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DOE STANDARD

DISPOSAL AUTHORIZATION STATEMENT AND TANK CLOSURE DOCUMENTATION

U.S. DEPARTMENT OF ENERGY
WASHINGTON, D.C. 20585

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ACRONYMS AND ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
ASR	Annual Summary Report
CA	Composite Analyses
CD	Critical Decision
CER	Compliance Evaluation Report
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CP	Closure Plan
CRD	Contractor Requirements Document
D&D	Decontamination and Decommissioning
DAS	Disposal Authorization Statement
DASWMM	Deputy Assistant Secretary for Waste and Material Management Director
DCFPAK	Dose Coefficient File Package
DNFSB	Defense Nuclear Facilities Safety Board
DRISE	Director Regulatory Intergovernmental and Stakeholder Engagement
DSA	Documented Safety Analysis
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EIS	Environmental Impact Statement
ELLWF	E Area Low-Level Waste Facility
EM	DOE Office of Environmental Management
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
FE	Field Elements
FEM	Field Element Manager
FEP	Features, Events and Processes
FFA	Federal Facilities Agreement
FFC	Federal Facility Compliance
FMB	Four Mile Branch
FUSRAP	Formerly Utilized Sites Remedial Action Program
G	DOE Guide

HLW	High-Level Waste
HQ	Headquarters
IAEA	International Atomic Energy Agency
ICRP	International Commission for Radiological Protection
LFRG	Low-Level Waste Disposal Facility Federal Review Group
LLW	Low-Level Waste
LTR	Lower Three Run
LLWDF	Low-Level Waste Disposal Facility
M	DOE Manual
MCEP	Motor Carrier Evaluation Program
MCL	Maximum Contaminant Level
MDA	Material Disposal Area
MEI	Maximally Exposed Individual
MLLW	Mixed Low-Level Waste
MonP	Monitoring Plan
MP	Maintenance Plan
NCRP	National Council on Radiation Protection and Measurements
NDAA	National Defense Authorization Act
NE	DOE Office of Nuclear Energy
NEA	Nuclear Energy Agency
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NNSA	National Nuclear Security Administration
NORM	Naturally Occurring Radioactive Material
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NUREG	NRC Regulatory Guides
O	DOE Order
ODAS	Operating DAS
P	DOE Policy
PA	Performance Assessment
PARC	PA/CA Review Committee
PDAS	Preliminary Disposal Authorization Statement

PEIS	Programmatic Environmental Impact Statement
POA	Point of Assessment
PSO	Program Secretarial Officers
QA	Quality Assurance
QAP	Quality Assurance Program
R&D	Research and Development
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
RWMB	Radioactive Waste Management Basis
SA	Special Analysis
SAR	Safety Analysis Report
SC	Steel Creek
SDF	Saltstone Facility
STD	DOE Standard
TED	Total Effective Dose
TENORM	Technologically Enhanced Naturally Occurring Radioactive Material
TRU	Transuranic Waste
UCAQE	Unreviewed Composite Analysis Question Evaluation
UCAQS	Unreviewed Composite Analysis Question Screening
UDQE	Unreviewed Disposal Question Evaluation
UDQS	Unreviewed Disposal Question Screening
WAC	Waste Acceptance Criteria
WIPP	Waste Isolation Pilot Plant

FOREWORD

The Disposal Authorization Statement and Tank Closure Documentation Technical Standard is being issued to provide consolidated guidance for implementation of DOE Order (O) 435.1, *Radioactive Waste Management*. The document is based upon the original Low-Level Waste Federal Review Group guides that were issued shortly after issuance of DOE O 435.1 in 1999. Other text amplifies the guidance and includes examples, figures, and tables. Definitions of the various terms used in the Standard can be found in DOE Manual 435.1-1, *Radioactive Waste Management Manual*. Numerous elements of this Standard have already been implemented at multiple sites, including the sites located at Portsmouth, OH; Idaho Falls, ID; and Richland, WA, and utilized by the Low-Level Waste Federal Review Group to perform reviews of technical basis documentation.

This U.S. Department of Energy Technical Standard is approved for use or reference by all Department of Energy Components and their contractors.

Comments (e.g., recommendations, additions, and deletions) and any pertinent data and lessons learned that may improve this document should be sent to:

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GUIDING PRINCIPLES

The following guiding principles pertain to the application and provisions of this Technical Standard:

The U.S. Department of Energy (DOE) meets its responsibilities regarding disposal of radioactive waste under the Atomic Energy Act of 1954, as amended, by providing the requirements for protection of the public, workers, and the environment for its radioactive waste disposal facilities in DOE Order (O) 435.1, *Radioactive Waste Management*. Requirements for protection of the public and environment from radiation are provided in DOE O 458.1, *Radiation Protection of the Public and the Environment.* DOE O 458.1, Section 4.h "Radioactive Waste and Spent Nuclear Fuel," contains the requirements unique to management radioactive waste. DOE requirements for radiation protection of workers are provided in 10 Code of Federal Regulations (CFR) 835, *Occupational Radiation Protection*. DOE requirements for nuclear safety are provided in 10 CFR 830, *Nuclear Safety Management.*

1. DOE O 435.1 provides the specific requirements to the Federal and contractor entities throughout the DOE Complex that must be followed to ensure DOE is meeting its regulatory radioactive waste management responsibilities. This Standard provides the associated guidance to the Federal and contractor entities throughout the DOE Complex that should be followed to ensure DOE is meeting its regulatory radioactive waste management responsibilities.
2. DOE will ensure the disposal of radioactive waste is protective of the public, workers, and the environment through a documented process of technical and management reviews and approvals prior to any waste disposal.
3. DOE will continually evaluate the performance of the disposal facilities and update the associated technical evaluations and administrative documentation to the latest DOE requirements considering other regulatory and commercial entities practices.

CHAPTER 1. INTRODUCTION & PURPOSE

1.1. Introduction

The U.S. Department of Energy (DOE) including the National Nuclear Security Administration (NNSA) design, construct, operate, and close low-level waste (LLW)[1] disposal facilities and conduct tank closures under the authority of the Atomic Energy Act of 1954, as amended, and in compliance with DOE Order (O) 435.1, *Radioactive Waste Management*, and guidance from this Standard.

This Standard, when implemented by facility operators, will help assure that the technical basis for radioactive waste management disposal authorization is complete and sufficient. DOE has developed a systematic methodology using technical justification through site characterization, facility design, laboratory and field studies, mathematical modeling, technical analyses, and commitments to continuous improvement to demonstrate that the facility should be authorized to dispose of LLW. This process will result in DOE disposal facilities and tank closures that are protective of the public and the environment.

This Standard provides a consistent approach for Federal and contractor personnel responsible for developing and/or reviewing documents that support the issuance of a Disposal Authorization Statement (DAS) and Tier 1 Closure Plans.

The DAS provides Federal government authorization, not unlike a Nuclear Regulatory Commission (NRC) license or an U.S. Environmental Protection Agency (EPA) or State Regulatory permit, to authorize radioactive waste disposal. The DAS is issued by the appropriate DOE Headquarters (HQ) Program Secretarial Officers (PSO) including the NNSA Administrator responsible for the facility. This document details the overall DAS process, format and content of the DAS documents, and review criteria used in the development/evaluation of these documents.

1.2. Applicability

This Standard is applicable to the development, review and approval of documents that support the issuance of and revision to a DAS for the disposal of: LLW, mixed low-level waste (MLLW), transuranic waste (TRU)[2] disposed onsite at DOE facilities other than the Waste Isolation Pilot Plant (WIPP), and Comprehensive Environmental Response, Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA)[3] waste at DOE

[1] When this Standard refers to LLW or TRU, it also includes the hazardous component of the waste.
[2] PAs prepared to address disposal of TRU waste should meet the requirements of 40 CFR Part 191, *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes*.
[3] Includes radioactive portion only.

disposal facilities. This Standard is applicable to government-owned, government-operated facilities in which DOE performs the function of the facility operator, as well as government-owned, contractor-operated facilities.

This Standard applies to DOE and NNSA on-site disposal facilities and tank closure, whether regulated by DOE alone or in tandem with other regulators such as EPA, or state/local regulators. DOE regulates the radioactive waste portion of mixed LLW/TRU; the states and/or EPA have regulatory authority for waste under their purview.

The approval to dispose of LLW is given by the appropriate PSO or NNSA Administrator that is responsible for the development and operation of the facility through the issuance of a DAS. The DAS is contractually enforceable under DOE requirements and Orders authorizing construction/operation of a LLW disposal facility. The DAS includes the design, construction, operational and closure requirements, conditions, and limitations that the disposal facility should meet to ensure continued protection of the public, and the environment.

To obtain a DAS, technical basis documents should be developed as described in this Standard, and as required by DOE O 435.1. A graded approach to developing technical basis documents should be chosen commensurate with the risks posed by any given facility.

1.3. Purpose and Overview of the Standard

This Standard identifies the documents required by DOE O 435.1 for DAS issuance or tank closure; the approval and issue process; and the maintenance and reporting requirements for a radioactive waste disposal facility.

The Standard's chapters are designed to be stand-alone documents, as each chapter refers to a separate technical basis document. In that regard, the Standard is a collection of technical basis documents to be referred to individually, and as needed.

At a minimum, the technical basis documents necessary for a preliminary DAS (PDAS) include:

- Performance Assessment (PA) (Chapter 2);
- Composite Analysis[4] (CA) (Chapter 3); and
- Change Control Process (Chapter 8).

At a minimum, the technical basis documents necessary for an Operating DAS (ODAS) include:

- Performance Assessment (PA) (Chapter 2);

[4] A final CA is not required; however, information showing compliance with the 100 mrem/yr performance measure and the effects of interacting sources must be available.

- Composite Analysis (CA) (Chapter 3);
- Closure Plan (CP) (Chapter 4);
- PA/CA Monitoring Plan (MonP) (Chapter 5);
- Waste Acceptance Criteria (WAC) (Chapter 6);
- PA/CA Maintenance Plan (MP) (Chapter 7);
- Change Control Process (Chapter 8); and
- Disposal Facility Annual Summary Report[5] (ASR) (Chapter 9).

At a minimum, the technical basis documents necessary for a Tier I Tank Closure include:

- Performance Assessment (PA) (Chapter 2);
- Composite Analysis (CA) (Chapter 3);
- Closure Plan (CP) (Chapter 4);
- PA/CA Monitoring Plan (MonP) (Chapter 5);
- PA/CA Maintenance Plan (MP) (Chapter 7); and
- Change Control Process (Chapter 8).

This Standard and the *Low-Level Waste Disposal Facility Federal Review Group (LFRG) Execution Plan* (LFRG Execution Plan) supersede all the following documents:

- LFRG Manual;
- LFRG Program Management Plan;
- LFRG Charter;
- Format and Content Guide for DOE LLW Disposal Facility PA and CA;
- Format and Content Guide for DOE LLW Facility CPs; and
- Maintenance Guide for DOE LLW Disposal Facility PAs and CAs.

The technical basis documents are presented as annotated outlines in the chapters of this Standard. The review criteria utilized by the Office of Environmental Management's (EM's) LFRG to evaluate the completeness and technical adequacy of technical basis documents are also included in this standard. These criteria are used to evaluate disposal facility performance and compliance. Modifications, deletions or additional review criteria for a specific disposal facility

[5] An ASR will be prepared after the initial issuance of the DAS, at one year of operations, and every year thereafter.

review may be required based on site specific considerations. The criteria used for each review should be documented in the LFRG Review Plan and approved by the LFRG (see "Review Criteria" and "LFRG Review Process" for details of the review plan).

A PDAS should be approved by the responsible PSO prior to construction of a LLW disposal facility. Low-level waste disposal may also include mixed low-level waste (MLLW) regulated under Resource Conservation and Recovery Act (RCRA) and CERCLA disposal facilities. The technical basis documents should be prepared to inform the process of designing and constructing the disposal facility per DOE O 413.3B, *Program & Project Management for the Acquisition of Capital Assets*. The final approval of the documents that supports the resulting ODAS is not required until prior to the start of operation. The PDAS and ODAS are contractually enforceable under DOE regulations and orders [DOE O 435.1, Attachment 1, "Contractor Requirements Document" (CRD)] authorizing operation of a radioactive waste disposal facility. The PDAS and ODAS should be included in the Radioactive Waste Management Basis (RWMB).

Successful PDAS and ODAS maintenance depends on the periodic review of the technical basis documents as new information (e.g., site characteristics, design, waste inventories, waste form, packaging) becomes available. Ensuring timely document revisions based on this enhanced understanding of the disposal system and operations is critical to compliance with DOE requirements. The annual summary review is an integral part of the DAS process and focuses on the changes of the current year's performance and operations relative to the approved PA, CA and technical basis documents. It should describe the facility history and background information.

The PDAS and ODAS compliance reviews may be initiated at any time by the LFRG, or other HQ organizations with responsibilities for line management or independent oversight of existing disposal facilities. For new facilities, compliance reviews should be completed before construction and operations of the facility begin. If any activities call into question the adequacy of an existing DAS, the LFRG, in collaboration with the LFRG site representative, should determine whether a revision is necessary and what that revision will contain. The LFRG will revise the PDAS or ODAS and present the draft to the DOE Office of Environmental Management (EM) PSO. The EM PSO will then present the PDAS or ODAS to the appropriate PSO disposal facility owner. A revision to either the PDAS or ODAS should be approved by the same PSO level of authority as the original.

1.4. Integrated Protection Systems Approach for Safe Disposal of Radioactive Waste

The guidance identified in this Standard reflects DOE-specific implementation of key parts of an integrated protection systems approach for safe disposal of radioactive waste. This also implements DOE's version of the safety case for a disposal facility recommended by the International Atomic Energy Agency (IAEA) [e.g., *IAEA Safety Glossary – Terminology Used in*

Nuclear Safety and Radiation Protection (IAEA 2007); SSR-5, *Disposal of Radioactive Waste, Specific Safety Requirements* (IAEA 2012); and SSG-23, *The Safety Case and Safety Assessment for the Disposal of Radioactive Waste* (IAEA 2012)]. DOE does not invoke IAEA standards but uses the concepts identified in these standards to improve DOE's radioactive waste management practices.

The IAEA publishes non-binding safety standards, including standards that address expectations for safe disposal of radioactive waste (SSR-5), as well as more detailed guidance for the development of a safety case and safety assessment (e.g., PA) (SSG-23). The IAEA safety standards provide general principles, but do not take the place of more specific national requirements. Similarly, the International Commission for Radiological Protection (ICRP) has produced recommendations related to radiation protection for radioactive waste disposal, and the National Council on Radiation Protection and Measurements (NCRP) published recommendations related to the development of PAs for disposal facilities [*Radiation Protection Recommendations as Applied to the Disposal of Long-Lived Solid Radioactive Waste, International Commission for Radiological Protection* (Publication 81, ICRP 1998)] (*Performance Assessment of Near-Surface Facilities for Disposal of Low-Level Radioactive Waste* (NRCP Report No. 152).

This Standard represents the DOE-specific implementation of recommendations and standards for radioactive waste disposal and tank closure, especially related to expectations for a safety case for a disposal facility as described in the IAEA publications. Numerous references are made in the Standard to IAEA, ICRP, NCRP and other national and international standards and guidance as part of the basis for specific expectations.

The safety case is generally defined as "A collection of arguments and evidence in support of the safety of a facility or activity.

- This will normally include the findings of a safety assessment and a statement of confidence in these findings.
- For a repository, the safety case may relate to a given stage of development. In such cases, the safety case should acknowledge the existence of any unresolved issues and should provide guidance for work to resolve these issues in future development stages" (IAEA 2007).

The safety case concept provides a means to address, acknowledge, and document the factors that contribute to the safe disposal of radioactive waste. Figure 1-1 from the IAEA illustrates these components of the safety case at a high level (see IAEA 2012 for more details). Notably, the safety assessment, which includes operational safety analysis, PAs and other calculations, is only one part of the overall safety case for the disposal facility. The role of a PA as only one part of the overall case for safe disposal is a key consideration for the DOE integrated systems

approach to safety. This provides for defense-in-depth with multiple layers of safety features that leads to protection of human health and the environment.

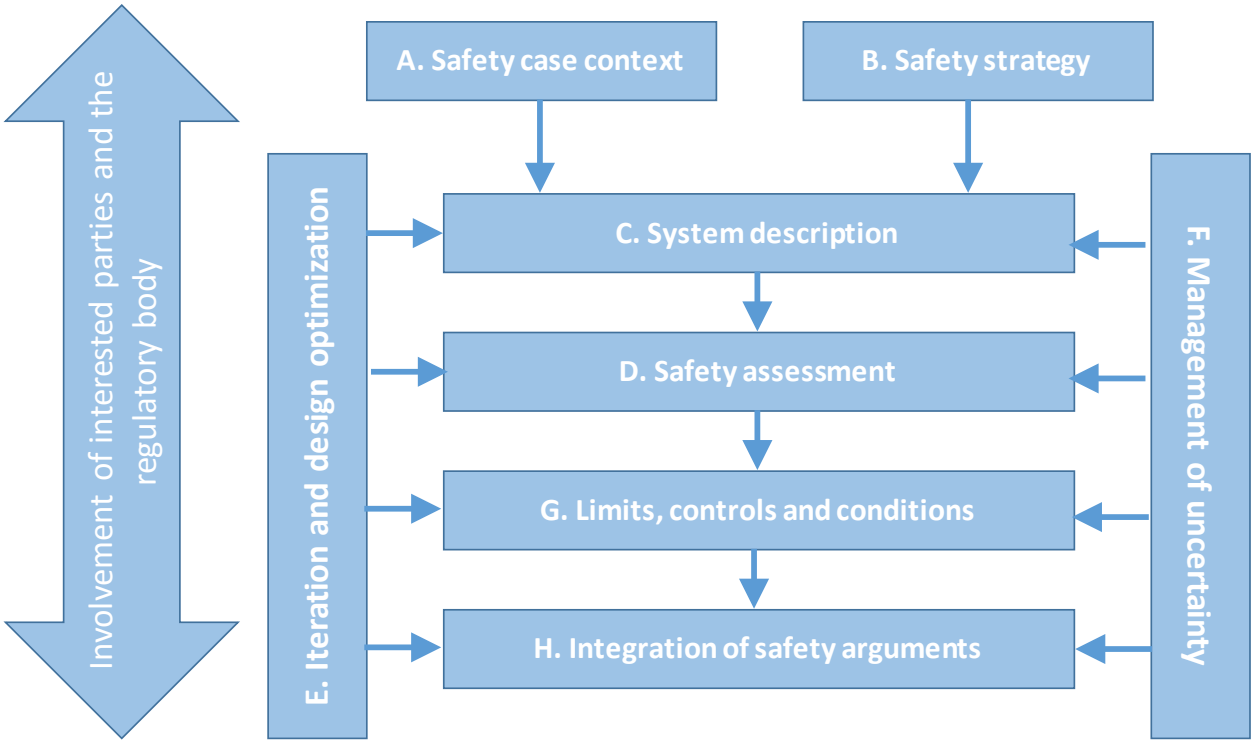


Figure 1-1. Components of the Safety Case, Including On-going Interactions with Interested Parties and Regulators (IAEA 2012)

The technical basis documents introduced at the beginning of this chapter reflect a number of the layers of safety features that are part of the DOE approach in addition to requirements related to siting, design, waste characterization, operations, institutional controls, etc., that are included in DOE O 435.1.

Figure 1-2 provides the contributors to the defense-in-depth approach that includes the following integrated safety features:

- Natural and engineered barriers as part of the design of the total disposal system;
- Rigorous assessments of facility performance (i.e. PA) and cumulative effects from other sources of radioactivity (i.e. CA) and use to refine the design and operations;
- RWMB, DASs, WAC, institutional controls;

- On-going monitoring and maintenance activities, including field and laboratory studies, change control and modeling refinements to manage uncertainties in the PA/CA; and
- Independent reviews of technical basis documents and annual operational reviews.

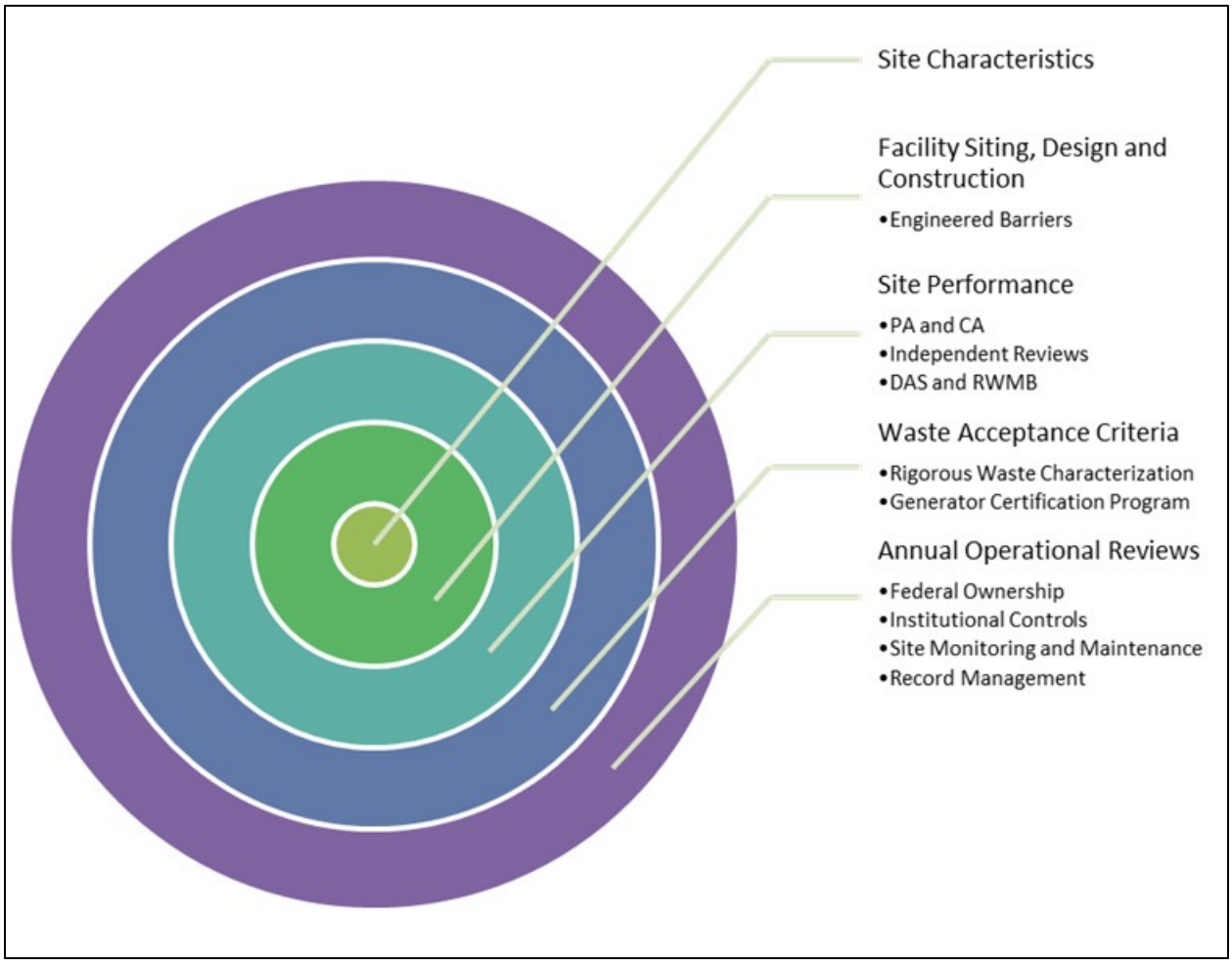


Figure 1-2. Contributors to Defense-in-Depth in DOE's Integrated Systems Approach for Safe Disposal of Radioactive Waste

1.5. Low-Level Waste Disposal Facility Federal Review Group

In order for a DAS or a Tier 1 Closure Plan to be issued, a review of the technical basis documents is required. EM, as the Office of primary responsibility for DOE O 435.1, leads the organization, LFRG, responsible for providing guidance and assistance, as well as regulatory oversight, to all DOE disposal facility operators. The LFRG provides regulatory oversight, identified in DOE Manual (M) 435.1-1, *Radioactive Waste Management Manual,* to confirm that

the disposal of low-level radioactive waste in DOE facilities and tank closures are conducted in a manner that is protective of public health and safety and the environment. A more detailed description of the LFRG membership, responsibilities, qualifications and process are contained in the LFRG Execution Plan.

The LFRG is comprised of Federal employees from DOE HQ and Field Elements with radioactive waste disposal facility responsibilities and include: EM, Associate Under Secretary for Environment, Health, Safety, and Security (AU), NNSA, Office of Science (SC), and Office of Nuclear Energy (NE). The LFRG organization is led by Co-Chairs from the Office of Regulatory Intergovernmental & Stakeholder Programs, and the Office of Waste & Materials Management, within the Office of Regulatory and Policy Affairs.

The LFRG process supports the DOE implementation of its regulatory responsibility under the Atomic Energy Act of 1954 as amended. The LFRG charters a technical review team comprised of Federal staff, site operating contractors, and consultant subject matter experts for DAS and tank closure technical basis document reviews. The results of the review are developed into a recommendation to the DOE PSO or NNSA Administrator. The recommendation may be to approve, approve with conditions, or disapprove technical basis documents.

1.6. Review Criteria

The LFRG review team conducts its review using the criteria established in this Standard. Each chapter of this Standard describes a specific basis document to be developed to technically justify the capabilities of a proposed or existing disposal facility or a tank closure. A description and annotated outlines are provided for the documents, as well as the review criteria.

The review criteria provided in each chapter of the Standard are used by the LFRG review team and the LFRG at-large to evaluate the completeness and adequacy of the technical basis documents. The LFRG may choose to modify the list of criteria to be used in a certain review, based on the specific features of the disposal facility.

The criteria used for each review should be documented in a review plan and used to evaluate the associated document. The results of the review will be documented in a review report, and approved by the LFRG. A description of how the LFRG conducts its review and the responsibilities of the LFRG, LFRG review team, and other technical staff are described in the LFRG Execution Plan.

1.7. Preliminary DAS and Operating DAS

Prior to developing a new disposal facility, the Field site should initiate plans to comply with the requirements of DOE O 435.1 and implement the guidance of this Standard.[6] Prior to

[6] A disposal facility may consist of several units (e.g., trenches). It is not necessary for each unit to have a DAS.

construction of the disposal facility, a DAS should be approved. The DAS should at a minimum include the following DOE approved documents: PA, change control process, and an evaluation that shows the facility will meet the CA performance measure. The DAS provides a means where the site may proceed with construction of the facility at risk based upon a preliminary design and PA. Once the final design of the facility is completed, the PA will be reviewed by the site and LFRG to confirm that any changes to the parameters and assumptions have not significantly altered the conclusion regarding compliance with performance objectives/measures. If there is a significant change, the PA will be revised and reviewed again by the LFRG. There is no specific point in the project management process for initiating the approval for a DAS prior to Critical Decision (CD)-3, "Approve Start of Construction," detailed in DOE O 413.3B. However, it is recommended that the DAS be approved once CD-3 is approved. DOE O 435.1 does not require a DAS be approved before construction begins.

Prior to operating the disposal facility, an Operational DAS should be approved. Operational DAS should include the following DOE approved documents: PA, CA, MP, MonP, CP, WAC, change control process and ASR. The ASR is required after the first year of operations and every year thereafter. Based on the significance of the changes between PDAS documentation and the ODAS documentation, the LFRG should identify the scope of the review that is required to develop the ODAS. The Field site is expected to provide complete accounting of changes between the PDAS and the requested ODAS documentation, and finalize all required technical basis documents.

During disposal facility operations, significant changes may occur from PA or CA assumptions, WAC, disposal practices, or new information may be discovered. While such changes are expected based on the newest information and captured through the "Change Control Process" (Chapter 8). A preponderance of changes is an indication that the DAS requires updating. The LFRG site member contacts the LFRG to inform them that a revision to the technical basis documents is being initiated. The site completes the appropriate update of the technical basis documents and notifies the LFRG that the revision is complete.

The DAS and associated technical basis documents should be revised periodically but, at a minimum, every ten years from the initial issuance of the DAS. A five to 10-year schedule for DAS revisions will be developed by the LFRG. Proposed revision of these documents will be at the discretion of the site contractor, LFRG member, and/or LFRG at-large. The responsible PSO will determine if the DAS should be revised.

When the disposal facility is planning to cease operations, the DOE site is required to complete a final CP. Details of the closure process are included in "Closure Plan" (Chapter 4). The need to update the PA, CA and MonP should also be assessed at the end of operations. The PA/CA should demonstrate that the facility will be under active institutional control for the first 100 years following the end of operations (unless a longer period of control is demonstrated, justified

and approved by the LFRG) and complies with the performance objectives/measures within the 1,000-year timeframe required by DOE O 435.1. The Federal government expects to maintain continuous control of the disposal facility. Although continuous government control is required while a significant hazard is present, analyses should be completed to consider the potential consequences associated with hypothetical inadvertent intrusion into the facility during a temporary loss of institutional control.

1.8. Tank Closure

Tier 1 and Tier 2 Closure Plans are required for tank closures per DOE O 435.1 and the Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005, Public Law 108-375, October 28, 2004 [see NDAA Section 3116)[7]. This process is similar to the DAS process for disposal of radioactive waste. The recommended technical basis documents are found in "Purpose and Overview of the Standard."

DOE M 435.1-1, 4.b.(4) describes the requirements for the closure of deactivated high-level waste (HLW) facilities and sites. Deactivated HLW facilities should be closed in accordance with applicable state and Federal requirements and in accordance with the requirements of Section 4.a.(11), "Facility Closure." Appropriate documentation should be developed for closure of deactivated facilities to describe the approach and plans by which closure is to be accomplished. Documentation should be completed and approved prior to the initiation of physical closure activities, and should include: a summary closure plan (Tier I) describing the planned approach for closing the deactivated HLW facilities; a PA; a CA; and a specific closure plan (Tier II) containing updated details on the closure activity, which supports final authorization to proceed with closure. The development of the PAs for the deactivation and closure of these facilities should be consistent with Chapter 2 of this Standard, and the review and approval of these PAs are the responsibility of the LFRG.

1.9. Comprehensive Environmental Response, Compensation, and Liability ACT/Resource Conservation and Recovery Act Integration

It is recommended that a PDAS and ODAS be issued for a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) facility that disposes of DOE radioactive waste at a DOE facility in addition to the Record of Decision (ROD) to clearly demonstrate DOE's regulatory authority under DOE O 435.1. A ROD for a CERCLA disposal facility may be designated to serve as the DAS per DOE O 435.1. For any DOE LLW disposal facility that is also regulated by the EPA or a State regulator, DOE allows the Field site to submit documentation completed for the other regulator along with a crosswalk. Other CERCLA/RCRA documents can be used to demonstrate compliance with DOE O 435.1. However, separate documentation may be necessary for those requirements specific to DOE. In

[7] Section 3116, *Waste Determinations with Related Disposal Performance Assessments*, Ronald Reagan National Defense Authorization Act (NDAA) for Fiscal Year 2005

this manner, DOE maintains its regulatory authority while minimizing duplication. DOE and other regulators should work in parallel for facilities having overlapping regulations to ensure all regulatory issues are identified and resolved in an expeditious manner.

1.10. In-Situ Closure

Facilities closed in-situ (utilizing existing structures/facilities) may need to meet the requirements of DOE O 435.1. If an in-situ facility closure contains CERCLA waste from outside the established CERCLA area of contamination, a crosswalk should be developed showing how CERCLA analyses and documentation and any needed supplementary information, demonstrate reasonable expectation of compliance with the performance objectives/measures requirements in the Order. A DAS is not required in this instance.

In-situ closure of radioactive facilities involving the placement of non-CERCLA waste (e.g., waste from site operations) into the facility should meet the requirements of DOE O 435.1 associated with the design, construction, operation, and closure of a LLW disposal facility, including the requirement for a DAS. CERCLA and non-CERCLA waste should not be co-mingled unless it is cost-effective and in the best interest of the government.

1.11. Obtaining Waste Disposal Authorization

The following sections describe the process for issuance of and revision to a DAS. The DAS may include specific requirements, conditions or limitations to the facility's design, construction, operations, and closure. Specific evaluations may be performed to enhance DAS technical basis documentation. Failure to comply with DAS requirements or limitations may result in suspension of operations, or DAS revocation by the issuing authority.

This Standard is the source for guidance regarding the format, content and review of technical basis documents supporting the DAS for a disposal facility. DOE O 435.1 takes precedent in the event a conflict exists between the Standard and the Order; the Standard takes precedent in the event of a conflict with DOE G 435.1-1, *Implementation Guide for Use with DOE M 435.1-1*.

1.12. Preliminary and Operating DAS Technical Basis Documentation Review and Approval

The LFRG is responsible for the independent regulatory review of DAS technical basis documents as delineated in Table 1-1 and for drafting of the DAS. The LFRG presents this draft to the responsible PSO for review and approval. In this capacity, the LFRG serves as the single point of contact between DOE HQ and facility personnel, both DOE and contractor, for all matters regarding the review of DAS technical basis documents. The LFRG site representative is responsible for coordinating any reviews with entities (i.e., NRC, EPA, state) having a vested interest through formal agreements or commitments associated with the facility. A DAS may be

granted when all the required technical basis documents have been reviewed, have met all applicable DOE O 435.1 requirements, and approved.

The PA, CA and preliminary CP are typically developed first in the DAS process as these analyses influence other technical basis documents. The site may submit the PA and CA for LFRG review at the same time or separately. However, a DAS cannot be issued until all the required documents have been approved. Table 1-1 lists the review and approval responsibilities for the various technical basis documents.

Table 1-1. Technical Basis Documents Review and Approval Responsibilities

Technical Basis Document	LFRG at-Large (2)	LFRG Site Member (3)	Program Secretarial Officers (PSO) (1)	Field Element Manager (FEM)	Contractor
Disposal Authorization Statements (preliminary and operational)	Develop initial and revisions --- Review during PA/CA update	NA --- Review during PA/CA update	Approve initial and revisions	NA	NA
Performance Assessment	Review initial and revisions	Review initial and revisions	Approve initial through DAS Approves subsequent revisions through DAS updates or approval letter	Concurs initial and revisions	Develop
Composite Analysis	Review initial and revisions	Review initial and revisions	Approve initial through DAS Approves subsequent revisions through DAS updates or approval letter	Concurs initial and revisions	Develop

Technical Basis Document	LFRG at-Large (2)	LFRG Site Member (3)	Program Secretarial Officers (PSO) (1)	Field Element Manager (FEM)	Contractor
Closure Plan	Review initial	Review initial and revisions	Approve initial through DAS Approves subsequent revisions through DAS updates or approval letter	Concurs initial --- Approve revisions	Develop
Maintenance Plan	Review initial	Review initial and revisions	Approve initial through DAS	Concurs initial --- Approve revisions	Develop
Monitoring Plan	Review initial	Review initial and revisions	Approve initial through DAS	Concurs initial --- Approve revisions	Develop
Waste Acceptance Criteria	Review initial	Review initial and revisions	Approve initial through DAS	Concurs initial --- Approve revisions	Develop
Special Analysis	Review if appropriate	Review	NA	Approve initial and revisions	Develop
Annual Summary Report	Review	Review	Review and approves continued operations	Approve initial and revisions	Develop
Unreviewed Disposal Question Evaluations (UDQE)	Review through Annual Summary Report	Review (4) positive UDQE	NA	NA	Develop and approve
Unreviewed Composite Analysis Evaluations (UCAE)	Review through Annual Summary Report	Review (4) positive UCAE	NA	NA	Develop and approve

(1) Office of Environmental Protection and ES&H Reporting (AU-20), is also responsible for review and approval of disposal documentation for TRU disposal at sites other than WIPP. AU is also a member of the LFRG and participates in the review and approvals.

(2) LFRG at-large is composed of a group of Federal employees from sites that have radioactive waste disposal facilities and DOE-HQ personnel. This group may review the CP, MP, MonP and WAC revisions if the DAS is being revised.

(3) LFRG site member is a member of the LFRG at-large with site specific disposal facility responsibilities. The LFRG site member has the responsibility to determine if a review of a revision to a technical basis document is needed by the LFRG at large.

(4) Positive UDQE & UCAE exist when the criteria for these documents indicate further evaluation is necessary (e.g., SA is required).

(5) DAS refers to Disposal Authorization Statement.

LFRG site members are responsible for determining DAS technical basis documents are complete, internally reviewed by appropriate personnel, and ready for LFRG review (LFRG Execution Plan provides detail on LFRG roles and responsibilities). The LFRG site members also ensure the contractor's self-assessment against the LFRG review criteria for the particular technical basis document has been completed. Although the LFRG site member usually serves as the point of contact for an LFRG review team, other site personnel may be assigned this role. In this case, the LFRG site member should remain involved throughout in order to fulfill the regulatory responsibilities. LFRG site members are responsible for the timely resolution of any identified issues and for providing the LFRG with any issue's closure documentation. Furthermore, the LFRG site member should notify the LFRG when he/she suspects facility operations warrant a DAS or Technical Basis Document(s) revision. The LFRG will assist in determining whether a DAS revision is necessary.

1.13. LFRG Review Process

Once the LFRG site member has confirmed the preliminary or operating DAS technical basis documents are ready for review, the LFRG designates a review team lead to manage the review and approval process. The LFRG ensures the review team lead is independent of the line organization responsible for DAS document preparation, and possesses the relevant technical competence. The review team lead's responsibilities include:

- Establishing a review team of technical experts;
- Developing a review plan;
- Coordinating communication between the site and review team;
- Facilitating the on-site review;
- Presenting a close-out briefing to site management;
- Facilitating issue resolution;
- Developing the final review team report;
- Coordinating factual accuracy review with the site; and

- Submitting the team's recommendation to the LFRG on the acceptability of the technical basis documents.

1.13.1. Review Team Establishment

LFRG review team members are selected based on their technical qualifications, experience, and expertise. Team expertise typically includes quantitative modeling, hydrology, geology, health physics, chemistry, radiological exposure analysis, engineering, waste management, DOE Order/regulatory compliance, and Quality Assurance (QA). Review team members should be independent (i.e., not a direct contributor to the documentation) of the facility being reviewed and are required to sign a conflict of interest form. Review team qualifications are detailed in LFRG Execution Plan.

1.13.2. Review Plan Development

The review team leader develops the review plan and works in coordination with the LFRG site member to ensure any necessary support and logistics are adequately addressed (e.g., access requirements, facility walkthroughs). Review plans should include:

- Team member names, affiliation, bios, contact information, and the site personnel assisting with the review;
- Review schedule: dates for review team pre-site visit meetings, the on-site review, and draft and final report availability;
- The site's self-assessment against the LFRG's DAS technical basis document review criteria; and
- Review criteria of the technical basis documents being evaluated and the review team members assigned responsibility for the criteria.

