(iii))
- 3.5.2 Criticality Safety Staff shall participate in audits that involve criticality safety as directed by management. (8.19 6.6)

3.6 Criticality Accident Emergency Response

- 3.6.1 Emergency procedures shall be prepared and approved by Facility Management. (8.1 4.1.7-1) (8.19 10.2-1)
- 3.6.2 Emergency procedures shall include instructions regarding response to criticality alarm signals. (8.3 7.1)
- 3.6.3 Emergency procedures shall clearly designate evacuation routes. (8.19 10.3-1)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 11
---	---	--

- 3.6.4 Evacuation routes shall be posted and follow the quickest and most direct routes to avoid recognized areas of higher risk to minimize radiation exposure to evacuating personnel. (8.19 10.3-2 and 10.3-3)
- 3.6.5 Personnel accountability during evacuation shall be established. (8.19 10.4-2)
- 3.6.6 Personnel assembly stations shall be designated. (8.19 10.4-1)
- 3.6.7 Personnel shall be trained in evacuation procedures. (8.19 10.5-1)
- 3.6.8 Evacuation procedures shall include provisions for visitors. (8.19 10.5-2)
- 3.6.9 Evacuation drills shall be performed at least annually. (8.19 10.5-3)
- 3.6.10 Evacuation drills shall be announced in advance. (8.19 10.5-4)
- 3.6.11 Organizations, local and offsite, that are expected to respond and provide assistance at emergencies shall be made aware of conditions that might be encountered. (8.1 4.1.7-2) (8.19 10.2-2)
- 3.6.12 Assistance to local and offsite organizations in preparing emergency response procedures should be provided as necessary. (8.1 4.1.7-3) (8.19 10.2-3)
- 3.6.13 Emergency response plans shall include the care and treatment of injured, exposed and contaminated personnel. (8.19 10.6-1 and 10.6-2)
- 3.6.14 Plans shall include a program for immediate identification of exposed personnel which includes the use of personnel dosimetry. (8.19 10.7)
- 3.6.15 In the event of a criticality accident, procedures and instrumentation shall be provided for determining radiation levels at the evacuated and assembly areas. (8.19 10.8-1)
- 3.6.16 During emergencies, radiation level information should be correlated at a central control point. (8.19 10.8-2)
- 3.6.17 Emergency response procedures shall include organization of response teams and re-entry requirements. (8.19 10.9)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 12
---	---	--

3.7 Criticality Safety Principles and Criteria

3.7.1 Contingency Principle

- 3.7.1.1 Process design and controls shall be established such that at least two unlikely, independent and concurrent changes (contingencies) in system conditions are required before a criticality accident is possible. (420.1 4.3.2.d.(1)-1) (8.1 4.2.2)
- 3.7.1.2 Protection against accidental criticality shall be provided by either the control of two independent process parameters (which is the preferred approach, if practical) or a system of multiple (at least two) controls on a single parameter. (420.1 4.3.2.d.(1)-2)
- 3.7.1.3 The number of controls required upon a single controlled process parameter shall be based upon control reliability and any features that mitigate the consequences of control failure. (420.1 4.3.2.d.(1)-3)
- 3.7.1.4 In all cases, no single credible event or failure shall result in a criticality accident. (8.1 4.1.3-4) (420.1 4.3.1-3 and 4.3.2.d.(1)-4)
- 3.7.1.5 The basis used to demonstrate that no single event can result in a criticality accident shall be documented. (420.1 4.3.2.d.(1)-5)
- 3.7.1.6 For systems where the margin of safety is determined by analytic modeling, the maximum allowable *effective multiplication* (k_{eff}) (see def.) is 0.95 under single failure conditions. This k_{eff} shall include the possible non-conservative bias of the *calculational method* (see def.) used and the statistical uncertainty (normally two standard deviations when using monte carlo methods) as well as consider all credible accidents, corrosion and manufacturing uncertainties. (ID N 420.B 3.b.(1) and 3.c.(1)(a))

Program Requirements	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier:	PRD-112
Document		Revision:	1
Companywide		Page:	13

3.7.2 General Criteria

- 3.7.2.1 Where a significant quantity of fissile material is being processed and criticality safety is a concern, passive engineered controls such as geometry control shall be considered as a preferred control method. (420.1 4.3.2.d.(2)-1) (8.1 4.2.3-1) (8.7 4.2.4)
- 3.7.2.2 Where passive engineered control is not feasible, the preferred order of controls is active engineered controls, followed by administrative controls. (420.1 4.3.2.d.(2)-2)
- 3.7.2.3 The double *contingency* (see def.) analysis shall justify the chosen controls. (420.1 4.3.2.d.(2)-3)
- 3.7.2.4 Preference shall be given to a low number of design features and/or administrative controls that have a relatively low probability of failure rather than numerous controls and/or design features that have a higher probability of failure. (ID N 420.B 3.)
- 3.7.2.5 Controls shall be based on the maximum credible neutron interaction with other fissile material. (BMP)
- 3.7.2.6 Process equipment used in areas where immediate evacuation is required to protect personnel shall be designed or controlled such that leaving equipment will not introduce significant risk. (8.3 4.1.2)
- 3.7.2.7 Process systems shall be designed to prevent the unsafe accumulation of fissile material and the carry-over or inadvertent transfer from geometrically favorable equipment to unsafe equipment. (BMP)
- 3.7.2.8 A monitoring and surveillance program shall be established, where applicable, to prevent and detect accumulation of fissile materials in, but not limited to, process equipment and storage, pipe and ventilation systems. (420.1 4.3.2.i.)
- 3.7.2.9 Single and multi-parameter limits of ANSI/ANS 8.15 for special actinides shall be used according to the requirements specified in sections 5 and 6 of ANSI/ANS 8.15. (8.15 5. and 6.)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 14
---	---	--

- 3.7.2.10 Single parameter limits listed in ANSI/ANS 8.1 shall be used according to the requirements specified in sections 5 and 6 of ANSI/ANS 8.1. (8.1 5.-1, 5.-2 and 6.)
- 3.7.2.11 Subcritical specifications for single column pipe intersections in ANSI/ANS 8.9 shall be used according to sections 4 through 6 of ANSI/ANS 8.9. (8.9 4.-6.)
- 3.7.2.12 *Subcritical limits* (see def.) for mixtures of plutonium and uranium in ANSI/ANS 8.12 shall be used according to sections 5 and 6 of ANSI/ANS 8.12. (8.12 5. and 6.)
- 3.7.2.13 Limits for conducting subcritical neutron-multiplication measurements in situ in ANSI/ANS 8.6 shall be used according to sections 4 through 6 of ANSI/ANS 8.6. (8.6 4.-6.)

3.7.3 Plant Protective Systems (PPS)

- 3.7.3.1 Active devices, together with associated equipment that initiates their action, shall be designated as PPS components if their function in conjunction with passive structures of the plant is identified in the facility safety analysis report as necessary to prevent a criticality accident. (ID N 420.B 3.a.(1))
- 3.7.3.2 PPS components shall meet the criteria delineated in IEEE STD 603-1991. (ID N 420.1.B 3.a.(1))
- 3.7.3.3 Plant protection systems shall monitor important process variables and take automatic action to place the process in a safe condition. However, operator action shall be allowed in place of automatic system operation, provided: (ID N 420.B 3.a.(1))
- (A) automatic system operation is not feasible;
 - (B) alarms that warn operators that manual action is required are audible and visible;
 - (C) more than one certified operator is present to act on such alarms; and
 - (D) those active devices used to alert operators that action must be taken are designated as plant protection system components and meet the criteria delineated in IEEE STD 603-1991.

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 15
---	---	--

- 3.7.3.4 When computer driven distributed control systems (DCS) are used to minimize the potential for criticality accidents by controlling system components, IEEE STD 603-1991 criteria shall be utilized in the DCS design. (ID N 420.B 3.a.(2))

3.7.4 Criticality Analyses Independent Review

- 3.7.4.1 Criticality analyses that form the basis for operational limits and controls shall be independently reviewed to ensure adequacy. (ID N 420.B 3.b.(2))
- 3.7.4.2 Independent reviews shall be performed by individuals who have not had direct responsibility for the initial analyses. Independent reviews may range from a second analysis, complete with independent calculations, to a simple review of the methodology and assumptions, depending on the complexity of the analysis and the consequences of error. (ID N 420.B 3.b.(2))
- 3.7.4.3 The LMITCO Criticality Safety Staff shall determine the type of reviews required. (ID N 420.B 3.b.(2))

3.7.5 Criticality Safety Parameters

- 3.7.5.1 The control against accidental criticality is based on applicable requirements for the following parameters. Unless otherwise specified, the following parameter values shall be calculated assuming the system is at its most reactive credible state, including consideration of normal and upset conditions of geometry, moderation and reflection. (ID N 420.B 3.c.(1)(a))
- 3.7.5.2 The specified limits shall also be shown to result in a system k_{eff} no greater than 0.95 under single failure conditions. (ID N 420.B 3.c.(1)(a))
- 3.7.5.3 Geometry
- 3.7.5.3.1 Dimensional limitations shall include an allowance for fabrication tolerance and potential dimensional changes from corrosion, erosion or mechanical distortion. (BMP)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 16
---	---	--

3.7.5.3.2 Criticality safety controls shall include provisions for periodic evaluation by an inspection program, use of corrosion specimens, etc., if a credible mechanism could change the geometry in a system that depends on geometry for criticality safety. (BMP)