Once the review team leader finalizes the plan, it is forwarded to the LFRG for a vote for approval. Plans for new facilities will likely contain the complete list of review criteria, while operating facilities may only contain a subset of the review criteria.

1.13.3. Document Review and Pre-Onsite Discussions

Prior to the on-site review, the review team reviews the documents for adequacy and participates in meetings with site Federal and contractor personnel. These discussions may be conducted via telephone, webinar, or some other method as determined by the review team lead. In order to best assist the review team members in reviewing the documents provided, technical discussions are held covering all of the areas of expertise. The review plan provides guidance on planning and conducting these discussions.

The Field site personnel are responsible for documenting all questions and responses asked during the discussions. This resulting document, as well as any presentation material prepared by the site for the discussions will become part of the review record.

Outside regulators (EPA, NRC, state) or other stakeholders may participate in these discussions at the discretion of DOE. The level of participation should be agreed upon prior to the review.

1.13.4. On-Site Review

On-site reviews are typically scheduled for five working days. The first day is usually a series of presentations by site personnel summarizing their assessments and conclusions, followed by a tour of the relevant site area(s). The remaining time involves in-depth discussions of the documents between review team members and site personnel. Team members document resolved and unresolved issues, observations or best practices. These issues or observations are gathered by the review team lead to be included in the review team report. The review team provides a close-out briefing summarizing its findings to site personnel and management.

Review team findings should be categorized as: key issues, secondary issues, or observations. Additionally, review team members should identify any new and noteworthy practices observed during the review to assist in the continuous improvement of the LFRG process. The review team members should complete the review criteria matrix including:

- Review criteria for the specific technical basis document being reviewed;
- Notes or comments associated with the review of the criteria;
- Key or secondary issues; and
- Observations or best practices.

The review criteria matrix becomes part of the final review team report.

A **key issue** is a problem or concern that affects the validity or utility of the technical basis documentation. Key issues generally involve:

- Technical errors that invalidate major conclusions relevant to meeting performance objectives/measures;
- Failure to adequately substantiate a major assumption or technical position central to meeting performance objectives/measures; or
- Failure to comply with a regulation or requirement.

Sites should formally respond to all key issues. All key issues should be corrected or have an LFRG approved corrective action plan in place before a PDAS or ODAS can be issued. Key

issues remaining un-resolved should become a condition in the PDAS or ODAS, tracked in the MP and reported on in the ASR.

A **secondary issue** is a problem or concern of sufficient importance that needs to be addressed, but does not constitute a key issue. Secondary issues typically involve:

- A lack of clarity requiring a revision of text;
- Insufficient documentation or references to fully support assumptions; or
- Need for additional research to substantiate assumptions.

Sites should formally respond to secondary issues. Before the team leaves the site, secondary issues should be resolved or a corrective action plan should be provided to the LFRG. Typically, secondary issues do not require immediate corrective action. Unresolved secondary issues should become a condition in the PDAS or ODAS, tracked in the MP and reported in the ASR.

Observations typically consist of recommendations to enhance the presentation of information and clarity of the document. Observations do not require a formal response and site personnel may exercise discretion in accepting or rejecting the recommendation.

Best practices are DAS-related processes, procedures, modeling approaches, or other activities implemented at the site that the LFRG determines are cost effective, technically sound, and should be shared with other sites.

1.13.5. Issue Response, Resolution, and Tracking

The site may respond with the appropriate corrective actions to issues during the onsite review or prior to the LFRG final report. During this phase, site responses and corrective actions should be submitted to the LFRG review team lead. The review team lead transmits the responses to the team member who identified the issue to verify the adequacy of identified corrective action. If a response or corrective action is not adequate, the review team lead facilitates further dialogue to obtain a satisfactory resolution. The LFRG at-large serves as the final arbitrator if agreement is not reached.

All key and secondary issues with their associated corrective action and resolution schedule should be tracked in a data base (See LFRG Execution Plan) by the LFRG until they are closed. The final disposition of all key and secondary issues should be documented, including dissenting views where applicable. Key and secondary issues not resolved during the onsite review, should be tracked by the site in the MP until closed and the status reported in the ASR. The LFRG Co-Chairs are responsible for assigning individuals/team to verify the issues have been properly closed. Closing secondary issues are discussed in the LFRG Execution Plan.

1.13.6. Final Review Team Report Submittal to the LFRG

The review team report should identify:

- All key and secondary issues, observations, and any best practices; and
- The review team's recommendation to: accept the document(s), accept it with conditions, or reject the DAS technical basis document(s).

The review team report is finalized after a factual accuracy review by the site and any necessary modifications are completed. The final report should be submitted to the LFRG for review and approval. Once submitted to the LFRG, no changes can be made to the report except through an addendum to the report. The LFRG should vote on accepting, rejecting, or requesting the team to provide additional information before a decision is made on accepting the review team report.

The LFRG may review additional information and reports or conduct other reviews, as necessary, to ensure that a thorough review has been performed of the facility's technical basis documents. If the LFRG deliberations conclude the site is not ready to begin construction or operations, the LFRG should inform the cognizant PSO through a formal memorandum. Once the LFRG has completed deliberations, the LFRG develops a draft PDAS or ODAS for approval by the responsible PSO. The PDAS or ODAS should only be issued once the site has properly addressed the LFRG concerns and the LFRG Co-Chairs have made a formal recommendation to the responsible PSO to grant the DAS to the site.

1.14. Preliminary or Operation DAS Development and Approval

The preliminary and operational DAS contents will vary depending on the disposal facility, but should address the facility's background, site characteristics, design, construction, radionuclide limits, waste forms and packaging, monitoring, and closure. Outstanding issues may also be included as conditions in the DAS, particularly if an issue requires additional research or analyses. DAS examples are provided in the LFRG Execution Plan.

When preparing a DAS for approval by the PSO, the LFRG also prepares a Compliance Evaluation Report (CER) summarizing key aspects of the disposal facility review. The CER should identify the basis for the LFRG recommendation for the operation of the facility. The basis should, at a minimum, be the LFRG review team report and any other information the LFRG used in making its decision and recommendation. The CER will vary according to the particular site being evaluated but will normally contain:

- A summary of the LFRG review issues, including resolution schedules;
- Complete corrective actions and agreed upon proposed corrective actions;

- LFRG recommendation to accept, accept with conditions, or reject the site's request for a DAS;
- LFRG Review Team's recommendation if different from the LFRG's recommendation;
- Any additional reports or research and development required;
- Comparison between PA/CA calculated and DOE O 435.1 performance objectives/measures; and
- Basis for any DAS conditions or limitations.

Drafts of CER and DAS documents are developed by a subset of LFRG members and approved by the LFRG at-large prior to submittal to the PSO for their approving signature. The DAS development, review and approval process is illustrated in Figure 1-3.

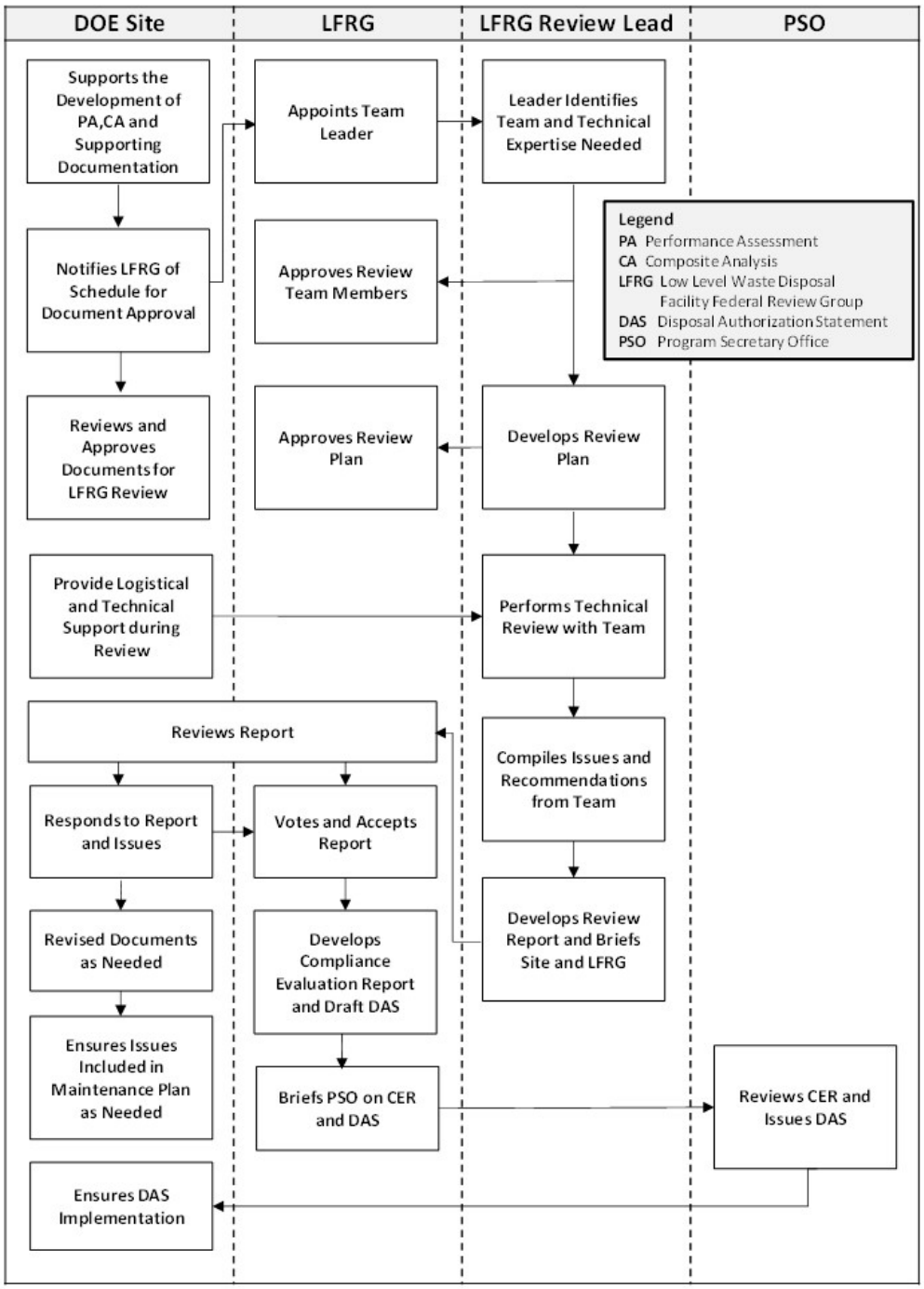


Figure 1-3. Disposal Authorization Statement Development, Review/Approval Flowchart

1.15. Preliminary and Operating DAS Maintenance and Revision

Successful DAS maintenance depends on the periodic review of the technical basis documents as new information (site data, waste inventories, waste form and packaging) becomes available. Ensuring timely document revisions based on this enhanced understanding of operations is imperative.

DAS compliance reviews may be initiated at any time by the LFRG, or other HQ organizations with responsibilities for line management or independent oversight of the disposal facilities. Should any activities call into question the adequacy of an existing DAS, the LFRG site member or the LFRG at large, may determine a revision is necessary. This determination should be documented. If required, the LFRG should develop a revised DAS for approval by the appropriate PSO. The DAS and associated technical basis documents should be revised, at a minimum, every ten years from the initial issuance of the DAS. A five to 10-year schedule for DAS revisions will be developed by the LFRG at large (see LFRG Execution Plan).

1.16. References

10 CFR Part 830, *Nuclear Safety Management*

10 CFR Part 835, *Occupational Radiation Protection*

Atomic Energy Act of 1954, NUREG-0980, U.S. Nuclear Regulatory Commission

DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets*, November 29, 2010

DOE Order 435.1, Chg 1, *Radioactive Waste Management*, July 09, 1999

DOE Manual 435.1-1, Admin Chg 2, *Radioactive Waste Management Manual*, July 09, 1999

DOE Guide 435.1-1, 1 Admin Chg 2, *Implementation Guide for Use with DOE M 435.1-1*, July 09, 1999

IAEA. *Disposal of Radioactive Waste, Specific Safety Requirements*, No. SSR-5, International Atomic Energy Agency, 2011

IAEA. *IAEA Safety Glossary – Terminology Used in Nuclear Safety and Radiation Protection*, 2007 Edition, International Atomic Energy Agency, Vienna, 2007

IAEA. *The Safety Case and Safety Assessment for the Disposal of Radioactive Waste*, Specific Safety Guide No. SSG-23, International Atomic Energy Agency, Vienna, 2012.

ICRP Publication 81, *Radiation Protection Recommendations as Applied to the Disposal of Long-Lived Solid Radioactive Waste*, International Commission for Radiological Protection, 1998

LFRG Execution Plan, Low-Level Waste Disposal Facility Federal Review Group, September 2015

NCRP. *Performance Assessment of Near-Surface Facilities for Disposal of Low-Level Radioactive Waste*, NCRP Report No. 152, National Council on Radiation Protection and Measurements, Bethesda, MD, December 2005

NDAA Section 3116, *Waste Determinations with Related Disposal Performance Assessments*, Ronald Reagan National Defense Authorization Act (NDAA) for Fiscal Year 2005

CHAPTER 2. PERFORMANCE ASSESSMENT GUIDE

2.1. Introduction

Goal

The goal of this guide is to support the U.S. Department of Energy's (DOE's) initiatives to improve and maintain the highest quality radioactive waste management standards and activities throughout the DOE complex.

The primary audience of this guide is the Federal Project Director and other DOE Federal/contractor employees involved in the disposal of low-level waste (LLW) and tank closure.

Objective

This chapter provides guidance to preparers of DOE or the National Nuclear Security Administration (NNSA) LLW, mixed low-level waste (MLLW), and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) disposal facilities and liquid waste tank closure performance assessments (PAs) required by DOE Order (O) 435.1, *Radioactive Waste Management*. PAs prepared to address disposal of transuranic waste (TRU) should meet the requirements of 40 CFR Part 191, *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes*. Key objectives for the preparation and associated Low-Level Waste Disposal Facility Federal Review Group (LFRG) review process are to ensure PAs are:

- Complete and thorough;
- Reasonable and logical;
- Technically correct and defensible; and
- Conclusions are valid and acceptable.

Guides do not impose requirements but may quote requirements if the sources are adequately cited. This guidance follows the format of an objective statement, discussion, examples, a statement of one way to measure compliance, and supplemental references. Following this Guidance provides a consistent approach for compliance with the requirements of DOE O 435.1. If the Guide has not been followed, then an explanation/justification as to why a different approach is acceptable should be provided.

The LFRG, functioning as the DOE regulatory authority, is the independent organization responsible for performing oversight of LLW disposal and tank closure in accordance with DOE O 435.1 [DOE Manual (M) 435.1-1, *Radioactive Waste Management Manual*, Chapter I,

2.E(1)(a)]. Therefore, the LFRG members utilize this Standard as guidance in performing oversight functions and judging compliance with the requirements of DOE O 435.1 (See LFRG Execution Plan for details of LFRG roles, responsibilities and processes).

Background

The DOE conducts activities, including disposal of LLW and remediation of radioactive contamination at DOE sites that could potentially result in long-term radiological exposure to future members of the public. These activities should, therefore, be conducted in a manner that is not only protective of the public during facility operations, but also ensures that future members of the public will be protected from the aggregate of all residual radioactive material on a DOE site. PAs and composite analyses (CAs) are conducted as part of the process employed by DOE to address radiological protection of the public.

PAs are used to provide DOE with a reasonable expectation that LLW disposal will meet the radiological performance objectives established in DOE O 435.1. PAs are reviewed and approved by DOE Headquarters (HQ) and are part of the basis for a Disposal Authorization Statement (DAS) to be issued by the appropriate Deputy Assistant Secretary or Deputy Administrator containing conditions for operation and waste receipt at the disposal facility being evaluated. It is not possible to provide absolute assurance of the performance of the disposed waste and various sources of radioactive material at some future time. Rather, the DOE O 435.1 requires that the PA be prepared to provide a reasonable expectation that the performance objectives will not likely be exceeded.

The PA for active and planned LLW disposal facilities is focused only on the disposal facility so that design and operational controls may be established to ensure that performance objectives will be met. PAs are focused on meeting the performance objectives for protection of the public established in DOE M 435.1-1 for the waste that is disposed in the facility after September 26, 1988. Contributions to cumulative dose for future exposures from sources disposed in a facility prior to September 26, 1988, and other sources that are significant contributors from outside the facility are addressed in the CA.

Role of PA During Facility Lifecycle. PAs play an important role throughout the development of a disposal facility for siting, design, construction, operations and considerations for closure. Calculations are used for a variety of other specific needs in addition to the role for demonstrating compliance with performance objectives.

During siting, initial PA calculations can be used to assess the feasibility of different sites and to begin to explore the need for engineered barriers. PAs have a significant role during the design stage or tank cleaning stage as part of the total systems approach for assessing performance of different combinations of natural and engineered barriers. PA calculations are used to consider different design alternatives and to provide a basis for the selection of specific design options.

During construction or tank closure activities PAs are used to assess as-built conditions and any design changes introduced during construction. PA plays a key role during operations for the establishment and maintenance of Waste Acceptance Criteria (WAC) and also for SAs. Note that the term PA is used throughout this chapter, but in many cases the guidance could also be addressed in a special analysis (SA) (see Chapter 8). Assumptions in the PA also form the technical basis for development of requirements in the monitoring and closure plans (CPs).

Relationship between PA and CA. PAs are closely linked with CAs, which DOE uses as planning tools to ensure that the combined effect of all sources of radioactive material that could significantly contribute to the dose calculated from LLW disposal and closed underground liquid waste storage tanks will not violate the requirements for the protection of the public. In some cases, with limited interactions with other sources, it may be possible to document the CA as an appendix or supplement to the PA. If the PA and CA are combined it will be necessary to include additional information (hydrogeology, facility descriptions, source characteristics, etc.), as appropriate, with the information needed to ensure that the review criteria for CAs are also satisfied.

PAs and CAs are not decision documents. The PA provides evidence of compliance with performance objectives for protection of the public and the environment, and for development of WAC, monitoring plans (MonPs) and CPs. The DAS is the ultimate decision document, which relies on the results of the PA and CA and other technical basis documents to support the decision to approve or not approve operations of a disposal facility or tank closure action. Development and maintenance of the PA and CA are iterative processes and the maintenance plan (MP) is used to document the plans to implement the iterative approach.

2.2. Annotated Outline for Performance Assessments

2.2.1. Executive Summary

The Executive Summary should provide a summary of the PA including the results compared to the performance objectives and key assumptions and information important to understand the factors with the greatest influence on the PA and conclusions made therein.

Information in this summary should include:

- A table with the results of the PA for each of the performance objectives and the intrusion analysis;
- A discussion of potential peaks beyond the compliance period;
- Pathways and radionuclides that are significant contributors to dose for each objective and measure;
- Critical assumptions and parameters relative to compliance;

- Key operating and closure conditions and assumptions;
- Regulatory context including land use assumptions; and
- A summary of the conclusions of the PA.

Objective

The objective of this guide is to describe the results of the PA compared with the appropriate performance objectives and measures. The Executive Summary also identifies key assumptions and provides a summary of the conclusions of the PA.

Discussion

This requirement provides a concise summary of the results and conclusions from the PA. Results from the analysis are provided in a table for quick reference (Table 2-1). The example table includes peak impacts during the compliance period and also includes some description of peaks that may occur after the compliance period. Peaks that may occur after the compliance period can also be described in the text and may be addressed quantitatively or qualitatively depending on the timing and site specific considerations. It can be helpful to also include a column in the table identifying the pathways and radionuclides that are the primary contributors to peak impacts or this can be described in the text.

Key assumptions that can influence the conclusions of the PA and/or need to be protected in the design and/or operational procedures are also discussed. Note the emphasis is on assumptions that could change the conclusions regarding compliance rather than simply assumptions that have a significant impact on the results. This discussion includes assumptions or parameters identified in a sensitivity or uncertainty analysis and design features or operational practices that were credited in the PA (e.g., assumed placement of specific wastes, cover thickness, etc.).

Table 2-1. Example Summary of PA Results from a Disposal Facility

Performance Objective and/or Measure	Standard	Performance Assessment Results	
		Compliance Period (2035-3025)[a]	Post-Compliance Period (3015-12035)[a]
All pathways (DOE O 435.1 Chg 1)	25 mrem/yr EDE	1.02 mrem/yr	1.88mrem/yr
Atmospheric (40 CFR 61, Subpart H)	10mrem/yr EDE	1.02 mrem/yr	0.51 mrem/yr

Performance Objective and/or Measure	Standard	Performance Assessment Results	
		Compliance Period (2035-3025)[a]	Post-Compliance Period (3015-12035)[a]
Atmospheric (40 CFR 61, Subpart Q)	20 $pCi.m^{-2}.s^{-1}$ radon flux (at surface of disposal facility)	0.11 $pCi.m^{-2}.s^{-1}$	0.08 $pCi.m^{-2}.s^{-1}$
Acute inadvertent intruder (DOE O 435.1 Chg 1)	500 mrem EDE[b]	5.51 mrem[f]	NA
Chronic inadvertent intruder (DOE O 435.1 Chg 1)	100 mrem/yr EDE[b]	9.27 mrem/yr[f]	NA
Groundwater protection (water resources) (40 CFR 141)	Beta-gamma dose equivalent $\leq$ 4 mrem/yr	0 mrem/yr	3.3[c] mrem/yr
	Gross alpha activity concentration (excluding radon and uranium) $\leq$ 5 pCi/L	0 pCi/L	1E-10[d] pCi/L
	Combined Ra-226 and Ra-228 concentration $\leq$ 5 pCi/L	0 pCi/L	1E-10[d] pCi/L
	Uranium concentration $\leq$ 8 pCi/L[e]	0 µg/L	1E-10[d] µg/L
	Sr-90 concentration $\leq$ 8 pCi/L[e]	NA	NA
	H-3 concentration < 20,000 pCi/L	0 pCi/L	1E-10[d] pCi/L

a. Compliance at 100 m downgradient of Environmental Restoration Disposal Facility (ERDF) except for inadvertent intruder scenarios

b. Not applicable for post-compliance time period.

c. Beta-gamma dose equivalent < mrem/yr (based on Federal MCL) and calculated as (C_{Peak}/MCL)*4 mrem/yr For Tc-99, which contributes almost the entire dose, C_{Peak} = 731 pCi/L and MCL = 900 pCi/L, so the equivalent does is calculated to be 3.3 mrem/yr

d. Concentrations less than 1E-10 pCi/L are essentially zero.

e. Not applicable; Sr-90 was screened out during evaluation of the groundwater pathway due to its relatively short half-life and its low mobility I the subsurface.

f. Peak dose based on assumed inadvertent intrusion at 100 years following loss of institutional control. Peak occurs at 100 years after closure.

EDE = effective dose equivalent

MCL -= maximum contaminant level

NA = not applicable.

2.2.2. Introduction

The introduction should provide background documenting why the PA was required and a high-level overview of the technical approach used in the development of the PA, including a content summary, and the relationship of the disposal facility (or other facility) to be closed as a LLW facility to any existing and potential future programs at the DOE site. This section should identify high-level assumptions about the facility that are critical to the analysis of performance, as well as changes in those assumptions from previous PAs or other similar analyses.

2.2.2.1 Basis for Performance Assessment

This section should summarize the reason necessitating the PA (e.g., PDAS to support construction of new disposal facility, change in design/layout, and accumulation of changes such that an update was deemed appropriate). It should provide background material, or reference to previously published documents that define PA scope and changes in assumptions from existing PA/CAs and other analyses to which the PA may be compared, as applicable.

Objective

The objective of this guide is to serve as a reference point identifying the underlying basis for the PA and identification of previous PAs and the presence of other analyses to which the PA may be compared.

Discussion

This subsection provides a frame of reference for the need for the PA and provides a single place for a reviewer to be made aware of previous PAs and other assessments. If the PA is a revision to close any outstanding secondary issues from an earlier PA, the issues should be specifically identified. If there is potential for the PA to be compared with other analyses, this section should refer the reader to "Related Analyses" in this chapter for a description of those analyses. The emphasis at this point is on identification and awareness of differences from previous PAs and other analyses. Detailed descriptions of modeling assumptions, etc. will be provided later in the PA, but general statements about the impacts of changes in assumptions on results of the PA are helpful in this overview with reference to the more detailed description.

Example:

> *A new PA is being conducted to address a new disposal concept and new waste streams that will be disposed. The PA also includes an updated conceptual site model with changes in assumptions regarding the vadose zone and underlying aquifer. This subsection introduces the changes to the disposal facility, the waste streams not considered in the previous PA, updates to the conceptual site model and a reference to where the new information is described in detail. The changes*

are provided in a bullet list with citations for more detailed discussions. General statements about the influence of the changes on the PA results can also be included (e.g., the new site data is expected to result in reduced doses because K_d values have been increased for a given radionuclide).

2.2.2.2 General Facility Description

The General Facility Description should provide a short summary description of the waste disposal concept, facility, location, and waste operations. The description should include:

- LLW disposal concept (e.g., vault, trench, tanks);
- Historical development and use;
- Generation, treatment, storage and disposal steps;
- WAC and waste tracking systems; and
- Waste characterization & certification program(s) summary.

Objective

This guide provides a summary of the disposal concept and site providing perspective on the relative importance of natural and engineered barriers. The waste management system associated with the disposal facility is also described.

Discussion

This subsection introduces important features at the site, the disposal facility location and the disposal concept and provides a description of the general steps in the waste management process from generation to treatment to staging/storage and disposal operations. WAC and waste tracking systems are also described as part of a summary of the waste characterization and certification program at the site.

2.2.2.3 Design Features

This section should provide perspective about the overall safety strategy, including a higher-level system view of how the components described in the "Site and Facility Characteristics" section function together to meet the performance objectives. This section should also identify significant design and operating constraints that are driven by considerations outside of the PA, and identify any safety analysis reports (SARs) associated with operation. This section should summarize:

- Disposal concept;
- Engineered features (waste forms, containers, vaults, caps, drainage systems, closure assumptions):
  - Safety roles of engineered and natural features in terms of reducing releases; and
  - Key interdependences between the different engineered and natural features affecting overall performance.
- General state of knowledge related to system behavior;
- Operational considerations that may impact long-term safety and feature protection; and
- Operational requirements, such as WAC, relevant to the long-term performance.

A figure or table illustrating/describing the different features of the facility and site and their roles for safety of the facility as considered in the PA should be provided.

Objective

This guide provides an introduction to the safety strategy for the disposal facility and natural system, including defense-in-depth considerations. Changes from previous PAs should be identified as part of the descriptions.

Discussion

This subsection provides an introduction to the integrated safety system, including different site and engineered features that make up the total disposal system that will be described in the "Site and Facility Characteristics." The description serves as an initial summary of the safety functions for key design features (e.g., waste forms, containers, vaults, covers, drainage systems, general closure assumptions) and considerations for development of conceptual models to be used for the PA. General perspective on evolution of the system is provided, including identification of interdependencies between barriers that could introduce counter-intuitive behavior (e.g., assuming increased recharge through cover while tank is still intact may not be conservative). Figure 2-1 is an example summarizing the evolution of the performance of different features in a disposal system over time.

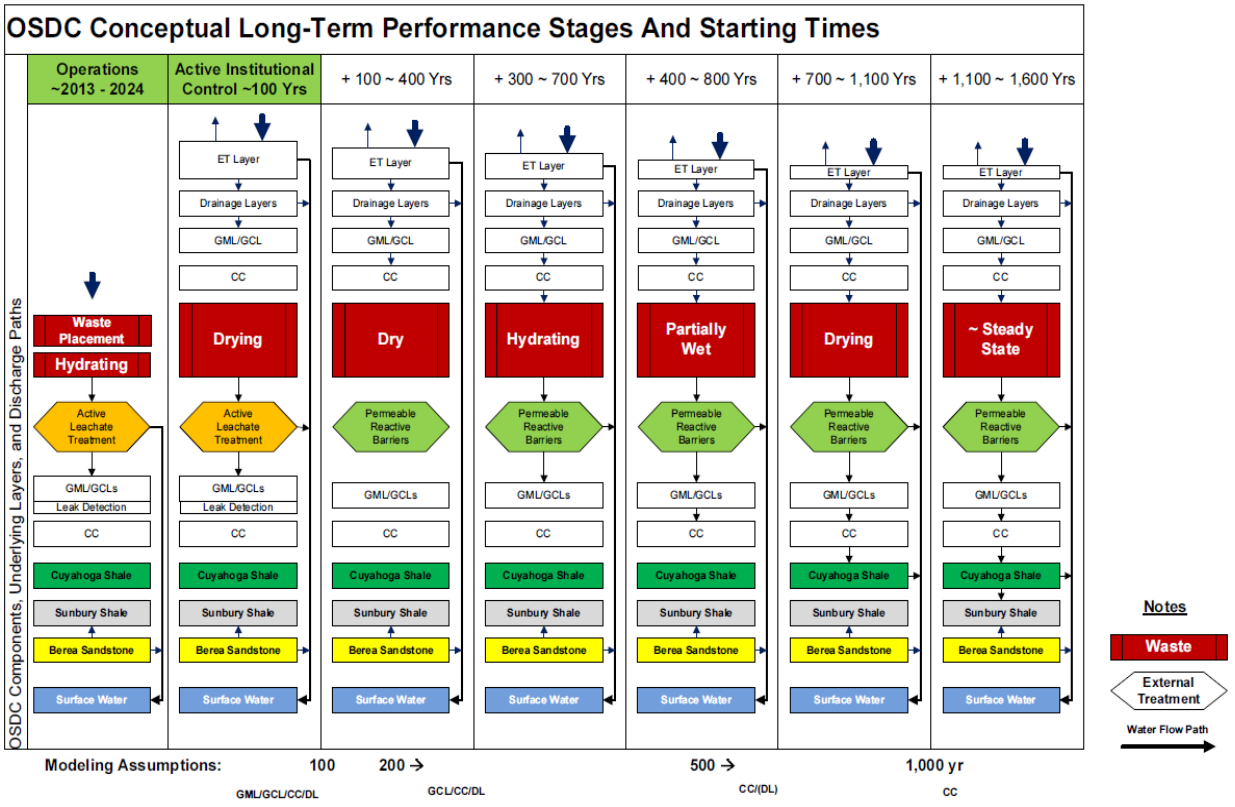


Figure 2-1: Example of Evolution of Performance of a Disposal Facility Over Time

The description also should provide an initial indication of which features are included/excluded from consideration in the PA, what needs to be defended with the PA, and the general state of knowledge related to the behavior of the system. For engineered features, links should be provided to more detailed descriptions that would be provided in "General Facility Description." For new facilities, there will also be a systems evaluation conducted as part of the sensitivity analysis or reference to an evaluation in an Appendix or supporting document (Attachment 2.1). Defense-in-depth considerations are also highlighted for features that are not part of the conceptual model, but contribute to safety (e.g., specific operational controls, WAC, barriers that are not credited in the PA models, etc.). As part of the discussion, significant changes in assumptions from previous versions of the PA should be identified (e.g., those changes that would be of interest to a reviewer or stakeholder). Modeling implications associated with those changes are discussed in "Related Analyses." Operational considerations that may impact long-term safety should also be introduced in this section. The section should identify SARs associated with operation of the facility and operational requirements, such as WAC, waste placement requirements, etc. relevant to the long-term performance of the disposal facility. The intent is to capture design and operating constraints that are driven by considerations outside of

the PA (e.g., constraints that would require the need to consider changes to documentation beyond the PA before they could be modified).

2.2.2.4 Low-Level Waste Disposal Facility Lifecycle and Closure Plan

This section should summarize the expected chronology for the operating life cycle of the disposal facility or tank farm through final closure, and identify any changes from assumptions in a previous PA.

The summary should include, as applicable:

- Waste disposal operations specific to disposal units prior to September 26, 1988;
- Waste disposal operations specific to disposal units from September 26, 1988 to present;
- Forecasted waste disposal operations specific to disposal units from present to end of operations;
- Any plans for installation of operational, interim and final covers from the present to the planned final closure (closure, active institutional control, and post-institutional control); and
- A summary of key assumptions related to facility closure that need to be captured in the CP (Chapter 4).

In the case of tank closure, a general description of the life cycle of the tank farm, followed by a summary of the schedule for closure of the tanks is prepared to address the content in the first three bullets above.

Objective

This guide provides details about historic and planned operations at the disposal facility or tank farm and identifies disposal units that are specifically considered and not considered in the PA. Assumptions regarding the timing of the planned closure of the facility are also specifically described.

Discussion

This subsection identifies the operational periods and closure status for all disposal units in the disposal facility including tank farms for tank closure PAs. Disposal units specifically considered in the PA are identified based on the timing of waste disposal or tank closure activities and site-specific considerations. A key aspect of this description is to identify changes in general operating plans from those considered in previous assessments (e.g., timing of facility start-up, timing of cover installation) that are important for the PA. For disposal facilities that began operation before the effective date of the Order, there may be specific units, or waste in a specific unit, excluded from consideration in the PA based on timing of disposal. These wastes

should also be identified and should be addressed in the CA. Key closure assumptions (e.g., timing of cover placement, assumed infiltration rates prior to and after final closure, etc.) that should be protected and documented in the CP are also identified in this subsection.

Example:

> *Liquid waste tanks at a site were operated prior to September 26, 1988, but closure decisions and actual closure will be completed after the effective date of the Order. Thus, residual waste that will be left in those tanks should be considered in the PA.*

Example:

> *Disposal operations for a given unit within a disposal facility began in 1984, which is before September 26, 1988. Since the unit includes waste disposed before and after the effective date of the Order, it was decided in that case to include all of the waste disposed in the unit in the PA for the disposal facility. This is not required, but was a choice made for that situation. Whether or not the waste disposed prior to the effective date of the Order was included in the PA, it would have to be addressed as a potential source for the CA.*

2.2.2.5 Related Analyses

This section should identify previous or on-going PA/CA-related analyses or other analyses at the site [e.g., risk assessments, National Environmental Policy Act (NEPA), etc.] that could be compared with the PA. Citations to relevant documents should be included. Significant differences in assumptions and results that may exist between the PA and any other pertinent modeling activities that may be compared with the PA (including changes to address comments on previous versions of the PA) should be identified and summarized to:

- Help reviewers focus on un-reviewed aspects that have changed from previous modeling efforts; and
- Address any differences in assumptions/results that could be seen as inconsistencies.

Objective

This guide identifies other modeling efforts that could be a point of comparison for modeling in the PA and serves to identify and explain different assumptions that may have been made.

Discussion

Multiple modeling efforts may be underway at a DOE site at any given time, especially larger sites, and assumptions may change when a PA is updated. There are often differences in the

level of detail or general approach taken for modeling depending on the purpose. The modeling may support different regulatory programs, be overseen by different DOE Field Offices at the site, and be conducted by different contractors or even different groups within a contractor. Inevitably, assumptions, approaches, and results from the PA will be compared with other similar efforts that may have been conducted at a given site (e.g., previous PAs, Environmental Impact Statements (EISs), risk assessments). These factors lead to a potential for apparent inconsistencies in modeling results, if the context of the modeling is not explained. It is important to acknowledge those differences and be prepared to explain the basis and significance.

This subsection expands on the introduction to other modeling efforts that could be compared with the PA listing the other analyses and identifying specific assumptions in the PA that differ from other modeling efforts and a brief discussion of the impacts on the results. From a general perspective, the intent is to demonstrate an awareness of other modeling efforts and an understanding of any significant differences. Note that differences from previous versions of the PA may be introduced in "Related Analyses" and discussed here with reference to more detailed descriptions later in the PA or in other documents.

Example:

> *A NEPA-related analysis was recently completed at the DOE site that included contributions resulting from releases from the PA facility. For the broader purposes of the EIS, the releases from the facility were assumed to not be attenuated by physical barriers around the waste. In the PA modeling, some credit was taken for the barriers that resulted in lower release rates. When results from the two models are compared, the EIS suggests higher release rates than the PA. This subsection would introduce the differences in assumptions and provide a general statement about potential impact on the results with reference to the section of the PA or other document describing the detailed assumptions for the modeling.*

2.2.2.6 Regulatory Context

This section should describe site specific regulatory context for the PA, including but not limited to the performance objectives, timing and point(s) of assessment, considerations for intrusion, and any relevant agreements between the DOE, Nuclear Regulatory Commission (NRC), the U.S. Environmental Protection Agency (EPA), other Federal agency, or the state. It should summarize activities undertaken to engage interested parties in development of the PA, including any agreements or commitments resulting from those activities (e.g., scoping meetings, modeling workshops, etc.).

If the PA is being conducted to support a CERCLA disposal cell, this section should provide references to relevant documentation that is used as supporting material for the PA (e.g., Remedial Investigation/Feasibility Study (RI/FS) documents, risk assessments, crosswalks) and describe the approach for integration (e.g., cross referencing to specific details in a risk assessment and/or RI/FS). This section should also describe stakeholder engagement and any institutional relationships, agreements, or commitments to provide the regulatory context that may affect the performance criteria or PA approach.

2.2.2.6.1 Performance Objectives

The performance objectives for all pathways, air, radon and groundwater protection should be specified. If for a particular site, there are performance objectives derived from other requirements (e.g., site-specific regulatory agency agreements), additional sections should be provided to discuss these agreements. This section should describe the pathway analysis from the facility only-background and other sources should not be included. The descriptions of the performance objectives should reflect the choice of a deterministic or probabilistic approach to compliance. The greater of the peak of the mean or median results should not exceed the applicable performance objectives for probabilistic approaches.

All Pathways. This section should describe the site-specific application of the requirement to provide a reasonable expectation that representative members of the public will not receive a total effective dose resulting from the disposal facility in excess of 25 mrem (0.25 mSv) in a year from all exposure pathways, excluding the dose from radon and its progeny in air. All pathways include the reasonable modes by which a representative receptor at the point of public access is assumed to be exposed, including the air pathway, groundwater pathway, direct contact, and consumption of contaminated foodstuffs, as applicable at a given site.

Air Pathways. This section should describe the site-specific application of the requirement to provide a reasonable expectation that representative members of the public will not receive a total effective dose via the air pathway in excess of 10 mrem (0.10 mSv) in a year, excluding the dose from radon and its progeny. This includes dose as a result of direct inhalation, immersion, and exposures from deposition of radionuclides transported via the air pathway, as applicable at a given site.

Radon Release. This section should describe the site-specific application of the requirement to provide a reasonable expectation that release of radon will not exceed 20 pCi/m2/s (0.74 Bq/m2/s) averaged over the surface of the disposal facility or concentrations will not exceed 0.5 pCi/L (0.0185 Bq/L) at the appropriate boundary.

Water Resources. This section should describe the site-specific application of the requirement to provide a reasonable expectation that impacts to water resources will not exceed applicable

EPA, state, or local regulatory requirements. Impacts should be assessed on a site-specific basis in accordance with the following hierarchical set of criteria:

- First, the DOE facility should comply with any applicable State or local law, regulation, or other legally applicable requirement for water resource protection.
- Second, the facility should comply with any formal agreement applicable to water resource protection that is made with appropriate State or local officials.
- Third, if neither of the above conditions apply, the site should select assumptions for use in the PA based on criteria established in the site groundwater protection management program and any formal land-use plans.
- If none of the above conditions apply, the site should select assumptions for use in the PA for the protection of water resources that are consistent with the use of water as a drinking water source unless there is formal agreement that the water is not considered suitable for drinking water.
- For groundwater as a drinking water source, the point of assessment (POA) should be the location of highest concentration in a drinking water source outside a 100-meter buffer zone surrounding the disposed waste.

Objective

Site specific implementation of the performance objectives that serve as the basis for determination of protection of human health and the environment at the POA during the time of compliance are described.

Discussion

The performance objectives provide a measure of disposal facility performance in limiting impacts to a member of the public from all pathways, water resource protection, air dose and the release of radon over the time of compliance. The disposal facility includes the buffer zone around the facility, the area underneath the facility to the aquifer and the area above the surface of the facility. The performance objectives were established in DOE O 435.1 to assure compliance with the requirements of DOE O 458.1, *Radiation Protection of the Public and the Environment*. They are generally consistent with the objectives established by other regulatory agencies (NRC, EPA) and the recommendations of the International Atomic Energy Agency (IAEA). Performance objectives are used as one of the limiting factors to establish WAC for the disposal facility operations including but not limited to allowable radionuclides and their concentrations, acceptable waste matrix, and containers. The performance objectives are enforced in the context of the compliance period and migration of radionuclides within the performance objectives are considered Federally authorized releases. Default assumptions for

performance objectives, measures and POA are summarized in Table 2-2. Additional guidance is provided following the table.

Table 2-2. Example Default Exposure Scenarios, Performance Objectives and Measures, and Points of Assessment for the Performance

Exposure Scenario	Objective or Measure	Point of Assessment	
		Operational & Active Institutional Control Periods [d]	Post-Institutional Control Period
PERFORMANCE OBJECTIVES FOR COMPLIANCE			
All-pathways	25 mrem/yr [a]	DOE Site Boundary	100 m [c]
Air pathway	10 mrem/yr [a]	DOE Site Boundary	100 m [c]
Radon	20 pCi/m^2/s	Flux rate at Facility surface	Flux rate at Facility surface
	0.5 pCi/L [b]	Facility Boundary	100 m [c]
Water Resources	Per State and local requirements	100 m [c]	100 m [c]
PERFORMANCE MEASURES			
Intruder	100 mrem/yr chronic [a]	Not applicable	Facility
	500 mrem acute [a]	Not applicable	Facility

Note: The disposal facility includes the buffer zone around the facility, the area underneath the facility to the aquifer and the area above the surface of the facility. "Facility surface" refers to releases from the waste into the atmosphere. "DOE site boundary" is the overall site boundary defined in land use plans.

a. Excluding radon in air.

b. Alternate radon Performance Objective.

c. The point of highest projected dose or concentration beyond a 100-meter buffer zone surrounding the disposed waste. A larger or smaller buffer zone may be used if adequate justification is provided.

d. The active institutional control period includes final closure.

Probabilistic Results. If calculations are performed probabilistically, the peak of the mean or median of the distribution of results, whichever is higher, should generally be used to compare with the performance objectives over the compliance period. Other results from the distribution should be used to inform the decision in conjunction with the results of sensitivity analyses and to assess a need for reduction in uncertainty via PA and CA maintenance, but no specific numerical criterion should be applied to other percentiles. Other indicators, such as the mean of the peaks, are not appropriate for the purposes of demonstrating reasonable expectation of meeting the performance objectives.

Example:

> *The Site X PA was performed probabilistically. The results of the exposure calculations over the 1,000-year assessment period are that the peak of the median of the dose distribution is 15 mrem/year, the peak of the mean is 18 mrem/year, and the 95th percentile is 110 mrem/year. Sensitivity and uncertainty analysis results and an ALARA analysis were used to address the 110 mrem/yr dose. The combinations of assumptions resulting in the 95th percentile results were reasonably unlikely and it was determined that a reasonable expectation of compliance was demonstrated. Thus, the PA results are compliant with the 25 mrem/year performance objective.*

NRC supports the use of central tendencies for distributions (i.e., mean, median) when comparing probabilistic results with deterministic standards. Some rationale for NRC opinions regarding the use of central tendencies is explained in NRC SECY-97-221, *Acceptance Guidelines and Consensus Standards for Use in Risk-Informed Regulation,* and further elaborated in NRC Regulatory Guide 1.174, *An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis* (e.g., pages 1.174 – 21 & 22). In these documents, it is stated that the use of central tendencies as a basis of comparison should be supplemented by qualitative judgments and sensitivity analyses to address uncertainties associated with, e.g., the model and overall completeness of the analysis. In this respect, it is emphasized that simply showing the mean or median is below the standard is not sufficient in itself. Information on the tails of the results distribution become increasingly dependent on specific assumptions regarding the input distribution, which may not be well defined. There may also be a need to address cost/benefit of reducing uncertainty via the PA and CA maintenance process.

. There is a need to maintain some perspective regarding interpretation of specific results on the tails recognizing the many different factors, biases, and different types of uncertainties that can affect the distributions of results. The use of the peak of the mean or median reflects the emphasis on using a central tendency rather than extremes when determining compliance. Although, the distributions of results will suggest that some higher doses could occur, the likelihood of an exposure actually occurring is generally not captured in the standard PA approaches. Thus, there is additional pessimism implicitly included in the distribution of the results by assuming that an exposure will occur at the point and time of the peak concentration for the assumed exposure scenarios. These factors should be discussed to provide context for the conclusions regarding compliance with the performance objectives.

All Pathways Dose. Consistent with established radiation protection practices articulated by the International Commission on Radiological Protection (ICRP) and the International Atomic Energy Agency Basic Safety Standards *Radiation Protection and Safety of Radiation Sources:*

International Basic Safety Standards (IAEA 2011), the projected dose attributable to any single source, practice, or activity should be some fraction of the applicable overall dose limit. Depending on the particular source of concern, DOE and the NRC have typically established limits of 10 to 25 percent of the primary dose limit for protection of the public [100 mrem (1 mSv/year)] to any particular source, although higher or lower fractions may be appropriate. This performance objective is used to provide a reasonable expectation that representative members of the public will not receive more than 25 percent of the primary dose limit of 100 mrem (1mSv) in a year from the disposal of low-level waste. The requirement addresses the annual total effective dose, inclusive of all potential exposure pathways (e.g., groundwater, surface water, air) except for dose from radon and its decay products in air for which a separate performance objective (rate of radon release or concentration in air) is stated.

All pathways include the modes by which a receptor at the point of presumed public access could reasonably be exposed to radioactive material migrating, via environmental media (e.g., water, soil, biota, air), from the disposed waste. "Reasonably exposed" in this context refers to the acceptable practice of using stylized representations of typical exposure pathways and scenarios representative of current habits and technologies in the region and should not be perceived to involve worst case or highly unlikely exposure scenarios. Radon and its decay products are considered separately from other radionuclides in the all pathway calculations consistent with 10 CFR Part 40, *Procedures for Transportation Workplace Drug and Alcohol Testing Programs,* (Appendix A, Criterion 6), 40 CFR Part 190.10(a) *Standards for Normal Operations*, and 10 CFR Part 20, Section1101(d) *Radiation Protection Plans*. Even though a separate performance objective is established for the air pathway, the air pathway is also included in the all pathways dose calculation.

The performance objective is applied in terms of dose to a representative member of the public to indicate the dose objective is not intended to be applied for assumptions regarding the age, sex, or assumed activities of any specific member of the public ICRP Publication 101, *Assessing dose of the representative person for the purpose of radiation protection of the public and optimization of radiation protection: Broadening the process.* The ICRP terminology used for this representative member of the public at the time this document was prepared is "Representative Person" (DOE O 458.1, ICRP Publications 101, and ICRP Publication103, *The 2007 Recommendation of the International Commission on Radiological Protection*). The use of the "representative person" construct addresses the fact that the performance objectives are generally applied, through the PA process, to hypothetical future members of the public, rather than to known and identified individuals. Use of the Representative Person construct is consistent with the use of the current recommended dose coefficients that have been developed for a "reference person" (DOE-STD-1196-2011, *Concentration Technical Standard*). The term "reference person" refers to the assumptions for development of dose coefficients (e.g., human body) and the term "representative person" refers to the assumptions for the receptor in the

performance assessment (e.g., more highly exposed member of the critical group). Also, see "Exposure Pathways and Scenarios" for further discussion.

Air Pathway Dose. This performance objective requires a reasonable expectation that representative members of the public will not receive from the disposed waste, via the air pathway alone, more than 10 mrem in a year, excluding the dose from radon and its progeny. The choice of 10 mrem/yr (0.1 mSv/yr) for this objective is drawn from the EPA National Emission Standards for Hazardous Air Pollutants (40 CFR Part 61, *Procedures for Transportation Workplace Drug and Alcohol Testing Programs*, Subpart H). Consistent with 40 CFR Part 61, Subpart H, dose from radon and its progeny are not included in assessing compliance with this performance objective.

The air pathway dose includes dose, as applicable, as a result of direct inhalation, immersion and exposures from deposition of radionuclides transported via the air pathway from the waste in the disposal facility being addressed in the PA. The effectiveness of covers, waste forms, containers and other barriers can be considered, as appropriate, in the air pathway calculations. In some cases, relatively simple calculations (e.g., a box model) can be sufficient to demonstrate compliance for a LLW disposal facility. If such an approach is used, it is important to document the assumptions and identify features that were not credited in the calculations. This provides a starting point to revise calculations in the future where it may be desirable to include credit for features that were not credited in the initial calculations.

Radon Exposure. This performance objective requires a reasonable expectation that radon, either as a constituent of waste at the time of disposal or produced by radioactive decay following disposal, is not released from the disposal facility at a rate that would exceed the limit established in 40 CFR Part 61, Subpart Q, *National Emission Standards for Radon Emissions from Department of Energy Facilities*. Compliance with this performance objective could address either of the two limits contained therein. The rate of radon release, over time, from the surface of the disposal facility could be projected for comparison with the flux limit. Alternatively, the concentration of radon in air could be projected for comparison with the concentration limit. In most cases, the ground surface emanation rate of 20 pCi/m2/s (0.74 Bq/m2/s) should be applied. However, in cases where the disposed waste radiologically resembles uranium or thorium mill tailings, the use of the limit on air concentration may be warranted. Alternatively, doses from radon and progeny may be included in the assessment of compliance versus the 10 mrem in a year air pathway performance objective. In this case, assuming that compliance with the 10 mrem in a year dose limit is projected, radon need not be addressed separately. Any of these approaches may be used to demonstrate that radon releases are within levels that are protective of human health. The PA should identify which approach is applied.

Water Resources. This performance objective includes calculations of surface or groundwater concentrations and/or drinking water doses for comparison with applicable Federal, state or local surface or groundwater protection standards to establish limits on radionuclides that may be disposed in near-surface disposal facilities.

DOE O 435.1 does not specify the level of protection for water resources that should be used in a PA for a specific low-level waste disposal facility, because surface or groundwater protection is typically addressed by other regulations at the state and/or local level. Thus, a site-specific approach, in accordance with a hierarchical set of criteria should be followed. This approach recognizes that there are no Federal requirements for protection of water resources for a radioactive waste disposal facility. The site-specific hierarchical approach, rather than mandating specific performance objectives for all sites, is consistent with the EPA strategy for water resource protection, which recognizes that groundwater protection is a state and local matter.

The hierarchy reflects that applicable state or local laws will be the first drivers for water resource protection. In this case, the term "applicable" has some emphasis to reflect that not all water resource protection laws are universally applicable. It is important to assess the applicability of a standard within the context of the waste disposal facility and land use/institutional control plans.

Example:

> *(Compliance with state requirement for water resources protection.) The closest water resource impacted by the disposal facility is the groundwater. Peak concentrations during the compliance period 100 m downgradient from the disposal site are analyzed to determine if it meets the drinking water standards as specified by 40 CFR Part 141.66 over the compliance period. The impact on groundwater resources will be evaluated by comparing the predicted groundwater concentrations against the drinking water standards. The State of Washington has adopted the Federal drinking water regulations (revised as of July 1, 2009) for MCLs for radionuclides in Washington Administrative Code Title 246, Chapter 246-290 (WAC 246-290-025 and WAC 246-290-310), Radiation Protection Standards. As a result, no separate calculations are needed to satisfy the State of Washington drinking water standard.*

The second and third options refer to any formal agreements that have been made that establish criteria for the protection of water resources. The fourth option can potentially refer to standards for protection of drinking water either at a state or Federal level (e.g., 4 mrem/yr effective dose equivalent for beta/gamma). It is important to consider whether it is appropriate to use Maximum Contaminant Levels (MCLs), other derived concentration limits, or a 4 mrem/yr dose standard. Note that in cases where it is not specified to use an MCL, use of a 4 mrem/yr drinking

water dose standard for water resource protection allows for use of current DOE approved dose coefficients rather than relying on older dosimetry used to develop the MCLs.

2.2.2.6.2 Point of Assessment and Timing Assumptions

This section should provide the basis and assumptions for the points of assessment and associated time of assessment. During operations and active institutional controls, the POA for all pathways and the air pathway objectives are at the site boundary. Radon flux and radon concentration POAs are at the surface of the facility and facility boundary respectively. The POA should correspond to the point of highest projected dose beyond a100 m buffer zone surrounding the disposed waste following the loss of institutional controls, except for the radon flux, which is assessed at the surface of the cover. Water resource protection is applied at the 100 m buffer zone during operations and active institutional controls and after loss of institutional controls. Table 2-2 includes a summary of the locations of the POAs.

The POA should be consistent with Land Use and Institutional Control Assumptions. The buffer zone is 100 m from the disposed waste assuming the footprint of the disposal facility extends below ground and into the air above the facility. A larger or smaller buffer zone may be used if adequate justification is provided. The location of the POA and timing of the hypothetical loss of institutional control leading to potential intrusion should be based on justification provided in the Land Use and Institutional Control Assumptions (e.g., regulatory agreements, site-specific conditions) and design and engineering considerations (e.g., effectiveness of waste forms, containers or barriers in deterring intrusion for longer times). This section should also refer to the requirement in DOE O 458.1 for DOE to maintain control of land until it can be safely released or transferred to another party.

The peak during a 1,000-year time period after facility closure for the entire facility should be used for direct comparisons of results for compliance and as a basis for the disposal facility's WAC. This section should provide documentation to support an assessment period greater than 1,000 years, if required by other DOE programs and plans; or by other applicable Federal, state, or local statutes, regulations, or agreements. The approach for addressing potential peaks beyond 1,000 years should also be described.

Objective

Site specific implementation of assumptions for the POA and time of compliance are described.

Discussion

A site developing a PA should include the necessary content with sufficient detail for reviewers to identify the time of compliance, approach to address potential peaks after the time of

compliance, and POA for each performance objective and the inadvertent intruder performance measure.

Point of Assessment. DOE is required to maintain control over land containing radionuclide sources until the land can be safely released pursuant to DOE O 458.1 or transferred to another authorized party. In spite of this requirement, it is generally assumed that following the 100-year active institutional control period, a member of the public could reside near the disposal facility. The POA is the location of the highest projected dose outside of the buffer zone. A default buffer zone can be assumed that includes the area projected through the aquifer below, in the air above and extending horizontally with a 10 footprint surrounding the disposed waste (i.e., 100 m surrounding the disposed waste does not imply that the POA is in the air 100 m above the waste or to the aquifer, the POA is the point of highest concentration at least 100 m from the footprint of the disposed waste). The information in Land Use and Institutional Control Assumptions is used to provide the basis for the assumptions regarding the location of different types of receptors and can also be used to describe the basis for any deviation from 100 m. The use of peak concentrations in space and time around the facility implements the International Commission on Radiological Protection (ICRP) expectation to consider more highly exposed members of the public. The POA can change as a function of time depending on the nature of the releases from a disposal facility and evolution of the plume.

The concept of a buffer zone is inherent in defining a low-level waste disposal facility and a 100 m buffer zone is consistent with assumptions for 10 CFR Part 61. The disposal facility is comprised of a number of disposal units (e.g., earthen trenches, tumuli, and vaults), the space between disposal units, and space around the collection of disposal units. This latter space is called the buffer zone. The buffer zone provides some radionuclide containment capability, as well as controlled space to establish monitoring locations and, as necessary, modify or supplement the design of the disposal facility. Consistent with established radiation protection practices articulated by the National Council on Radiation Protection and Measurements (NCRP) and the ICRP, the projected dose attributable to any single source, practice, or activity should be some fraction less than the applicable overall dose limit.

The requirement provides flexibility in establishing the extent of the buffer zone considering site-specific issues. In certain instances, e.g., if the disposal facility is located adjacent to the current DOE site boundary, it may be more appropriate to use a smaller buffer zone. In other cases, e.g., where the disposal facility is located far from the DOE site boundary, and the site's land-use planning does not envision relinquishing control of the site, a larger buffer zone, potentially extending to the site boundary, could be considered. In any case, justification for the selection of the buffer zone should be provided.

The justification for the selection of the point of compliance and size of the buffer zone is based on land use plans and commitments that have been negotiated during consent agreements or

other regulatory actions. If land use planning has not progressed enough for commitments to exist, the justification could also be based on published information about site boundaries in documentation such as EISs. The justification could also be based on the proximity of already existing contaminated areas or nearby operational facilities that establish a boundary, or which would render the 100-meter point of compliance as unreasonable.

The buffer zone is to be established based on land use planning and commitments, a reasonable judgement concerning nearby facilities and areas of contamination, and natural borders (see example below). The buffer zone cannot be established arbitrarily, or moved to a specific distance to achieve a disposal objective, such as accommodating a large concentration of a mobile radionuclide.

Example:

> *A low-level waste disposal facility is located in a quadrant of the DOE site that includes several contaminated areas and other waste management facilities. The current land use plan negotiated with stakeholders at the site, and which is incorporated by reference in the Consent Order at the site, shows this land remaining under DOE control. The buffer zone for this facility is extended out to a point about half way between the disposal facility boundary and the site boundary.*

In the intruder assessment, it is assumed that there is a temporary loss of passive and active institutional controls after 100 years following disposal facility closure. The timing of this hypothetical loss of institutional control can be extended beyond 100 years based on justification provided in the Land Use and Institutional Control Assumptions (e.g., regulatory agreements, site-specific conditions) and/or design and engineering considerations (e.g., effectiveness of waste forms, containers or barriers in deterring intrusion for longer times). Approaches that have been successful for expanding the extent of a buffer zone or extending the time of effectiveness of institutional controls generally involve formal agreements with regulators to maintain controls over the facility or the land including the facility. The effectiveness of barriers in delaying the potential for inadvertent intrusion is discussed in the section on the Hypothetical Inadvertent Intruder in this Guide.

Active Institutional Control Period. Institutional control, for the purposes of PA, is assumed to last for a minimum of 100 years. Longer periods may be assumed with sufficient justification (e.g., formal regulatory agreements). However, the actual period of institutional control, when DOE maintains a custodial presence and controls the use of the land, is required to be maintained until the facility can be released. A low-level waste disposal facility or closed tank cannot be released until the requirements for public and environmental radiation protection of DOE O 458.1 for releasing a facility for unrestricted use are met. Institutional controls are no longer

necessary for a facility released for unrestricted use. Institutional controls are also addressed in "Land Use and Institutional Controls."

For low-level waste disposal facilities and tank closure, the period of active institutional control could extend long beyond 100 years before the requirements of DOE O 458.1 are met. The CP includes the necessary activities to be performed during this period of institutional control to ensure the protection of the public health and the environment, such as facility monitoring, custodial maintenance, access controls, corrective actions, passive controls and restrictions, reporting requirements, and record keeping. The determination of the necessary activities to be performed during the institutional control period is based on the documentation and analysis included in the facility radioactive waste management basis, including the performance assessment, composite analysis, closure plan, and monitoring plan. Institutional control measures should be incorporated into the site's land use and stewardship plans, programs and procedures to ensure that control of the site is not compromised. Throughout the period of institutional control, the responsibility for maintaining the facility to protect the public and the environment rests with the Field Element Manager (FEM).

Compliance Period. The compliance period is defined as a 1,000-year period after the assumed facility closure. A 1,000-year compliance period should be used for direct comparisons of results with the performance objectives in the context of compliance and as a basis for the disposal facility's WAC. 1,000 years is viewed as a reasonable time frame over which calculations have sufficient credibility and meaningfulness on which to base decisions regarding quantitative compliance. Beyond 1,000 years, assumptions and calculations become increasing speculative and uncertain and results need to be viewed with increasing caution. It is recognized that there may be circumstances where a regulator or other stakeholder requests calculations for a different time frame. In such a case, the basis for the different time frame needs to be described to clarify the purpose of the calculations.

Nevertheless, 1,000 years is not viewed as a cutoff to calculations, rather it is considered a point of transition in how results are interpreted. DOE expects that potential peaks will be addressed for times after 1,000 years. However, in the context of decision-making, peaks occurring at increasing time frames are addressed in an increasingly risk-informing and qualitative manner rather than from the perspective of quantitative compliance with a performance objective. Peaks occurring shortly after 1,000 years will be viewed more critically than peaks occurring many thousands of years in the future. An important consideration is changes in assumptions that could shift a peak from after 1,000 years to before 1,000 years (e.g., overly optimistic K_d values or barrier lifetimes that delay the appearance of a peak).

Consideration of potential peak impacts after 1,000 years is intended to provide additional information to support decision making. The calculation of potential peaks in the far future does present the possibility that there may be results that exceed the performance objectives. The

significance of these results needs to be addressed with caution and judgment recognizing the context of the assumptions on which the calculations are based (conservatism, speculation, uncertainty). The further out in time that the peak impacts are projected to occur, it becomes more important to take a risk-informed view of the significance of the specific values that are calculated relative to the inherent uncertainties. The discussion of peaks that may occur after 1,000 years represents best management practice in the conduct of PAs, but those maxima may be presented in forms other than a dose. The level of quantitative rigor expected for such calculations is also reduced for longer time frames consistent with the presence of increasing speculation and uncertainties associated with human evolution and catastrophic natural events that will overwhelm the effects of parametric uncertainties in the models. Nevertheless, consideration of performance for longer time frames should be used to provide additional insights about the behavior of the model of the site and the system being modeled that would not be available if the calculations were truncated at the time of compliance. This additional information may be useful in evaluating alternative designs and optimization of protection [As Low As Reasonably Achievable (ALARA)].

Potential alternatives to a strict dose limit for times beyond 1,000 years have been discussed. The concept of complementary safety indicators (e.g., concentrations or fluxes in the environment, comparisons against background, etc.) gained increasing attention in the mid-to-late 1990s and has subsequently appeared in international recommendations and standards. The term "peak impacts" is used rather than peak dose in this Standard to reflect the use of complementary safety indicators to provide additional perspective when considering performance in the far future. The recognition of the role of complementary indicators of impacts to aid decision-making for very long time frames reflects the ICRP position that dose estimates "should not be regarded as measures of health detriment beyond times of around several hundreds of years into the future" (ICRP 1998). Examples of complementary safety indicators include concentrations in the environment and fluxes in the environment or through engineered features (also see IAEA 2003, *Safety Indicators for the Safety Assessment of Radioactive Waste Disposal – Sixth Report of the Working Group on Principles and Criteria for Radioactive Waste Disposal;* IAEA 2012, *The Safety Case and Safety Assessment for the Disposal of Radioactive Waste*).

As introduced above, although calculations can be conducted for any selected time frame, caution should be exercised when interpreting dose results over time frames beyond several hundred years. For example, ICRP Publication 81, *Radiation Protection Recommendations as Applied to the Disposal of Long-Lived Solid Radioactive Waste, International Commission for Radiological Protection,* includes the following recommendations regarding the role of judgment when considering long-term projections:

> *"Demonstration of compliance with the radiological criteria is not as simple as a straightforward comparison of calculated dose or risk with the constraints, but*

requires a certain latitude of judgment. Neither should estimated transgression of a constraint necessarily oblige rejection, nor should numerical compliance alone compel acceptance of a waste disposal system. The dose or risk constraints should increasingly be considered as reference values for the time periods farther into the future, and additional arguments should be duly recognized when judging compliance [emphasis added]."

"To evaluate the performance of waste disposal systems over long time scales, one approach is the consideration of quantitative estimates of dose or risk on the order of 1,000 to 10,000 years. This approach focuses on that period when the calculation of doses most directly relates to health detriment and also recognizes the possibility that over longer time frames the risks associated with cataclysmic geologic changes such as glaciation and tectonic movements may obscure risks associated with the waste disposal system. Another approach is the consideration of quantitative calculations further into the future making increasing use of stylized approaches and considering the time periods when judging the calculated results. Qualitative arguments could provide additional information to this judgmental process."

The IAEA 2012 also includes recommendations regarding the consideration of very long time frames beyond 1,000 years for near surface disposal facilities:

"Safety assessment calculations should cover a time period that is long enough to determine the maximum, or peak, dose or risk. However, this may not always be possible. For example, in the case of disposal of long lived waste (e.g., from uranium mining) on or near the surface where there is uncertainty in the durability of engineered barriers (e.g., dams and covers), doses and risks may remain constant or may even increase long into the future, through time frames in which uncertainties in the assessment increase significantly and limit the meaningfulness of the assessment. This may limit the timescale for the assessment in general, or at least the timescale for quantitative assessments."

"For above surface disposal facilities (e.g., for waste from mining), the uncertainties in modelling results will already be substantial when considering periods of several hundred years, and quantitative estimates may become meaningless already beyond a period of a thousand years. For engineered near surface disposal facilities, which are subject to processes that may affect their integrity (e.g., erosion, human intrusion) to a lesser degree or with a smaller probability, modelling periods of a few thousand years may still be reasonable."

Thus, ICRP and IAEA recommendations support the concept that peaks occurring after 1,000 years for near surface disposal can be interpreted in a more qualitative, risk-informed context to

include comparisons to background radiation levels and concentrations, average annual exposure, trends in radionuclide releases relative to natural fluxes etc. rather than focusing strictly on quantitative, compliance-oriented comparisons to a dose constraint. This reflects the potential for catastrophic changes in the natural environment over these times. It is advocated to use calculations after 1,000 years to increase the understanding of the models and assumptions used and to optimize designs, but the results are not considered a requirement for directly determining compliance with the performance objectives. Likewise, they should not be ignored when considering acceptance of a disposal facility. Probabilities associated with consequences also become more important when considering very long time frames. Individual deterministic results become less significant in terms of decision making over very long times, because of the increasingly speculative nature of the results. Thus, there is an increasing need to consider likelihoods in conjunction with consequences at those longer time scales.

Example:

> *A situation in which a qualitative assessment of all pathways peak impact may be in order is an arid site characterized by an aquifer that lies far below the surface of the disposal facility. Under normal circumstances, the small amount of precipitation falling on the site results in low rates of infiltration through the disposal units. Radionuclides leached from the waste are slowly transported downward to the aquifer; a journey that may require thousands to tens of thousands of years to complete. The outcome may be peak groundwater impacts that occur well after 1,000 years. Faced with these conditions, quantitative modeling would be extended to estimate the migration of radionuclides for a period of several thousand years after the disposal facility undergoes final closure. Subsequently, a qualitative discussion would be provided that considers the potential for further impacts beyond this time in the context of the growing uncertainties associated with the evolution of the local geology, climate and human activities. This discussion might rely on projections of groundwater flow rates, taken from the quantitative modeling, and information about the decay and sorption properties of the radionuclides leached from the various sources to provide a broad estimate of when contaminants may appear in the aquifer. Lacking quantitative modeling, estimates of the magnitude of any exposures received far into the future would not be provided. However, general statements about the potential for impacts greater than those estimated during the initial thousands of years may be possible.*

Example:

> *The results of a PA for an engineered, near-surface disposal facility suggest that peak impacts may occur after 1,000 years. To address the potential peaks in the*

far future, quantitative sensitivity and uncertainty analysis calculations are extended for several thousand more years. Interpretation of these calculations is focused on identifying the key safety functions of the engineered and natural features that influence the timing and magnitude of the peak that is projected to occur. This is accomplished by identifying the assumptions having a significant influence on releases of key radionuclides from the waste form as well as the fluxes out of the disposal facility and concentrations in the natural environment. These results are used to identify design assumptions that can significantly influence the magnitude of the releases. Design modifications are proposed that are expected to reduce the magnitude of the peak and addressed in the ALARA analysis. Calculations of groundwater concentrations in the aquifer are also provided to illustrate the potential for catastrophic increases in impacts. The concentration results indicate that although some increases could potentially occur, the increases are not considered catastrophic in the context of the increasingly speculative nature of the uncertainties associated with the natural environment and human activities in the far future. Additional arguments are provided to address the potential for increases in concentrations at longer times beyond the calculations, but the increases were not considered significant in relation to the other potential catastrophic changes in the surface environment (e.g., ice ages).

2.2.2.7 Inadvertent Intrusion

Reasonable efforts should be made to provide engineered and administrative controls to address the potential for and/or consequences of doses to a hypothetical, inadvertent human intruder that may disrupt the disposal facility. Intrusion is assumed to occur after a temporary loss of institutional controls and memory of the disposal facility. The stylized analyses (i.e., drilling and basement excavation) for inadvertent intrusion should be based on credible (reasonably expected) exposure assumptions for current site-specific practices. The likelihood of inadvertent intruder scenarios can be considered when interpreting the results of the analyses and establishing radionuclide concentrations that can be disposed in the facility, if adequate justification is provided. It is more common to provide some qualitative discussion of likelihood to place results in perspective.

The results from the assessment of human intrusion should be considered as part of developing limits on the concentration of radionuclides that can be disposed in the facility (i.e., WAC). Active institutional controls are assumed to be effective in deterring intrusion during the period of active institutional control (usually 100 years) following the end of operations at the disposal facility. Delays beyond 100 years should be justified in the "Land Use and Institutional Control" assumptions or, for engineered/design features, should be justified in the detailed description of the analysis.

The potential for acute and chronic exposure scenarios should be considered. Acute scenarios involve exposures of people conducting drilling or excavation activities for a limited period of time (e.g., drilling a well, excavating a basement for a home). Chronic scenarios involve individuals establishing a residence and being exposed to materials exhumed from the site and distributed on the ground surface. Chronic exposure is assumed to result from external exposure to, and direct and indirect inhalation and ingestion of (e.g., plant uptake, bio-accumulation, etc.) radionuclides in the waste.

This analysis should use 100 mrem annual total effective dose, excluding doses from inhalation of radon and progeny, as the performance measure for chronic exposure from residing at or frequently visiting the disposal site following an intrusion event. The analysis should use 500 mrem total effective dose, excluding radon and progeny, as the performance measure for acute exposures during the event assumed to result in the disruption of the waste.

Objective

Site specific implementation of the performance measures and assumptions to consider potential inadvertent intrusion are described. Any assumptions that delay or preclude inadvertent intrusion relative to the default assumptions are also introduced.

Discussion

Although DOE intends to exercise control of the LLW disposal facility or tank closure facility until it can be safely released pursuant to DOE O 458.1, there is a requirement to consider the impacts of potential inadvertent human intrusion. However, since it is hypothetical and unexpected, intrusion is considered to be an accidental, temporary event and is compared with a performance measure rather than a performance objective. This perspective is consistent with ICRP and IAEA recommendations [ICRP Publication 81 and the IAEA *Disposal of Radioactive Waste, Specific Safety Requirements* (IAEA 2011)] to consider inadvertent intrusion in the context of optimization rather than against a dose constraint. Nevertheless, the results of inadvertent intrusion analyses are used as an input for development of waste concentration limits that would be considered when developing WAC for a disposal facility.

The intrusion event should be considered to occur due to a lapse in passive controls, after active institutional controls are assumed to be lost, that would be remedied within a time frame that limits the exposure time to one year or less. Notably, there is general international consensus that these requirements do not apply to the protection of individuals that knowingly/intentionally intrude into a disposal facility.

Timing of Intrusion. In the intruder assessment, active institutional controls are assumed to be effective in preventing intrusion for at least 100 years following disposal facility or tank closure; longer periods of institutional controls may be assumed with justification (e.g., land-use

planning, passive controls). Active institutional controls, as applied here, means that there is human involvement and an active presence in controlling and maintaining the facility.

It is not expected that there would be a complete loss of memory on day one following the end of active controls. It is possible to take credit for passive controls (e.g., records, land use restrictions, etc.) to extend the time of institutional control, although this is not common and requires substantial justification (e.g., formal expert elicitation, documented agreements with site regulators). Note that, in the context of activities conducted under 10 CFR Part 20, *Standards for Protection Against Radiation,* the NRC considers state or Federal government ownership and control to provide the most durable level of institutional controls (see NUREG-0706, *Final Generic Environmental Impact Statement on Uranium Milling, Project M-25,* Vol. 1, M.2). The timing assumptions need to be consistent with the information in "Land Use and Institutional Controls."

Engineered features of the disposal/closure system such as intrusion barriers in a cap, concrete vault, or the waste form, may also be effective in deterring inadvertent intrusion into the facility for an extended period of time. If barriers are credited for delaying intrusion, degradation of the barriers (e.g., erosion, subsidence, biointrusion, concrete degradation, etc.) needs to be addressed and durability against intrusion should be defended based on current drilling and basement construction practices in the region. For inadvertent intrusion analyses in the context of Tank Closure PAs, it is generally accepted that a closed tank (e.g., filled with grout) is considered to be a robust, stable form. Thus, inadvertent drilling into a closed tank can be assumed to only occur after 500 years, which is consistent with NRC scenarios considered for developing the classification system in 10 CFR Part 61. Note that other features in a tank farm (pipelines, etc.) are generally assumed to not provide a significant barrier, thus inadvertent intrusion is assumed to possibly occur following the assumed loss of institutional controls. Credit for longer delays beyond the 100-year active institutional control period or 500 years for robust, stable waste forms (e.g., robust concrete barriers), respectively, may be possible with proper justification based on local conditions. Substantial justification (e.g., independent review) should be provided.

Stylized Analyses and Performance Measures. Inadvertent intruder assessment is conducted using a limited set of illustrative scenarios. DOE provides a framework for stylized scenarios using two classes of exposures consistent with scenarios considered for the classification system in 10 CFR Part 61. Residential/future use and active construction/drilling activities are considered. The residential or future use scenarios are referred to as Chronic (long-term, lower exposure) and the drilling/construction scenarios are referred to as acute (shorter-term, higher exposure). If the doses from chronic or acute scenarios can be demonstrated to bound the doses of the other scenarios, only the bounding type of scenario needs be analyzed and presented in detail.

Two performance measures are considered in intrusion assessments. For chronic exposure scenarios (i.e., continuous or ongoing exposures for a hypothetical resident at the facility after an intrusion event), the performance measure is 100 mrem (1 mSv) in a year, total effective dose. Thus, applies to exposures associated with waste remaining in the facility and cuttings/excavated material brought to the surface as a result of the intrusion. DOE's use of 100 mrem/yr for chronic scenarios by DOE rather than 500 mrem for chronic scenarios used for the basis for 10 CFR Part 61 provides some added margin. With this more restrictive value, DOE does not require that contributions from the groundwater pathway be included in this analysis. The underlying assumption is that groundwater protection is sufficiently addressed in the water resources and all pathways dose performance objectives, which use performance objectives significantly less than 100 mrem/yr. For acute exposure scenarios (i.e., one time only events or single exposures to hypothetical people involved in constructing a basement or drilling a well), the performance measure is 500 mrem (5 mSv) in a year, total effective dose. Doses from the progeny of radon that are present in the disposed waste should be included in the intruder analyses, but the chronic and acute performance measures exclude doses from radon and its progeny via the air pathway.

Basement evacuation scenarios use the assumption that a 3m deep excavation is made [[NUREG-1757, Vol 2, *Consolidated Decommissioning Guidance, Characterization, Survey, and Determination of Radiological Criteria,* NUREG/CR-4370, *Update of Part 61 IMPACTS Analysis Methodology*, Kennedy and Peloquin (1988)[8]]. The drilling scenario is generally based on drilling practices in the local area. However, each of these scenarios may not need to be assessed in all cases (e.g., maintaining > 3m of clean cover, even after erosion or other natural processes, will preclude excavation of waste during a basement scenario) or drilling or excavation scenarios may be delayed by robust barriers as described above. It is generally expected that some form of drilling scenario will need to be considered after barriers have degraded.

The use of stylized scenarios addresses the need to ensure that PAs do not become extreme in their analyses via undue speculation about the activities and lifestyles of future generations. Thus, the requirement is to assume that customs and practices of today continue into the future for the purposes of a stylized/illustrative analysis. This provides a more common basis across the complex for conducting analyses. The representative person construct should also be used for dose calculations for the inadvertent intruder scenarios.

In general, intruder scenarios should be developed considering the following:

- Intruders may carry out activities for no more than about a year before discovery.

[8] Kennedy, Jr., W.E. and R.A. Peloquin, *Intruder Scenarios for Site Specific Low-Level Radioactive Waste Classification*, DOE/LLW-71T, 1988

- An intruder may perform reasonable activities consistent with regional social customs and well drilling, excavation, and construction practices, and the regional environmental conditions projected for the time that intrusion is assumed to occur.
- Intrusion events may involve random contact with waste, but some materials may serve as effective barriers to direct contact. This could apply for activated metals and reinforced concrete vaults or containers for the time frame that they maintain sufficient integrity depending on drilling methods.
- An intruder will usually take reasonable, investigative actions upon discovery of unusual materials.
- Intrusion events that contact waste may be assumed to be limited to drilling or simple excavation scenarios involving use of relatively unsophisticated tools and commonplace machinery.
- Doses calculated for an intruder will depend on waste disposal facility design and operating practices, and may be reduced and/or delayed by practices such as disposal below depths normally associated with common construction activities, use of engineered barriers or durable waste forms or containers, or distributed disposal of higher-activity waste.