3.7.5.3.3 All dimensions, nuclear properties and other features on which reliance is placed shall be documented and verified prior to beginning operations and control exercised to maintain them. (420.1 4.3.2.d.(2)-4) (8.1 4.2.3-2) (8.17 4.8)

3.7.5.4 Mass

3.7.5.4.1 For a system to be considered critically safe by mass alone, it shall not have more than 75 percent of the critical mass assuming the system is in its most reactive credible state. (ID N 420.B 3.c.(1)(a))

3.7.5.4.2 If over-batching is credible and mass is the only parameter controlled, 45 percent of the critical mass shall be used. (ID N 420.B 3.c.(1)(a))

3.7.5.4.3 For fuel handling applications, a Fuel Handling Unit (FHU) shall contain no more than 75 percent of the minimum critical number of elements and the contents of the FHU shall not exceed a k_{eff} of 0.95 under single failure conditions (see 3.7.5.2). (BMP)

3.7.5.4.4 For fuel handling applications, if over-batching is credible and the number of fuel elements is the only parameter controlled, the FHU shall contain no more than 45 percent of the minimum critical number of elements. For those special cases where the minimum critical number of elements is two, the handling of a single element is permissible provided the probability of failure of the primary control is low. (BMP)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 17
---	---	--

3.7.5.5 Volume

- 3.7.5.5.1 For a system to be considered critically safe by volume alone, the volume of the system shall be less than 75 percent of the critical volume assuming the system is in its most reactive credible state. (ID N 420.B 3.c.(1)(a))

3.7.5.6 Concentration

- 3.7.5.6.1 For a system to be considered critically safe by concentration alone, the fissile isotope concentration shall be limited to 75 percent of the critical concentration for a geometrically infinite system or, if used in concert with geometry, 75 percent of the critical concentration for the most reactive credible geometry. (ID N 420.B 3.c.(1)(a))
- 3.7.5.6.2 The potential for concentrating fissile material shall be considered in the determination of concentration limits. (ID N 420.B 3.c.(1)(a))
- 3.7.5.6.3 If the system is a solution system, the chemical stability shall be guaranteed or precipitation or mass transport between phases considered, as applicable. (ID N 420.B 3.c.(1)(a))

3.7.5.7 Moderator/Reflector Controls

- 3.7.5.7.1 Moderator and reflector controls shall only be used in conjunction with another acceptable parameter, when practical alternatives do not exist and the risk of fire is sufficiently low. (BMP)
- 3.7.5.7.2 Moderation and reflection by materials with better moderating/reflecting properties than water shall be evaluated if their introduction into the system is credible. (ID N 420.B 3.c.(1)(a))

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 18
---	---	--

3.7.5.8 Fixed Neutron Absorbers (Poisons)

- 3.7.5.8.1 The use of fixed poisons for criticality control requires that their presence, poison worth and intended geometry is verified before the materials are used and their continued effectiveness is periodically verified, as defined in the facility safety analysis. (ID N 420.B 3.c.(1)(b)) (8.1 4.2.4-1) (8.17 4.9-1) (8.19 9.3) (8.21 4.-1, 4.-2, 5.1.1.1-1, 5.1.1.1-2, 5.3.2.1, 5.3.2.3 and 5.3.2.4)
- 3.7.5.8.2 The time interval for the verification required for the use of fixed poisons shall be justified in the facility safety analysis. (ID N 420.B 3.c.(1)(b)) (8.21 5.3.1.1-1 and 5.3.1.1-2)
- 3.7.5.8.3 The justification of the verification period shall discuss corrosion and credible accidents related to the presence of the poison. (ID N 420.B 3.c.(1)(b)) (8.21 4.-3)
- 3.7.5.8.4 The design of systems relying on fixed poisons shall utilize features that minimize the vulnerability of the poison to deterioration in performance, i.e., corrosion, physical or chemical actions, material composition changes, inadvertent removal, depletion and containment. (ID N 420.B 3.c.(1)(b)) (8.21 5.-1, 5.1.1.2-1, 5.1.1.2-2, 5.1.3, 5.2.1.1 and 5.2.1.2)
- 3.7.5.8.5 Fixed neutron absorbers shall be designed to maintain their required geometrical relationship with fissile materials and neutron absorption capability during the intended operating life. (8.21 5.1.1 and 5.1.1.2.1)
- 3.7.5.8.6 Radiation effects on the neutron absorber system shall be evaluated. (8.21 5.1.1.2.2)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 19
---	---	--

- 3.7.5.8.7 Design considerations shall make allowances for process material variations, manufacturing tolerances, absorber density and distribution uncertainties, and uncertainties in the nuclear properties (such as the accuracy of neutron cross sections) of the neutron absorbers. (8.21 5.1.1.3)
- 3.7.5.8.8 The neutron absorber system shall be designed so that the criticality safety function is not compromised for all credible operational and natural phenomena events for the facility or equipment, unless double contingency is provided by other controls. (8.21 5.1.2)
- 3.7.5.8.9 The design of equipment and facilities incorporating fixed neutron absorbers shall incorporate human factors engineering practices for installation, operation and maintenance of fixed neutron absorbers. (8.21 5.1.4)
- 3.7.5.8.10 The requirements of operations, fissile material accountability and other safety disciplines shall be considered in the design of the neutron absorber system. (8.21 5.1.5)
- 3.7.5.8.11 Any event that subjects the neutron absorber system to physical or chemical conditions outside the design envelope shall require the reassessment of continued use of the system or prior to restart of operations. (8.21 5.2.1.3)
- 3.7.5.8.12 The criticality calculational methods used shall be appropriately explicit to replicate the effect of neutron flux depressions associated with localized neutron absorbers. (8.21 5.2.2.1)
- 3.7.5.8.13 The effect on criticality safety of in-homogeneity of the fixed neutron absorbers shall be assessed, i.e., neutron streaming through the in-homogeneous neutron absorber material.
(8.21 5.2.2.2)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 20
---	---	--

- 3.7.5.8.14 Evaluations shall consider manufacturing tolerances, material substitutions, geometry changes, corrosion allowance, modeling assumptions, process variables and other relevant uncertainties. (8.21 5.2.3)
- 3.7.5.8.15 Inspection and verification for fixed neutron absorber systems shall conform to the operating facility quality assurance requirements. (8.21 5.3.1-1)
- 3.7.5.8.16 Action resulting from inspection and verification shall not compromise the nuclear criticality safety of the operating system. (8.21 5.3.1-2)
- 3.7.5.8.17 Inspection and verification activities shall be documented and records maintained for the operating life of the facility and neutron absorber system. (8.21 5.3.1-3)
- 3.7.5.8.18 Testing methods used to verify neutron absorber properties shall be calibrated, as applicable, to material standards traceable to the National Institute of Standards and Technology. (8.21 5.3.1.3)
- 3.7.5.8.19 The inspection and verification activities shall include material acquisition, neutron absorber system component manufacturing, installation, operation and maintenance of the neutron absorber system. (8.21 5.3.2)
- 3.7.5.8.20 Conformance to design drawings and specifications of neutron absorber system components shall be verified before installation. (8.21 5.3.2.2)
- 3.7.5.8.21 Results of in-service verifications shall be evaluated and if necessary, appropriate corrective actions taken. (8.21 5.3.3)
- 3.7.5.8.22 The use of borosilicate Raschig rings for criticality control shall be in accordance with requirements in ANSI/ANS 8.5. (8.5 3 - 7)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 21
---	---	--

3.7.5.9 Soluble Neutron Poisons

3.7.5.9.1 The use of soluble poisons for criticality control requires all of the following criteria are satisfied:
(ID N 420.B 3.c.(1)(c) (8.1 4.2.4-2)
(8.17 4.9-2)

- (A) personnel are protected from radiation by shielding that limits whole body doses received to 25 REM in the event of a criticality accident;
- (B) geometric and other alternative controls are not reasonably achievable;
- (C) a reliable Plant Protective System monitors the presence of the poison or the barriers that assure the presence of poison;
- (D) at least two independent analyses, by different individuals, preferably on samples taken from different sample points and analyzed with different techniques, are used to periodically (as defined in the facility safety analysis) verify the required concentration of neutron absorber during system operation; and
- (E) the minimum allowed absorber concentration is 125 percent of the concentration required for a $k_{\text{eff}} = 0.95$ assuming other species are at concentrations which maximize reactivity under maximum credible accident or upset conditions.

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 22
---	---	--

3.7.6 Fissile Material Storage and Transport

- 3.7.6.1 Storage facilities and structures shall be designed, fabricated and maintained in accordance with good engineering practices. (8.7 4.2.2, 4.2.3 and 4.2.5)
- 3.7.6.2 Combustible materials should be controlled within fissile material storage and handling areas. (8.7 4.2.6-1)
- 3.7.6.3 Fire protection systems shall be installed in fissile material storage and handling areas where combustion hazards exist. (8.7 4.2.6-2)
- 3.7.6.4 Containers of fissile materials shall be designed to prevent the unsafe accumulation of water in areas with water fire suppression systems. (8.7 4.2.7)
- 3.7.6.5 Where water fire suppression systems are used in fissile material storage areas, consideration shall be given to the possibility of a criticality occurring in an accumulation of runoff water. (8.7 4.2.8)
- 3.7.6.6 Good housekeeping within fissile material storage and handling areas shall be incorporated as an important part of criticality safety practices. (8.7 4.2.10)
- 3.7.6.7 Fissile material storage and handling area mass limits listed in ANSI/ANS 8.7 shall be used according to the requirements specified in sections 5 and 6 of ANSI/ANS 8.7. (8.7 5 - 6)
- 3.7.6.8 Criticality calculations for fuel element handling and storage shall be based on one of the following: (8.17 4.10-1 and 4.10-2)

NOTE: When credit is taken for burnup or neutron poisons, the fuel and poison inventories must be guaranteed by the shipper and approved by the LMITCO Criticality Safety Staff.