Example:

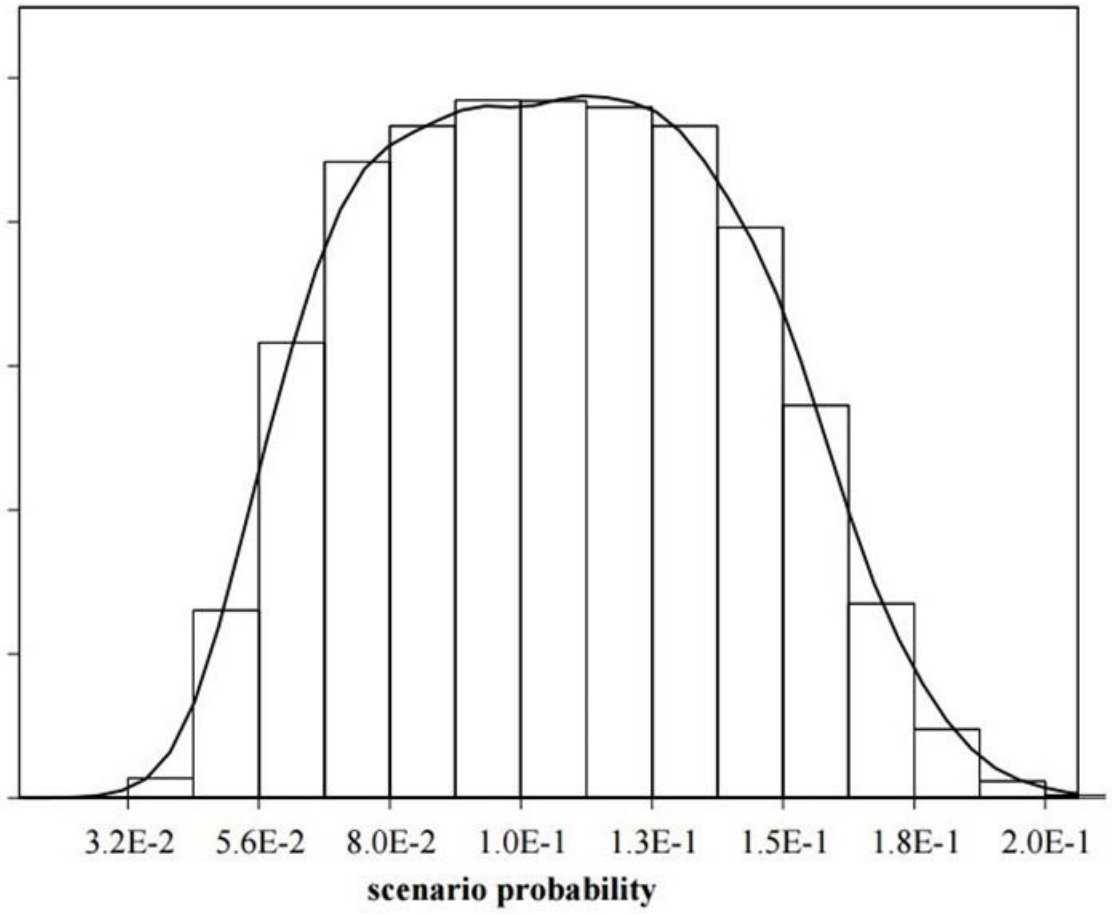
> *A disposal facility is developed in a location comprising soils and unconsolidated sediments. The facility includes the use of reinforced concrete barriers above the waste. Common drilling methods for wells in the area are designed to drill through soils rather than robust materials. Thus, it is assumed that a drilling scenario that would penetrate the reinforced concrete barrier would not be reasonably expected to occur until the barrier is assumed to lose its physical integrity. Thus, the impacts of inadvertent intrusion are not assumed to occur at 100 years and are delayed until several hundred years in the future.*

For the purposes of establishing waste acceptance requirements on the disposal facility or evaluating potential impacts of tank waste residuals, the likelihood of intruder scenarios may be addressed. Justification of intruder scenarios' probabilities needs to be included if used in the intruder assessment. As an alternative, a qualitative discussion can be included describing the relative likelihood to provide perspective on the robustness of the system, but not formally credited in the analysis.

Example:

> *Expert elicitation was conducted to identify a reasonable estimation of the probability of inadvertent intrusion. The process resulted in a probability distribution reflecting a range of probabilities that inadvertent human intrusion*

would occur that were applied in a probabilistic PA. Figure 2-2 is an illustration of the distribution that was used, where the central, most likely value of the distribution is roughly a 10 percent probability of occurrence.



Estimated distribution of the overall probability of IHI overlaid on the simulated relative frequency distribution.

Figure 2-2: Example of a Distribution of the Probability of Inadvertent Intrusion

Justification for probabilities of scenarios or timing of scenarios can also include consideration of engineered barriers and their effectiveness in delaying or precluding potential intrusion. For example, robust steel reinforced concrete vaults or containers can serve to preclude the potential for drilling or basement construction to contact the waste while they maintain their integrity. The design of a container could also serve to reduce the probability of contacting the waste when drilling (e.g., potential deflection of the drill bit). There is also a likelihood associated with the potential for direct contact with any specific container in the context of the areal extent of the

disposal facility. Although inadvertent intrusion should be assumed to occur at the time of loss of institutional controls, it can be assumed to be a random event within a disposal facility.

Example:

> *Site X has disposed of a discrete higher activity waste form after conducting a Special Analysis to supplement the approved PA, to demonstrate that the disposal of the waste form will be within the performance objectives and measures specified in this Order. The random location of a hypothetical inadvertent intrusion within the footprint of the facility was considered when addressing the likelihood of direct contact with this specific container.*

2.2.2.7.1 ALARA Analysis

The ALARA process should be used to optimize the LLW disposal facility performance by applying a graded approach to optimization of the disposal system for maintaining doses to members of the public (both individual and collective) and releases to the environment as low as reasonably achievable, per DOE O 458.1. This analysis should reflect a graded approach recognizing the relative hazards associated with disposed waste as compared to other nuclear operations when considering the need for design or other modifications of disposal facilities or other closure activities.

Objective

Describe the approach applied for the PA to consider ALARA requirements. The details for the analysis and results may be provided here or can be provided in a specific section.

Discussion

DOE's approach to radiation protection for LLW disposal is based on two key components. One component is the performance objectives described above, which specify maximum impacts for various pathways. The other component is the ALARA principle where impacts should also be optimized below the performance objective.

DOE has developed a handbook (DOE-HDBK-1215-2014, *Optimizing Radiation Protection of the Public and the Environment for use with DOE Order 458.1, ALARA Requirements*) to assist program and field offices in understanding what is necessary and acceptable for implementing the ALARA provisions of DOE O 458.1, which are also applicable for DOE O 435.1. The handbook identifies the goals, requirements and issues that need to be addressed when developing ALARA analyses for optimization of various programs to support DOE's diverse missions. Various case studies and examples are also provided to further assist in implementing the ALARA process.

DOE's ALARA process helps ensure that optimization techniques will be integrated into the design and analyses of programmatic options necessary for the protection of the public and the environment in accordance with the requirements of DOE O 458.1. As much as possible, DOE sites should consider using existing processes, programs or documentation for addressing the provisions of DOE O 458.1 and DOE O 435.1 in the development and implementation of the ALARA process. It is important to recognize that optimization is not minimization. Optimization is the result of an evaluation that carefully balances the benefits from exposure reduction (e.g., health, regulator and public goodwill, etc.) with the costs (e.g., economic, schedule, social, etc.). Thus, the best option is not necessarily the one with the lowest dose.

Potential long-term hazards associated with waste disposal considered in PAs are generally low relative to active nuclear facility operations. Thus, it is important to use a graded approach to address ALARA requirements. DOE-HDBK-1215-2014 includes recommendations to help guide the necessary level of analysis (Figure 2-3):

> "It is difficult to be prescriptive in setting guidelines for the level of ALARA analysis because many factors – both technical and societal in nature – can influence such an evaluation. A detailed quantitative ALARA analysis may only be necessary for major actions. DOE has therefore opted to provide flexibility in selecting the level of analysis. "Reference" dose levels have been established to help determine the level of effort required for an ALARA analysis. In general, if the dose to the maximally exposed individual (MEI), or the representative person of the critical group, is much less than 1 mrem (0.01 mSv) in a year and the collective dose to the exposed population is less than 10 person-rem in a year, only a qualitative ALARA analysis is warranted. When doses are near the reference levels, it may be necessary to evaluate the alternatives semi-quantitatively. However, if individual doses are significant compared to the primary dose limit, e.g., tens of millirem in a year, or the collective dose exceeds 100 person-rem in a year, a quantitative ALARA analysis is recommended."

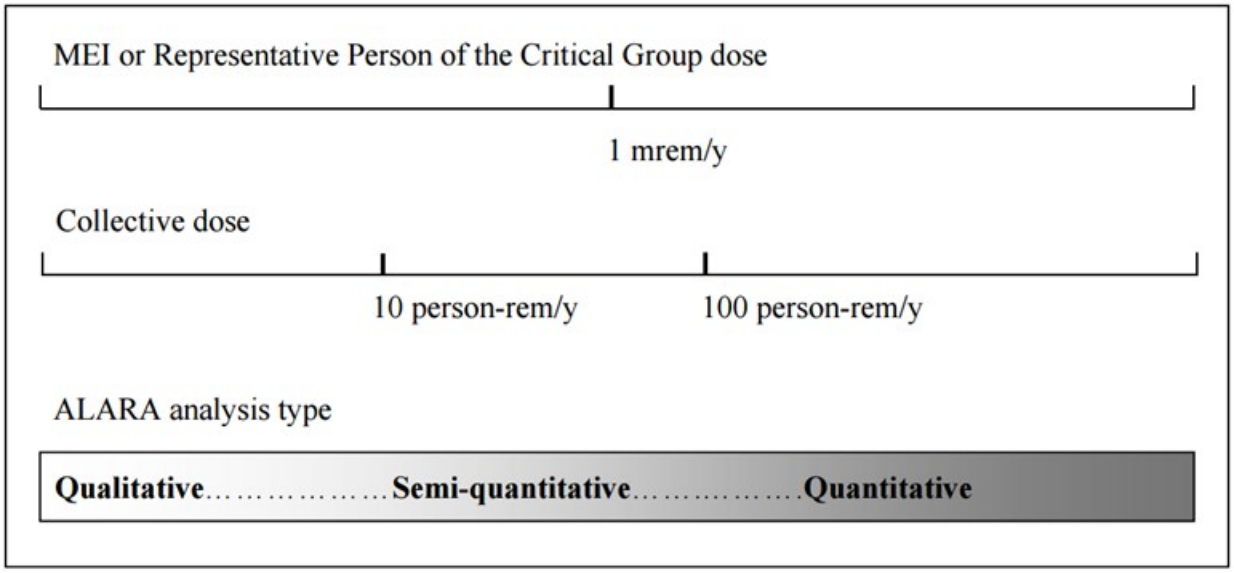


Figure 2-3. General Guidance for Determining the Level of ALARA Analysis Required

Per DOE-HDBK-1215-2014, a qualitative ALARA analysis is done by describing alternatives and comparing the costs and benefits without estimating their monetary or numerical values. A simple "pros and cons" analysis is an example of a qualitative type of analysis. A semi-quantitative ALARA analysis develops alternative descriptions and estimates of the costs and benefits which can be enumerated readily, but may lack a comprehensive numerical comparison employing all factors. Although numerical criteria (some subjectively assigned) may be used to help rank alternatives in the decision process. Examples of the different types of analyses are provided in the handbook.

Example:

> *An EIS was prepared to consider alternatives for waste tank closure at the site. The EIS considered social, technical, economic and public policy aspects. Thus, the selected option from the EIS has addressed key considerations for an ALARA analysis and the options considered and conclusions from the EIS can be cited as part of the basis for demonstrating meeting the ALARA requirement. Furthermore, NDAA Section 3116*[9] *and DOE O 435.1 require that highly radioactive radionuclides be removed from the tanks to the maximum extent practical, which is another ALARA consideration. The PA included a variety of calculations and sensitivity and uncertainty analysis to consider the impact of different design and barrier assumptions and to consider peaks well beyond the*

9 National Defense Authorization Act (NDAA), Fiscal Year 2005 (NDAA FY2005)

1,000-year compliance period. Given the variety of cases considered, other documentation of alternatives analysis, and the fact that the peak doses for the compliance period were below 1 mrem/yr for the compliance case, it was determined that a quantitative ALARA analysis was not necessary for the PA.

2.2.2.7.2 Other Requirements

This section should summarize any requirements that should be met per external regulations (e.g., Resource Conservation and Recovery Act (RCRA), CERCLA, 40 CFR Part 191) and the means for demonstrating compliance (e.g., via separate documentation for those regulations, crosswalk). This may include: Records of Decision for environmental restoration under CERCLA, agreements for remedial action under RCRA, agreements associated with tank closure [e.g., NDAA Section 3116 of P.L. 108-375, *Waste Determinations with Related Disposal Performance Assessments* (NDAA FY2005)], or agreements on groundwater management and protection.

Objective

Identify and describe any additional regulatory requirements or agreements that apply and the approach used to meet those requirements.

Discussion

This section of the PA should present a discussion of all applicable relationships for the disposal facility or tank closure between the waste management assessments, plans, and evaluations at the DOE site to provide the site-specific regulatory context within which the PA has been prepared (e.g., closure, monitoring, and land-use plans, site treatment plans, environmental impact statements, ground water protection management plans). This section should also describe any institutional relationships, agreements, or commitments that may affect the performance criteria for the disposal facility, including any stakeholder workshops or meetings that were convened. As applicable for the disposal facility or tank closure, the following examples should be identified and discussed or citation provided for further discussion in the PA (e.g., land use in ”Land Use and Institutional Controls”:

- Any relevant agreements between the DOE, the EPA, or other Federal agency, including other offices from DOE (e.g., NNSA, NE, Office of Science (SC), etc.) or the state, including agreements or Records of Decision (RODs) for environmental restoration of waste disposal sites under CERCLA, agreements for remedial actions under RCRA, or agreements on groundwater protection, and any other relevant agreements;
- Any planned or completed evaluations or documents prepared to comply with the NEPA, with mention of the specific activities evaluated in each document; and

- Any SARs in accordance with DOE Order requirements, and any operational requirements, such as waste acceptance requirements or information relevant to the long-term performance of the disposal facility.

Tank closure and development of disposal facilities for remediation wastes involve external regulators and additional regulatory requirements. These additional requirements often involve a need to prepare different documentation with redundant information (e.g., a PA and a remedial investigation/feasibility study). A crosswalk may be prepared that identifies the location of the information required for the PA that was prepared in other regulatory documents. The crosswalk needs to be specific enough for a reviewer to easily identify the information provided in the other documentation to satisfy content requirements and review criteria for the PA (e.g., citations should be page and section specific, as applicable). When determining the appropriate location for a given description or analysis, it is expected that DOE-specific requirements (e.g., inadvertent intrusion, dose calculations) are documented in the PA, because DOE has the authority for the review and compliance determination.

Executive Order 13653, *Preparing the United States for the Impacts of Climate Change*, was issued to address sustainable practices and take actions to consider potential impacts of climate change. For waste disposal, this will include operational safety and long term performance impacts addressed in the PA and CA. From a PA and CA perspective, potential climate change impacts are addressed by considering potential changes in the natural system (e.g., changes in erosion/deposition, changes in infiltration/recharge).

It is generally recommended to submit a draft crosswalk to the LFRG Co-Chairs for informal review early in the PA process. This is also an opportunity to gain approval to deviate from the recommended structure of the PA report in this Standard.

2.2.2.8 Land Use and Institutional Controls

This section should summarize the current predominant land use and assumptions regarding future land use in vicinity of the disposal facility that influence the timing and location of points of assessment used for compliance. The summary should include:

- Any land use or land use changes that affect points of assessment as a function of time and the timing of hypothetical inadvertent intrusion; and
- Citations or reference to relevant documents or agreements serving as the basis for land use and institutional control assumptions.

Objective

Identify and describe land use and institutional control assumptions that form the basis for the selection of the POA as a function of time and also determine when inadvertent intrusion needs to be considered as a possibility.

Discussion

DOE maintains control over the disposal facility until it can be released in accordance with DOE O 458.1. Nevertheless, for the purposes of the PA, the default assumption is that institutional controls are maintained for 100 years. This section summarizes information on land use in the area of the facility to provide perspective on the likelihood and types of potential exposure scenarios in the area and when and where those exposures could occur. Any formal agreements and regulatory commitments for institutional controls documents specific agreements and commitments for institutional controls that form the basis for assumptions about the timing and location of the POA are also documented.

Commitments to institutional controls, industrial land use, etc. should be included here, although it will be necessary to justify their effectiveness in order to consider an extension of the length of time institutional controls can be effective for a PA. There are examples where a combination of documented agreements and expert elicitation have been used to justify an extended period before intrusion can occur, (e.g., roughly another 100 years) but are not expected to preclude the need to address inadvertent human intrusion when developing waste acceptance criteria. Although it is possible to justify the effectiveness of institutional controls beyond 100 years, it is more common that agreements or regulatory commitments are used as a demonstration of added defense-in-depth rather than trying to justify a change in assumptions regarding future exposures. This is different from assumptions for hazardous waste disposal facilities where controls are assumed to be able to be maintained in perpetuity or for remedial actions, where in some cases it is accepted to only allow industrial or other land use that limits the potential exposure scenarios. There also may be situations where extensions of the active institutional control period are mandatory and judicious, for example to provide for continued surveillance and maintenance of the closure cap in cases where settlement/subsidence or other disruptions to the closure cap are a concern for the PA.

Example:

> *Site X closed their onsite LLW disposal facility and has performed a final performance assessment and closure plan. The site assumed a 50-year active institutional control period where the site will be fenced in and will have employees that perform periodic inspections of the facility for possible intrusion and for subsidence, drainage, etc. This scenario was evaluated in the PA and the*

closed site will meet all performance objectives throughout the compliance period.

Example:

Site Y has closed their onsite LLW disposal facility. The final PA and closure plan has identified an active institutional control period of 125 years. This assumption is based upon a land use plan that is signed by the DOE and agreed to by the State regulators that includes the LLW disposal facility being identified on local government property maps, a fenced that surrounds the facility, permanent markers every fifty yards that identify the area as a radioactive site and DOE personnel actively inspecting the facility on a scheduled basis for intruders. This well documented institutional control plan is included as part of the closure plan.

2.2.2.9 Summary of Key Assumptions

This section should summarize the key assumptions in the PA important to projected performance of the disposal facility with specific emphasis on assumptions related to key uncertainties or data gaps that will be addressed as part of the maintenance process or need to be protected in design, operating or closure documents should be included. Assumptions related to design, operations and closure that need to be protected by the facility operators and transferred to the closure and institutional control authority should be identified and communicated to the appropriate organization and captured in designs and operating procedures, as appropriate.

Where certain key assumptions are associated with uncertainties or data gaps that will be addressed as part of the PA maintenance process, these assumptions should be presented in such a way that the implications of the uncertainty, approach for managing the uncertainty, and required actions are clearly understood. Significance of these key assumptions should be put in context by explaining relevance to controlling pathways or scenarios analyzed.

Objective

Identify and describe key assumptions that have the greatest influence on the conclusions of the PA. Specifically identify assumptions that need to be protected in operating, design or closure documentation and assumptions that are being addressed through the PA maintenance process (e.g., to address secondary issues from an LFRG review team).

Discussion

This section should highlight key assumptions used in the PA that are most critical to the analysis of performance. This could include, for example, the assumed future boundary of land controlled by DOE, assumed design and/or performance of a cover system, or simplifying

assumptions made to facilitate groundwater flow and transport modeling. The significance of these assumptions should be put into context by explaining their relevance to the controlling pathways or scenarios analyzed, key assumptions, or their use in justifying a point of compliance (i.e., beyond a 100-meter buffer zone surrounding the waste).

Certain key assumptions may be associated with uncertainties or data gaps identified in Secondary Issues from an LFRG review that will be addressed as part of the PA maintenance process. These assumptions should be presented in such a way that the implications of the uncertainty and the actions needed to manage the uncertainty are clearly understood. This information can then be readily used to support the PA maintenance process. Specific uncertainties and data gaps that need to be addressed through research and development should be highlighted so they can be documented in the PA/CA MP.

Assumptions related to design, operations and closure that need to be protected by the facility operators and transferred to the closure and institutional control authority should be identified and communicated to that organization and captured in designs and operating procedures, as appropriate. Significance of the assumptions needs to be put in context by explaining relevance to controlling pathways or scenarios analyzed.

Examples of key assumptions:

- *Active institutional control will be maintained for 100 years;*
- *Minimum of 4 feet of native soil will be placed over the waste;*
- *At least 25-feet should be maintained from the bottom of the waste to the aquifer;*
- *No more than 25 Ci of Tritium may be disposed in the facility; and*
- *Only onsite LLW will be accepted for disposal.*

2.2.3. Site and Facility Characteristics

These sections should provide detailed descriptive information and data for the DOE site, the environment, and disposal facility to provide the basis for the conceptual model. Documentation of key site-oriented parameter values used in the models (e.g., precipitation rates) and citations should be provided.

Additional emphasis is expected for characteristics that are important drivers for the disposal system performance. Information to support the development of ranges/distributions should be provided or referenced in this chapter. Development of the ranges and/or distributions of input parameters and failure modes/scenarios should be discussed either here or with the discussion of the conceptual and mathematical models.

A total systems approach, recognizing the interrelationship of site characteristics and the conceptual facility design should be provided. In addition, reasonably foreseeable natural processes (e.g., climate impacts, erosion, subsidence, burrowing animals, etc.) that might disrupt natural and engineered barriers should be addressed. All information sources should be clearly referenced, and significant changes from previous PAs or other modeling efforts should be identified.

Objective

This Chapter provides the detailed information about the site and disposal facility (natural and engineered features) that form the basis for development of the conceptual models. Uncertainties and potential alternative representations of key components of the system are also described.

Discussion

This Chapter should provide descriptive information and data for the DOE site, environment, LLW disposal facility, and LLW characteristics to provide the basis for the conceptual model of the disposal facility and site, and to support a thorough understanding of the method of analysis. The information in this section comprises a detailed description including specific sources for data and uncertainties associated with the data, including potential alternative interpretations that may need to be considered. The emphasis of information in this section should be on those characteristics that are important to the performance of the disposal system, the source term models, the transport models, and the dose analysis. The roles of the key features in terms of limiting the eventual impacts of the disposal facility (safety functions, e.g., Nuclear Energy Agency (NEA) 2012, *Methods for Safety Assessment of Geological Disposal Facilities for Radioactive Waste – Outcomes of the MeSA Initiative*) should be summarized in preparation for the development of conceptual models and scenarios to be considered. The information provided should also be developed with a view towards identifying relevant features, events and processes (FEP) and screening FEP that are not significant. Safety functions and FEP will be considered for the development of the scenarios and conceptual models.

A graded approach should be used to assure that an appropriate level of detail commensurate with the relative importance and quantity and quality of available information is presented. For example, if a PA of a similar facility has previously been performed at the same DOE site, it may be possible to summarize the information and cite the other reports for the detailed description. In any event, the level of detail provided (either directly, in appendices, or references) should be sufficient to allow an independent reviewer to conclude that the site-specific analysis of performance is complete, logical, technically correct, rigorous, and defensible.

Probabilistic approaches for the PA or the sensitivity and uncertainty analyses will require distributions for key parameters and may also consider alternative conceptual models. The basis for any distributions provided should be justified, especially considering the quality and

applicability of the information on which the distribution is based. Often simplified distributions are selected reflecting a lack of information. The potential for risk dilution should be considered when estimating distributions.

When developing site and facility characteristics, it is required to address reasonably foreseeable natural processes. The emphasis is placed on identifying processes that are expected to significantly influence the conclusions of the analysis regarding the ability to meet the performance objectives.

The term “reasonably foreseeable natural processes” is used to clarify expectations for assessments addressing the long-term evolution of the natural and engineered systems and the ability to maintain releases at acceptable levels. The emphasis of the consideration of natural processes is focused on the 1,000-year period of assessment for comparison with performance objectives. Natural processes that have a significant likelihood of impacting natural or engineered features over that time frame need to be described in the context of the continuing ability for the disposal facility to meet the performance objectives. It is also important to address potential impacts of natural processes in the far future after 1,000 years, but such consideration should be placed in context of the growing uncertainties and speculation associated with human behavior, natural process and broader more catastrophic impacts that are expected to occur in the far future (e.g., glaciation, meteors, etc.).

Consideration of natural process should be put in the context of the ability of natural and engineered barriers to continue to fulfill their intended role to provide reasonable expectation that performance objectives will continue to be met. The use of concepts like “safety functions” that has been advocated internationally can help to focus on the specific roles that different barriers need to perform in order for the performance objectives to be met. Understanding the roles that are expected of each barrier in terms of limiting migration helps to focus on how changes in the system could lead to a situation where those roles cannot be fulfilled and potential for compromised performance.

The roles of natural processes are captured through the definition of the conceptual model and scenarios for the evolution of the facility. It will be necessary to provide supporting information documenting the basis for the conceptual model and reference and alternative scenarios considered as part of the PA. A graded approach is recommended where the level of detail in a conceptual model may be more simplified at the start of the process and refinements are added in areas that are deemed important for the conclusions of the analysis that support decision-making.

As PAs will be updated as part of the maintenance process, it is very important that all sources of information presented in this section be clearly referenced (page, section, and table/figure specific references), including the date of the information. This will help assure that updates incorporate the most recent data.

2.2.3.1 Site Characteristics

The Site Characteristics subsections should:

- Include the relevant natural and demographic characteristics and data for the disposal site and surrounding area in sufficient detail to provide a basis for the conceptual model of the site- and facility-behavior;
- Address reasonably foreseeable natural events that might disrupt barriers (e.g., severe storms, tornados, and seismic events);
- Highlight key parameters and assumptions and provide information to serve as a basis for development of ranges/distributions to support consideration in the sensitivity/uncertainty analysis and incorporate into the PA maintenance activities, as applicable; and
- Provide a brief explanation of how the information is used in the PA.

2.2.3.1.1 Geography and Demographics, Populations, Use of Adjacent Lands

Describe the regional setting for the DOE site and the disposal facility (e.g., distance and direction to nearby towns, rivers, or other natural or man-made landmarks). A site map clearly indicating the regional setting, the boundaries of existing or proposed disposal site, and the future boundary of DOE controlled land should be included. Any planned or expected need for expansion of the disposal facility should be described to the extent necessary for a reviewer to understand the analysis of site performance.

Site Description. Provide a general description of the disposal facility and surrounding area including the physical area, actual disposal facility, general vegetation type, topography, and location relative to nearby bodies of water, roadways, or other landmarks. Include any nearby features that are potentially significant relative to the long-term performance of the facility (e.g., nearby dams).

Population Distribution. Present existing and projected area populations to support the land use plans related to the site and specification of the POA included in the PA.

Use of Adjacent Lands. Summarize relevant historical and current land uses in the vicinity of the disposal facility. Emphasize predominant uses that could potentially impact assumptions regarding performance of the facility (e.g., large scale irrigation changing recharge or aquifer assumptions) and any relevant uses that could be adversely affected by releases of contaminants from the disposal facility.

2.2.3.1.2 Meteorology and Climatology

Provide a general description of regional and site-specific climatological conditions, with an emphasis on local meteorology and microclimate, in sufficient detail to support the conceptual model for the disposal facility and associated modeling of site performance. This section should serve as the basis for assumptions related to precipitation and natural recharge, which are generally a significant consideration for a PA. Ranges and distributions of precipitation and recharge data should be discussed. Information to serve as the basis for development of ranges and distributions that would be used in the PA should also be provided or citations should be included for more details. Examples of how changes in precipitation and recharge (e.g., natural cycles, climate change) have been addressed is available in existing PAs and additional information on climate change can be found at www.climate.org.

If necessary to support assumptions, the relationship between regional atmospheric conditions and local meteorological conditions should be described. Include any interpretations of data for defining parametric values used in the PA or provide reference to another section/appendix where this information is provided. Include a brief discussion of the data on which meteorological and climatological characterization are based, including locations of meteorology stations and duration of data collection.

To the extent practical, the PA should assess the potential impacts of reasonably foreseeable natural phenomena that could impact the facility (e.g., tornadoes, storms, water or wind erosion, freeze-thaw) and longer-term climate change (e.g., increased storm frequency, changes in average precipitation and groundwater levels) and identify opportunities to incorporate principles of sustainability into waste facility design and operation. Potential impacts on groundwater levels and flow directions and rates resulting from significant changes in precipitation also need to be addressed.

2.2.3.1.3 Ecology

Provide relevant information derived from existing site surveys, environmental impact statements, or other analyses concerning plant and animal species and communities important to long-term performance of the disposal facility, including burrowing insect or mammal populations, major plant communities, or vegetation types influencing cover performance. This information should include reasonably foreseeable long-term changes in biological processes.

2.2.3.1.4 Geology, Seismology, and Volcanology

Provide relevant information on the geologic, seismic, and volcanic characteristics of the site and the region in sufficient detail to support the conceptual model and the performance analysis. Provide applicable information on the history and frequency of regional natural processes and phenomena that are reasonably foreseeable (e.g., earthquake frequency, volcanic eruptions).

2.2.3.1.5 Hydrology

Data and results of technical analyses that describe the surface and groundwater hydrology of the site and vicinity in sufficient detail to support the conceptual model and the performance analysis should be presented. Include descriptions of existing surface and groundwater users and community water systems near the facility and planned future development of water resources.

Surface Water. Provide characterization of disposal site drainage and the surrounding watershed, including topographic maps showing elevations and relevant system features, natural drainages, and man-made features. Describe the location, size, shape, and other hydrologic characteristics of relevant surface water bodies near the site, including sources of potable water.

Vadose Zone and Aquifer. Provide relevant information, including uncertainties, that describes the hydrogeologic setting to be used in the development of the conceptual model and the performance analysis. Known factors that result in changes to the migration of groundwater over time should also be identified (e.g., existing high points in an aquifer resulting from previous operations that are decreasing over time).

Provide the direction and velocity of unsaturated flow, total and effective porosity, hydraulic conductivity, specific retention and relative permeability relationships, saturated hydraulic conductivity, and volumetric water content sufficient to support the conceptual model, including references and sources of information used in modeling (e.g., monitoring wells and boreholes at or near the disposal site.)

Provide data describing the saturated zone including lateral extent and thickness, flow directions and velocities, effective and total porosity, saturated hydraulic conductivity, and storativity (storage coefficient) for each potentially affected aquifer sufficient to support the conceptual model. Include sources of information used in development of groundwater modeling.

Include existing concentrations of radionuclides in groundwater, if relevant to the water resources impact assessment.

2.2.3.1.6 Geochemistry

Applicable background information and data to support the geochemical assumptions and conceptual model should be presented. Include information and data describing the water chemistry and geochemistry for the surface and subsurface environment at the disposal facility. Include significant physical parameters (e.g., temperature) and chemical data such as pH, dissociation constants, oxidation/reduction characteristics, and concentrations of inorganic and organic constituents necessary to support the conceptual model. Include information characterizing the significant chemical features of soils and rock units at the disposal site to support the conceptual model of the facility and the modeling of the facility performance.

2.2.3.1.7 Natural Resources

Describe current or reasonably foreseeable exploitation of natural resources in the vicinity that impact the conceptual model of the facility and any related assumptions in the analysis of performance. Provide a description of any economically valuable natural resources, their location, the degree of current or potential exploitation, and the potential impacts on the facility.

Geologic Resources. Provide a description of location and extent of ores, fuels (e.g., coal), hydrocarbons (e.g., gas, oil), industrial mineral deposits (e.g., sand, gravel, clay, building stone), geothermal resources, and any other significant resources in the area of the site that would affect the analysis of performance.

Provide current and projected use estimates including at least a qualitative discussion of economic value and feasibility of recovery.

Water Resources. Provide data on use of surface and groundwater in the area that may be affected by the site. Provide relevant features of typical well construction in the region, drilling methods, dimensions, to support development of intrusion scenarios. Present anticipated effects of water use relevant to the conceptual model of the facility and associated modeling of site performance.

2.2.3.1.8 Natural Background Radiation

Present concise summary of relevant natural environmental radiation from facility and surrounding area.

Objective

This section provides the detailed information about the site and natural system that form the basis for development of the conceptual models.

Discussion

This section of the PA should present the relevant natural and demographic characteristics and data for the disposal site and surrounding area. The safety functions of the different features should be introduced with any insights as to the relative significance in the context of the total system, as applicable (e.g., sorption, dispersion and dilution in groundwater, delay and dispersion in the vadose zone). The use of the concept of safety functions tends to be more clear and relevant for engineered features, but the general intent is to identify expected roles of the natural system in reducing potential impacts at a receptor. The other component is associated with FEP. The discussion for each area should also consider potential factors (e.g., FEP) that could impact the effectiveness of a safety function. For example, recharge rates could increase or decrease, thus impacting assumptions about the timing of migration through the system (positive or

negative effect). The level of detail included in this section should be sufficient to provide a basis for the conceptual model of the site and facility behavior, and the modeling assumptions made in the performance analysis and details may be provided in supporting documentation. The presentation of the site characteristics should provide sufficient information to allow an independent reviewer to conclude that the site-specific analysis of performance that follows is complete, logical, technically correct, rigorous and defensible.

For proposed facilities, the site characteristic information should sufficient to support the site evaluation process and should be coordinated with NEPA or other regulatory analyses. This guide specifies the primary site characteristics that should be evaluated in the process of establishing a new LLW facility so that the features of the site can be thoroughly understood, that a determination can be made that the site is suitable to support the facility, and so relevant features of the site can be appropriately balanced with considerations for the facility design.

The presentation of site characteristics should also include identification of uncertainties associated with the information and data presented. Uncertainties and alternative interpretations should be highlighted so that they can be evaluated in the sensitivity/uncertainty analysis and, as appropriate, incorporated into the PA maintenance and research and development planning and implementation processes. Additional guidance is provided below for specific subsections.

Geology. The structural geology of the region should be described, and its relationship to the disposal site geologic structure should be discussed to provide the basis for the conceptual model of the disposal facility and the modeling of the disposal facility. Any relevant features, such as faults, folds, open jointing, fractures, or shear zones in the region should be identified, and their significance to the projected long-term performance of the disposal facility should be discussed. Maps and geologic profiles should be presented to supplement the descriptive language.

In addition to supporting the analysis of performance, identification of any existing or potential disposal site conditions that could compromise the ability of the disposal site to fulfill the required performance objectives should be presented in this section. This includes significant topographical features and the surface and subsurface geologic characteristics of the disposal site and its vicinity, such as soil characteristics, mineralogy, particle size, organic materials, degree of cementation, zones of alteration, and depositional environment of unconsolidated strata.

Reasonably foreseeable processes such as mass wasting, erosion, slumping, land sliding, and weathering should also be described as necessary to support conceptual model and the analysis of performance. Any applicable results from geotechnical engineering studies conducted at or near the disposal site should also be summarized and referenced.

Seismology. Relevant information describing all known or inferred faults in the disposal site vicinity that could potentially affect waste isolation should be described. Graphical presentation of the relationship of seismic features to the disposal facility should be included, as appropriate.

The relationship of these faults to the present-day local stress field should be described, as well as any potential effects on the disposal site as a result of fault displacement. This section should also provide applicable information on the seismological investigations that have been or are to be carried out at the disposal site and the region surrounding the disposal facility.

Volcanology. If a LLW disposal site is located within a region of active plate tectonics characterized by volcanism, available and applicable data resulting from geophysical and geodetic monitoring in the region should be described and referenced. Maps should also be presented to complement the discussion. The sequence and ages of previous volcanic flows in the region should be described, and the potential for renewed volcanic activity and effects on long-term performance of the disposal site should be discussed.

Surface Water. The data and information included in this section should provide a characterization of disposal site drainage and the surrounding watershed. As necessary, topographic maps should be included that show elevations of the disposal site and relevant features of the disposal system, natural drainages, and man-made features. The location, size, shape, and other hydrologic characteristics of relevant surface water bodies near the disposal site should be described. The potential for the disposal site to be flooded should be discussed, including the occurrence of any previous flooding at the disposal site.

Groundwater. Information characterizing the hydrology of the disposal site should be provided. This should include descriptive information on both the saturated and unsaturated zones, as well as technical data used in modeling the flow of water and the transport of contaminants in the subsurface environment.

Information provided about the unsaturated zone should be sufficient to support the conceptual model of the facility and the modeling of site performance. Topics to be addressed include the direction and velocity of unsaturated flow, total and effective porosity, hydraulic conductivity, water retention and relative permeability relationships, saturated hydraulic conductivity, and volumetric water content. Sources of information should be provided and the data should be summarized.

Information provided about the saturated zone should be sufficient to support the conceptual model of the facility and the modeling of site performance for all potentially affected aquifers. Topics to be addressed include lateral extent and thickness, flow directions and velocities, effective and total porosity, saturated hydraulic conductivity, and storage coefficient for each potentially affected aquifer. Seasonal fluctuations of the water table or any changed in the water table resulting from operational changes at the site should also be addressed.

This section should also include relevant data from monitoring wells and boreholes at or near the disposal site. Information should be limited to the relevant geologic, geochemical, or hydraulic information that directly supports the conceptual model and the analysis of performance.

Existing concentrations of radionuclides in groundwater should also be included, if relevant to the water resources impact assessment.

Water Resources. The information in this section should support the conceptual model of the disposal facility, the analysis of performance, and the water resources impact analysis. The general information required is related to data on use of surface and groundwater in the area that may be affected by the disposal site. Some of the information to be described may already be provided in "Use of Adjacent Lands" (e.g., large-scale irrigation), in which case it need not be repeated here, but should be referenced. The discussion of groundwater uses should also include a description of the relevant features of typical well construction in the region to support assumptions for the intruder analysis (e.g., hard rock drilling that could penetrate concrete features). The anticipated effects of water use that are relevant to the conceptual model of the disposal facility and the modeling of disposal site performance should also be presented.

2.2.3.2 Principal Facility Design and Operational Features

This section should provide an overview of principal design features and their roles as barriers to potential exposures (e.g., safety functions) including:

- Features that limit water infiltration;
- Features that limit releases from waste forms or the facility;
- Features that promote cover integrity (e.g., erosion/sedimentation);
- Features that provide for backfill, waste, and cover structural stability (e.g., address potential subsidence/settlement); and
- Features that provide a barrier against biotic and inadvertent human intrusion.

This section should also describe the operational and closure approach for disposal at the facility with an emphasis on assumptions that are addressed in the PA (e.g., waste placement (location and timing), segregation requirements, subsidence considerations, plans for interim/operational closure prior to final closure). Evolution of physical and chemical properties over time is a typical area of significant uncertainty that need to be addressed.

This section should describe the closure configuration as the basis for developing conceptual models for evaluating long-term performance of the disposal facility, including descriptions and data for:

- All design features and data/assumptions directly necessary for the conceptual model and performance analysis;
- Information necessary to develop ranges/distributions for key parameters and assumptions to be addressed in the sensitivity and uncertainty analysis;

- Key design and operational assumptions that should be maintained through operational procedures, design constraints, CPs, etc., should be identified and formally tracked to ensure they are protected; and
- Assumptions necessary to develop the compliance case and alternative scenarios based on the assumed roles of design and natural features in limiting releases to the natural environment (e.g., sustainability considerations, measures to address subsidence, evolution of barrier performance).

Objective

This section provides the detailed information about the disposal facility (engineered system) that form the basis for development of the conceptual models.

Discussion

This section should provide sufficient description of the disposal facility and its design features to provide a basis for developing the conceptual models for the evaluation of long-term performance of the disposal facility. Detailed descriptions and data should be provided, as necessary, for all design features of the disposal facility and disposal units directly related to the conceptual model for the disposal facility and the analysis of performance.

The information included should address the principal design features of the facility and disposal units that contribute to the long-term isolation of disposed waste to the extent necessary to justify any design information used in the conceptual model of the disposal facility, or associated with key assumptions or parameters in the assessment of performance. The information provided should be complete enough to provide support for development of the conceptual/mathematical models, including a description of potential roles of different design features over time limit releases to the natural environment (i.e., Safety Functions as described in NEA 2012). Figure 2-4 is an example of design features in a cover from SRS. FEP that affect the ability of a design feature to adequately perform a safety function should be introduced as well. Examples of safety functions and FEP that influence covers and liners are provided in Phifer, Seitz and Suttora (2014)[10].

[10] Phifer, M., R. Seitz, L. Suttora, On Performance of Covers and Liners in Performance Assessments

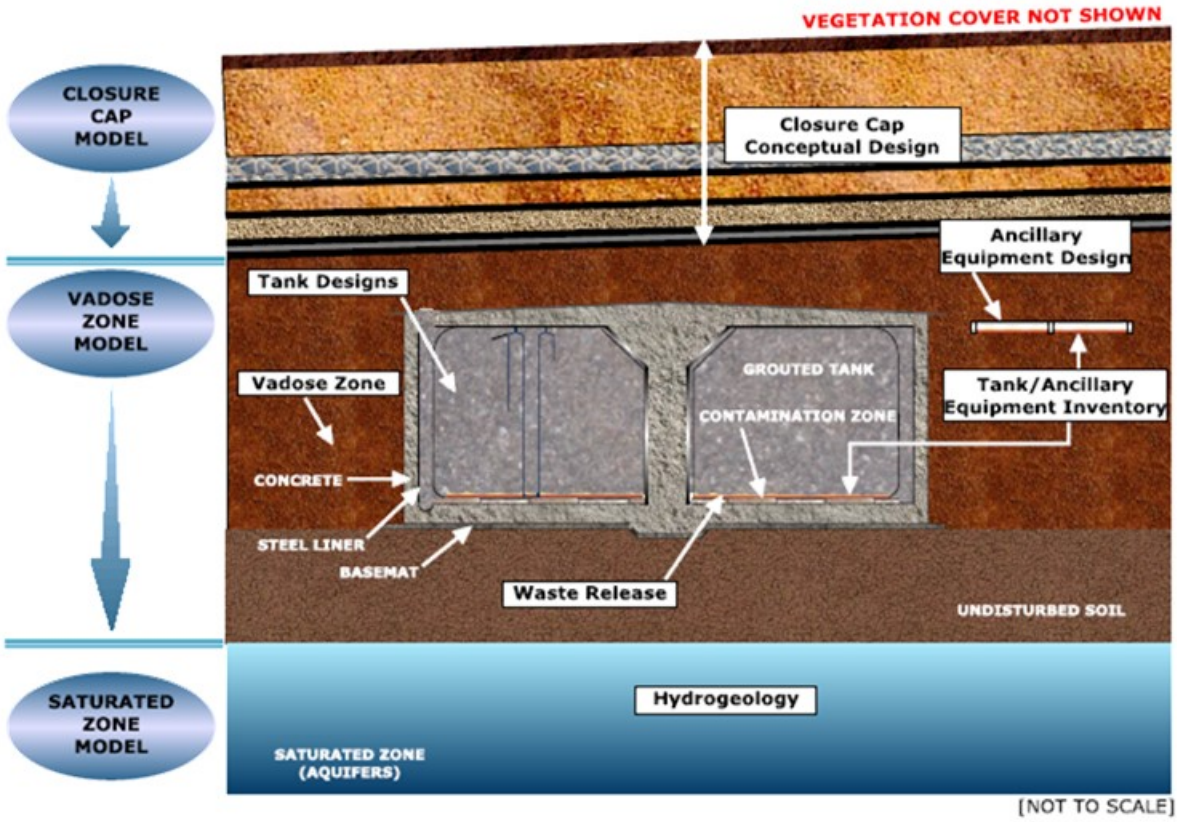


Figure 2-4. Example Design Features Associated with a Tank Closure PA Required

Principal design features that should be addressed in detail include: 1) features that limit the infiltration of water through disposal units; 2) features that ensure integrity of disposal unit covers (e.g., erosion/sedimentation); 3) features that provide for the structural stability of backfill, waste, and covers (e.g., address potential subsidence/settlement); and 4) features that provide a barrier against biotic and inadvertent human intrusion. Each of these principal design features is discussed in the following sections. When discussing covers, any plans for interim/operational covers should be described and the rationale for the timing for final closure should be addressed, especially if there are plans to allow for settlement/subsidence before placement of the final cover. For each stage of operations and closure, considerations related to sustainability and features to provide resilience against changes in climate or extreme events should be clearly identified.

This section of the PA should provide a total system perspective for the disposal facility to allow the reader to conclude the analysis of the disposal facility and its long-term performance is complete, logical, technically correct, rigorous, and defensible. Support for assumptions regarding material properties and their evolution over time is also provided in this section.

The information should also be prepared recognizing a need to support decisions regarding what features are accounted for in the conceptual model and features that are considered as part of defense-in-depth. Each applicable section may identify where credit will and will not be taken for specific features with justification to support why inclusion or exclusion is expected to bias the results in a protective manner or that information can be provided in the discussion of the conceptual model.

The presentation of facility characteristics and design features should include identification of uncertainties associated with the information and data presented and credible alternative interpretations. Approaches to manage the uncertainty can be described (e.g., evaluated in the sensitivity/uncertainty analysis, defense-in-depth – not credited in the PA, PA maintenance activities). Evolution of physical and chemical properties over time is a typical area of significant uncertainty and assumptions regarding distributions, and failure modes will need to be discussed in detail either here or with the discussion of the conceptual and mathematical models.

For new facilities that have yet to be constructed, one objective of the PA may be to determine key design features that will provide the safety functions critical for the reasonable expectation of meeting performance objectives. In such cases, the design may be conceptual in nature and the description will focus on required performance specifications (e.g., maximum infiltration rates).

Water Infiltration. The information on design features used to limit water infiltration should include those that are designed to encourage evapotranspiration, direct onsite precipitation away from the disposal units, as well as features that direct the flow of offsite surface and groundwater away from the disposal facility or disposal units.

Disposal Unit Cover Integrity. The information on design features used to ensure the integrity of disposal unit covers should normally include erosion protection of disposal unit covers. In addition, any features relating to assumptions used for modeling the long-term degradation of disposal unit covers should be presented.

Structural Stability. Information on design or operational features that ensure the structural stability of the fill, wastes, and cover during each phase of operations and closure. If stability is planned to be addressed with deferred actions, these need to be clearly identified. In cases where the PA results demonstrate some amount of subsidence is acceptable, the basis for the amount of subsidence and impacts on the closed facility need to be described (e.g., increased infiltration, localized depressions and loss of cover thickness, etc.). Details should normally emphasize modeling assumptions such as the volume of anticipated voids within waste containers and within the backfill around the containers, the effects of voids that might result from operational occurrences, and anticipated degradation of fill, waste forms, engineered features, and waste cover materials.

Biotic and Inadvertent Human Intruder Barrier. Information on design features related to potential biotic intrusion (e.g., burrowing animals, tap roots) and human intrusion should address information such as effectiveness for limiting or addressing potential impacts of animal burrows or root penetration and a description of design features in the context of site specific drilling or construction methods. The descriptions should address potential engineered barriers and degradation rates, potential for and impacts of subsidence, and the materials separating stable and unstable wastes.

2.2.3.3 Development of PA Waste Inventory

This section should describe the waste that has been disposed and is planned to be disposed or left in tank farms [i.e., the source term(s)] in sufficient detail to support the initial phases of a graded approach to the analysis (e.g., screening of radionuclides). Detailed information on inventories associated with specific waste forms, containers, etc. to support further iterations of a graded modeling approach should be described in this section or with the source term conceptual model, as applicable.

This section should summarize and/or describe:

- All radionuclides disposed or anticipated to be disposed, based on WAC, or other process or operational controls, waste disposal records, waste disposal projections, shipping records, sampling and assay data, in-situ sampling data, and other investigations;
- Activities and inventories of radionuclides disposed after September 26, 1988;
- Activities and inventories of radionuclides forecasted for disposal;
- Total volume of waste disposed, to be disposed and timing of the disposals;
- Information on locations of disposed waste within the facility;
- The major waste forms and waste types disposed and to be disposed;
- Security classification of wastes;
- Packaging criteria and packaging methods for waste types;
- Acceptance restrictions for chelating and complexing agents having the potential for mobilizing radionuclides; and
- Any other acceptance restrictions related to wastes previously disposed and waste to be disposed included in the waste characterization and certification program.

This section should identify any changes from previous PAs or modeling efforts in the assumptions regarding waste inventories and waste forms that have been disposed or are projected to be disposed in the future.

2.2.3.3.1 Waste Characteristics for Screening

This section should describe the methods and assumptions used to determine the radionuclide inventories and waste volumes considered in the screening calculations. The basis for assumptions about concentrations and chemical form of radionuclides in the disposed waste and the chemical and physical properties of the waste, backfill and any associated packaging necessary to support the calculations should also be provided. This more specific information may also be provided in the conceptual model discussions, if the screening approach does not require that information. This section should also discuss uncertainties associated with the information and data and how the uncertainty is managed.

2.2.3.3.2 Radionuclide Inventory Screening for Water and Air Pathways

This section should provide a complete description and justification for the radionuclides eliminated from further consideration in the PA modeling for air and water pathways, as applicable.

For each level of screening conducted in a graded approach, this section should identify, justify and document:

- Methods, data sources, assumptions, calculations and quality assurance (QA) provisions applied for the screening approach;
- Justification of the basis to exclude radionuclides from further analysis should be based on demonstrated insignificance in the context of compliance with the performance objectives; and
- Inventories on which the screening is based should be documented for all screened radionuclides. If future inventories for a radionuclide to be disposed are expected to exceed the inventory considered for screening, the continued validity of the screening should be addressed using the change control process to determine if the radionuclide should be considered in a more detailed analysis.

2.2.3.3.3 Radionuclide Inventories for Further Analysis

The list of radionuclides and inventories that will be considered in subsequent more detailed PA modeling for the air and water pathways should be provided as the conclusion from this section.

Objective

This section provides the information about the types, quantities and activity of wastes to be considered in the PA. The information is provided in sufficient detail to support screening efforts prior to implementation of the more detailed PA modeling. Screening approaches and results are documented and the inventory and wastes to be considered in detail in the PA are

identified. Depending on the site-specific circumstances, some or all of the contents for this section may be included in "Source Term Release."

Discussion

This section should provide information and data for the waste that should be considered in the PA. At this stage in the document, the emphasis is on developing a comprehensive inventory of waste that should be considered in more detail. Prior to operations, and during the operational life of a facility, the inventory will be based on actual disposals and forecasted disposal until facility closure. Prior to tank waste removal, the PA inventory will be based on an estimated residual waste inventory. When considering final closure, the actual inventories disposed in the facility or left in tanks, will need to be confirmed against the assumed inventory. This initial list serves as the basis for determining the comprehensiveness of the inventory (i.e., has a waste stream been missed). This initial inventory may have hundreds of radionuclides and numerous waste streams included. Lengthy tables or lists of radionuclides can also be included as an appendix. The process used to screen the list of all potential radionuclides to a list to be considered in the detailed analysis should be presented, along with justifications for removing any radionuclides from detailed consideration.

The description of waste characteristics should clearly describe the methods and assumptions used to determine the inventory and concentration of radionuclides in the disposed waste and the volume of waste disposed. Any changes in the waste characteristics for wastes to be disposed of in the future should also be presented. The maximum volumetric capacity of the disposal facility should also be presented to provide a means to compare the proposed disposal volume with the available volume in the facility. Figure 2-5 provides an example of summary inventory information.

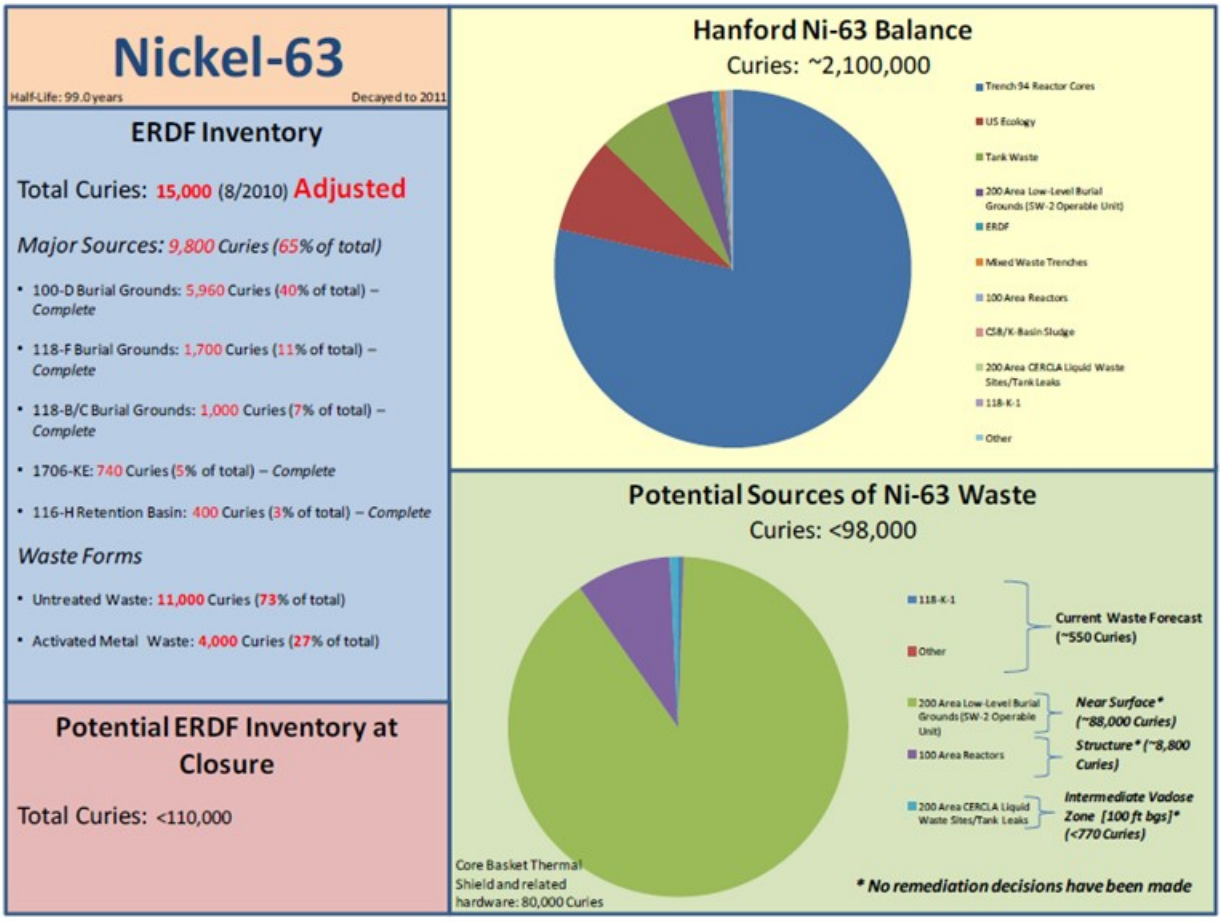


Figure 2-5. Example Illustration of Summary Inventory Information for a Disposal Facility

Inventory information is a common source of uncertainty that should be addressed in a PA. The presentation of waste characteristics should include identification of any uncertainties associated with the information and data presented. Uncertainties should be highlighted so that they can be evaluated in the sensitivity/uncertainty analysis and, as appropriate, approaches to manage the uncertainty can be incorporated as part of PA maintenance.

The purpose of the screening steps is to eliminate radionuclides and waste streams that are insignificant as dose contributors from detail consideration (i.e., small contribution to impact relative to the performance objective) and focus the detailed PA calculations on the radionuclides and waste streams that are significant relative to the performance objectives. Screening can be conducted for radon, air and water pathways. In some cases, the radon or air pathway analysis may strictly be a screening analysis and not need to be addressed in detail in the PA.

The information for each screening step should be at a level sufficient to support the calculations. Thus, it is not necessary to provide detailed waste characteristics at this time unless they are used in the screening calculations. This is consistent with the graded approach where the intent is to provide the detailed characterization only for those waste forms that are significant contributors (there may also be graded levels of "detailed" characterization).

The assumptions should be maintained for any radionuclides/waste streams screened from more detailed evaluation (e.g., assumed concentration/inventory, assumed travel time if used for screening). This information should be tracked in order to confirm that, for example, any new waste streams do not exceed the inventory assumed for a screened radionuclide or new information does not change the travel time assumptions on which the screening was based.

There are a variety of screening approaches that can be used, but all have to be defended for the specific PA (e.g., Wood et al. 1994,[11], NCRP Report 123, *Screening Models for Releases of Radionuclides to Atmosphere, Surface Water and Ground,* and existing PAs provide examples). If calculations are conducted, the documentation and QA should be commensurate with the level of calculation conducted. If computer codes are used, they should be documented with the other tools used in the PA (see "Modeling Tools").

The definition of "insignificant as a dose contributor" is somewhat subjective and should be justified based upon demonstrating that the cumulative dose from all excluded radionuclides/waste streams would still be (1) insignificant relative to the dose from the included radionuclides; and (2) insignificant relative to causing the total projected consequences to approach the applicable performance objective.

Example:

> *A two-step approach is used for screening for a given disposal facility. The first step involves screening based on radionuclide half-life. The travel time to the aquifer is greater than 30 years for a tracer. As an initial screen, radionuclides with half-lives less than 1 year are screened from further consideration based on the expected decay before reaching the aquifer. The second screening step involved a simplified screening model applied broadly at the site using bounding K_ds and assuming the radionuclides are distributed on the ground surface with no credit for barriers. All but 11 radionuclides were screened based on results showing individual doses less than 0.4 mrem/yr. As a secondary criterion, screened 2 radionuclides were retained for further analysis, because they had been identified as contaminants of concern in other investigations. It was confirmed that the cumulative peak drinking water dose from all of the screened*

[11] Wood, D.E., R.U. Curl, D.R. Armstrong, J.R. Cook, M.R. Dolenc, K.W. Owens, E.P. Regnier, G.W. Roles, R.R. Seitz, M.I. Wood, Performance Assessment Task Team Progress Report

radionuclides was less than 0.4 mrem/yr (or 10% of the 4 mrem/yr drinking water standard).

In this default annotated outline, the initial screening steps are described in this section separately from the detailed PA modeling. The end result for this section is a list of the inventory that should be considered in more detail in the PA. Note that based on site-specific considerations, this information may also be provided in "Analysis of Performance" and presented as part of the general graded approach for the PA.

2.2.4. Analysis of Performance

This chapter should provide a detailed description and basis for the conceptual and mathematical models/modeling tools and how they are applied for the analysis of performance to assess compliance with the performance objectives. Sensitivity and uncertainty analysis and the assessment for inadvertent intrusion are addressed in "Sensitivity and Uncertainty Analysis" and "Hypothetical Inadvertent Intruder Analysis," respectively.

Each subsection should describe how the linkages between the conceptual models for different components (natural and engineered) are implemented in the context of total system performance. The modeling components are separated into source term, radionuclide transport, exposure pathways and scenarios, and dose assessment, but different approaches can be used (e.g., cover, vadose zone, saturated zone). The mathematical and numerical models and modeling tools, as applicable, should be described in this chapter. Key assumptions should be identified in each description as input to be considered for alternative models, sensitivity and uncertainty analysis and the integration and interpretation of results.

Additionally, this chapter should include a summary of how the conceptual models are implemented in the mathematical and numerical models in order to calculate doses and concentrations for comparison with the performance objectives.

2.2.4.1 Overview of Analysis of Performance

This introductory section should provide a roadmap for more detailed descriptions and reference material for each component of the total system model, including a "higher-level perspective" of the different system features that are represented in the conceptual models described in more detail below. It should generally describe the linkages between conceptual and mathematical models for the different components of the total disposal system (e.g., waste form, facility, natural system, and other relevant components).

This section should also include a description of the scenarios for the engineered and natural systems and exposure pathways considered for the compliance case, including alternative conceptual models and scenarios, and the general approach for the integration of the conceptual models. The methods used to select the features, events and processes and exposure pathways to

be considered and those to be screened should be summarized with reference to more detailed documentation of the basis for the selection or screening in an appendix and/or separate report(s).

Objective

This section provides introductory information with a general overview of the different conceptual models that will be described and how those models are linked. This section is also where the approach to identify the scenarios, including the compliance case and any alternatives, to be considered in the PA is described.

Discussion

The first part of this section provides a single location where reviewers can find an introduction to the different conceptual models to be described and a mapping to where those conceptual models are described in the following subsections. Linkages between individual conceptual models and between the conceptual and mathematical modeling tools are also introduced. Figure 2-6 is an illustration of conceptual models considered at the Nevada National Security Site and Figure 2-7 is an example of the exposure pathways considered for Los Alamos. Figure 2-8 is a general overview of the different models that comprise a PA for tank closure at SRS.

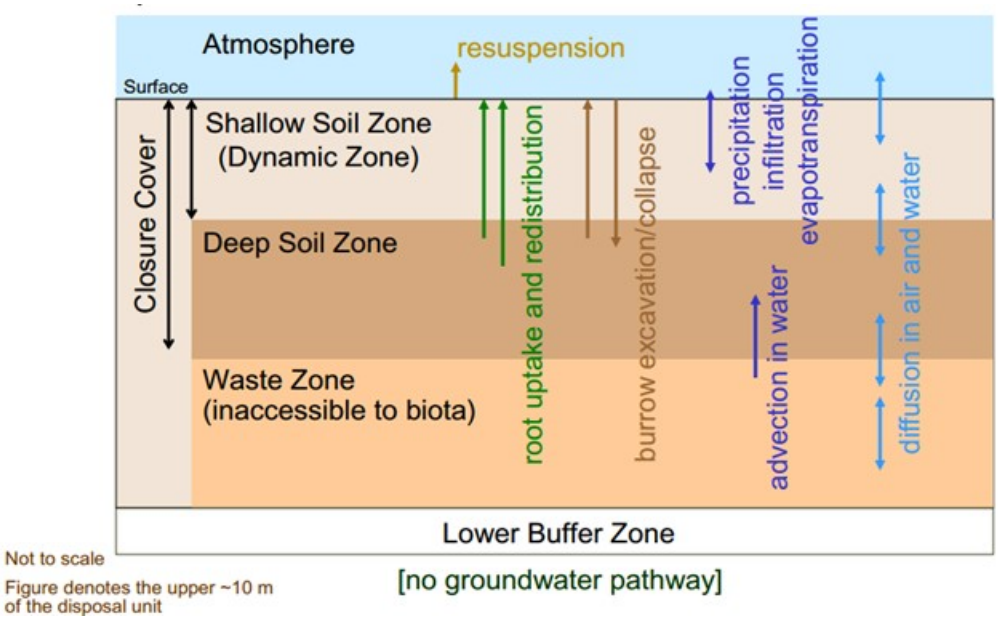


Figure 2-6. Example of a Conceptual Model of Shallow Land Burial

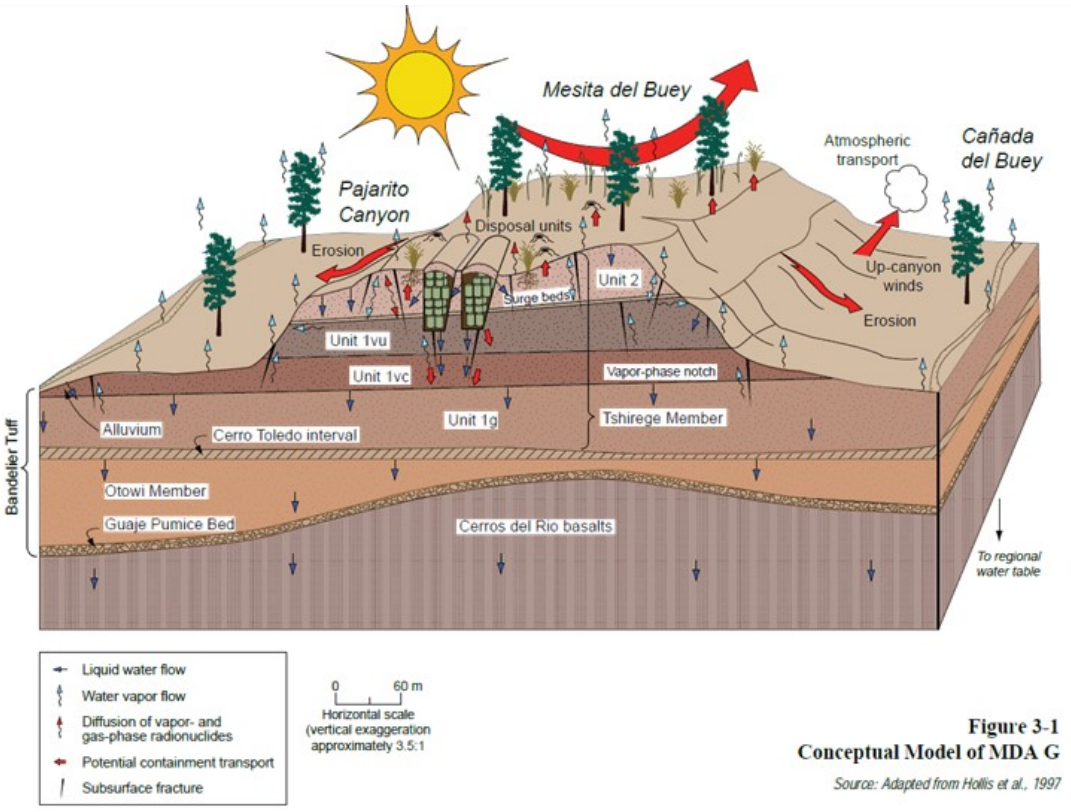


Figure 2-7. Example Transport Pathways Considered for a Disposal Facility

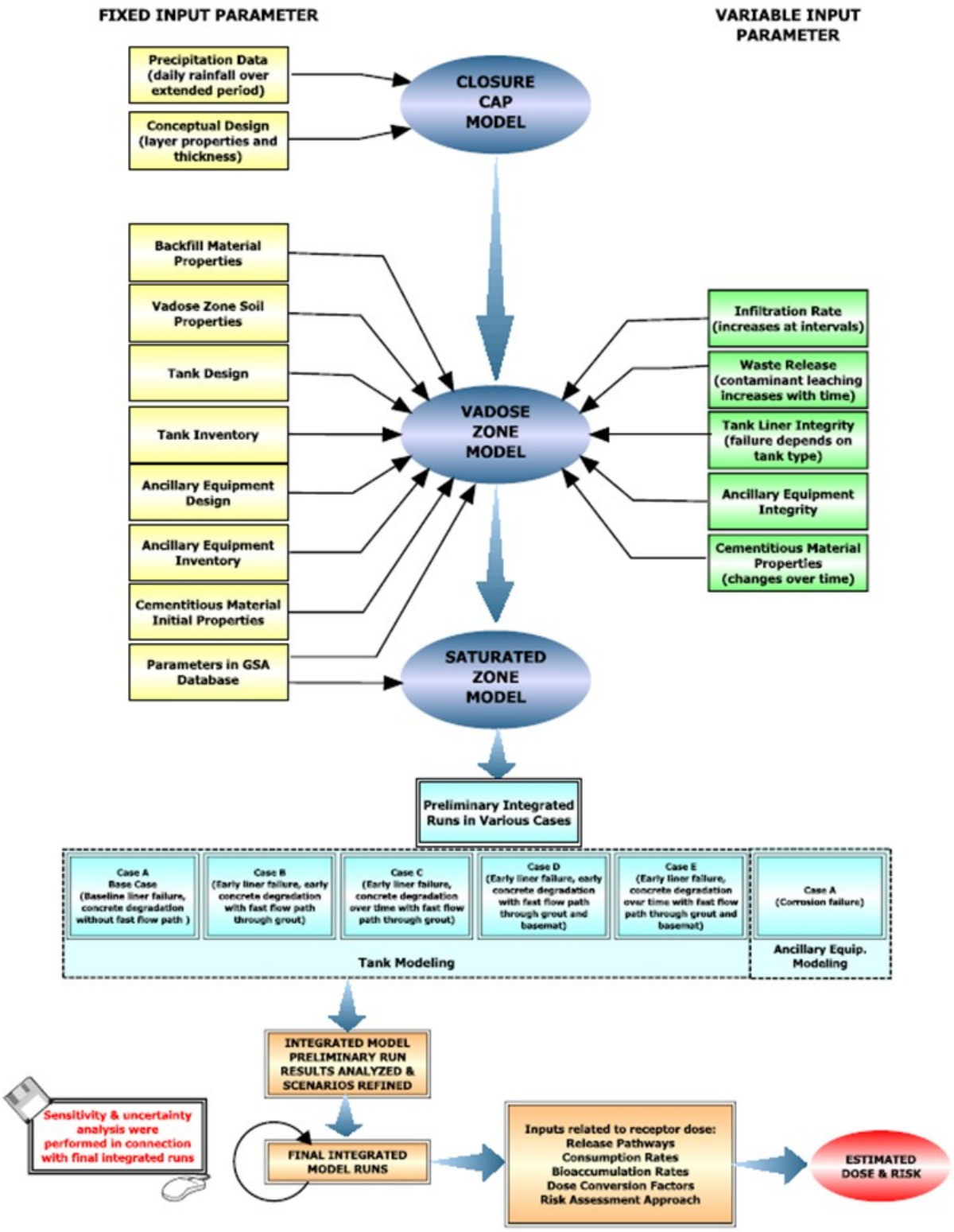


Figure 2-8. Example Showing Different Modeling Components and Features Considered for Tank Closure PA

The second part of this section describes the basis for the selection of the different scenarios that are considered for the PA. For example, Figure 2-8 identifies a number of different cases that were considered for the PA. The process used to select those scenarios is summarized and citation can be provided for a more detailed description. The process may have formal and informal elements. For example, the main scenarios may be identified based on an evaluation involving FEP and/or safety functions, there may be other cases that are added because of a specific sensitivity (e.g., what-if or alternative conceptual model), or an alternative approach may be used. Approaches involving some consideration of FEP have become more common, although FEP are considered in different ways. Current recommendations from the NEA, described below, advocate the use of a combined "top-down, bottom-up" approach. This takes advantage of the efficiency and the conceptual model-based focus of a safety functions based approach and uses the thoroughness of a FEP based approach in an audit role. Given that these approaches are still evolving; the best approach can depend on the specific circumstances. The following is a brief discussion of different approaches.

Two general classes of approaches have historically been used: performance-based, top-down approaches and bottom-up approaches based on development of comprehensive lists of factors to be considered. The top-down approach begins with development of an understanding of the disposal system and conceptual models to be used and using that knowledge to identify scenarios based on the areas deemed to be of greatest importance. The bottom-up approach focuses on identifying "comprehensive" lists of factors to be considered and using those lists to develop scenarios to be considered.

The first class of approaches ("top down") has been used for many disposal facilities and for decision making related to remediation of contaminated sites. It is based on developing a technical understanding and conceptual model of the disposal system using that understanding to identify of the roles and functions of key barriers, and using that knowledge to develop consensus with reviewers and stakeholders to agree on appropriate scenarios to be considered. More recently (see for example, NEA 2012, EC 2009, *The Joint EC/NEA Engineered Barrier System Project: Synthesis Report*), the concept of safety functions for different features of a disposal system has been advocated for a more structured means to consider the roles of different barriers in a top-down approach. The safety functions concept provides an effective means to identify and assess the significance and roles of different engineered and natural barriers that are part of the disposal system.

The second class of approaches ("bottom-up") started in geologic disposal programs and gained some popularity in the context of near surface disposal in the 1990s and 2000s (e.g., IAEA 2004, *Safety Assessment Methodologies for Near Surface Disposal Facilities - Results of a Coordinated Research Project: Volume I - Review and Enhancement of Safety Assessment Approaches and Tools*). The bottom-up approach is largely built upon the use of the concept of FEP to identify factors to be considered in scenarios for the PA. These approaches have

advocated an intent to comprehensively address all conditions that could impact the performance of a disposal facility and developing documentation of the basis for including or not including each factor that could influence performance. In practice, strict bottom-up, FEP-based approaches have not proven to be practical even in the context of geological disposal programs. A recent NEA report (NEA 2012) highlighted the more recent practical application of "top-down" approaches in lieu of "bottom-up" approaches with the comment that "It could be contended that the "top-down" approach described in recent safety assessments is in fact a more accurate representation of the approach that was in reality adopted (though not documented) in earlier safety assessments."

The implication being that earlier assessments claimed to be using a "bottom-up" approach, but in actuality were using something that was more like a "top down" approach. The report also includes the statement that "It could be further contended that "top-down" approaches … are, in fact, better described … as 'top-down, bottom-up'." This reflects a view that although much attention has been placed on FEP-based "bottom-up" approaches, in practical application, safety assessments have often been implemented using "top-down" approaches that are supplemented using FEP in an audit or supporting type of role. This is consistent with experiences with recent PAs conducted for disposal facilities around the DOE Complex.

The NEA "top-down, bottom-up" philosophy for scenario development reflects practical experience gained from PA applications in geologic disposal programs- (NEA 2012), which is also reasonably consistent with DOE approaches used for near surface disposal. The approach begins with the development of the conceptual model, building an understanding of system behavior, and identifying safety functions associated with different natural and engineered barriers (e.g., roles of different barriers in limiting releases and subsequent migration). Identification of possible FEP that could compromise the roles (safety functions) of the key barriers becomes the focus rather than comprehensively considering and documenting all possible FEP, many of which are inconsequential. The top-down, bottom-up approach involves the use of a recognized FEP list in a targeted audit role for key aspects of the system rather than being the driver for scenario development.

Example:

> *A PA was conducted that began with efforts to collect information regarding the facility design, durability of barriers, site characteristics and the waste form as well as previous modeling efforts. This information was used to develop an initial conceptual model for the facility and the site that formed the basis for the first iteration of modeling, including a sensitivity and uncertainty analysis. The results of the initial modeling efforts were used to identify key assumptions, processes and design features that had a significant impact on the conclusions of the assessment. Based on the initial findings and consultations with external*

reviewers and collection of additional data, modifications were made to the conceptual model and alternative conceptual models were identified to address additional sets of conditions. This process continued in an iterative manner to address potential concerns. FEP lists were considered as part of this process as an audit tool to confirm that the primary factors that could influence the conclusions were considered appropriately, but were not used as the basis for the formulation of scenarios.

Such a risk-informed approach has the benefit of leading to the development of design requirements and specifications for different elements of the system based on the "safety functions" related to system behavior in the context of meeting performance objectives. The blended top-down, bottom-up approach takes advantage of experience obtained from initial modeling efforts, uses specific auditing against existing international FEP lists (see lists identified in DOE-NE 2011, *Features, Events and Processes for the Disposal of Low-Level Radioactive Waste - FY 2011 Status Report*), and feedback from reviewers to identify the features and assumptions that are expected to be important for the decision. It is more efficient by providing for focused efforts on aspects that are expected to be important rather than trying to be completely comprehensive without considering the relative importance of different factors. The emphasis is on identifying and developing a better understanding of important features rather than seeking "comprehensiveness" by starting from consideration of every possible FEP.

2.2.4.2 Conceptual Models

This introductory section should provide a summary, including an overview of the different system features that are represented in the conceptual models described in more detail below. Conceptual models provide a description of the processes considered for each radionuclide transport pathway and any linkages between pathways or models. Each subsection should identify and sufficiently justify assumptions, simplifications and limitations of the approach and processes, and parameter values included in the conceptual model(s). Separate discussions should be provided in cases where a graded approach is applied with differing levels of detail or when alternative conceptual models are considered. Justification for initial conditions, boundary conditions, and changes in properties with time that are derived from existing site data or information should be presented.

Uncertainties associated with gaps in knowledge in the behavior of the engineered and natural systems should be identified and the approach for managing the uncertainties should be described. The use of a graded approach, including the degree of conservatism and processes considered/not considered should be described, as applicable. The effects of reasonably foreseeable natural processes such as mass wasting, erosion, flooding, and weathering that could result in changes to the conceptual model should be included. If developed in support of a revised PA, the conceptual model descriptions should provide a rationale for changes in source

term release, transport mechanisms, receptor locations, exposure media, and uptake pathways from the previous PA.

If probabilistic approaches are used, the basis for selecting parameters to be included and the ranges and distributions of parameter values should be provided. The descriptions in each subsection should provide the basis for and description of any alternative conceptual models that are included. The information should provide sufficient justification and description of the conceptual models to support implementation in the mathematical models and modeling tools.

Where different levels of modeling detail are applied to provide the basis for assumptions in a less detailed system level model (e.g., hybrid modeling approach), this section should describe how insights from the more detailed models are implemented in the total system model. Describe any conceptual models and references to any computer codes used to develop assumptions about the disposal site geochemistry or other more detailed phenomena that serve as technical underpinning for the compliance-related conceptual model, including any related information on data bases, input and output data, and interpretation of results. The basis for the linkage between the detailed and higher level models should be documented including key uncertainties associated with the integration of the different conceptual models. As applicable, describe the relationship between the current PA and previous existing PAs, CAs and other assessments and discuss the significance or insignificance of the differences in the approaches.

Objective

This section includes the detailed description of the conceptual model(s) used to represent performance of the site and the disposal facility.