- (A) beginning of life fuel loadings without credit for neutron poisons;

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 23
---	---	--

- (B) most reactive time in life fuel and neutron poison inventories;
- (C) guaranteed end of life fuel and poison inventories; or
- (D) guaranteed end of life fuel inventories.

3.7.6.9 Department of Transportation (DOT) shipping packages, Nuclear Regulatory Commission (NRC) shipping packages or on-site casks may be used to store fissile material according to the respective SAR, safety analysis report for shipping (SARP) or Certificate of Compliance (COC) requirements. (BMP)

3.7.6.10 Shipping packages used to store fissile material shall be opened in CCAs (see section 3.10, "Criticality Control Areas"). (BMP)

NOTE: Fissile material in an opened DOE or NRC shipping package can be assumed to be in "interim approved storage" during unloading/handling operations (in a Procedure CCA only). (BMP)

3.7.6.11 For on-site transportation, contractors shall be required to follow an approved on-site transportation safety manual. (Reference LMITCO Packaging and Transportation Safety Manual, issued June 1995.) (420.1 4.3.2.j.(1))

3.7.6.12 The requirements of DOE 460.1 shall be complied with regarding off-site shipment of fissile material. (420.1 4.3.2.j.(2))

3.8 Criticality Accident Detection System

3.8.1 Criticality Alarm System Applicability

3.8.1.1 The nuclear criticality safety program shall include assessment of the need for criticality accident detection devices and alarm systems, and installation of such equipment where total risk to personnel will be reduced. (420.1 4.3.1.(iv))
(8.3 4.2.1-1 and 4.2.1-2)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 24
---	---	--

3.8.1.2 Criticality Alarm Systems (CAS) and Criticality Detection Systems (CDS) coverage shall be required as follows:
(420.1 4.3.2.e)

NOTE: In what follows, 10^{-6} per year is used as a measure of credibility and does not mean that a probabilistic risk assessment (PRA) has to be performed. Reasonable grounds for incredibility may be presented on the basis of commonly accepted engineering judgment.

3.8.1.2.1 In those cases where the mass of fissile material exceeds 700 grams of ^{235}U , 520 grams of ^{233}U or 450 grams of ^{239}Pu or 450 grams of any combination of these three isotopes and the probability of criticality is greater than 10^{-6} per year (as documented in a DOE approved SAR), a CAS meeting ANSI/ANS-8.3 shall be provided to cover occupied areas in which the expected dose exceeds 12 rads in free air, where a CAS is defined to include a criticality accident detection device and a personnel evacuation alarm.
(420.1 4.3.2.e.(1))

3.8.1.2.2 In those cases where the mass of fissile material exceeds 700 grams of ^{235}U , 520 grams of ^{233}U or 450 grams of ^{239}Pu or 450 grams of any combination of these three isotopes and the probability of criticality is greater than 10^{-6} per year, (as documented in a DOE approved SAR), but there are no occupied areas in which the expected dose exceeds 12 rads in free air, a criticality detection system shall be provided where a criticality detection system is defined to be an appropriate criticality accident detection device but without an immediate evacuation alarm. The criticality accident detection system response time should be sufficient to allow for appropriate process-related mitigation, recovery actions and minimization of personnel exposure.
(420.1 4.3.2.e.(2))

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 25
---	---	--

- 3.8.1.2.3. In those cases where the mass of fissile material exceeds 700 grams of ^{235}U , 520 grams of ^{233}U or 450 grams of ^{239}Pu or 450 grams of any combination of these three isotopes, but a criticality accident is determined to be impossible due to the physical form of the fissile material or the probability of occurrence is determined to be less than 10^{-6} per year (as documented in a DOE approved SAR), neither a CAS nor a criticality detection system is required. Neither a CAS nor a criticality detection system is required for fissile material during shipment of fissile material packaged in approved shipping containers awaiting transport provided no other operation involving fissile material not so packaged is permitted in the area. (420.1 4.3.2.e.(3))
- 3.8.1.2.4. If a criticality accident is possible wherein a slow (i.e., quasistatic) increase in reactivity could occur leading from subcriticality to supercriticality to self-shutdown without setting off emplaced criticality alarms, then a CAS might not be adequate for protection against the consequences of such an accident. To aid in protecting workers against the consequences of slow criticality accidents in facilities where analysis has shown that slow criticality accidents are credible, CASs should be supplemented by warning devices such as audible personnel dosimeters (e.g., pocket chirpers/flashers or their equivalents), area radiation monitors, area dosimeters or integrating CASs. (420.1 4.3.2.e.(4))
- 3.8.1.2.5. Neither a CAS nor a CDS is required to be installed for handling or storage of fissile material when sufficient shielding exists that is adequate to protect personnel (e.g., spent fuel pools, hot cells or burial grounds); however, a means to detect fission product gasses or other volatile fission products should be provided in occupied areas immediately adjacent to such shielded areas, except for systems where no fission products are likely to be released. (420.1 4.3.2.e.(5))

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 26
---	---	--

3.8.2 Alarm Requirements

- 3.8.2.1 Where alarm systems are installed, emergency plans shall be maintained. (8.3 4.1.1)
- 3.8.2.2 Criticality alarm signals shall be for prompt evacuation or other protective actions. (8.3 4.3.1-1)
- 3.8.2.3 The mode of detection and alarm systems should be uniform for each operation. (8.3 4.3.1-2)
- 3.8.2.4 The signals shall be distinctive from other signals or alarms that require a response different from that necessary in the event of a criticality accident. (8.3 4.3.1-3)
- 3.8.2.5 For all occupied areas where personnel protective action is required, the number and placement of criticality alarm signal generators shall be such that the signals are adequate to notify personnel promptly throughout those areas. (8.3 4.3.5)
- 3.8.2.6 The audio generators should produce an overall sound pressure level of at least 75 dB, but not less than 10 dB above the maximum ambient noise level typical of each area for which audio coverage is to be provided. (8.3 4.3.6)
- 3.8.2.7 The signal generators should not produce an A-weighted sound level in excess of 115 dB (referenced to 20 $\mu\text{N}/\text{m}^2$) at the ear of an individual. (8.3 4.3.7)
- 3.8.2.8 In areas with very high audio background or mandatory hearing protection, visual signals or other alarm means should be considered. (8.3 4.3.8)
- 3.8.2.9 The signal-generating system(s) shall be automatically and promptly actuated upon detection of a criticality accident. (8.3 4.3.2)
- 3.8.2.10 The alarm trip point shall be set high enough to minimize the probability of an alarm from sources other than a criticality. (8.3 5.7.2-1)
- 3.8.2.11 The alarm trip point shall be set low enough to detect the *minimum accident of concern* (see def.). (8.3 5.7.2-2)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 27
---	---	--

- 3.8.2.12 After actuation, the signal generators shall continue to function as required by emergency procedures. (8.3 4.3.3-1)
- 3.8.2.13 Manual alarm resets with limited access, should be provided outside the areas to be evacuated. (8.3 4.3.3-2)
- 3.8.2.14 All components of the system should be located or protected to minimize damage in case of fire, explosion, corrosive atmosphere or other extreme conditions. (8.3 5.2-1)

3.8.3 Dependability/Reliability

- 3.8.3.1 Alarm system(s) shall be designed and operated to detect a criticality and minimize false alarms. (8.3 4.1.3, 4.2.3 and 4.4.1-1)
- 3.8.3.2 In redundant systems, failure of any single channel shall not prevent compliance with the detection criterion. (8.3 4.4.1-2)
- 3.8.3.3 The system shall be sufficiently robust as to actuate the alarm signal when exposed to the maximum radiation expected. (8.3 4.4.4)
- 3.8.3.4 Alarm systems shall be designed for high reliability and the design should be as simple as is consistent with the single objective of reliable activation of the alarm. (8.3 5.1-1 and 5.1-3)
- 3.8.3.5 The system should be designed to minimize the effects of non-use, deterioration, power surges and other adverse conditions. (8.3 5.1-2)
- 3.8.3.6 The system should be designed to minimize the potential for failure, including false alarm, due to human error. (8.3 5.2-2)
- 3.8.3.7 Major system components should be labeled. (8.3 5.2-3)
- 3.8.3.8 *Process areas* (see def.) 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. (8.3 4.4.3)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 28
---	---	--

- 3.8.3.9 Where portable instruments are used, the usage shall be evaluated to determine appropriate criteria of this standard (ANSI/ANS 8.3). (8.3 4.4.2-1 and 6.5-2)
- 3.8.3.10 Criteria for use of portable instruments shall be specified in procedures. (8.3 4.4.2-2)
- 3.8.3.11 Alarm systems should remain operational in the event of seismic shock equivalent to the site specific design basis earthquake or the equivalent value specified by the Uniform Building Code. (8.3 5.3)
- 3.8.3.12 A visible or audible warning signal should be provided at some normally occupied location, to indicate system malfunction or the loss of primary power. (8.3 5.4)
- 3.8.3.13 Criticality alarm systems shall be designed to respond immediately to the minimum accident of concern. (For this purpose, in areas where material is handled or processed, the minimum accident may be assumed to deliver the equivalent of an absorbed dose rate in free air of 0.2 Gy/min [20 rad/min] at 2 meters.) (8.3 5.6-1)
- 3.8.3.14 The basis for a different minimum accident of concern shall be documented. (8.3 5.6-2)
- 3.8.3.15 The alarm system shall be designed to produce the desired evacuation signal within one-half second of recognition of a criticality accident. (8.3 5.5)
- 3.8.3.16 Alarm systems shall be designed so that instrument response and alarm latching shall occur as a result of transients of 1 ms duration. (8.3 5.7.1)
- 3.8.3.17 The location and spacing of detectors should be chosen to avoid the effect of shielding by massive equipment or materials. (8.3 5.8-2)
- 3.8.3.18 The spacing of detectors shall be consistent with the selected alarm trip point and with the detection criterion. (8.3 5.8-1)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 29
---	---	--

3.8.4 Testing

- 3.8.4.1 Procedures for system testing shall minimize false alarms and inadvertent initiation of emergency response. (8.3 6.6-1)
- 3.8.4.2 The alarm system shall be returned to operating conditions immediately following tests. (8.3 6.6-2)
- 3.8.4.3 Initial tests, inspections and checks of the alarm system shall verify that the fabrication and installation were made in accordance with design plans and specifications. (8.3 6.1)
- 3.8.4.4 Following significant modification or repair to an alarm system, there shall be tests and checks equivalent to the initial installation tests. (8.3 6.2)
- 3.8.4.5 Alarm system response to radiation shall be measured periodically to confirm continuing instrument performance. (8.3 6.3-1)
- 3.8.4.6 The alarm system test interval should be determined on the basis of experience; however, in the absence of experience the tests should be performed at least monthly. (8.3 6.3-2 and 6.3-3)
- 3.8.4.7 Records of alarm system tests and corrective actions shall be maintained. (8.3 6.3-4 and 6.7)
- 3.8.4.8 The entire alarm system shall be tested periodically. (8.3 6.4-1)
- 3.8.4.9 Each signal generator should be tested at least annually. (8.3 6.4-2)
- 3.8.4.10 Field observations shall establish that the alarm signal is audible above background throughout all areas to be evacuated. (8.3 6.4-3)
- 3.8.4.11 All personnel in affected areas shall be notified in advance of an audible alarm system test. (8.3 6.4-4)
- 3.8.4.12 When alarm system tests reveal inadequate performance, corrective action shall be taken without unnecessary delay. (8.3 6.5-1)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 30
---	---	--

3.9 Criticality Safety Training

3.9.1 Criticality Safety Training Program Requirements

NOTE: The training requirements in section 3.9.1 apply to facilities that have Criticality Control Areas (CCAs). Items 3.9.1.9, 3.9.1.10 and 3.9.1.11 apply only to those facilities with credible criticality accident scenarios.

- 3.9.1.1 Facility Management shall establish a Criticality Safety Training Program tailored to and in support of specific areas or processes. (8.20 5.1 and 6.1-2)
- 3.9.1.2 Criticality Safety Staff personnel shall participate in the development of the training program and should participate in its implementation and the evaluation of its effectiveness. (8.20 5.3)
- 3.9.1.3 Criticality Safety Training and Refresher Training Program requirements shall be documented. (8.20 6.1-1, 6.2-1 and 8.2-1)
- 3.9.1.4 Refresher criticality safety training shall occur at least every two years. (8.20 6.2-2)
- 3.9.1.5 A documented evaluation of the Criticality Safety Training Program shall be performed periodically to determine the adequacy of the program. (8.20 8.1-1, 8.1-2 and 8.1-3)
- 3.9.1.6 Weaknesses identified during personnel criticality safety training shall be addressed by additional training. (8.20 8.2-2)
- 3.9.1.7 The adequacy of an individual's criticality safety training shall be certified by Facility Management. (8.20 8.2-3)
- 3.9.1.8 Each employee's criticality safety training record shall be documented and retained for a minimum of four years. (8.19 5.3-2) (8.20 8.3)
- 3.9.1.9 The Criticality Safety Training Program shall include the recognition of and the response to criticality alarms. (8.20 7.4.1)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 31
---	---	--

- 3.9.1.10 The reduction in received dose resulting from a criticality as a function of time, distance and shielding shall be part of the Criticality Safety Training Program. (8.20 7.4.2)
- 3.9.1.11 The Criticality Safety Training Program shall include information concerning health effects from radiation. (8.20 7.1.3)
- 3.9.1.12 The Criticality Safety Training Program shall make each individual, regardless of position, aware that nuclear criticality safety in their work area is their responsibility. (8.19 4.3-3)
- 3.9.1.13 The Criticality Safety Training Program shall inform employees that they have the right to question and stop any operation that is believed to be unsafe. (8.20 7.6.5)

3.9.2 Fissile Material Handler Requirements

NOTE: This section applies to handling quantities greater than 15 grams of ^{233}U , ^{235}U , ^{239}Pu and ^{241}Pu , excluding natural and depleted uranium, in a CCA.

- 3.9.2.1 Personnel who handle fissile material shall be trained as "Fissile Material Handlers" as specified by the following requirements and as specified by DOE Order 5480.20A "Personnel Selection, Qualification and Training Requirements for DOE Nuclear Facilities." (5480.20A IV.4.b.)
- 3.9.2.2 Fissile Material Handler Training shall address instrumentation and control, including types of instruments and control systems, principles of operation and consequences of malfunctions. (5480.20A IV.4.b.(1))
- 3.9.2.3 Fissile Material Handler Training shall address facility operating characteristics, including principle features, operating parameters and operating limits of the facility (to include auxiliary systems). (5480.20A IV.4.b.(2))
- 3.9.2.4 Fissile Material Handler Training shall address principles of nuclear facility operation, including the processes involved and technical terminology for the chemical, physical and metallurgical reactions, and criticality safety principles, controls and specifications. (5480.20A IV.4.b.(3))

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 32
---	---	--

- 3.9.2.5 The effects and application of the following factors that are relevant shall be part of the Fissile Material Handler Training for each process or operation: (8.20 7.5.1)
- (A) mass,
 - (B) shape,
 - (C) interaction and separation,
 - (D) moderation,
 - (E) reflection,
 - (F) concentration,
 - (G) volume,
 - (H) density,
 - (I) neutron absorbers,
 - (J) heterogeneity, and
 - (K) enrichment.
- 3.9.2.6 The criticality scenarios postulated in the safety analysis shall be part of the Fissile Material Handler Training. (8.20 7.5.3 and 7.6.1)
- 3.9.2.7 Operational limits and controls for the safety of each area shall be part of the Fissile Material Handler Training. (8.20 7.5.2, 7.5.4 and 7.6.3)
- 3.9.2.8 The proper use of checklists, sign-off sheets and other documentation required in procedures shall be part of the Fissile Material Handler Training. (8.20 7.6.2)
- 3.9.2.9 The proper response to abnormal situations and conditions shall be part of the Fissile Material Handler Training. (8.20 7.6.4)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 33
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3.10 Criticality Control Areas

- 3.10.1 Laboratories, storage areas and processes that contain greater than 15 grams of fissile material (^{233}U , ^{235}U , ^{239}Pu , ^{241}Pu with exception of natural and depleted uranium) shall be designated as Criticality Control Areas (CCAs). (BMP)

NOTE: Waste vessels or areas containing fissile concentrations less than or equal to 5×10^{-3} g/l are exempt from CCA requirements. Areas that contain fissile material in a form or distribution that is impossible for criticality are exempt from CCA requirements. Department of Transportation (DOT), on-site casks with an approved SAR or NRC licensed shipping packages that are stored according to their respective safety analysis report for packaging (SARP) or Certificate of Compliance, are exempt from CCA requirements.

- 3.10.2 The establishment and status change of a CCA shall require the approval of the LMITCO Criticality Safety Staff. (BMP)
- 3.10.3 CCAs shall be categorized according to the following: (BMP)

NOTE: For mixtures of fissile nuclides, each gram of ^{233}U and ^{239}Pu count as two grams of ^{235}U . ^{241}Pu can be counted as equivalent to ^{239}Pu .

- (A) Mass Limit CCA - areas that contain less than or equal to the equivalent of 250 grams ^{233}U , 350 grams ^{235}U or 250 grams ^{239}Pu . Mass Limit CCAs are controlled by these generic mass limits.
- (B) Procedure CCA - areas that contain more than the equivalent of 250 grams ^{233}U , 350 grams ^{235}U or 250 grams ^{239}Pu . Procedure CCAs require an approved safety analysis report and area specific controls and limits.

- 3.10.4 CCA boundaries shall be clearly defined and marked. (BMP)
- 3.10.5 Mass Limit CCAs shall maintain a continuous fissile material inventory. (BMP)
- 3.10.6 The use of special reflecting/moderating materials (beryllium, carbon [density ≥ 1.6 g/cm³], heavy water and lead) in a Mass Limit CCA or Procedure CCA shall be specifically evaluated in a CSE or require the approval of the Criticality Safety Staff. (BMP)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 34
---	---	--

- 3.10.7 An approved safety analysis report shall be required for Procedure CCAs.
(BMP)
- 3.10.8 CCA custodians shall understand criticality safety principles and know the applicable criticality safety controls and operating procedures in their CCA.
(BMP)

3.11 Firefighting

- 3.11.1 Fire protection systems shall not cause a nuclear criticality accident. (BMP)
- 3.11.2 Firefighting guidelines shall be based on comparisons of the risks and consequences of postulated fires for the respective area(s).
(420.1 4.3.2.k.-1)
- 3.11.3 Facility fire suppression restrictions shall be documented in the SAR.
(420.1 4.3.2.k.-2)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 35
---	---	--

4. DEFINITIONS

Bias. A measure of the systematic disagreement between the results calculated by a method and experimental data.