Discussion

This section should present the conceptual model(s) of facility performance; the discussion should provide sufficient information to understand the relationship between the detailed elements of the analysis of performance, and to clearly understand the basis for the choice of conceptual models/scenarios, logic and rigor of the method of analysis in the context of the use of the results. The conceptual model should address all the elements to be considered in detail for the evaluation of dose to the exposed individuals for the LLW disposal facility. The conceptual model discussion should include references and citations to geochemical, geologic, meteorologic and hydrologic data, and to other analyses or investigations that justify the conceptual model as being technically correct and rigorous. The method of analysis may be structured to calculate inventory or concentration limits for radionuclides in waste which meet the performance criteria. This approach is especially helpful for establishing WAC for the disposal facility.

Should the method of analysis be structured to calculate the inventory or concentration limits in the disposed waste that meet the performance criteria, this section should clearly identify how non-linear phenomena, that may be associated with the conceptual model, are addressed. Important assumptions and simplifications of natural processes incorporated into the conceptual model should be identified and justified. Uncertainties in the behavior of the site or the disposal facility included in the conceptual model(s) that are associated with gaps in knowledge and variability are also identified, and the potential significance and approach to manage the uncertainty is discussed.

It is generally expected that a PA will include some combination of deterministic and probabilistic modeling. There are pros and cons for both approaches and the use of the two complementary approaches together is viewed as an effective means to provide multiple lines of reasoning and an overall improved understanding of system behavior (e.g., Seitz et al. 2008[12] and NEA 2012). Recent PAs have included the use of deterministic simulations to provide more detailed consideration of specific processes expected to be of importance for the analysis. Often, a deterministic model will be used as the reference, base or compliance case that is used as the basis for comparison with the performance objective. The compliance case may be supplemented by a number of alternative scenarios to illustrate the influence of changes in key assumptions.

The results of the more detailed deterministic modeling are also used to inform the development of a less detailed, "system" level model that is more amenable for use to generate the hundreds or thousands of realizations needed for a probabilistic assessment. The approach to apply a probabilistic approach to demonstrate compliance with the performance objectives was described with the performance objectives, when that approach is desired. The system level model provides the ability to more rigorously address sensitivity and uncertainty, although typically using a more simplified representation of the system.

A graded approach linked to the significance relative to the conclusions of the analysis is recommended for an efficient PA, with less complex modeling for wastes or features with little dose significance and best-estimate, more complex modeling for wastes and features that have greater dose significance. When developing conceptual models, the PA should address reasonably foreseeable natural processes. The initial conceptual model discussion in the introduction provides a "higher-level perspective" regarding the relative roles of different features of the system in limiting the release and migration of radionuclides to a receptor. This discussion also introduces the factors that are credited and not credited in the analysis in the context of their roles limiting migration of radionuclides to a receptor ("safety functions" in international guidance). Details for the roles and processes considered should be described in the section for each individual component of the conceptual model. References and citations to

[12] Seitz, R.R., B. Crowe, M. Sully, and M. Wood, Probabilistic Sensitivity and Uncertainty Analysis Workshop Summary Report, 2008

geochemical, geologic, meteorologic, ecologic and hydrologic data, and to other analyses or investigations that justify the technical validity, rigor and consistency across the site of the conceptual model should be included. The basis for any alternative conceptual models that are included should be provided.

Either best estimate input data with distributions or bounding (conservative) input data may be utilized. Input data is only considered bounding or conservative if it results in a greater dose than best estimate input data. A graded approach based upon the significance of the base case dose relative to the 25 mrem/yr all pathways or other performance objectives should be implemented relative to the input data utilized. In general, the use of bounding (conservative) input data becomes more acceptable the lower the base case maximum dose relative to the performance objective. As the base case maximum dose using bounding (conservative) input data approaches or exceeds a performance objective, the more important it becomes to use best estimate input data with distributions. In general, if the base case model is performed probabilistically, the input data distributions would also be utilized in the base case modeling with the best estimate input data forming the central tendency.

Should the project team preparing the PA find it preferred to include some of the details regarding input data in the implementation section it may do so. In any case, citations and references should include page number(s) and table or figure number(s) for the source of the data to provide a traceable record.

Important assumptions and simplifications of natural processes incorporated into the conceptual model should be identified and justified. Uncertainties in the behavior of the site or the disposal facility included in the conceptual model that are associated with gaps in knowledge should also be identified, and the potential significance of the uncertainties discussed, as applicable. The conceptual model description should also include detailed information about the parameter values and other alternative models and scenarios that are considered. Key assumptions linked to the mathematical models should be described along with potential limitations of the models.

2.2.4.2.1 Source Term Release

This subsection should identify and describe the assumptions associated with releases from the disposal facility into the natural environment. Waste characteristics, generic or specific waste forms, containers, covers, backfill and engineered features of the disposal facility (e.g., liners, vaults) should be addressed, as applicable. Assumptions related to timing and changes in material properties, chemistry, etc. and use of conservatism or alternative models to address uncertainty should also be addressed. Specific assumptions related to releases of potentially volatile radionuclides to the atmospheric pathway and potential radon flux to the surface should also be addressed in this section.

Objective

This section includes the information and data to support development of the conceptual model for the source term for the LLW disposal facility PA including: chemical & physical characteristics of waste forms considered in the analysis, packaging methods, backfill materials, and engineered features.

Discussion

The section on source term includes all features that influence the release of radionuclides from the disposal facility into the natural environment. Individual subsections are provided for each of the different features of the waste and disposal facility: waste characteristics, containers and backfill, covers, and engineered features (including liners). The subsections below represent one approach for presenting the source term, there may be multiple parts to each subsection and different choices may be made for organization of the material depending on site-specific conditions. Generally, more detail regarding input parameters and assumptions will be included with the conceptual models, but some details may also be provided as part of the implementation discussion in "Implementation of the Modeling."

The conceptual model descriptions should identify the features of the waste and disposal facility included in the analysis and the justification for not including mechanisms which could potentially be considered applicable. Related assumptions should be identified and justified. Typical parameters for each component in the system include: unsaturated and saturated flow, total and effective porosity, hydraulic conductivity, water retention, relative permeability relationships, volumetric water content, retardation, and diffusion that are based on data, related investigations, or documented references relevant to the site and disposal facility.

Credit taken for engineered features such as waste characteristics and containers, disposal unit covers, leachate collection systems, and documented CPs should be identified and justified by data or related investigations. It is common that some features are not credited in a PA. Features that are not credited in the analysis should be identified for contributions to defense-in-depth. Discussion is also expected to address potential counter-intuitive behavior associated with features not credited.

Uncertainties should be identified in each subsection along with the approach to management of the uncertainty (e.g., the degree of conservatism, distributions for inputs and alternative conceptual models, alternative conceptual models). A key area of interest will be the basis for assumptions related to the evolution of properties assumed for waste forms and engineered features and any alternative conceptual models. For example, the effects of natural processes such as mass wasting, erosion, flooding, and weathering should be addressed and, depending on the potential for consequences of subsidence or burrowing animals, it may be necessary to include ranges of parameters or sensitivity cases with higher infiltration rates. The relationship

between the conceptual model, parameters included in the conceptual model, the available data, and other investigations should be clear. Critical assumptions for the waste and engineered features should be identified and captured in the WAC, operational procedures, and CPs as applicable.

Waste Characteristics. The discussion of waste characteristics addresses all of the radionuclides considered in Analysis of Performance for the PA (radionuclides screened from consideration in "Development of PA Waste Inventory" are not included). If screening was not documented separately, all radionuclides and sources are addressed in this discussion. The focus of this discussion should be on those characteristics that are necessary for the conceptual model of the disposal facility and the modeling of the facility performance. Waste characteristics excluded from the conceptual model of the disposal facility or the detailed analysis of the performance of the disposal facility should be justified as contributing to defense-in-depth or having an insignificant effect on the results of the analysis.

When specifying the waste characteristics, it is important to maintain a distinction of the initial form of the radionuclide associated with the output in the PA model. This allows waste form specific WAC to be established (e.g., Doses associated with Ra-226 initially present as a parent are reported separately from Ra-226 that results from decay of U-238).

This section should provide sufficient information for a reader to conclude the wastes analyzed in the PA are complete, logically determined, technically correct, and defensible. The factors to be addressed when describing waste characteristics considered in the analysis include:

- Chemical and physical properties of the waste form, including assumptions about the evolution of those properties over time (pH, hydraulic conductivity, Eh). The level of detail will depend on the expected level of detail for the modeling to be conducted;
- Location of the radionuclides with respect to the waste form, e.g., entrained in activated metal, blended with grout, surface contamination;
- The backfill, including grout in tanks, as applicable, from the perspective of influences on releases from the waste forms/containers and migration through the facility;
- Chemical form(s) of each radionuclide, as needed, to determine mobility; and
- Description of any containers and assumptions for evolution over time, as applicable, when a container is assumed to perform as a barrier.

Common sources of uncertainty for waste characteristics include - treatment processes not sufficiently developed to verify physical and chemical characteristics of waste forms; fraction of radionuclides in activated metal; and the evolution of physical and chemical properties/conditions of waste forms and containers over time.

A key objective of the PA is to develop WAC in the form of concentration or inventory limits, restrictions on the allowable form, or other limitations, such as containerization. The waste form or containers can have an influence on the WAC for a given radionuclide.

For selected radionuclides, it is often desirable to establish different WAC depending on the form in which it is disposed. For example, the WAC would tend to be more restrictive for a mobile radionuclide present as surface contamination and less restrictive for the same radionuclide that is blended in a grout or present as an activation product in a stainless-steel component.

Engineered Features. Individual subsections with assumptions and inputs regarding different engineered features of the disposal facility are expected, including covers, vaults, liner systems or other barriers. These descriptions should address the initial properties and assumed evolution of properties over time with an emphasis on properties that serve a significant role (safety function) relative to compliance with the performance objectives. For sites with more significant infiltration, there may be more reliance on safety functions provided by engineered features and thus, more effort will be required to account for performance and manage uncertainty for inputs and assumptions.

Phifer, Seitz and Suttora (2014) provide detailed information and a general approach to consider the performance of covers and liners in a PA. The Cementitious Barriers Partnership provides a variety of information on laboratory and field studies as well as modeling approaches to consider the performance of barriers using cementitious materials. Approved PAs also include examples of acceptable approaches to consider engineered features.

2.2.4.2.2 Radionuclide Transport

This section should present the conceptual model(s) for transport of radionuclides released from the disposal facility through the environment to the points of exposure, including the analysis for atmospheric, hydrologic, radon and biotic transport. The relationship between the conceptual model(s) and the available geochemical, geologic, meteorological, and hydrologic data and other related investigations should be included and any alternative conceptual models or conservatisms built into the conceptual models should be discussed.

Water Pathway. The discussion of radionuclide transport in the water pathway should include projected transport mechanisms of radionuclides through unsaturated and saturated media, including the basis for choices of mechanisms that are included or excluded. Details regarding the parameterization for unsaturated and saturated flow and transport models should be provided in a manner sufficient to support the implementation as described in "Implementation of the Modeling." The assumptions to identify the concentrations used for the water resources protection and other dose calculations in support of the all pathways analysis should be described.

Atmospheric Pathway. The discussion of radionuclide transport in the air pathway should include the assumptions regarding volatilization; migration through the waste zone, engineered features and cover; and assumptions required to determine the concentration in air assumed for exposures, including the basis for choices of mechanisms that are included or excluded. Details for parameterization of the models should be provided in a manner sufficient to support the implementation as described in "Implementation of the Modeling." The assumptions for determining the concentration in air used for compliance with the air pathway objective or the basis for screening the air pathway from further consideration should be described.

Radon Pathway. Describe the conceptual model for the emanation and migration of radon from disposed wastes or the basis for screening of the radon pathway. A demonstration of representativeness of the model based on site data or referenced information sources should be provided. Parameter values used in the modeling should be based on site or laboratory data, or referenced literature sources applicable to the site. Identification of uncertainties incorporated in radon pathway analysis should be presented. A description of the conceptual approach assumed for converting the release of radon to either a flux or a concentration in air at the POA should be presented.

Biotic Pathway. Describe the conceptual model for potential biotic transport including transport via uptake in flora and potential contact and transport of waste through burrowing animals (e.g., ants, mammals). The basis for assumptions for the depths of root penetration and depth and volume of disruptions related to animal burrowing should be provided, as applicable. The assumed role of engineered features (e.g., waste forms, covers, barriers) in delaying or preventing biotic pathways should also be discussed. The assumptions to determine the concentrations in media used as part of the all pathways exposure and dose calculations or the basis for screening the biotic pathway from further consideration should be described.

Objective

This section includes the information and data to support development of the conceptual model for radionuclide transport in the natural system including: water, atmospheric, and biotic pathways and radon releases.

Discussion

The section on radionuclide transport includes migration through the natural system following source term release and addresses specific assumptions related to radon transport. Individual subsections are provided for each of the pathways from source to the location of the assumed exposure: water, atmospheric, biotic and radon. The subsections represent one approach for presenting the radionuclide pathways. There may be multiple parts to each subsection and different choices may be made for organization of the material depending on site-specific conditions. Generally, more detail regarding input parameters and assumptions will be included

with the site description and conceptual models, but some details may also be provided as part of the discussion in "Implementation of the Modeling."

The explanation should identify the mechanisms included in the detailed analysis for atmospheric transport and hydrologic transport, and the justification for ignoring any mechanisms that could be considered important. The relationship between the conceptual model, and the available geochemical, geologic, meteorologic, and hydrologic data and other related investigations should be clear. Assumptions and the associated uncertainties with the assumptions should be identified, justified, and evaluated with respect to degree of conservatism to the extent possible. The description for radionuclide transport should include parameterizations for unsaturated and saturated flow, total and effective porosity, hydraulic conductivity, water retention, relative permeability relationships, volumetric water content, retardation, and diffusion that are based on data or related investigations which are documented or included in the appendices. When provided, the basis should be described for selected parameter values, ranges, or distributions (for probabilistic analysis) and alternative conceptual models used in the analysis.

This section also addresses considerations related to calculating radon flux to the surface and transport via biota, if those pathways were not previously screened. Any credit for properties of the cover, waste, and engineered features in the context of radon and biota should be identified and should generally be consistent with the discussion in "Design Features." For the calculation of the radon concentration in air, the methods described for the atmospheric pathway should be followed (either screening or detailed, as appropriate). For the calculation of radon flux at the surface, the conceptual model for the emanation rate from the waste and the migration rate to the surface should be presented. Additional detail may be needed for the waste forms that are sources of radon or other engineered features in cases where credit will be taken for a reduction in release due to delays in the waste form or engineered features (this description could be provided here or in "Design Features" with a reference to that section included here).

Depth to the waste and inclusion of biotic barriers in a cover design are often critical considerations for biotic transport and the dependence on depth and relationship to the expected thickness and durability of the cover and effectiveness of any biotic barriers should be described. Specific considerations for the cover related to biota may be described here or in "Design Features." When selecting input values to be used for biotic pathways based on site- or region-specific information, median or mean values, as appropriate, should generally be used in deterministic models and to represent the central tendencies for input distributions in probabilistic models. If generic values are used in a deterministic analysis, more bounding inputs are expected to be used without site-specific justification. The analyst will need to defend the specific values that are used for a given PA.

2.2.4.2.3 Exposure Pathways and Scenarios

This section should describe the basis for the inputs and assumptions for the exposure pathways in the conceptual model and method(s) for evaluating the potential doses to a hypothetical, individual member of the public. Each performance objective should be addressed (i.e., all pathways, air, radon, and water resources protection, as applicable). It should include exposures that represent reasonable actions of a group of individuals performing activities that are consistent with regional social customs, work, and housing should be identified (e.g., assumption that exposure occurs at the time and location of peak concentration beyond the 100-meter buffer zone).

This section should justify selection of the use of a representative person or maximally exposed individual to be considered in the analysis. It should include receptor locations, exposure media, and uptake pathways and the parameters necessary (e.g., transfer factors; consumption, inhalation and external exposure rates and assumptions) to implement the modeling tools used for exposure assessments. The rationale for assumed changes in these factors over time and methods to manage uncertainty should also be addressed.

Objective

This section includes the information and data to support development of the conceptual model for exposure pathways and scenarios to be considered in the PA (Figures 2-9 and 2-10).

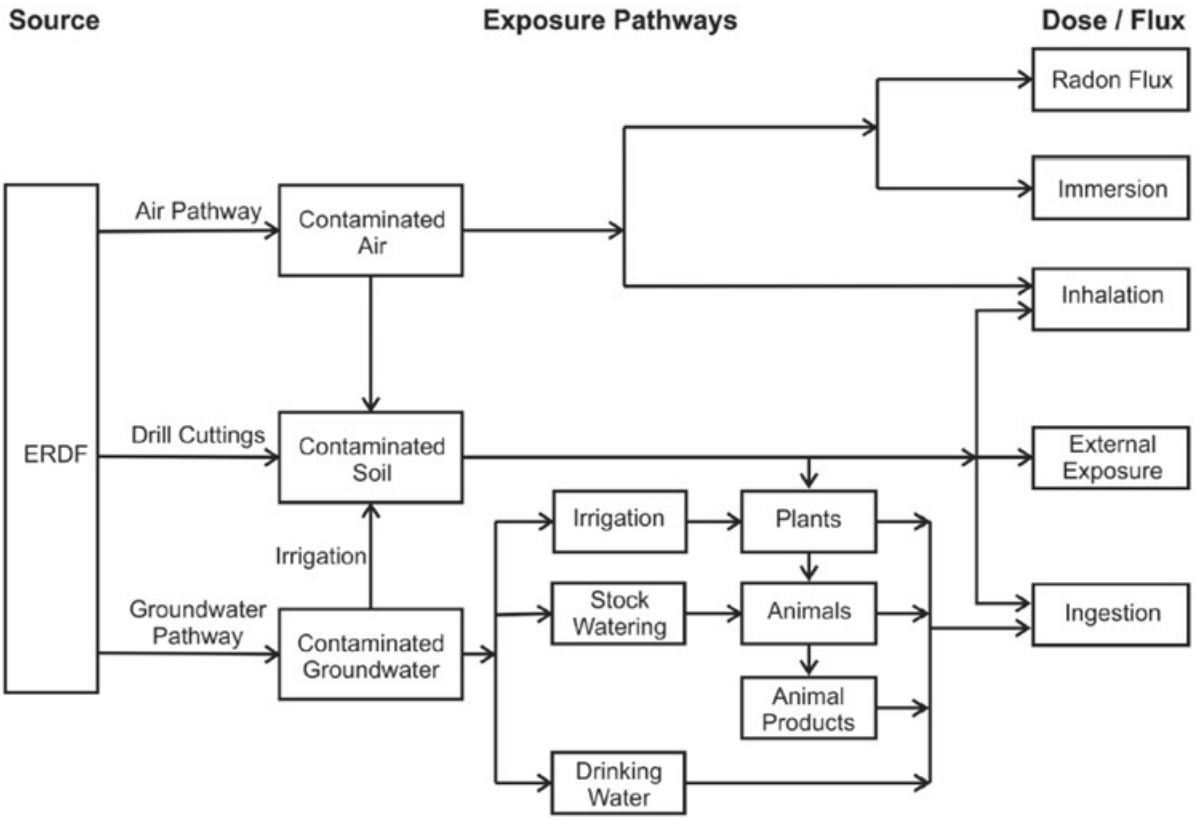
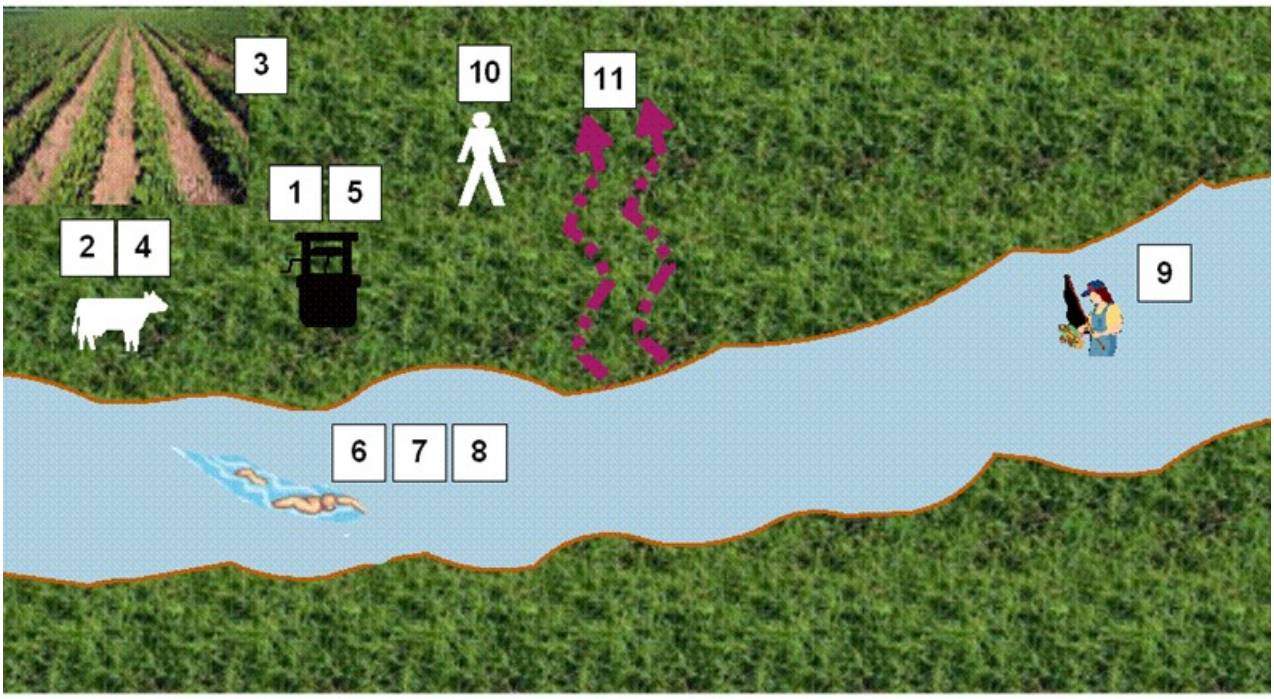


Figure 2-9. Example Exposure Pathways for a PA



Scenario with Well Water as Primary Water Source

1. Direct ingestion of well water
2. Ingestion of milk and meat from livestock (e.g., dairy and beef cattle) that drink well water
3. Ingestion of vegetables grown in garden soil irrigated with well water
4. Ingestion of milk and meat from livestock (e.g., dairy and beef cattle) that eat fodder from pasture irrigated with well water
5. Ingestion and inhalation of well water while showering
6. Direct irradiation during recreational activities (e.g., swimming, fishing) from stream water
7. Dermal contact with stream water during recreational activities (e.g., swimming, fishing)
8. Incidental ingestion and inhalation of stream water during recreational activities
9. Ingestion of fish from the stream water
10. Direct plume shine
11. Inhalation

Figure 2-10. Example Illustration of Different Exposure Scenarios for a PA

Discussion

The description of the exposure pathways and scenarios included in the conceptual model should provide a complete explanation of the method for evaluating the potential doses to a hypothetical, individual member of the public. Exposure pathways and scenarios should be based on reasonable activities consistent with regional social customs, work, and housing practices, and regional environmental conditions based on current conditions. The assessment should not be based on "worst case" assumptions. The discussion should include transport

mechanisms, receptor locations, exposure media, and uptake pathways and describe any changes in locations that may occur over time. The rationale and discussion for any changes in exposure media, receptor locations, and exposure pathways over time should be presented. Generally, the exposure scenarios are dominated by the atmospheric and hydrologic transport of contaminants.

The important exposure pathways for hydrologic transport that should be considered include groundwater and surface water use for drinking water, irrigation, livestock watering, and biotic transport. Water resources impacts should be evaluated to meet the criteria described with the performance objectives. The important exposure pathways for atmospheric transport that should be considered include the dispersion of volatile and non-volatile radionuclides, deposition of contaminated particles, and resuspension of contaminated particles.

The exposure scenarios for hydrologic pathways should consider the ingestion of water at the POA. Hydrologic exposure scenarios should be consistent with local and regional practices. Common exposure scenarios to consider potentially include the ingestion of dairy products, livestock, fish, crops, and soil that could become contaminated from the use of contaminated water.

The exposure scenarios for atmospheric pathways should consider immersion in and direct inhalation of air contaminated with volatile and non-volatile radionuclides. Atmospheric exposure scenarios should also consider external exposure, ingestion of crops, soil, livestock and dairy products from the deposition of contaminated particles, and inhalation of re-suspended contaminated particles.

The current recommended approach for describing a hypothetical member of the public to be considered in projections of future doses uses the construct of a representative person. A representative person is described as an age and gender weighted average (reference) person receiving a dose that is representative of the more highly exposed individuals in the population (see DOE O 458.1 and ICRP Publications 101 and 103). A maximally exposed individual may also be used consistent with DOE O 458.1.

Additional scenarios may also need to be considered based on site-specific practices and land use assumptions (e.g., recreational, industrial). More extreme pathways and scenarios, if considered, are typically addressed as part of sensitivity and uncertainty analyses.

Examples of pathways and scenarios to be considered and approaches for modeling exposure scenarios are provided by the NCRP, *Performance Assessment of Near-Surface Facilities for Disposal of Low-Level Radioactive Waste* (NCRP Report No. 152); Yu et al. (2007)[13] (2007); Napier, B.A. (2011)[14]; and EPA, *Preliminary Remediation Goals for Radionuclides -- User's*

[13] Yu, C., E. Gnanapragasam, B.M. Biwer, S. Kamboj, J.-J. Cheng, T. Klett, D. LePoire, A.J. Zielem, S.Y. Chen, W.A. Williams, A. Wallo, S. Domotor, T. Mo, A. Schwartzman, *User's Manual for RESRAD-OFFSITE*, 2007

[14] B.A. Napier, *GENII Version 2 Users' Guide*, PNNL-14583 (2011)

Guide (2012). Representative input data are provided in recent publications from the EPA *Exposure Factors Handbook* (2011) and EPA 2012); IAEA, *Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Terrestrial and Freshwater Environments* (2010); and Staven et al. (2003)[15]. Older references are also available that may be helpful (Baes et al., (1984)[16]; Wang et al. (1993)[17]; and NCRP (1996). The analyst should use site specific information where possible, but generic values starting with the more recent documents above can be used with proper justification and recognition of the uncertainties in the context of the conclusions of the analysis. EPA (2012) provides input values that can be used for initial screening when using reference person dose coefficients.

Any assumptions regarding human habits at times far in the future will be speculative, so it is important that there not be an expectation that the calculations are a prediction of an actual impact. Exposures at the time and location of peak concentrations and habits such as those of a subsistence farmer are assumed to bias results towards what would be considered a more highly exposed individual. Median or mean exposure parameter values consistent with current regional or site-specific practices are generally considered appropriate for projections of future impacts under these conditions. This approach is consistent with the implementation for an average member of the critical group that has been used in the past. If a representative person approach is used, weighted average exposure factors should generally be used when there is a need to refine initial screening calculations.

More bounding values, such as EPA (2012) can be used for screening when using reference person dose coefficients. In general, it is recommended to place some perspective on the assumptions regarding consumption and exposure applied for a subsistence farmer relative to the majority of the population in a given area. The analyst will need to defend the specific values that are used for a given PA.

For probabilistic analyses, the same considerations for documentation and development of distributions will apply as were discussed with other models (e.g., source term, water and air). Distributions or sensitivity analyses may be used for environmental parameters (e.g., concentration ratios for milk or meat, soil to plant, etc.). However, given the high level of uncertainty regarding human habits in the far future, exposure parameters (e.g., consumption rates, occupancy, etc.) may not need to be considered in the uncertainty analysis. This is consistent with the use of stylized assumptions based on current behavior. If bounding values

[15] Staven, L.H., B.A. Napier, K. Rhoads, D.L. Strenge, *A Compendium of Transfer Factors for Agricultural and Animal Products*, PNNL-13421 (2003)

[16] Baes III, C.F, R.D. Sharp, A.L. Sjoreen, and R.W. Shor. *A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture*, ORNL-5786 (1984)

[17] Wang, Y.-Y, B.M. Biwer, C. Yu, *A Compilation of Radionuclide Transfer Factors for the Plant, Meat, Milk, and Aquatic Food Pathways and the Suggested Default Values for the RESRAD Code*, ANL/EAIS/TM-103

are used for consumption rates, etc., this should be clearly identified as a contributor to defense in depth.

2.2.4.3 Modeling Tools

This section should include a description of the modeling tools and their implementation for the PA. The descriptions should reflect the practical implementation of the conceptual models described in the Conceptual Model section, including source term, radionuclide transport, exposure pathways and scenarios. The dose assessment modeling tools should also be described. The introductory discussion should include a summary of the general linkages between the modeling tools, the flow of information, and how the tools are integrated to provide the overall model of system performance.

The primary modeling tools and any other tools used for supporting calculations including sensitivity and uncertainty analysis should be separately described in the subsections. The description for each tool should address the mathematical models, their limitations, and basis for selection of the modeling tool with supporting information presented in the appendices and/or supporting document(s).

For each modeling tool, documentation of the QA in accordance with procedures for computer code selection, use, modification and application should be presented in the PA or appendices. For the purpose of confidence building, also summarize available activities to build confidence in the results from the modeling tools (e.g., references to plume matching efforts, natural analogs, benchmarking studies, or model validation activities).

Objective

This section provides the description of the modeling tools used for the PA, including the basis for selection and QA.

Discussion

Each of the modeling tools used in the PA and linkages between the models should be described (Figure 2-11). The basis for selection of each of the modeling tools should be presented, with supporting information presented in the appendices or supporting documentation. The use of the modeling tools should be justified in the context of the adequacy to consider the processes and features described in the conceptual models. In general, the complexity of the models selected should be commensurate with the available data. As applicable, models should be documented and verified in referenced publications or supporting documentation for the PA. The QA procedures for model selection, use, and application should be identified with citations for additional detail. If the modeling tools differ from those used for an earlier version of the PA, then some discussion of the basis for the change should be provided.

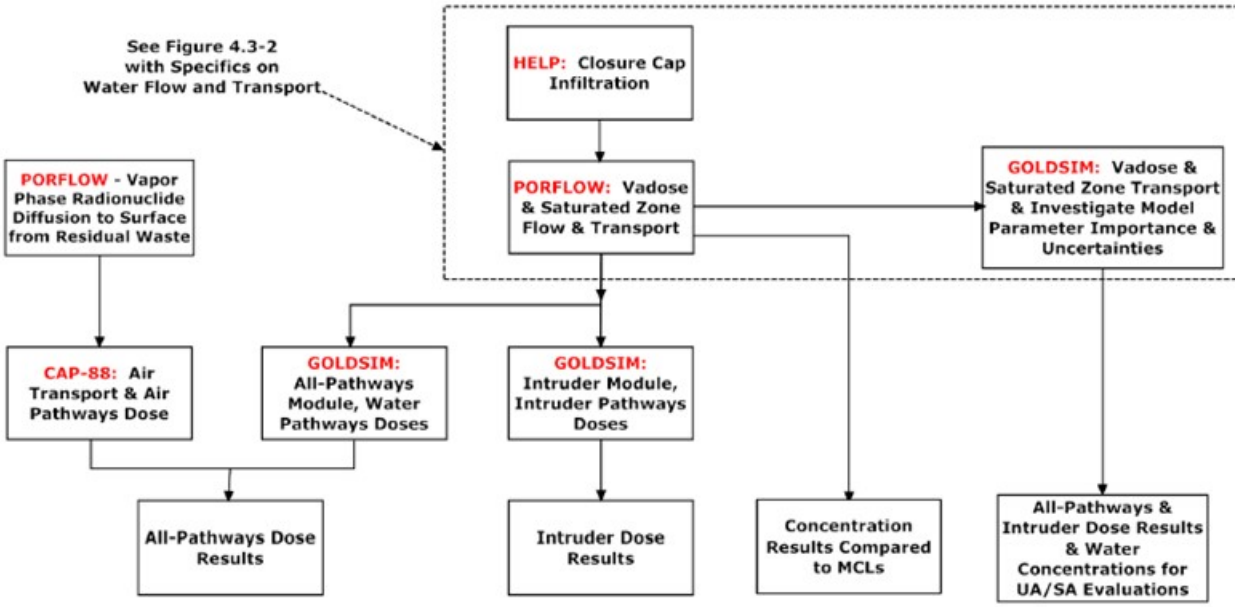


Figure 2-11. Example Summary of PA Modeling Tools

Verification and validation in the form of confidence building to the extent practicable of the mathematical models for the transport of radionuclides in the atmospheric and hydrologic environments for the site-specific application should be presented, including comparisons to existing data or related investigations, e.g., CERCLA groundwater modeling, environmental monitoring data, field, and laboratory experiments. Such validation can include comparisons with associated PA results, DOE O 458.1 monitoring data and dose projections, other site-specific monitoring data. Such validation may require that intermediate modeling outputs, i.e., those prior to calculation of the projected annual dose, associated with the source release, fate and transport, and all-pathways dose modeling are saved for appropriate comparisons.

The benchmarking will emphasize a comparison of the models, but additional description should also be provided to discuss how each model represents behavior in the natural and engineered system.

2.2.5. Implementation of the Modeling

This section should provide the description of the implementation of the modeling efforts, including production of any intermediate results. Results that are passed between different tools and how those linkages are implemented (e.g., scripts, manually, integrating platform) should also be described in the PA or supporting documentation. Each subsection should include a description of methods of analysis, including a description and justification of any credit taken

for engineered features, land use assumptions, or documented site CPs included in the modeling and references for QA documentation for models and simulations.

The individual subsections should describe key assumptions associated with the mathematical model(s), limitations of the models and a description of input data not presented with the conceptual model but used for the implementation of the mathematical models. Justification and verification of initial conditions, boundary conditions, and changes of properties with time derived from existing site data or information should be included. For probabilistic simulations, the basis for the selected modeling approach, implementation of parameter distributions, and the justification for the number of realizations considered for the probabilistic analysis should be included. The rationale for any additional sensitivity cases to describe alternative scenarios or representations should also be provided as applicable. The descriptions in the PA and supporting documentation should be sufficient for a reviewer to understand and assess the validity of the approach.

Include justification of the dimensionality of the model(s), the necessary geometry and mechanisms associated with radionuclide source release, radionuclide fate and transport, and dose modeling. In cases where abstractions are used to produce simplified representations of more detailed models (e.g., where a deterministic model is used as a basis for parameterization of a simplified representation to conduct many simulations for a probabilistic model or in cases where a differing levels of detail are used in a probabilistic framework), benchmarking documentation of the two modeling approaches should be provided to demonstrate that the simplified (abstracted) model adequately captures the behavior of the system for the purposes of the uncertainty analysis. Time steps for each simulation based on the ability to appropriately capture peak doses should be described and justified.

2.2.5.1 Source Term

This section should present the approach for implementation of the source term modeling including the engineered aspects of the system to quantify the release rates from the facility for the air and water pathways, respectively. This includes waste characteristics, waste forms, containers, covers, backfill, and engineered barriers (liners, vaults, tanks, etc.), as applicable. Approaches to represent any specific waste forms or containers that were modeled in detail should be provided. Assumptions and the rationale for the method to implement changes in chemistry and material properties over time should be described, including any use of alternative conceptual models or scenarios to address different potential evolution of the system. Method(s) for addressing non-linear mechanisms (e.g., unsaturated moisture characteristic for soils and engineered features or solubility assumptions) should be addressed.

2.2.5.2 Atmospheric and Groundwater Pathways

This section should present the approach for implementation of the modeling for air and water transport pathways following release from the disposal facility. It should provide a comparison with other related modeling efforts at the site and discuss the basis for any significant differences in the approach. Consistency of the modeling with known plumes at the site should also be addressed as applicable.

This section should demonstrate model capability to analyze radionuclide transport in the environment consistent with the conceptual model, including model suitability to estimate the time history of contaminant transport (to maximum concentrations) for each radionuclide. Method(s) for addressing non-linear mechanisms included in contaminant transport (e.g., unsaturated moisture characteristic for soils) and parametric representations of natural processes in the mathematical models should be presented. A demonstration of the model(s) capability to provide the necessary output to support dose estimation at the POA for the all-pathways, air pathways, and water resource impact assessment performance objectives should be included.

2.2.5.3 Radon Analysis

This section should describe the modeling approach to implement the conceptual model for calculating the average flux of radon through the cover or the concentration of radon at the POA for compliance with the radon performance objective. Assumptions and parameters implemented in the modeling but not described with the conceptual model should be addressed.

2.2.5.4 Biotic Pathways Analysis

This section should describe the modeling approach to consider potential biotic pathways, how concentrations in environmental media are developed, and the method for incorporating the analysis of biotic pathways into the all-pathways and air pathways analyses.

Objective

This section provides the details regarding the implementation of the conceptual models in the modeling tools.

Discussion

Each subsection should provide a discussion of the mathematical models and modeling simulations for the PA and demonstrate the capability to produce the results needed to support the required exposure and dose calculations in "Exposure and Dose Analysis." Input data and assumptions not described with the site and facility description or the conceptual model and used for the mathematical models need to be described in each subsection and justification and citations are provided for more detailed documentation. The initial conditions, boundary

conditions, and changes in properties with time should be justified and described consistent with existing site data or facility information. Citations and references need to include page number and table or figure number for the source of the data to provide a clearly traceable record. Key assumptions associated with each mathematical model need to be described along with any limitations of the models that may be relevant for the use of results in decision-making. Any differences in key assumptions in the current models relative to models used in a previous PA or other assessments related to the facility need to be identified and described. Figure 2-12 is an illustration of the implementation of a modeling approach using two complementary models with differing levels of detail.