Bias uncertainty. The uncertainty in the bias is interpreted as a measure of both the accuracy of the calculation and the precision of the experimental data. It is assumed also to include (a) the precision of the calculation if the calculation is stochastic (notwithstanding that such precision often can be made as great as desired) and (b) the accuracy of the experimental data if the experiment is a mock-up of a referenced system.

Calculational method. The mathematical equations, approximations, assumptions, associated numerical parameters (e.g., cross sections) and calculational procedures that yield the calculated results.

Contingency. A possible but unlikely change in a condition/control important to the nuclear criticality safety of a fissile material operation that would, if it occurred, reduce the number of barriers (either administrative or physical) that are intended to prevent an accidental nuclear criticality.

Controlled parameter. A parameter that is kept within specified limits and, when varied, influences the margin of subcriticality.

Criticality accident. The release of energy as a result of accidentally producing a self-sustaining or divergent neutron chain reaction.

Criticality Safety. Protection against the consequences of an inadvertent nuclear chain reaction, preferably by prevention of the reaction. This encompasses procedures, training and other precautions, in addition to physical protection.

Effective multiplication factor (k_{eff}). The ratio of the total number of neutrons produced during a time interval (excluding neutrons produced by sources whose strengths are not a function of fission rate) to the total number of neutrons lost by absorption and leakage during the same interval.

Fissile material. Materials containing nuclides capable of sustaining a fission chain reaction (e.g., ^{233}U , ^{235}U , ^{239}Pu , and ^{241}Pu).

Hazard. A source of danger (i.e., material, energy source or operation) with the potential to cause illness, injury or death to personnel or damage to a facility or to the environment (without regard for the likelihood or credibility of accident scenarios or consequence mitigation).

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 36
---	---	--

Minimum accident of concern. The smallest accident a criticality alarm system is required to detect.

Process area. An area in which fissile material is handled, stored or processed.

Safety analysis. A documented process: (1) to provide systematic identification of hazards within a given DOE operation; (2) to describe and analyze the adequacy of the measures taken to eliminate, control or mitigate identified hazards; and (3) to analyze and evaluate potential accidents and their associated risks.

Safety Analysis Report (SAR). The report that documents the adequacy of safety analysis for a nuclear facility to demonstrate that the facility can be constructed, operated, maintained, shut down and decommissioned safely and in compliance with applicable laws and regulations.

Subcritical limit. The limiting value assigned to a controlled parameter that results in a subcritical system under specified conditions. The subcritical limit allows for uncertainties in the calculations and experimental data used in its derivation but not for contingencies; e.g., double batching or failure of analytical techniques to yield accurate values.

Validated computational techniques. A calculational method that has been tested, by comparison with experiment, to establish the reliability of results when the method is applied to conditions of interest.

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 37
---	---	--

5. REFERENCES

1. DOE Order 420.1, "Facility Safety," section 4.3, "Nuclear Safety," August 1995

 ANSI/ANS-8.1,1983, R88, "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors"
 ANSI/ANS-8.3-1997, "Criticality Accident Alarm System"
 ANSI/ANS-8.5-1986, "Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material"
 ANSI/ANS-8.6-1983, R88, "Safety in Conducting Subcritical Neutron-Multiplication Measurements in Situ"
 ANSI/ANS-8.7-1975, R87, "Guide for Nuclear Criticality Safety in the Storage of Fissile Materials"
 ANSI/ANS-8.9-1987, "Nuclear Criticality Safety Criteria for Steel-Pipe Intersections Containing Aqueous Solutions of Fissile Materials"
 ANSI/ANS-8.12-1987, R93, "Nuclear Criticality Control and Safety of Plutonium-Uranium Fuel Mixtures Outside Reactors"
 ANSI/ANS-8.15-1981, R87, "Nuclear Criticality Control of Special Actinide Elements"
 ANSI/ANS-8.17-1984, R89, "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-8.21-1995, "Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors"
 ANSI/ANS-8.20-1991, "Nuclear Criticality Safety Training"
2. DOE-ID Notice ID N 420.B "Nuclear Criticality Safety," 6-7-95
3. DOE Order 5480.20A, "Personnel Selection, Qualification and Training Requirements for DOE Nuclear Facilities," 11-15-94
4. DOE Order 5480.19, "Conduct of Operations Requirements for DOE Facilities," 5-18-92
5. DOE-STD-3007-93, "Guidelines for Preparing Criticality Safety Evaluations at Department of Energy Non-Reactor Nuclear Facilities," November 1993
6. IEEE STD 603-1991, "Criteria for Safety Systems for Nuclear Power Generating Stations"

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 38
---	---	--

6. ATTACHMENTS

ANSI/ANS 8.1 CROSS REFERENCE

<u>ANSI/ANS 8.1 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
4.1.1-1	3.1.7	Management shall establish responsibility for criticality safety
4.1.1-2	3.1.4	Criticality safety is assigned importance equal to all other functions
4.1.1-3	3.2.7	Individual responsibility for criticality safety
4.1.1-4	3.1.5	Management shall provide personnel skilled in criticality safety
4.1.1-5	3.1.5	Management shall provide personnel skilled in criticality safety
4.1.1-6	3.3.1	Management shall establish the criteria to be satisfied
4.1.2-1	3.4.1.1	Determine that the entire process will be subcritical
4.1.2-2	3.4.1.3	Determine conditions which result in the maximum effective multiplication factor (k_{eff})
4.1.3-1	3.2.5	Operations shall be governed by written procedures
4.1.3-2	3.2.7	Personnel shall understand and be familiar with procedures
4.1.3-3	3.4.3.1	Procedures shall specify all safety parameters
4.1.3-4	3.7.1.4	No single event shall result in a criticality
4.1.4-1	3.4.2.1	Movement of fissile materials shall be controlled
4.1.4-2	3.4.2.3	Materials labeling and area posting shall be maintained
4.1.5-1	3.4.3.6	Violations and conditions outside the authorization basis shall be reported and investigated
4.1.5-2	3.4.3.7	Action to prevent a recurrence shall be taken
4.1.6-1	3.5.1	Operations shall be reviewed frequently (at least annually)
4.1.6-2	3.5.1	Reviews shall be conducted
4.1.7-1	3.6.1	Emergency procedures shall be prepared and approved by management
<u>ANSI/ANS 8.1 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
4.1.7-2	3.6.11	Organizations responding to emergencies shall be made aware of conditions

Attachment E412.09#
(10/20/97 - Rev. #01)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 39
---	---	--

4.1.7-2	3.6.12	Assistance to off-site organizations shall be provided
4.2.1	3.4.1.3	Controlled parameters and their limits shall be specified
4.2.2	3.7.1.1	Process designs include at least two changes in conditions before a criticality accident is possible
4.2.3-1	3.7.2.1	Reliance shall be placed on equipment design
4.2.3-2	3.7.5.3.3	Dimensions and nuclear properties shall be verified
4.2.4-1	3.7.5.8.1	Maintain neutron absorber continual presence
4.2.4-2	3.7.5.9.1	Use of soluble poisons
4.2.5	3.3.8.1	Subcritical limits shall be established
4.3.1-1	3.3.8.2	Validation of calculational method
4.3.2	3.3.8.3	Supplemental calculational methods
4.3.3-1	3.3.8.4	A margin in the correlating parameter shall be prescribed
4.3.3-2	3.3.8.5	A margin shall include allowances for uncertainties
4.3.4-1	3.3.8.6	Checks shall confirm mathematical operations
4.3.4-2	3.3.8.7	Computer program changes shall be followed by reconfirmation
4.3.6	3.3.8.8	Validation shall be documented
5-1	3.7.2.10	Application of single-parameter limits
5-2	3.7.2.10	Specifications to prevent exceeding limits
6	3.7.2.10	Multi-parameter control

Attachment E412.09#
(10/20/97 - Rev. #01)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 40
---	---	--

ANSI/ANS 8.3 CROSS REFERENCE

<u>ANSI/ANS 8.3 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
4.1.1	3.8.2.1	Where alarm systems are installed, emergency procedures shall be maintained
4.1.2	3.7.2.6	Process equipment shall be designed so that leaving the equipment (evacuation) will not introduce significant risk
4.1.3	3.8.3.1	Hazards resulting from false alarms should be evaluated
4.2.1-1	3.8.1.1	The need for a criticality alarm system shall be evaluated
4.2.1-2	3.8.1.1	The evaluation shall be made whenever quantities exceed subcritical mass limits specified in ANSI/ANS 8.15
4.2.2-1		(alarm requirements modified by DOE Order 420.1)
4.2.2-2		(alarm requirements modified by DOE Order 420.1)
4.2.2-3		(alarm requirements modified by DOE Order 420.1)
4.2.3	3.8.3.1	Where alarm coverage is required, a means shall be provided to detect and signal
4.3.1-1	3.8.2.2	Criticality alarm signals shall be for prompt evacuation
4.3.1-2	3.8.2.3	The alarm signals should be uniform throughout the system
4.3.1-3	3.8.2.4	The signals shall be distinctive from other signals
4.3.2	3.8.2.9	Signal generators shall be automatically and promptly actuated upon detection of a criticality accident
4.3.3-1	3.8.2.12	After actuation, signal generators shall continue to function as required by emergency procedures
4.3.3-2	3.8.2.13	Manual resets, with limited access, should be provided outside areas that require evacuation
4.3.5	3.8.2.5	The number and placement of criticality alarm signal generators shall be adequate
4.3.6	3.8.2.6	Audio generators should produce an overall sound pressure of at least 75 dB, but not less than 10 dB above the maximum ambient noise level

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 41
---	---	--

4.3.7	3.8.2.7	Audio generators should not produce an A-weighted sound level in excess of 115 dB at the ear of an individual
4.3.8	3.8.2.8	Visual signals should be considered for areas with high audio background or mandatory hearing protection
4.4.1-1	3.8.2.1	Consideration shall be given to avoidance of false alarms
<u>ANSI/ANS 8.3 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
4.4.1-2	3.8.3.2	In redundant systems, failure of any single channel shall not prevent compliance with the detection criteria
4.4.2-1	3.8.3.9	Where portable instruments are used, the usage shall be evaluated to determine appropriate criteria of this standard
4.4.2-2	3.8.3.10	Criteria for use of portable instruments shall be specified in procedures
4.4.3	3.8.3.8	Areas in which activities will continue during power outages, shall have emergency power or activities shall be monitored continuously with portable instruments
4.4.4	3.8.3.3	The system shall be sufficiently robust as to actuate the alarm signal when exposed to the maximum radiation expected
5.1-1	3.8.3.4	The system shall be designed for high reliability and should utilize components that do not require frequent servicing
5.1-2	3.8.3.5	The system should be designed to minimize the effects of non-use, deterioration, power surges and adverse conditions
5.1-3	3.8.3.4	The design should be as simple as is consistent with the objectives of ensuring reliable actuation of the signal and avoidance of false alarms
5.2-1	3.8.2.14	Components of the system should be located or protected to minimize damage in case of fire, explosion, corrosion or other extreme conditions
5.2-2	3.8.3.6	The system should be designed to minimize the potential for failure, including false alarm, due to human error
5.2-3	3.8.3.7	Major system components should be labeled
5.3	3.8.3.11	The system should remain operational in the event of seismic shock
5.4	3.8.3.12	The system should be designed to provide a visible or audible warning signal at some

412.09#
(10/20/97 - Rev. #01)

normally occupied location to indicate system malfunction
or loss of primary power

5.6-2	3.8.3.14	The basis for a different minimum accident of concern shall be documented
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TOPIC

5.7.2-2	3.8.2.11	The level shall be set low enough to detect the minimum accident of concern
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5.8-2	3.8.3.17	Location and spacing of detectors should minimize the effect of shielding
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6.1 3.8.4.3 Initial tests, inspections and checks shall verify fabrication and installation

6.2	3.8.4.4	Following significant modification, tests and checks shall be performed
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6.3-1	3.8.4.5	shall be measured	System response to radiation
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6.3-2	3.8.4.6	Test interval should be determined on basis of experience
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6.3-3	3.8.4.6	In absence of experience, tests should be performed at least monthly
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6.3-4	3.8.4.7	maintained	Records of tests shall be
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6.4-1	3.8.4.8	The entire alarm system shall be tested periodically
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6.4-2	3.8.4.9	Each signal generator should be tested at least annually
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6.4-3	3.8.4.10	Field observation shall establish criticality alarm signals are functional
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6.4.4 3.8.4.11 before testing Personnel shall be notified

Attachment E

412.09#
(10/20/97 - Rev. #01)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 43
---	---	--

6.5-1	3.8.4.12	When tests reveal inadequate performance, corrective action shall be taken
6.5-2	3.8.3.9	If portable instrument is used, the criteria of ANSI/ANS 8.3 shall be met
6.6-1	3.8.4.1	Testing procedures shall minimize false alarms and inadvertent initiation of emergency response
6.6-2	3.8.4.2	Test procedures shall require the system to be returned to normal operation immediately following test
6.7	3.8.4.7	Records of tests and corrective actions shall be maintained

ANSI/ANS 8.3 SECTION

CSPRM SECTION

TOPIC

7.1	3.6.2	Instructions regarding response to alarm signals shall be posted at strategic locations
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ANSI/ANS 8.5 CROSS REFERENCE

ANSI/ANS 8.5 SECTION

CSPRM SECTION

TOPIC

3 - 7	3.7.5.8.22	Use of borosilicate Raschig rings
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ANSI/ANS 8.6 CROSS REFERENCE

ANSI/ANS 8.6 SECTION

CSPRM SECTION

TOPIC

4.-6.	3.7.2.13	Limits for conducting subcritical neutron-multiplication measurements in situ
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ANSI/ANS 8.7 CROSS REFERENCE

ANSI/ANS 8.7 SECTION

CSPRM SECTION

TOPIC

4.1.2-1	3.2.5	Storage operations shall be described in procedures
4.1.2-2	3.2.7	Personnel be familiar with procedures
4.1.2-3	3.4.3.4	Limits for storage shall be posted
4.1.3	3.2.4	Reviews shall be performed for procedure compliance
4.1.4	3.4.2.2	Access to storage areas shall be controlled
4.2.1	3.3.8.1	Limits for the storage of fissile material
4.2.2	3.7.6.1	Design and maintenance of storage facilities
4.2.3	3.7.6.1	Storage requirements concerning fire, flood, earthquake, etc.

Attachment E412.09#
(10/20/97 - Rev. #01)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 44
---	---	--

4.2.4	3.7.2.1	Design of storage facilities
4.2.5	3.7.6.1	Shelving shall be sturdy and noncombustible
4.2.6-1	3.7.6.2	Combustible materials in storage areas
4.2.6-2	3.7.6.3	Fire protection for storage areas where combustibles may accumulate

Attachment E412.09#
(10/20/97 - Rev. #01)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 45
---	---	--

<u>ANSI/ANS 8.7 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
4.2.7	3.7.6.4	Accumulation of water in fissile material containers
4.2.8	3.7.6.5	Accumulation of runoff water from sprinkler systems
4.2.9	3.8	A criticality alarm shall be provided per ANSI/ANS-8.3
4.2.10	3.7.6.6	Good housekeeping practices
Sections 5 & 6	3.7.6.7	Mass limits

ANSI/ANS 8.9 CROSS REFERENCE

<u>ANSI/ANS 8.9 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
4 through 6	3.7.2.11	Criteria for steel-pipe intersections containing aqueous solutions of fissile material

ANSI/ANS 8.12 CROSS REFERENCE

<u>ANSI/ANS 8.12 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
5 and 6	3.7.2.12	Control and safety of plutonium-uranium fuel mixtures outside reactors

ANSI/ANS 8.15 CROSS REFERENCE

<u>ANSI/ANS 8.15 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
5 and 6	3.7.2.9	Single and multiparameter limits for special actinide elements

ANSI/ANS 8.17 CROSS REFERENCE

<u>ANSI/ANS 8.3 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
4.2	3.3.8	Methods used to calculate subcriticality shall be validated in accordance with ANSI/ANS 8.1
4.4	3.4.1.1	Criticality safety evaluation shall be performed for all normal and credible abnormal conditions
4.5	3.4.1.3	Criticality safety evaluation shall identify parameters and limits
4.6	3.3.3	The criticality safety evaluation shall be documented with sufficient detail and clarity
4.7	3.4.1.2	Independent assessment shall confirm adequacy of evaluation
4.8	3.7.5.3.3	Verification of as-built conditions

<u>ANSI/ANS 8.3 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
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Attachment E412.09#
(10/20/97 - Rev. #01)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 46
---	---	--

4.9-1	3.7.5.8.1	Control of neutron-absorbing materials
4.9-2	3.7.5.9.1	Control of neutron-absorbing materials
4.10-1	3.7.6.8	Composition and characteristics shall result in maximum neutron multiplication factor
4.10-2	3.7.6.8	Consideration shall be given to the axial distribution of burnup in the fuel unit
4.11	3.4.2.1	Handling of fuel to prevent criticality accident
5.1	3.3.8.5	Criteria to establish subcriticality

ANSI/ANS 8.19 CROSS REFERENCE

<u>ANSI/ANS 8.19 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
4.1-1	3.1.7	Overall responsibility for safety of operations
4.1-2	3.1.2	Continuing interest in safety
4.2	3.3.1	Formulate criticality safety policy
4.3-1	3.1.7	Assign responsibility and delegate commensurate authority
4.3-2	3.1.4	Responsibility for criticality safety compatible with other safety disciplines
4.4-1	3.1.5	Provide skilled personnel independent of process supervision
4.4-2	3.1.5	Provide skilled personnel independent of process supervision
4.5	3.1.9	Establish monitoring of the criticality safety program
4.6	3.1.10	Management shall periodically participate in auditing
5.1	3.2.1	Supervisory responsibility for the safety of operations
5.2-1	3.2.6	Supervisory knowledge of criticality safety
5.2-2	3.3.6	Training and assistance from Criticality Safety Staff
5.3-1	3.2.7	Training, responsibility and understanding for criticality safety procedures and considerations

Attachment E412.09#
(10/20/97 - Rev. #01)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 47
---	---	--