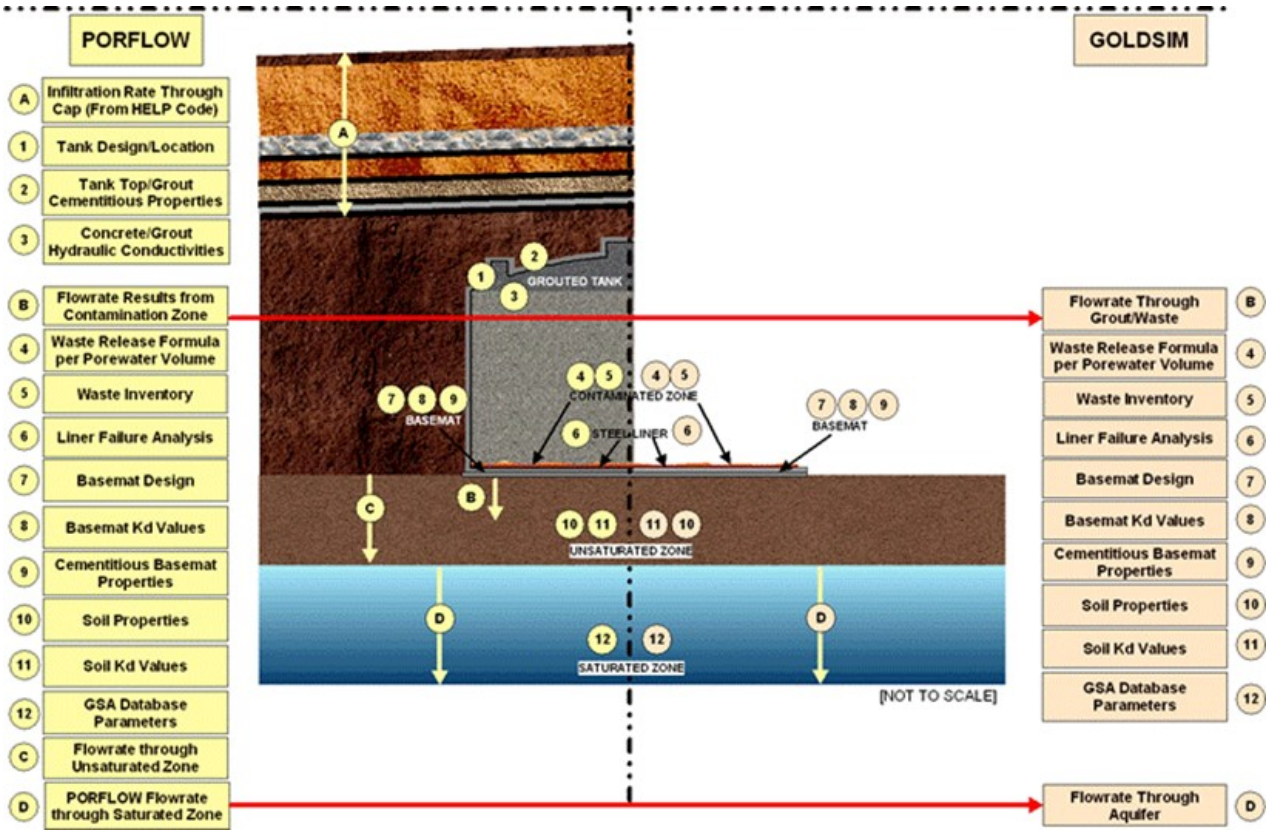


Figure 2-12. Example Elements of the Models Implemented for a Tank Closure PA

Uncertainties associated with parameters or parameter values need to be identified and the approach for managing those uncertainties should be summarized with reference to more detailed descriptions as needed. For probabilistic approaches, the basis for the selection of parameters considered in the uncertainty analysis and parameter distributions should be provided. It is also important to consider the potential for risk dilution when developing input distributions for a

probabilistic assessment using the peak of the mean or median as the indicator of compliance. Risk dilution can result from a situation where the choice of input distributions inappropriately influences the central tendency of the output. For example, use of what appears to be a conservatively wide input distribution to cover a large range of potential input values for a critical parameter may bias the mean or median in a non-conservative manner and provide an overly optimistic result. The basis for the number of realizations considered for the probabilistic analysis also needs to be provided. This typically includes a discussion of any exploratory simulations that were conducted with different numbers of realizations. The purpose is to demonstrate that changes in the number of realizations do not substantially change the results in the context of how the results are used.

When considering the level of detail to represent in mathematical models, it is often necessary to make simplifications to enable many different simulations to be conducted. Often, a PA will include the use of one or more mathematical models with different levels of detail. In cases where abstractions are used to produce simplified representations of more detailed models (e.g., where a deterministic model is used as a basis for parameterization of a simplified representation to conduct many simulations for a probabilistic model or in cases where a differing levels of detail are used in a probabilistic framework), benchmarking of concentrations or fluxes documenting the two modeling approaches should be provided to demonstrate that the simplified (abstracted) model adequately captures the behavior of the system for the purposes of the uncertainty analysis (Figure 2-13). Such benchmarking facilitates probabilistic approaches and has proven to be a valuable checking approach for detailed and simplified models and helps to demonstrate an understanding of the different models (e.g., Seitz et al. 2008).

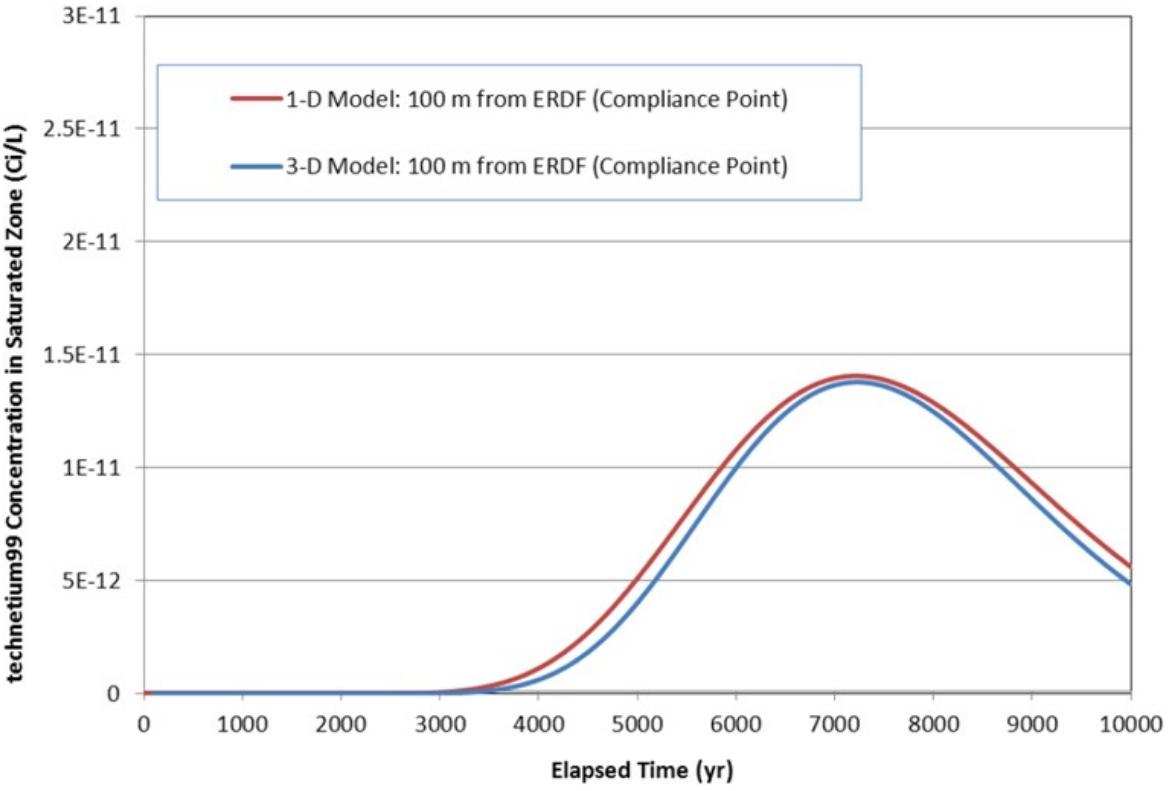


Figure 2-13. Example of Benchmarking Concentrations from a 3D Model with a 1D Abstraction of the 3D Model

Selection of appropriate grid spacing can provide for an appropriate level of averaging of concentrations in the aquifer. Care should be applied to not select such small cell volumes that it would yield concentrations in a small volume that would not be representative of actual water use. Likewise, time steps are also a consideration when considering peaks. Time steps should not be so small that peaks in any given step are not representative of the average dose that one would be expected to receive. This is especially a concern for short lived radionuclides. For example, a peak observed in a one-day time step would not be representative of the annual usage of water.

It is common practice to use finer time steps during the early part of simulations to capture the peaks of fast moving radionuclides, and larger time steps are generally sufficient during the latter part of the simulation, when the peaks of slower moving radionuclides appear. However, if releases of fast moving radionuclides are delayed, finer time steps may be required at the time of actual release.

Availability of data to support the model is an important consideration when determining the appropriate level of complexity. Generally, the modeling approach should be commensurate

with the available data. However, additional complexity can be useful to help with understanding and gaining insights regarding specific aspects of a system, but the results should be viewed in proper perspective considering the data on which the model is based. The mathematical models need to reflect the conceptual models described previously. The dimensionality of the model(s) will be justified and sufficiently capture the necessary geometry and mechanisms associated with radionuclide source release, radionuclide fate and transport, and dose modeling in the context of the decision being made. Linkages between all the different models need to be described to document how information is passed between the different models.

Although the focus of the compliance determination when using probabilistic approaches will be on a central tendency, results from higher percentiles can be used to inform decision-makers regarding potential variability. Parameter combinations that can result in higher doses can be identified and used to make modifications to improve the robustness of the design or identify critical uncertainties.

Each model should be capable of providing the time history of data required as input for the next model (e.g., release rates to air and vadose zone from the facility as a function of time are an input for the modeling of the natural system, concentrations in air and water in the natural system are used as an input for the exposure and dose calculations). Approaches for considering alternative conceptual models or failure scenarios for the waste forms, covers and other engineered features should also be described. The results from each model need to be consistent with the inputs for other calculations and the approach for transferring the information from one model to another model needs to be described, as applicable.

The linkage of the source term analysis with the other components of analysis relevant for the inverse calculation of allowable limits should also be provided. Methods used to represent nonlinear mechanisms in the source term, such as solubility limits for certain radionuclides, should be described, especially in the context of deriving WAC based on the results. It is important to maintain a direct relationship between the calculated results and each source term that may require different limits (e.g., preserve the ability to determine what peak dose is associated with releases of C-14 in a specific activated metal waste form, if there are different limits being developed for that waste form).

2.2.5.5 Exposure and Dose Analysis

This section should include a description and justification of the models and parameters used for each radionuclide for each pathway and scenario considered in the dose analysis (e.g., transfer factors between media, consumption rates of radioactively contaminated materials, inhalation rates of contaminated materials, and external exposure rates and conditions). DOE-approved dose coefficients should be included for all radionuclides, including short-lived radionuclides not included with the parent.

The dose analysis should be capable of providing:

- Maximum projected dose (or other criteria) and time of occurrence during first 1,000 years;
- Discussion of potential peaks that may occur beyond 1,000 years;
- Dominant pathway contributing to dose; and
- Radionuclides responsible for dose (or other criteria).

2.2.5.6 Risk Assessment Integration

For disposal cells that are also regulated with performance criteria in the form of risk rather than dose (e.g., CERCLA disposal cells), the section should describe the relationships assumed between the dose calculations and risk calculations.

Objective

This section describes the implementation of the exposure and dose modeling to produce the results that will be used to compare with the dose-based performance objectives.

Discussion

This section should provide a description of the method of analysis for estimating doses from the modeling analyses discussed that use dose as the performance objective. At the time this Standard was developed, the most recent guidance for dose coefficients was provided in DOE-STD-1196-2011) which accompanies DOE O 458.1. The current DOE-approved approach uses dose coefficients that have been developed for a "reference person," which are developed to be consistent with the concept of a representative person and are to be used for application for the Maximally-Exposed Individual. Dose coefficients for each radionuclide should include contributions of short-lived progeny, when these progenies are not explicitly considered separately.

The current DOE approved ingestion and inhalation dose coefficients are the Reference Person effective dose coefficients in DOE-STD-1196-2011. The current DOE approved air submersion dose coefficients are the adult effective dose coefficients in DOE-STD-1196-2011. The current DOE approved water submersion and ground shine dose coefficients are the adult effective dose coefficients provided in Federal Guidance Report 12 (EPA 1993), but are expected to soon be replaced by Federal Guidance Report 15. These coefficients, along with adult effective dose coefficients for water submersion and ground shine are also available in the Dose Coefficient File Package (DCFPAK) database. Currently, DCFPAK 3.02 is utilized, but is expected to soon be replaced by DCFPAK 4.0 (https://www.dcfpak.org).

The analysis should provide the maximum projected dose or other criterion and time of occurrence for the first 1,000 years, the dominant pathway contributing to the dose or other criterion, and the radionuclides responsible for the maximum dose or other criterion. As described previously, peak impacts, potentially including indicators other than dose (e.g., fluxes or concentrations in the environment), occurring after 1,000 years should also be used as part of the decision-making process, but are not directly compared with performance objectives in the context of compliance.

This section should identify the doses attributable to each radionuclide considered in the dose analysis for ingestion, inhalation, immersion, and external exposures. The models and parameters used in the dose analysis should be described and justified for each of the exposure pathways described in the conceptual model to establish the annual effective dose for each radionuclide for each pathway and scenario considered in the dose analysis. Any parameter values used for the dose analysis, that were not described with the conceptual model should be identified and justified using references to the literature or site-specific investigations. These parameters include all of the transfer factors between media, the consumption rates of radioactively contaminated materials, the inhalation rates of contaminated materials, and the external exposure rates and conditions to radioactive materials not previously described with the conceptual model.

2.2.6. Results of Analysis

This section should provide, as applicable, intermediate results from the various models in the analysis and results directly needed to support a comparison of the projected peak dose or concentration at the POA during the compliance period with the performance objectives. Detailed descriptions of calculations and results should be provided in the text or provide citations for detailed descriptions in an appendix or separate reference.

A combination of tabular and graphical information should be provided as applicable for each subsection to provide a sufficient basis to evaluate the adequacy of the modeling approaches, identify trends, support development of the integration and interpretation of results, and support the assessment of compliance with the performance objectives. Significant insights that can be provided regarding assumptions and processes with the greatest influence on the results should be included. For probabilistic approaches used for compliance, graphics and tabular information for the mean and median concentrations/flux/doses as a function of time should be provided. Provide results on the tails of the distribution for information (e.g., range between the 5th and 95th percentiles). The results of sensitivity cases and any alternative scenarios that were considered should also be provided here or cross referenced to the sensitivity and uncertainty analysis section.

The results should address the full compliance period (1,000 years after facility closure). For results that are expected to peak after the compliance period, the potential peaks should be

addressed to consider the potential for catastrophic impacts later in time as well as the robustness of the models and to identify assumptions that may influence the timing of the peaks, especially assumptions that could result in peaks shifting into the compliance period.

2.2.6.1 Source Term

This section should describe the results of modeling for the cover, waste forms/containers and the engineered features (e.g., liners, vaults) and identify information that is passed to the air and water transport models, respectively. Presentation of the source term analysis results, including tabular and graphical presentations of key input parameters and output for source term calculations should be included, as applicable, with additional details included in appendices or supporting documents. Results of all radionuclides identified as contributing significantly to total dose in the Screening Approaches section (i.e., not screened out) and a time history of the release of radionuclides from the waste to the environment should be included.

Identification of the most significant source terms (radionuclides and wastes) and explanation of how uncertainties are addressed (e.g., uncertainty analysis, conservatism) should be included to provide perspective to support the integration and interpretation of results. A demonstration that the results are consistent and defensible based on site monitoring data and field investigations, or an explanation of any inconsistencies should be presented.

2.2.6.2 Radionuclide Transport

This section should provide results describing the migration of radionuclides through the natural environment with separate subsections for groundwater, air, radon and biotic transport pathways. The results should include sufficient information to justify the selection of the POA that will be applied for the comparison with the performance objectives. Radionuclide-specific time histories at the POA should be provided for all radionuclides contributors to support comparisons with the water resources protection and radon performance objectives and to serve as inputs for the exposure and dose calculations for the all pathways and air performance objectives. Include appendices or reference supporting documents, as appropriate, for additional detailed listings of inputs and outputs of the analysis.

Each subsection should include a discussion of significant radionuclide concentrations, dominant transport processes, and an explanation of how uncertainties are addressed (e.g., uncertainty analysis, conservatism) to provide perspective to support the integration and interpretation of results. A discussion of the consistency of results with other PA results, monitoring results and supporting field investigations should be provided. Descriptions of the basis for significant inconsistencies should also be provided.

2.2.6.3 Exposure and Dose Analysis

This section should provide time histories of results from the dose analysis for the radionuclides, exposure pathways and scenarios considered in the PA. A presentation of dose (or other criteria) associated with each of the performance criteria in tabular form should be provided that identifies the radionuclides that are primary contributors to the peak dose (or other criteria) and which pathways and scenarios significantly contributed to the peak dose. A presentation of maximum doses during the compliance period for the projected inventory of wastes in the disposal facility should be provided for deterministic simulations. For probabilistic simulations, the peak of the mean and median dose from the distribution of results should be provided to demonstrate compliance and ranges of results are provided for information. Potential peaks beyond the compliance period should also be described.

2.2.6.4 ALARA Analysis

The ALARA analysis consistent with DOE-HDBK-1215-2014 and a graded approach as required for compliance with DOE O 458.1 and any changes implemented based on the analysis should be documented in this section.

Objective

This section provides the results of the analysis, including intermediate results from the source term, radionuclide transport and exposure pathway calculations, for the scenarios and pathways identified in the conceptual modal for all radionuclides that were not screened.

Discussion

This section should present the results of the PA modeling described in the modeling implementation. The peak results during the compliance period for all radionuclides that were not screened are provided for completeness, but most of the tables, graphics and text will focus on those radionuclides making the primary contributions to the determination of compliance or with significant peaks after the compliance period. Intermediate results from the various models in the analysis are provided to gain insights into the relative importance of the different components of the PA in terms of determining the peak dose. For peaks occurring at increasingly long times after the compliance period, alternative indicators may be used rather than a calculation of dose. This is consistent with the decreasing relevance of dose as an indicator of health effects in the far future. The information in this section should be used to support the choices made for the sensitivity and uncertainty analysis and will also provide the comparison of results with the performance objectives that will be used as the basis demonstrating compliance.

Source Term. Tabular and graphical presentations of the key input parameters and output from the calculations for the source term are presented, as applicable, with references to the

appendices or other documentation for additional detailed listings of inputs and outputs of the analysis. Examples of information to be presented can include: figures or tables with fluxes and concentrations as a function of time, figures illustrating failure times/rates for different barriers or containers, evolution of the physical or chemical properties as a function of time, and/or figures illustrating velocity vectors as a function of time. Explanations of the results should be included to identify the most significant source terms and key assumptions and provide an understanding of the linkage of these results with the other PA results presented in this and other sections. The discussion should demonstrate that the results are consistent with available site monitoring data, supporting field investigations that have been completed to the extent possible, and are defensible representations of performance.

Radionuclide Transport. Tabular and graphical presentations of the summary of the results for the various transport calculations in water and air are presented with references to the appendices or other documentation for additional detailed listings of inputs and outputs of the analysis. Explanations of the results should be included to provide an understanding of the linkage of these results with the other PA results. The discussion also includes demonstrations that the results are consistent with available site monitoring data and supporting field investigations, as applicable. The discussion needs to demonstrate the results are defensible representations of performance in the context of the conclusions of the analysis and provide insights into key assumptions.

The presentation of results for all radionuclides that were not screened includes separate results for the hydrologic and atmospheric transport of radionuclides, radon releases, and biotic pathways, as applicable. The results include a time history of the concentrations (or flux for radon) of radionuclides in the environment in air, water and/or soil, as applicable, at the POA that are used for the exposure and dose calculations.

Exposure and Dose Analysis. Tabular and graphical presentations of the summary of the results for the various exposure pathways and scenarios considered in the analysis should be provided, with references to the appendices for detailed explanations and calculations. The results are presented in tabular form the dose or other criteria associated with each of the performance criteria and should identify the radionuclides that are primary contributors to the peak dose or other criteria and which pathways and scenarios resulted in the peak dose. These details will focus the reviewer on the aspects that are most important. Potential peaks beyond the compliance period are addressed on a case-by-case basis with a primary focus on peaks occurring shortly after the compliance period or peaks for which different assumptions regarding travel time could potentially shift a peak into the compliance period. If compliance related limits are illustrated on the graphs, they should only extend for the time period over which they apply (e.g., a line for the 25 mrem/yr performance objective should only be shown for the first 1,000 years). Additional considerations for peaks beyond 1,000 years were described in “Compliance Period.”

Example:

It is beneficial to provide detailed summary tables or graphs that include peaks or dose versus time plots for all of the radionuclides that were not screened in the Screening Approaches section (Figure 2-14). The exposure scenario(s) or pathway(s) and radionuclides that contribute the largest dose for each of the performance criteria are identified either in figures or tables.

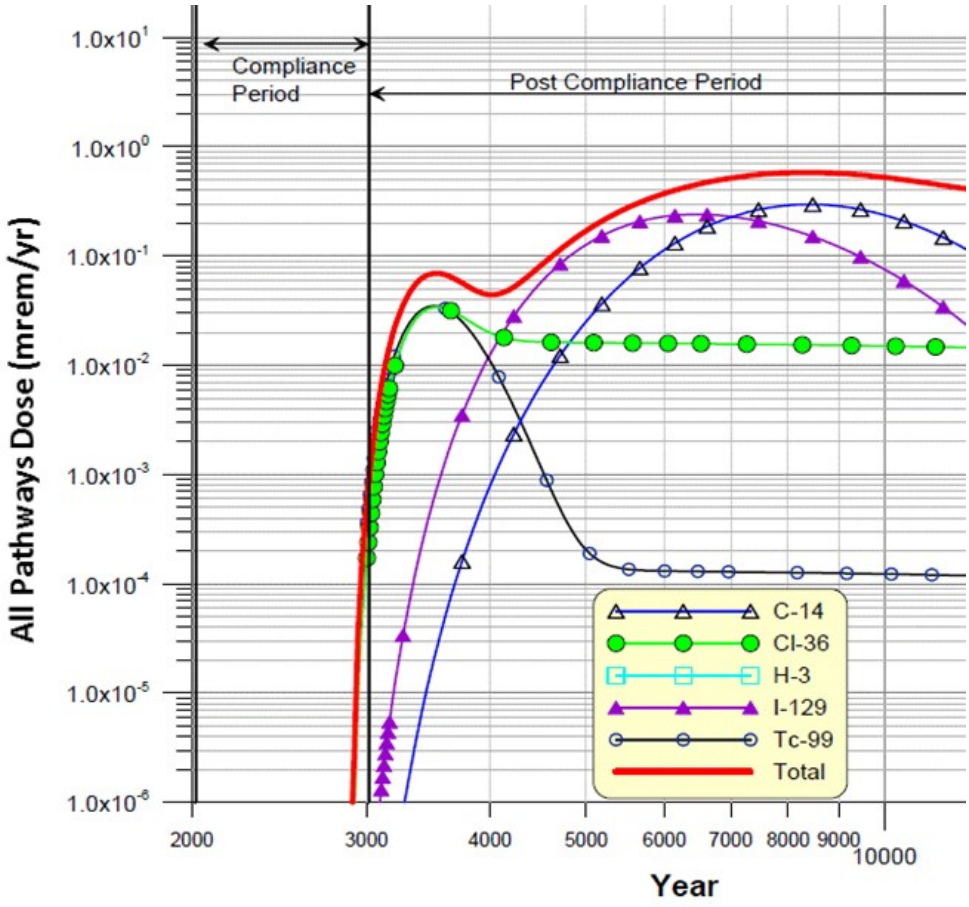


Figure 2-14. Typical Figure Illustrating the Contribution of All Key Radionuclides to the Total Dose as a Function of Time

Example:

Although the focus of the compliance determination will be on a central tendency, results from higher percentiles can be used to inform decision-makers regarding potential variability and identify parameter combinations that can result in higher doses and can be used to make modifications to improve the robustness of the design or identify critical uncertainties. Figure 2-15 is an example showing the range of results from the 5 to 95 percentile. Note that the implicit assumption that

an exposure will occur at the time and location of the peak concentration should also be addressed as part of the interpretation of the results.

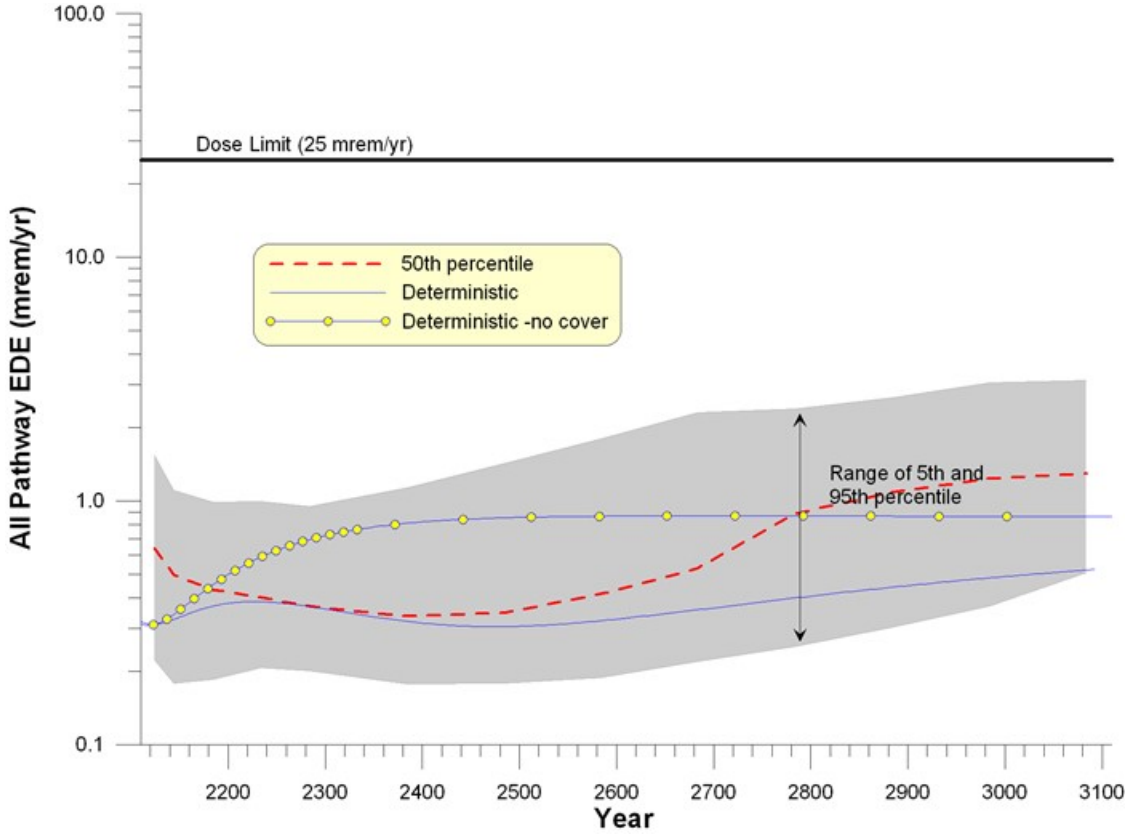


Figure 2-15. Example Graphic to Illustrate the Range of Results with the Deterministic Compliance Case Included for Comparison

The results of the dose analysis should be presented as maximum doses for the projected inventory of wastes in the disposal facility and may also be presented as limiting concentrations or inventories that meet the dose limits included in the performance criteria at the time of compliance and the point or points of assessment to support development of WAC. The discussion should clearly present the relationship between the calculated results and each of the performance criteria.

For existing disposal facilities, it may be beneficial to separately calculate 1) the potential doses from waste already disposed, and 2) the potential doses from waste projected to be disposed in the future.

ALARA Analysis. The results of any ALARA analysis should be documented here. The ALARA analysis may be qualitative, semi-quantitative or quantitative depending on the projected dose associated with the disposal facility. DOE-HDBK-1215-2014 provides specific expectations for the conduct and documentation of ALARA analyses. This description of the results of the ALARA analysis should include the basis for the level of analysis considered, any alternatives addressed, and a description of any modifications that were made based on the analysis.

2.2.7. Sensitivity and Uncertainty Analysis

This section should provide a description of the methods used for the sensitivity and uncertainty analyses. If a probabilistic approach was used for the compliance calculations, then much of the information for the uncertainty analysis will be addressed in "Analysis of Performance" and "Implementation of the Modeling" as part of the discussion and methods/assumptions for the compliance analysis and do not need to be repeated here. This section should be used to identify those parameters and assumptions found to be most important in the determination of compliance with PA performance objectives, development of WAC, and other regulatory decisions. This section should identify the results of sensitivity and uncertainty analyses necessary to support the identification of confirmatory activities for the PA/CA MP and monitoring needs to be included in the PA/CA monitoring plan (MonP).

Sensitivity and uncertainty analysis results should be used as a basis to demonstrate an understanding of the behavior of the disposal system, especially the assumptions and parameters that have the greatest influence on the results and conclusions of the PA. Thus, the results are a key consideration to support development of the section on Integration and Interpretation of Results. This section should also describe any linkages between the sensitivity and uncertainty analysis and formal decision tools that are applied to support prioritization of activities during development of the facility or to support integration of stakeholder input to support decision making.

2.2.7.1 Sensitivity Analysis

This section should include a discussion of the methods used for the sensitivity analysis and should identify the parameters and assumptions that when changed have the potential to influence the conclusions of the analysis. This section should provide the results in graphical and tabular form to identify the radionuclides, pathways, model parameters and/or conceptual model alternatives that could significantly influence the conclusions of the PA.

A discussion of the methods used to identify parameters and assumptions most sensitive to change and their influence on the conclusions should be provided, including any modeling tools used, the basis for their selection, limitation for the approaches and QA information should be included.

2.2.7.2 Uncertainty Analysis

This section should provide a description of the method used for uncertainty analysis, including both model uncertainty and data uncertainty. This section should include a discussion of whether the uncertainties are epistemic (due to a lack of knowledge) or aleatory (subject to chance). Input distributions should be described in tabular form, if not addressed in earlier sections of the PA. Methods for defining and implementing distributions for input variables, sampling, analytical approach for uncertainty analysis and basis for determination of number of realizations run to yield reliable statistics should be included. This section should provide results of uncertainty analysis in tabular and graphical form as applicable to illustrate variability of inputs and uncertainties on dose.

A comparison should be made between the deterministic compliance case model and probabilistic model(s), as applicable, including perspective between the deterministic inputs and the input data distributions utilized in the probabilistic uncertainty modeling. This section should identify assumptions and parameter values associated with realizations yielding doses at the extremes of the outputs and the potential for those combinations. If a probabilistic approach was used for the compliance case, this section should address any additional calculations conducted to enhance the uncertainty analysis and any different assumptions, modeling tools, and approaches that may have been used for the supplemental calculations.

Objective

This section provides a description of the sensitivity and uncertainty analyses implemented in the PA and the conclusions regarding assumptions and parameters with the greatest impact on the results.

Discussion

The identification of the parameters that have the greatest impact on the projected doses (sensitivity analysis) and varying these parameters through a reasonable range of values to provide information regarding the uncertainty of the conclusions of the assessment to changes in key assumptions and design features (uncertainty analysis) is a critical aspect of the assessment process. The NCRP Report No. 152 identified to the concept of “importance analysis” to reflect a specialized version of sensitivity analysis. This approach helps to provide a better understanding of system behavior and build confidence by identifying parameters and assumptions that have significant influence on the conclusions for potential further study and, likewise, parameters and assumptions having minimal influence on the conclusions do not require further study. Efforts to refine data collection, design and/or modeling is then focused on those aspects of the problem that have the greatest influence on the conclusions. Conditions of operation of a facility, if required, may also be considered to assist in understanding or discussing the complexity of uncertainties associated with some of the parameters in the PA.

NCRP Report No. 152 has used the term “importance analysis” in the context of performance assessment to reflect the emphasis of a sensitivity analysis on the input parameters and assumptions deemed to have the greatest impact on the conclusions of the analysis. For example, when deciding where to invest resources to reduce uncertainty, there is less interest where changing a parameter may cause the results to change several orders of magnitude (highly sensitive), but all of the results are well below the standard (inconsequential to the decision). This focus on the impact on conclusions rather than simply the magnitude of the results helps to direct efforts to reduce uncertainties to areas that influence decisions rather than simply influencing the magnitude of results.

Assessments are used in the context of compliance to provide a quantitative comparison with the performance objectives and measures for the disposal facility. In accordance with the existing regulatory structure, performance is evaluated in the context of dose or concentrations that have single values. Even though the dose rate estimates may also be expressed as single values, they have associated uncertainties. For this reason, it is recommended that a discussion of these uncertainties be included as part of the interpretation of results and in expressing the outcomes of the assessment. The goal of this discussion should be to bring these uncertainties to the attention of decision makers, identify activities conducted to address the uncertainties, and provide perspective regarding their significance in the context of the conclusions of the analysis. These analyses can also be used to address potential peaks beyond the compliance period.

A graded approach for the extent of the sensitivity and uncertainty analyses should be used based upon the significance of the base case result to the performance objectives. In general, as the base case maximum result approaches or exceeds the performance objectives, the more important the sensitivity and uncertainty analyses are to the interpretation of the results. Therefore, the sensitivity and uncertainty analyses should be more extensive as the performance objective is approached or exceeded. The sensitivity and uncertainty analyses are less important to the interpretation of PA results, and thus, can be less detailed in cases where the deterministic case maximum result is well below the performance objective.

There are multiple approaches that can be used for sensitivity and uncertainty analysis and a variety of approaches have been used successfully for DOE PAs conducted to date. The key for an effective sensitivity analysis is to use approaches that help to provide a better understanding of relative importance of data and assumptions in the context identifying the aspects of the disposal system that have the greatest influence on performance, and likewise, identifying aspects of the disposal system that have minimal influence. The most effective uncertainty analyses provide perspective on the range of potential results, central tendencies of those results and help to identify combinations of assumptions and parameter values that lead to extreme results.

Experience in the United States (Seitz et al. 2008) and internationally (NEA 2012) has reflected application of approaches that utilize a combination of deterministic and probabilistic simulations to provide a more complete understanding of the relative importance of input assumptions on the results and conclusions from the assessment. This dual or hybrid approach provides different perspectives and insights and fits with the context of "multiple lines of reasoning" that is advocated for effective approaches to manage uncertainties. Such approaches also provide flexibility to use different methods to address aleatory (variability) and epistemic (model) uncertainties. Distinguishing between the different types of uncertainty is important when identifying areas where uncertainties can be reduced with additional information and to identify areas where uncertainties cannot be reduced.

Probabilistic modeling should be used to perform parameter uncertainty analysis, e.g., if the compliance modeling is being conducted in a deterministic manner, a probabilistic uncertainty analysis is more frequently being used to supplement the analysis and illustrate the range of potential results associated with input parameter variability and conceptual uncertainties. There may be cases where an uncertainty analysis comprised of a number of deterministic cases may be sufficient. However, it is more commonly expected that some form of probabilistic modeling will be used. If the compliance or base case is conducted using a probabilistic model, then the uncertainty and sensitivity analysis can be based on the same model.

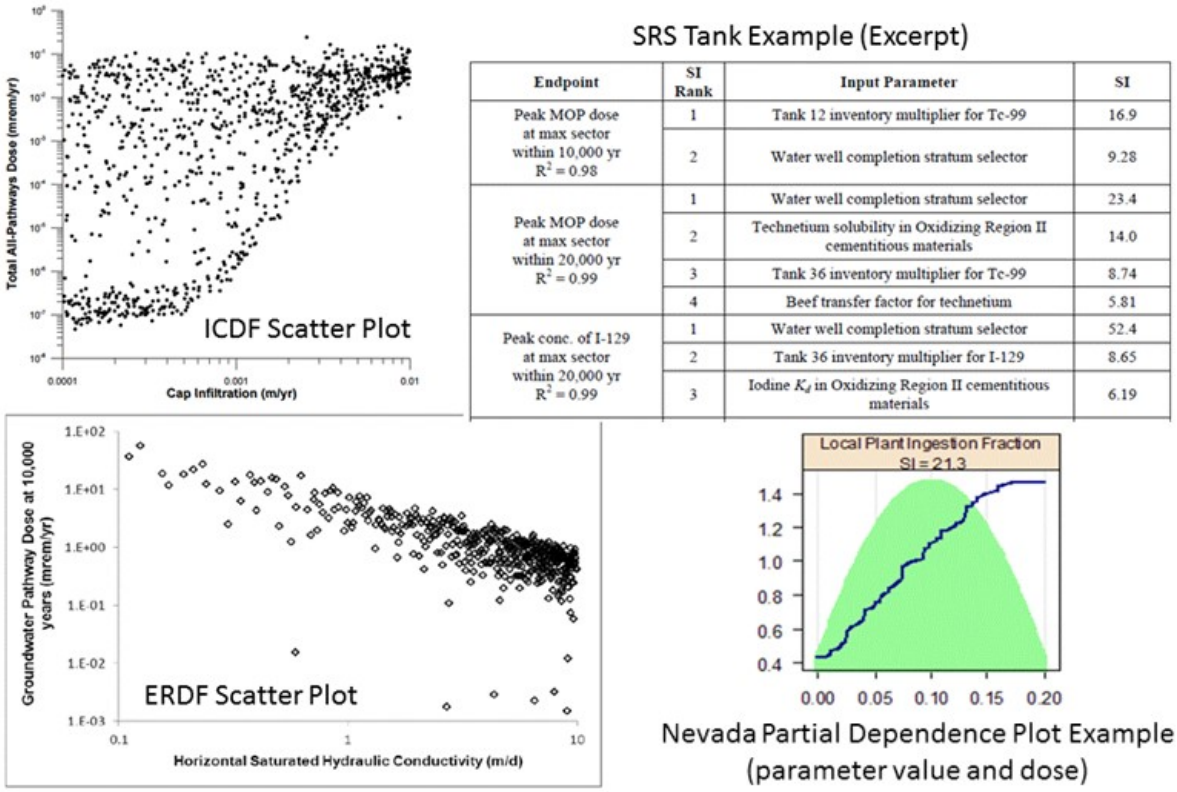
Deterministic one-off (one parameter at a time) sensitivity cases can also be used to illustrate the impacts of changes in one parameter or assumption on the results of the analysis. Deterministic approaches provide the ability to explore more detailed representations of a system (processes, dimensionality, and grid refinement) for a limited number of simulations. Such simulations are typically a collection of sensitivity analyses considering changes in specific parameters and can also include what-if simulations to address model or knowledge related uncertainties associated with different conceptual models or a variety of different scenarios for the future evolution of the disposal system. These simulations help to provide insights into the relative importance of specific processes and broader model related uncertainties on overall performance.

Such deterministic simulations are also used to inform development of a simplified representation of the system that is amenable to numerous simulations associated with, for example, a Monte Carlo approach. It is expected that the simplified representation needs to adequately capture key behaviors from the system being modeled, however, there needs to be perspective that the purpose of these efforts is to gain insights into system behavior. Thus, the level of agreement between the deterministic and more simplified models used for the probabilistic analysis should be commensurate with how the results are being used. Even if there is not an exact match, it may still be possible to gain valuable insights by using the two complementary modeling approaches.

In terms of detailed approaches for sensitivity and uncertainty analysis, some examples are discussed in Seitz et al. (2008) and are also documented in more detail in a number of recent PAs that have been conducted for DOE disposal facilities. The NCRP Report No. 152 included a discussion of the relative merits of different approaches and recommendations for the conduct of sensitivity and uncertainty analyses.