<u>ANSI/ANS 8.19 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
5.3-2	3.9.1.8	Personnel training and certification records
5.4-1	3.2.6	Supervisory participation in development of written procedures
5.4-2	3.2.5	Procedures reflecting changes in operations
5.5	3.2.8	Verification of compliance for new or modified equipment before its use
5.6	3.2.7	Conformance with good safety practices
6.1	3.3.2	Criticality Safety Staff technical guidance
6.2-1	3.3.4	Criticality personnel be familiar with criticality safety standards, guides and codes
6.2-2	3.3.4	Criticality personnel be familiar with criticality safety standards, guides and codes
6.3	3.3.4	Criticality personnel be familiar with criticality safety standards, guides and codes
6.4	3.3.5	Criticality personnel be familiar with all operations
6.5	3.3.6	Criticality personnel assist in training personnel
6.6	3.5.2	Criticality personnel participate in audits involving criticality safety
6.7	3.3.7	Reporting of procedural violations and deficiencies
7.1-1	3.4.3.5	Procedures and postings
7.1-2	3.4.3.5	Procedures and postings
7.2-1	3.4.3.1	Procedural controls and limits significant to criticality safety
7.2-2	3.4.3.2	Procedures shall be such that no single, inadvertent departure can cause a criticality accident
7.3	3.4.3.3	Review and revision of procedures
7.4	3.4.3.3	Review and revision of procedures
7.5	3.4.1.6	Review of new or revised procedures
7.6	3.4.3.4	Procedures supplemented with posted criticality safety limits
7.7-1	3.4.3.6	Reporting and investigation of violations and conditions outside the authorization basis
7.7-2	3.4.3.7	Action to prevent a recurrence
<u>ANSI/ANS 8.19 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
7.8-1	3.2.4	Review of operations

Attachment E412.09#
(10/20/97 - Rev. #01)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 48
---	---	--

7.8-2	3.5.1	Review to ascertain procedures are being followed and process conditions have not been altered
7.8-3	3.5.1	Review shall be conducted in consultation by individuals who are knowledgeable in criticality safety but not immediately responsible for operations
8.1	3.4.1.1	Determine the entire process will be subcritical
8.2-1	3.4.1.3	Determine and identify the controlled parameters and limits
8.2-2	3.4.1.4	Safety analysis shall be sufficient to determine the effect of changes in the controlled parameters
8.3	3.3.3	Documentation of criticality safety calculations
8.4	3.4.1.2	Independent assessment prior to beginning operations
9.1	3.4.2.1	Control movement of fissile materials
9.2	3.4.2.3	Material labeling for handling and storage of fissile material
9.3	3.7.5.8.1	Maintain continued presence of neutron absorbers
9.4	3.4.2.2	Controlled access to areas
9.5	3.4.3.1	Control of spacing, mass, density and geometry of fissile material
10.2-1	3.6.1	Emergency procedures
10.2-2	3.6.11	Organizations responding to emergencies
10.2-3	3.6.12	Assistance to organizations in responding to emergencies
10.3-1	3.6.3	Evacuation routes
10.3-2	3.6.4	Posted evacuation routes
10.3-3	3.6.4	Evacuation routes and areas of higher risk
10.4-1	3.6.6	Personnel assembly stations
10.4-2	3.6.5	Personnel accountability
10.5-1	3.6.7	Personnel training
10.5-2	3.6.8	Evacuation procedures for visitors
10.5-3	3.6.9	Evacuation drills
<u>ANSI/ANS 8.19 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
10.5-4	3.6.10	Advance announcement of evacuation drills
10.6-1	3.6.13	Care and treatment of injured and exposed personnel
10.6-2	3.6.13	Personnel contamination

Attachment E412.09#
(10/20/97 - Rev. #01)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 49
---	---	--

10.7	3.6.14	Personnel dosimetry and identification of exposed individuals
10.8-1	3.6.15	Radiation doses at the assembly and evacuated area(s)
10.8-2	3.6.16	Information point
10.9	3.6.17	Re-entry procedures and response teams

ANSI/ANS 8.20 CROSS REFERENCE

<u>ANSI/ANS 8.20 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
5.1	3.9.1.1	Establish a criticality safety training program
5.2	3.2.7	Supervisors shall ensure that their staffs are suitably trained
5.3	3.9.1.2	Criticality Safety Staff shall participate in the development of the training program
6.1-1	3.9.1.3	Determine and document training requirements
6.1-2	3.9.1.1	Training program content
6.2-1	3.9.1.3	Determine and document refresher training requirements
6.2-2	3.9.1.4	Refresher training shall be provided at least every two years
7.1.3	3.9.1.11	Health effects of criticality accidents shall be discussed
7.4.1	3.9.1.9	Alarm recognition training shall be provided in accordance with ANSI/ANS-8.3
7.4.2	3.9.1.10	Emphasize the need for prompt evacuation
7.5.1	3.9.2.5	Explain and illustrate the effects and application of relevant factors
7.5.2	3.9.2.7	Operational limits shall be discussed
7.5.3	3.9.2.6	Use examples appropriate to the facilities

Attachment E412.09#
(10/20/97 - Rev. #01)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 50
---	---	--

<u>ANSI/ANS 8.20 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
7.5.4	3.9.2.7	The concept of contingencies for checking the validity of criticality safety limits shall be discussed
7.6.1	3.9.2.6	Facility Management's criticality safety policy shall be described
7.6.2	3.9.2.8	Facility policy for documentation, execution of procedures shall be explained
7.6.3	3.9.2.7	Relevant procedures shall be discussed
7.6.4	3.9.2.9	Policy relative to situations not covered by procedures shall be described
7.6.5	3.9.1.13	Employees shall be informed of their right to question safety of any operation
8.1-1	3.9.1.5	Criticality safety training program shall be evaluated periodically
8.1-2	3.9.1.5	The evaluation shall provide confidence in the adequacy of the total training program
8.1-3	3.9.1.5	The evaluation process and the evaluations shall be documented
8.2-1	3.9.1.3	Satisfactory completion of training
8.2-2	3.9.1.6	Identified weaknesses shall be addressed by additional training
8.2-3	3.9.1.7	Acceptance of the adequacy of the individual's total training record
8.3	3.9.1.8	Documentation and retention of employee training records

ANSI/ANS 8.21 CROSS REFERENCE

<u>ANSI/ANS 8.21 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
4.-1	3.7.5.8.1	Verification of absorbers required before the materials are used
4.-2	3.7.5.8.1	Verification to ensure neutron absorber system is in place
4.-3	3.7.5.8.3	Extent and frequency of verification
5.-1	3.7.5.8.4	Design, safety evaluations, verification and inspection consideration
5.1.1	3.7.5.8.5	Designed to maintain required geometrical relationship
5.1.1.1-1	3.7.5.8.1	Verification for neutron absorber system

Attachment E

412.09#
(10/20/97 - Rev. #01)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 51
---	---	--

<u>ANSI/ANS 8.21 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
5.1.1.1-2	3.7.5.8.1	Requirements for in-service verification
5.1.1.2-1	3.7.5.8.4	Assessment of operating environment
5.1.1.2-2	3.7.5.8.4	Degradation of the system or materials used due to chemical, physical, radiological, mechanical shall be protected against
5.1.1.2.1	3.7.5.8.5	Neutron absorber shall maintain its capability
5.1.1.2.2	3.7.5.8.6	Radiation effects shall be evaluated
5.1.1.3	3.7.5.8.7	Process material variations, manufacturing tolerances, uncertainties in the system
5.1.2	3.7.5.8.8	Criticality safety function shall not be compromised
5.1.3	3.7.5.8.4	System shall be designed to prevent inadvertent removal, displacement or alteration
5.1.4	3.7.5.8.9	Neutron absorber system shall incorporate human factors, engineering practices and maintenance
5.1.5	3.7.5.8.10	Requirements of operations, accountability, safety disciplines shall be considered
5.2.1.1	3.7.5.8.4	Neutron absorber degradation shall be assessed
5.2.1.2	3.7.5.8.4	Credible adverse environmental and operating conditions shall be evaluated
5.2.1.3	3.7.5.8.11	Neutron absorber system subjected to physical or chemical conditions outside the design envelope shall require reassessment prior to restart
5.2.2-1	3.3.8.1	Safety analysis shall be based on validation calculational methods
5.2.2-2	3.3.8	Calculational methods shall be validated in accordance with ANSI/ANS 8.1
5.2.2.1	3.7.5.8.12	The criticality calculational methods used shall be appropriately explicit
5.2.2.2	3.7.5.8.13	Effect on criticality of in-homogeneity shall be assessed
5.2.3	3.7.5.8.14	Evaluations shall consider tolerances, material substitutions, geometry changes, corrosion allowance, modeling assumptions, process variables

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 52
---	---	--

5.3.1-1	3.7.5.8.15	Inspection and verification plan shall conform to quality assurance requirements
5.3.1-2	3.7.5.8.16	Inspections and verification plans shall not compromise criticality safety
<u>ANSI/ANS 8.21 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
5.3.1.-3	3.7.5.8.17	Inspection and verification shall be documented and records maintained
5.3.1.1-1	3.7.5.8.2	Frequency of inspection and verification shall be determined
5.3.1.1-2	3.7.5.8.2	Safety analyses, environment and material properties shall be considered
5.3.1.3	3.7.5.8.18	Testing methods shall be calibrated to material standards
5.3.2	3.7.5.8.19	Inspection and verification shall be implemented for material acquisition, component manufacturing, installation, operation and maintenance
5.3.2.1	3.7.5.8.1	Neutron absorber material verification shall be obtained before use
5.3.2.2	3.7.5.8.20	Neutron absorber components shall be verified to conform with design drawings and specifications before installation
5.3.2.3	3.7.5.8.1	Proper installation shall be verified prior to use
5.3.2.4	3.7.5.8.1	Operation of the neutron absorber system shall be periodically verified to conform to the safety analysis report requirements
5.3.3	3.7.5.8.21	Results of verifications shall be evaluated and appropriate corrective action taken

DOE ORDER 420.1 CROSS REFERENCE

<u>DOE 420.1 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
4.3	3.1.2	The contractor is required to establish a nuclear criticality safety program that applies to fissile materials
4.3.1-1	3.4.1.1	Operations with fissile materials which pose a criticality accident hazard shall be evaluated and documented to demonstrate that the operation will be subcritical under both normal and credible abnormal conditions
4.3.1-2	3.4.1.5	Fissile material operations shall be conducted in such a manner that consequences to personnel and property that result from a criticality accident will be mitigated
4.3.1-3	3.7.1.4	No single credible event or failure shall result in a criticality accident having unmitigated consequences

Attachment E

412.09#
(10/20/97 - Rev. #01)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 53
---	---	--

4.3.1-4	3.1.8	The criticality safety program shall be documented
4.3.1-4	3.1.9	The criticality safety program shall be evaluated
<u>DOE 420.1 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
4.3.1.(i)	3.1.6	The criticality safety program shall include criticality safety evaluations for normal and credible abnormal conditions that document the parameters, limits and controls required to ensure that the analyzed conditions are subcritical
4.3.1.(ii)	3.4.3.1	The criticality safety program shall include implementation of limits and controls identified by the criticality safety evaluations
4.3.1.(iii)	3.5.1	The criticality safety program shall include reviews of operations to ascertain that limits and controls are being followed and that process conditions have not been altered such that the applicability of the criticality safety evaluation has been compromised
4.3.1.(iv)	3.8.1.1	The criticality safety program shall include assessment of the need for criticality accident detection devices and alarm systems and installation of such equipment where total risk to personnel will be reduced
4.3.2-1	3.1.2	Fissile materials shall be produced, processed, stored, transferred, disposed or otherwise handled in such a manner that the probability of a criticality accident is acceptably low
4.3.2-2	3.1.3	and to the extent practical, persons, government, public and private property, and the environment are protected
4.3.2.a.	3.1.1	Contractor Criticality Safety Programs (CCSPs) shall apply to operations involving fissile materials that pose a criticality accident hazard
4.3.2.b.	5.	The basic elements and control parameters of programs for nuclear criticality safety shall satisfy the requirements of the following American Nuclear Society's ANSI/ANS standards: 8.1, 8.3, 8.5, 8.6, 8.7, 8.9, 8.12, 8.15, 8.17, 8.19, 8.21
4.3.2.c.	2.	Contractors shall regard all recommendations in the standards. When recommendations are not implemented, justification shall be documented in the Implementation Plan
4.3.2.d.(1)-1	3.7.1.1	Process designs shall incorporate sufficient factors of safety to require at least two unlikely, independent and concurrent changes in process conditions before a criticality accident is possible
4.3.2.d.(1)-2	3.7.1.2	Protection shall be provided by either the control of two independent process parameters (the preferred approach) or a system of multiple controls on a single process parameter

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 54
---	---	--

<u>DOE 420.1 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
4.3.2.d(1)-3	3.7.1.3	The number of controls required upon a single controlled process parameter shall be based upon control reliability and any features that mitigate the consequences of control failure
4.3.2.d(1)-4	3.7.1.4	In all cases, no single credible event or failure shall result in the potential for a criticality accident
4.3.2.d(1)-5	3.7.1.5	Double contingency shall be demonstrated by documented evaluations
4.3.2.d(2)-1	3.7.2.1	Where a significant quantity of fissile material is being processed, passive engineered controls such as geometry shall be the preferred control method
4.3.2.d(2)-2	3.7.2.2	Where passive engineered control is not feasible, the preferred order of control is active engineered controls, followed by administrative controls
4.3.2.d(2)-3	3.7.2.3	The double contingency analysis shall justify the chosen controls
4.3.2.d(2)-4	3.7.5.3.3	All dimensions, nuclear properties and other features upon which reliance is placed shall be documented and verified prior to beginning operations, and control shall be exercised to maintain them
4.3.2.e.	3.8.1.2	Criticality Alarm System (CAS) and Criticality Detection Systems (CDS) requirements replacing the requirements in ANSI/ANS 8.3 relating to the needs for an alarm system
4.3.2.e.(1)	3.8.1.2.1	Criticality Alarm System (CAS) and Criticality Detection Systems (CDS) requirements replacing the requirements in ANSI/ANS 8.3 relating to the needs for an alarm system
4.3.2.e.(2)	3.8.1.2.2	Criticality Alarm System (CAS) and Criticality Detection Systems (CDS) requirements replacing the requirements in ANSI/ANS 8.3 relating to the needs for an alarm system
4.3.2.e.(3)	3.8.1.2.3	Criticality Alarm System (CAS) and Criticality Detection Systems (CDS) requirements replacing the requirements in ANSI/ANS 8.3 relating to the needs for an alarm system
4.3.2.e.(4)	3.8.1.2.4	Criticality Alarm System (CAS) and Criticality Detection Systems (CDS) requirements replacing the requirements in ANSI/ANS 8.3 relating to the needs for an alarm system

Attachment E412.09#
(10/20/97 - Rev. #01)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 55
---	---	--

<u>DOE 420.1 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
4.3.2.e.(5)	3.8.1.2.5	Criticality Alarm System (CAS) and Criticality Detection Systems (CDS) requirements replacing the requirements in ANSI/ANS 8.3 relating to the needs for an alarm system
4.3.2.i	3.7.2.8	The program shall detect inadvertent accumulation of significant quantities of fissile material
4.3.2.j.(1)	3.7.6.11	Transportation Requirements for fissile material shall apply to all activities where fissile material is transferred from one operation to another within a facility and from one on-site location to another
4.3.2.j.(2)	3.7.6.12	The requirements of DOE 0.460.1 (Packaging and Transportation Safety) shall be complied with regarding off-site shipment of fissile material
4.3.2.k-1	3.11.2	Firefighting guidelines shall be based on comparisons of risks and consequences of a criticality accident with the risks and consequences of postulated fires for the respective area(s)
4.3.2.k-2	3.11.3	The basis for the guidelines shall be documented

DOE-ID NOTICE ID N 420.B CROSS REFERENCE

<u>ID N 420.B SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
3.	3.7.2.4	Preference of low number of design features/administrative controls
3.a.(1)	3.7.3.1	Plant Protective Systems (PPS) requirements
3.a.(1)	3.7.3.2	PPS components shall meet IEEE STD
3.a.(1)	3.7.3.3	PPS criteria
3.a.(2)	3.7.3.4	Distributed control systems (DCS) requirements
3.b.(1)	3.7.1.6	Single failure conditions shall not exceed a k_{eff} of 0.95
3.b.(2)	3.7.4.1	Independent review of criticality analyses
3.b.(2)	3.7.4.2	Independent review requirements
3.b.(2)	3.7.4.3	Independent review requirements
3.c.(1)(a)	3.7.1.6	Non-conservative bias of the calculational method
3.c.(1)(a)	3.7.5.1	Parameter control requirements

Attachment E412.09#
(10/20/97 - Rev. #01)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 56
---	---	--

<u>ID N 420.B SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
3.c.(1)(a)	3.7.5.2	Specific limits shall also be shown to result in a system k_{eff} of no greater than 0.95
3.c.(1)(a)	3.7.5.4.1	Mass shall be limited to not more than 75% of the critical mass
3.c.(1)(a)	3.7.5.4.2.	If over-batching is credible, 45% of the critical mass shall be used
3.c.(1)(a)	3.7.5.5.1	Volumetric safety limits shall not exceed 75% of the minimum volume required for credible criticality
3.c.(1)(a)	3.7.5.6.1	Concentration limits shall not exceed 75% of the credible minimum critical value
3.c.(a)(a)	3.7.5.6.2	The potential for concentrating fissile material shall be considered in the determination of limits
3.c.(1)(a)	3.7.5.6.3	Chemical stability, precipitation and mass transport between phases shall be considered
3.c.(1)(a)	3.7.5.7.2	Moderation by materials other than water shall be evaluated
3.c.(1)(b)	3.7.5.8.1	Verification of fixed poisons
3.c.(1)(b)	3.7.5.8.2	Time interval for verification shall be justified in facility safety analysis
3.c.(1)(b)	3.7.5.8.3	The justification of the verification period shall discuss corrosion and credible accidents
3.c.(1)(b)	3.7.5.8.4	Design shall utilize features minimizing vulnerability of the poison
3.c.(1)(c)	3.7.5.9.1	Criteria for use of soluble poisons

DOE ORDER 5480.19 CROSS REFERENCE

<u>5480.19 SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
Chapter XVII	3.4.3.4	Operator Aid Postings

Attachment E412.09#
(10/20/97 - Rev. #01)

Program Requirements Document Companywide	CRITICALITY SAFETY PROGRAM REQUIREMENTS MANUAL	Identifier: PRD-112 Revision: 1 Page: 57
---	---	--

DOE ORDER 5480.20A CROSS REFERENCE

<u>5480.20A SECTION</u>	<u>CSPRM SECTION</u>	<u>TOPIC</u>
IV.4.b.	3.9.2.1	Fissile Material Handler training
IV.4.b.(1)	3.9.2.2	Fissile Material Handler training
IV.4.b.(2)	3.9.2.3	Fissile Material Handler training
IV.4.b.(3)	3.9.2.4	Fissile Material Handler training