The results from sensitivity and uncertainty analyses can also be used in conjunction with decision tools to help prioritize activities that would be most beneficial to manage uncertainties in the results from a PA. Such an approach can be a valuable tool to help manage the expenditure of resources and direct them to the areas of greatest potential benefit towards managing uncertainties associated with the PA. Such an approach also provides clear justification for activities that would provide a benefit for reducing uncertainties that are a concern through the PA/CA MP and the PA/CA MonP.

Sensitivity Analysis. The goal of the sensitivity analysis is to identify the radionuclides and/or pathways that can significantly influence the conclusions of the PA and therefore the results. A variety of different sensitivity analysis approaches (Figure 2-16) should be used to provide different perspectives regarding the influence of changes in specific parameters on the conclusions of the analysis. For approaches that involve calculations and modeling, this section should describe the modeling approach used and a description of any computer codes provided in "Modeling Tools." If rank correlation or fitting based approaches are used based on probabilistic results, the goodness of fit can be discussed in terms of R^2 or other criteria to help demonstrate the adequacy of the model.



SRS Tank Example (Excerpt)

Endpoint	SI Rank	Input Parameter	SI
Peak MOP dose at max sector within 10,000 yr $R^2 = 0.98$	1	Tank 12 inventory multiplier for Tc-99	16.9
	2	Water well completion stratum selector	9.28
Peak MOP dose at max sector within 20,000 yr $R^2 = 0.99$	1	Water well completion stratum selector	23.4
	2	Technetium solubility in Oxidizing Region II cementitious materials	14.0
	3	Tank 36 inventory multiplier for Tc-99	8.74
	4	Beef transfer factor for technetium	5.81
Peak conc. of I-129 at max sector within 20,000 yr $R^2 = 0.99$	1	Water well completion stratum selector	52.4
	2	Tank 36 inventory multiplier for I-129	8.65
	3	Iodine K_d in Oxidizing Region II cementitious materials	6.19

Figure 2-16. Examples of Different Approaches to Illustrate Sensitivity Analysis Results

It is recommended to provide a variety of different graphics and tabular presentations, e.g., scatter plots and influence diagrams, to illustrate the relationship between changes in an input and changes in the results (consistent with a graded approach). Tabular output can be used to emphasize relative rankings of the importance of different parameters and assumptions in terms of the influence on the model results. The intent is to provide multiple perspectives on specific parameters and assumptions that have a significant impact on the conclusions.

Experience has shown that it is valuable to target the sensitivity analysis to the times and receptor locations associated with peaks. Such an approach tends to highlight parameters and assumptions that are important for a specific peak rather than for the analysis in general. For example, in Figure 2-17, the parameters important for the peak during the early times will be different than parameters that influence the peak at a few thousand or many thousands of years later in time. It can also be valuable to understand the assumptions that may move a peak from after the period of compliance to times within the period of compliance.

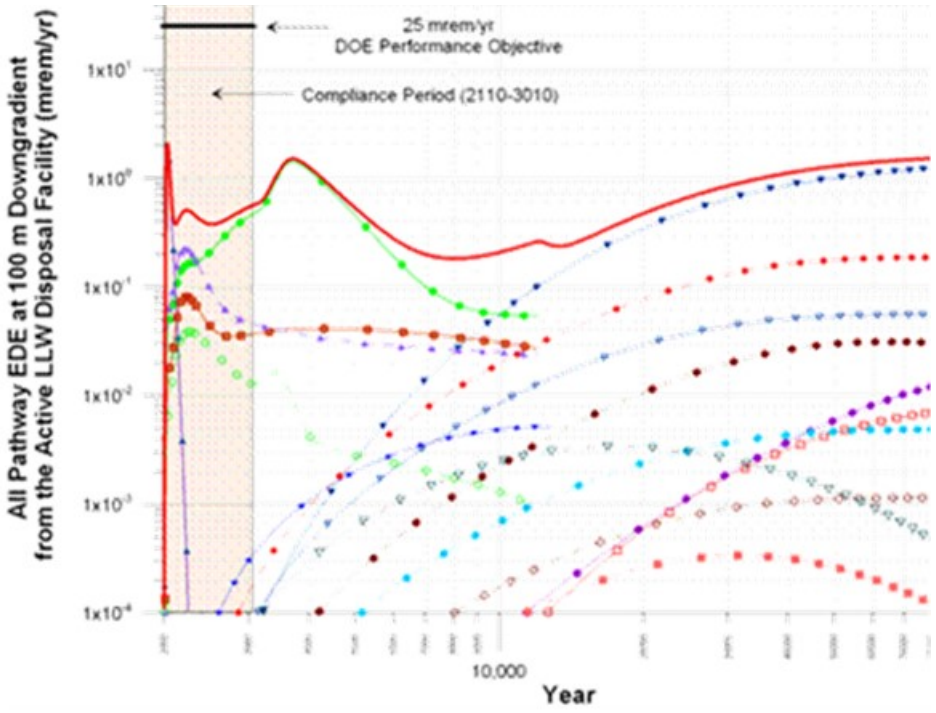


Figure 2-17: Example Illustrating Different Peaks that are Dominated by Different Radionuclides and thus will Have Different Drivers of the Sensitivity

A graded approach to sensitivity analysis is recommended starting with methods like one-off (one parameter at a time) deterministic cases or methods involving simply viewing the output that are generated from a probabilistic analysis (e.g., scatter plots of results versus input data). These approaches provide a limited, but focused view of the relationship between changes in inputs and changes in the output. Subsequent approaches can involve manipulation of the results (e.g., bootstrapping, fitting) to provide greater insights into effects of changes in multiple inputs and a more general view of relative importance of different input parameters.

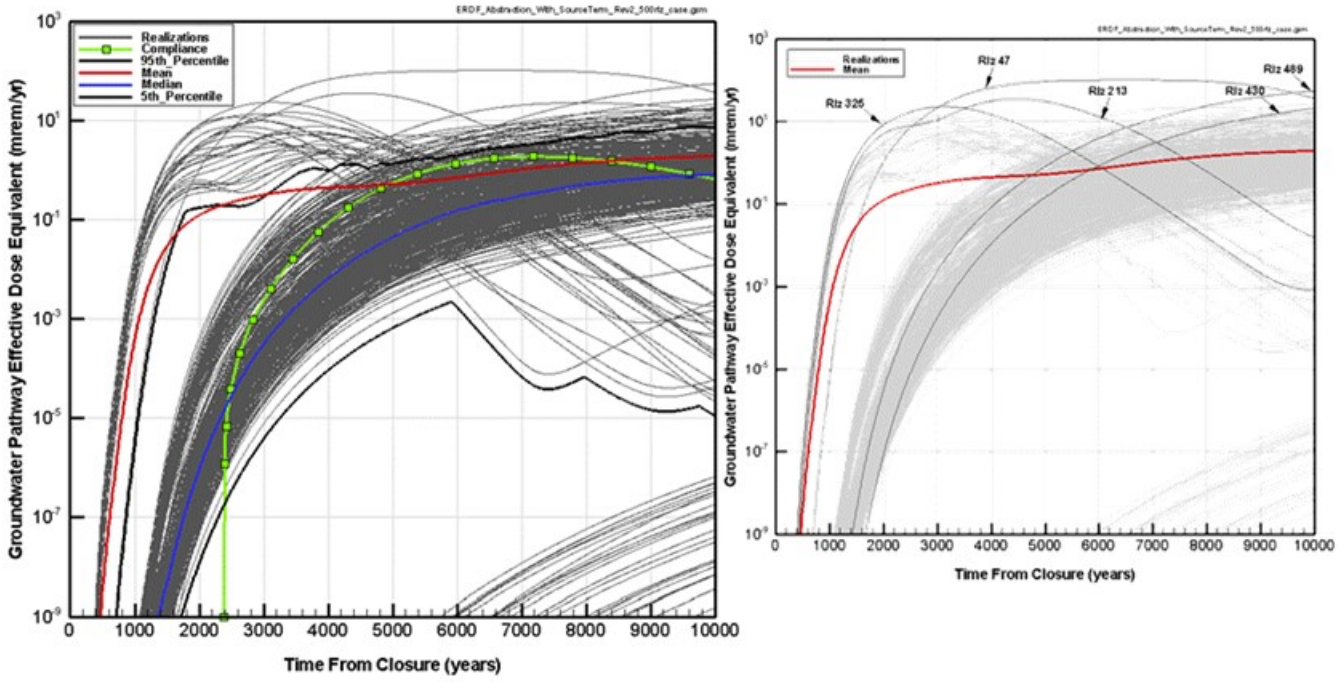
Uncertainty Analysis. The methodology used for sampling and to conduct the uncertainty analysis should be documented along with the basis for determining that a sufficient number of realizations were run to yield reliable statistics. If a multi-dimensional compliance or base case model is abstracted to a lower dimensional model to facilitate the uncertainty analysis, or other simplifications are made, it should be demonstrated that the abstraction sufficiently captures the behavior represented by the original model. The results of benchmarking between the deterministic base case model and the simplified model used for the probabilistic model should be documented and should demonstrate the adequacy of the agreement.

An overview of the input data distributions utilized in the probabilistic uncertainty modeling should be provided. The choice of input parameters for which to develop input distributions and

those to treat deterministically should be justified. Any assumptions associated with the input data distributions not described previously should be clearly identified and justified, and have a defensible technical basis.

PAs may include multiple conceptual models, mathematical models, and scenarios with different assumptions about the key parameters (e.g., institutional controls, future land uses, degradation of the facility features, alternate future climates). Uncertainty and confidence in the PA results should also be discussed in light of any alternative uncertainty cases that are considered.

The results of the uncertainty analysis are presented in tabular and graphical form to illustrate the effects of variability of inputs and conceptual uncertainties (Figure 2-18) on the magnitude of the doses. It is useful to also present results from deterministic compliance case simulations along with the probabilistic results and to discuss the relationship between the two types of results. The results discussion needs to identify any recurring parameter values and assumptions that are associated with results on the tails and the actual likelihood of those combinations to provide input for decision makers to understand the conditions associated with doses at the extremes.



The right figure includes the realization identifiers for results that reflect extremes in order to further investigate assumptions for those cases.

Figure 2-18. Example Illustration of Outputs from an Uncertainty Analysis

2.2.8. Hypothetical Inadvertent Intruder Analysis

This section should identify and assess potential impacts associated with a hypothetical individual that may inadvertently bring waste to the ground surface resulting in short term or chronic exposures. The scenarios should be based on stylized assumptions consistent with current habits generally involving limited excavation or drilling activities. The general models for uptake, exposure and dose for compliance with the performance objectives should be used for the intruder analysis, although different assumptions for uptake factors, exposure times and rates are expected based on the scenarios considered for the inadvertent intruder.

The scenarios should include a demonstration of reasonable representations of potential exposures to individuals to average concentrations of radionuclides in wastes. The results should address direct intrusion into the disposal facility and exhumation of accessible wastes for exposure scenarios, with the consideration of operational (e.g., WAC), design (e.g., waste placement, barriers) or closure features (e.g., active and passive controls) that can be implemented to reduce the potential for and/or consequences of inadvertent intrusion presented.

Scenarios involving cases where someone knowingly intrudes into a disposal facility or continues an action after recognizing that waste is being exhumed are not addressed. Intrusion is assumed to be possible following the temporary loss of institutional controls as described in the sections describing “Land Use and Institutional Controls” and “Timing of Intrusion.”

This section should provide and justify the methodology for performing the hypothetical inadvertent intruder analysis, including any screening techniques for the identification of scenarios and radionuclides to be analyzed specific to the facility and site. The role of any barriers included in the analysis of intrusion to delaying or precluding intrusion, and credits for the long-term performance of barriers or other controls assumed to delay or preclude intrusion should be included. Historical examples of longevity for similar materials, analysis of degradation rates, drilling practices related to the type of barriers such as concrete or activated metal waste forms should be justified. The basis for any probability assigned to an intrusion scenario should be justified.

A description and justification of models and exposure scenarios used, the basis for selection of numerical models used, and consistency with other models used at the site should be provided and documented.

2.2.8.1 Acute Scenarios

This subsection should include a description of the hypothetical acute intruder scenarios considered and analyzed, including assumptions on occupancy times, exposure periods, usage parameters, dose factors, and other information necessary to describe the analyses of reasonable acute scenarios.

2.2.8.2 Chronic Scenarios

This subsection should include a description of the hypothetical chronic intruder scenarios considered and analyzed, include assumptions on occupancy times, exposure periods, concentration ratios, transfer factors, usage parameters, dose coefficients, and other information necessary to describe the analyses of reasonable chronic scenarios.

Intruder Analysis Results. The results of the assessment of the radiological impacts of potential acute and chronic intrusion into the facility should be included, including a description of the radionuclides comprising the peak doses, the timing of the exposures and identification of the dominant exposure pathways leading to the peak doses. Describe how the results are to be applied for development of WAC. Identify any design, operational, or closure changes made to improve the robustness against inadvertent intrusion. Uncertainties associated with the assumptions for the intruder analysis and the approach for managing those uncertainties should be discussed in the context of the results.

Intruder Sensitivity and Uncertainty Analysis. A description of any sensitivity and uncertainty analysis applied for the intruder analysis and the uncertainties associated with these parameters, the exposure scenarios and the models used should be included. Any factors considered to be conservative biases (margins) associated with the results in the hypothetical inadvertent intruder analysis should be identified.

Objective

This section provides a description of the inadvertent intruder analyses, the modeling approach and results compared with the performance measure. The use of the results as a contributor to the basis for WAC is also described.

Discussion

This section should present the method for performing the inadvertent intruder analysis, and the results of that analysis. Guidelines for intruder analyses were described in "Inadvertent Intrusion." The method of analysis should be summarized in this section and the details of the method of analysis should be presented in an appendix or separate documentation. The use of any screening techniques for the identification of scenarios and radionuclides to be analyzed should be presented and justified. Any credits for the long-term performance of barriers that would discourage intrusion and are included in the analysis of intrusion should also be identified and justified (e.g., historical examples of longevity for similar materials, analysis of degradation rates). For some tank closure PAs, the inadvertent intruder analyses should address NRC performance objectives and DOE performance measures.

Models and exposure scenarios to be used in the analysis should be described and justified. The basis for selecting any numerical models used for analysis should be presented. The

documentation for the models and verification of the model should be provided in "Modeling Tools." The exposure scenarios considered for inadvertent intrusion should be consistent with potential exposures to individuals to average concentrations of radionuclides in wastes, and consider direct intrusion into the disposal facility and exhumation of accessible wastes. Relevant chronic exposure scenarios to be considered include agricultural, residential, and post drilling that incorporate ingestion of foodstuffs, ingestion of soil, external exposure, and inhalation of re-suspended particles. Relevant acute exposure scenarios to be considered include discovery, construction and drilling that incorporate external exposure, inhalation of re-suspended particles, and ingestion of particles. If the doses from chronic or acute scenarios can be demonstrated to bind the doses of the other, only the bounding type of scenario need be analyzed and presented in detail.

The assessment for a hypothetical inadvertent intruder is not intended to be an attempt to identify and address all possible ways that intrusion could occur. The focus of the intruder analysis should be on the selection of a few reasonable illustrative, stylized scenarios and reasonably realistic input parameters (e.g., ICRP Publication 81). It is common to consider a drilling scenario with shorter term exposure to the driller (i.e., an acute scenario) and a post drilling scenario, where a resident or frequent visitor (recreational) is exposed to doses resulting from the drill cuttings being left on site (i.e., a chronic exposure scenario, see example in Figure 2-19). In cases where the cover does not provide the thickness to preclude a basement reaching the waste, there can be similar acute and chronic scenarios associated with some form of excavation or construction scenario. Other scenarios that may need to be considered include a discovery type scenario, where someone encounters the waste and recognizes that it is a waste after a short exposure.

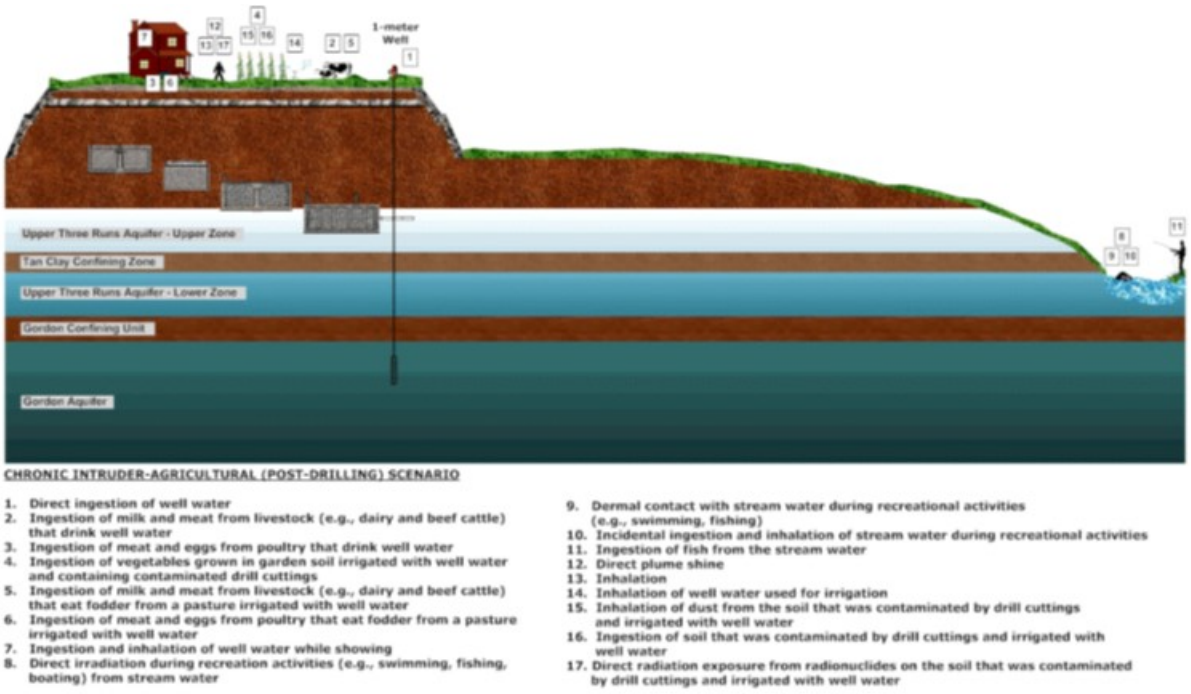


Figure 2-19. Example Exposure Scenarios from Intrusion Associated with Tank Closure at SRS to Address NRC Expectations

The NRC may also request consideration of the use of contaminated groundwater for the chronic scenario in the case of tank closure under Section 3116 of the Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005. In that case, it is assumed that groundwater near the tanks is used, but the dose from water ingestion is considered as part of the performance objective for protection of individuals from inadvertent intrusion (10 CFR Part 61.42). This is hypothetical and it is not necessary to assume the drill creates a pathway for transport, the concentrations in groundwater are taken from the normal scenario without intrusion. The DOE chronic scenario uses a dose measure of 100 mrem/yr, but excludes the contributions from drinking contaminated groundwater.

The use of stylized scenarios addresses the need to ensure that PAs do not become extreme in their analyses via undue speculation about the activities and lifestyles of future generations. Thus, the requirement is to assume that customs and practices of today continue into the future for the purposes of a stylized/illustrative analysis. This provides a common basis across the complex for conducting analyses. The representative person construct should also be used for dose calculations for the inadvertent intruder scenarios.

The inadvertent intruder assessment is required to be included in the PA for tank closure and disposal facilities. However, for the purposes of establishing waste acceptance requirements and

other controls on the disposal facility or assessing the potential impacts of tank waste residuals, the likelihood of intruder scenarios may be addressed in the interpretation of the results of the inadvertent intruder assessment. Justification of intruder scenarios' probabilities needs to be included if used in the intruder assessment.

Sensitivity and uncertainty analysis for hypothetical inadvertent intruder analyses tend to be more limited than for the performance objectives (e.g., explanation of the rationale for scenarios and parameters selected, identification of defense-in-depth), but can be conducted in a more formal manner with proper justification. The analysis should identify sensitive parameters incorporated into the intruder analysis and the uncertainties associated with these parameters. The overall effect of the uncertainties in parameters should be discussed. Uncertainties in the exposure scenarios and the models for analyzing these scenarios should also be discussed. In general, given the use of stylized scenarios to manage uncertainty, sensitivity and uncertainty analyses for intrusion should emphasize the pessimistic bias implicit in the scenarios considered. The analysis presented in this section should demonstrate the extent to which the results in the inadvertent intruder analysis provide a pessimistic bias in the results.

2.2.9. Integration and Interpretation of Results

The objective of this section is to integrate the information, calculations, and results of the PA to demonstrate a sufficient understanding of the low-level waste disposal facility (LLWDF) system and to build confidence in the conclusions regarding compliance with the performance objectives. An evaluation of the sensitivity and uncertainty analyses results identifying the assumptions and parameters that have the greatest influence on the decision to be made should be included.

This section should identify and explain critical assumptions and barriers associated with the ability of the facility to meet the performance objectives based on sensitivity and uncertainty analysis results and provide a rational basis to conclude:

- Factors influencing behavior of the system are sufficiently understood;
- Assumptions with the potential to change conclusions have been identified and are sufficiently addressed;
- The facility performance has been sufficiently addressed for the use of the results;
- The analysis is logically interpreted; and
- The results sufficiently capture the facility performance for their intended use.

This section should provide a summary of all the results establishing a basis for the development of WAC and the limits for each of the radionuclides considered in the analyses of the disposal facility.

Assumptions that are assumed to be pessimistic (e.g., not taking credit, conservative bias in parameter values) are also summarized here to document areas where further credit could potentially be taken in the future.

Objective

This section provides the demonstration of an understanding of the disposal system sufficient to confirm compliance with the performance objectives.

Discussion

This section should provide an interpretation of results presented in "Implementation of the Modeling," "Hypothetical Inadvertent Intruder Analysis" and "Sensitivity and Uncertainty Analysis." The intent is to provide a demonstration of the overall understanding of the disposal system and the features that have the greatest influence on the ability to meet the performance objectives. The different results presented in the PA should be reviewed and consolidated to provide a reasoned basis for evaluating the performance of the disposal facility. The interpretation of results should address the findings of the sensitivity and uncertainty analyses to describe defense-in-depth considerations and an overall summation of the expected performance of the disposal facility that is defensible for each of the performance criteria. The interpretation of results should provide a rational basis to conclude the performance of the LLW disposal facility has been completely addressed, the analysis is logically interpreted, the results are correct representations of the facility performance, and the results are sufficiently rigorous.

For PAs that are structured to determine allowable concentration or inventory limits for the disposal of wastes that meet the performance criteria, a summarization of all the results that establish the limits for each of the radionuclides considered in the analyses that provide a basis for the development of WAC for the disposal facility. For PAs that are structured to project inventories and concentrations in wastes and calculate the resulting doses, a summary of the largest contributing dose for each radionuclide should be presented. An explanation of the use of this summary for developing WAC for the disposal facility should be included in the discussion.

2.2.10. Performance Evaluation

This section should present a comparison of PA results to performance objectives for the compliance period. The PA results should include an analysis of implications of the results and the need for any site characterization, monitoring, operations, and other regulatory related considerations (e.g., identification of weaknesses in the understanding of the system and the need for future work).

2.2.10.1 Comparison of Results to Performance Objectives

This section should summarize the results of the PA compliance against all relevant PA performance objectives and measures. A table should be provided summarizing the results and the applicable performance objectives and measures. This section should provide interpretive material helpful to the understanding of results comparison (e.g., key assumptions, result of sensitivity analyses) and establish the basis for concluding acceptable facility performance and a reasonable expectation that performance objectives will be met. Potential peaks beyond the compliance period should also be addressed.

In addition, this section should identify constraints, including Federal, state, and local statutes, regulations or agreements that impact the site design, facility design, or facility operations.

2.2.10.2 Use of Performance Assessment Results

This section should include a discussion of the use of PA to develop WAC or other operational limits for the facility, and describe judgments made in applying the PA results to the development of radionuclide concentration and total inventory limits for the disposal facility. It should describe numerical values and specific techniques used (e.g., sum of fractions rule), identify key assumptions used in the PA that form the basis for the results, and identify controls to be used in the operation of the disposal facility or the analysis to protect these assumptions.

The PA and any additional constraints should be used to provide a complete representation of the development of the WAC for the disposal facility, and should provide a determination that the projected releases of radionuclides to the environment are consistent with the ALARA process in accordance with the requirements in DOE O 458.1. Any changes made as a result of the ALARA analysis should also be identified.

2.2.10.3 Future Work

This section should describe specific ongoing and additional investigations (e.g., performance monitoring, compliance monitoring, and laboratory experiments) required to address uncertainties in the PA and to provide additional assurance the performance objectives will be met for the facility. It should present information describing future work and the basis for the need for the work, so as to allow incorporation into the PA maintenance, research, development planning, monitoring, and implementation processes. Activities directly linked to resolution of an outstanding issue or condition resulting from an LFRG review should be clearly identified. A schedule(s) for implementation of required investigations and any PA revisions that may be necessary as a result of these investigations should be included.

Objective

This section provides the final comparison of the results with the performance objectives and is the ultimate demonstration of compliance. The use of the results and any future work to address outstanding issues are also described.

Discussion

This section represents the formal demonstration of compliance with the performance objectives and serves as a reference point for information necessary for development of documentation associated with the DAS and a summary of key assumptions and other information that need to be protected in other documentation (operating procedures, WAC, CPs). Future work to address any outstanding issues is also identified to be transferred to the MP.

2.2.11. Quality Assurance

A summary of the QA requirements and site procedures implemented during the preparation and documentation of this analysis should be included. QA requirements associated with inventories, input data, software, models, output data, records, documentation, and data management should be documented in this section. This section should document (by appendices or references) the basis for:

- Ensuring radionuclide inventories, model input data and distributions are traceable, qualified, controlled, and archived;
- Ensuring software used was evaluated for functionality regarding the problem being solved, was verified prior to use, is under configuration control, is managed under a software problem reporting system, and is archived;
- Ensure development and use of models is documented, verified, under configuration control, and archived in accordance with DOE O 414.1D, *Quality Assurance,* and DOE G 414.1-4, *Safety Software Guide for Use with 10 CFR 830, Subpart A, Quality Assurance Requirements, and DOE O 414.1C, Quality Assurance*; and
- Document activities for confidence building (e.g., model evaluation) to the extent practicable and appropriate.

An archive should be established, as appropriate, and include inventory, input data, software, models, output data, the PA, and associated records, documents, and references.

Objective

This section documents the QA program used for development and documentation of the PA.

Discussion

QA procedures and record keeping provisions associated with the PA program are described. The emphasis of this section is documentation of the QA program and how it was implemented for the PA calculations and the input data and assumptions on which the PA is based. References to the procedures will be provided.

Compliance Demonstration

Compliance with the requirement in DOE O 435.1 to develop a facility-specific PA can be demonstrated by a site developing a PA that is in compliance with the performance objectives in DOE M 435.1-1, has been reviewed by the LFRG, and approved by DOE management. The LFRG review will consider the review criteria and consistency with the guidance in this chapter or approved modifications. Key assumptions from the PA that must be maintained in operating procedures, waste acceptance criteria, monitoring and closure plans are identified and documented appropriately.

Copies of this information (at a minimum, the procedures that implement these requirements) should be included in the applicable facility Radioactive Waste Management Basis (RWMB).

2.2.12. Preparers

A list of the preparers of the PA, including a brief overview of their qualifications and experience should be included.

2.2.13. References

Include a complete list of citations for materials referenced in the PA.

2.2.14. Appendices

Include appendices to the PA as necessary to provide technical details supporting the data and analyses presented in the PA. For new facilities, a systems evaluation is also required as an Appendix or supporting document.

2.3. Attachments

Attachment 2-1. *Example Structure for Systems Evaluation*

2.4. References

DOE Order 414.1D, *Quality Assurance*, April 25, 2011

DOE Order 435.1, Chg 1, *Radioactive Waste Management*, July 09, 1999

DOE Order 458.1, *Radiation Protection of the Public and Environment*, February 11, 2011

DOE-STD-1196-2011, *Derived Concentration Technical Standard*, U.S. Department of Energy Technical Standard, Washington DC, April 2011

DOE Guide 414.1-4, DOE G 414.1-4, *Safety Software Guide for Use with 10 CFR 830, Subpart A, Quality Assurance Requirements, and DOE O 414.1C, Quality Assurance*, June 17, 2005

DOE Guide 435.1-1, 1 Admin Chg 2, *Implementation Guide for Use with DOE M 435.1-1*, July 09, 1999

DOE Manual 435.1-1, Admin Chg 2, *Radioactive Waste Management Manual*, July 09, 1999

DOE-HDBK-1215-2004, *Optimizing Radiation Protection of the Public and the Environment for use with DOE Order 458.1, ALARA Requirements*, November 10, 2014

DOE-NE 2011, *Features, Events and Processes for the Disposal of Low Level Radioactive Waste - FY 2011 Status Report*, FCRD-USED-2011-000297

10 CFR Part 20, *Standards for Protection Against Radiation*

10 CFR Part 20, Section 1101(d), *Radiation Protection Plans*

10 CFR Part 40, (Appendix A, Criterion 6), *Procedures for Transportation Workplace Drug and Alcohol Testing Programs*

40 CFR Part 61, Subpart H**,** *Procedures for Transportation Workplace Drug and Alcohol Testing Programs*

40 CFR 61, Subpart Q, *National Emission Standards for Radon Emissions from Department of Energy Facilities*

40 CFR Part 141, *National Primary Drinking Water Regulations*

40 CFR Part 190.10(a), *Standards for Normal Operations*

40 CFR Part 191, *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes*

EC 2009, *The Joint EC/NEA Engineered Barrier System Project: Synthesis Report (EBSSYN)*, EUR 24232 EN

IAEA. *Disposal of Radioactive Waste, Specific Safety Requirements*, No. SSR-5, International Atomic Energy Agency, 2011

IAEA. *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards*, Interim Edition, General Safety Requirements Part 3, No. GSR Part 3, 2011

IAEA. *Safety Assessment Methodologies for Near Surface Disposal Facilities - Results of a Coordinated Research Project: Volume I - Review and Enhancement of Safety Assessment Approaches and Tools*, IAEA-ISAM, International Atomic Energy Agency, Vienna, 2004

IAEA. *Safety Indicators for the Safety Assessment of Radioactive Waste Disposal – Sixth Report of the Working Group on Principles and Criteria for Radioactive Waste Disposal*, IAEA-TECDOC-1372, International Atomic Energy Agency, Vienna, 2003

IAEA. *The Safety Case and Safety Assessment for the Disposal of Radioactive Waste*, Specific Safety Guide No. SSG-23, International Atomic Energy Agency, Vienna, 2012.

ICRP Publication 101, *Assessing dose of the representative person for the purpose of radiation protection of the public and optimization of radiation protection: Broadening the process*, International Commission on Radiological Protection, 2006

ICRP Publication 103, *The 2007 Recommendations of the International Commission on Radiological Protection*, 2007

ICRP Publication 81, *Radiation Protection Recommendations as Applied to the Disposal of Long-Lived Solid Radioactive Waste, International Commission for Radiological Protection*, 1998

NCRP. *Performance Assessment of Near-Surface Facilities for Disposal of Low-Level Radioactive Waste*, NCRP Report No. 152, National Council on Radiation Protection and Measurements, Bethesda, MD, December 2005

NCRP. *Screening Models for Releases of Radionuclides to Atmosphere, Surface Water and Ground*, NCRP Report No. 123, National Council on Radiation Protection and Measurements, Bethesda, MD, January 1996

NDAA Section 3116, *Waste Determinations with Related Disposal Performance Assessments*, Ronald Reagan National Defense Authorization Act (NDAA) for Fiscal Year 2005

NEA. *Methods for Safety Assessment of Geological Disposal Facilities for Radioactive Waste – Outcomes of the MeSA Initiative*, Organization for Economic Cooperation and Development – Nuclear Energy Agency, Paris, 2012

NRC. *Acceptance Guidelines and Consensus Standards for Use in Risk-Informed Regulation*, SECY-97-221, Nuclear Regulatory Commission, September 30, 1997.

NRC. Regulatory Guide 1.174 - *An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis*, Nuclear Regulatory Commission, Revision 1, November 2002.

NRC. *Final Generic Environmental Impact Statement on Uranium Milling, Project M-25,* NUREG-0706, Volume 1, M.2, September 1980, U.S. Nuclear Regulatory Commission

Title 246, *Radiation Protection Standards*, Washington Administrative Code Title 246, Chapter 246-290 (WAC 246-290-025 and WAC 246-290-310),

B.A. Napier, *GENII Version 2 Users' Guide,* PNNL-14583, Rev 3, Pacific Northwest National Laboratory, Richland, WA, September 2011

Baes III, C.F, R.D. Sharp, A.L. Sjoreen, and R.W. Shor. *A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture,* ORNL-5786, Oak Ridge National Laboratory, Oak Ridge, TN (1984)

Kennedy, Jr., W.E. and R.A. Peloquin, *Intruder Scenarios for Site Specific Low-Level Radioactive Waste Classification*, DOE/LLW-71T, U.S. Department of Energy, 1988

Phifer, M., R. Seitz, L. Suttora, *On Performance of Covers and Liners in Performance Assessments*, U.S. Department of Energy, 2014

Seitz, R.R., B. Crowe, M. Sully, and M. Wood, *Probabilistic Sensitivity and Uncertainty Analysis Workshop Summary Report*, WSRC-STI-2008-00333, Rev. 0, Savannah River National Laboratory, Aiken, SC, 2008

Staven, L.H., B.A. Napier, K. Rhoads, D.L. Strenge, *A Compendium of Transfer Factors for Agricultural and Animal Products*, PNNL-13421, Pacific Northwest National Laboratory, Richland, WA (2003)

Wang, Y.-Y, B.M. Biwer, C. Yu, *A Compilation of Radionuclide Transfer Factors for the Plant, Meat, Milk, and Aquatic Food Pathways and the Suggested Default Values for the RESRAD Code*, ANL/EAIS/TM-103, Argonne National Laboratory, Argonne, IL (1993)

Wood, D.E., R.U. Curl, D.R. Armstrong, J.R. Cook, M.R. Dolenc, K.W. Owens, E.P. Regnier, G.W. Roles, R.R. Seitz, M.I. Wood, *Performance Assessment Task Team Progress Report*, DOE/LLW-157, Revision 1, EG&G Idaho, Inc., Idaho Falls, ID, May 1994

Yu, C., E. Gnanapragasam, B.M. Biwer, S. Kamboj, J.-J. Cheng, T. Klett, D. LePoire, A.J. Zielem, S.Y. Chen, W.A. Williams, A. Wallo, S. Domotor, T. Mo, A. Schwartzman, *User's Manual for RESRAD-OFFSITE* Version 2, DOE/HS-0005, Argonne National Laboratory, Argonne, IL (2007)

2.5. Performance Assessment Review Criteria

The Table 2-3 may be used to evaluate whether the document contents are complete and thorough and the document is technically adequate and defensible. Review criteria may be changed according to the scope and facility being reviewed. However, the LFRG Co-Chairs must approve the review criteria being used in the LFRG Review Plan for a specific facility.

Note: numbers in parentheses refer to the section number in the chapter.

Table 2-3. Performance Assessment Review Criteria

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
PA-1	The PA provides an adequate description of other relevant statutes, regulations and/or agreements that have an influence on the assumptions for the PA or criteria that are applied. (2.2.2.5, 2.2.2.6, 2.2.2.8)		
PA-2	The PA adequately identifies and describes other modeling efforts for the facility and other programs at the site in the context of consistency with assumptions made in the PA. Any existing secondary issues from previous PAs are identified and potential inconsistencies with other modeling efforts are identified and addressed. (2.2.2.12.2.2.8)		
PA-3	The PA adequately describes the total disposal system, including roles of key features, and assumptions regarding operations, design and closure that are critical to the conclusions and meeting the performance objectives and should be protected in procedures, closure documentation and/or other regulatory agreements. (2.2.2.2, 2.2.2.3, 2.2.2.4, 2.2.2.8, 2.2.2.9)		
PA-4	The PA adequately describes the context for the PA and compliance with requirements in DOE O 435.1.		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
	The context includes the performance objectives from DOE O 435.1 and any alternative indicators that may be used, the basis for the selection of specific radon and water resources protection objectives, the basis for the time periods considered and receptor locations (points of assessment), approach used to determine compliance during the compliance period (probabilistic or deterministic) and to assess impacts after the compliance period (e.g., alternative indicators), general approach adopted to address inadvertent intrusion (e.g., timing and extent), and considerations related to ALARA. *The PA time of compliance is a 1,000-year period after the assumed end of facility operations. If a longer compliance period is used (e.g., required by other DOE programs and plans; or other applicable Federal, state, or local statutes, regulations, or agreements), documentation is provided to support the longer time frame. The location of the point of assessment is clearly identified and justified based on land use and institutional control assumptions.* (2.2.2.6, 2.2.2.7, 2.2.2.8)		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
PA-5	The PA adequately describes the Site Characteristics and their significance to support the site evaluation process and to support the assumptions made for the conceptual models and site evolution that were adopted. *The site characteristics include a broad collection of information, including but not limited to geography and demographics, land uses, meteorology, hydrology, geochemistry, natural resources, and background radiation levels. Uncertainties and reasonably foreseeable natural processes that could affect the evolution of the system are also addressed. The basis for ranges or distributions of parameters used for uncertainty quantification are adequately justified.* (2.2.3.1)		
PA-6	The PA adequately describes the facility design and operational approach and the significance of different features to support the conceptual models and evolution of parameters over time. The facility design includes a detailed description of any engineered barriers and a description of their functional roles in terms of controlling releases from the facility, specifics about waste placement plans, and the expected waste inventory. Waste forms and containers are also generally discussed in the context of the placement plans. Uncertainties, data gaps and the expected evolution of the design features are also addressed. (2.2.2.2, 2.2.2.3, 2.2.3.2)		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
PA-7	Radionuclide inventories and their basis, including uncertainty, are adequately documented and defensible. *Inventory estimates are quantified and supported by a thorough analysis of disposal records, data, studies and evaluations to ensure that all of the radionuclides disposed and anticipated to be present in forecast wastes are evaluated. The technical bases for estimates of the radionuclide concentrations, including assumptions for distributions or ranges for any uncertainties, for past and future waste disposal is sufficiently described and documented.* (2.2.3.3)		
PA-8	The radionuclides and pathways screened and included for the PA are clearly identified, and the bases for inclusion or screening and exclusion are adequately documented and defensible. *The screening method provides a logical basis for including or excluding radionuclides and pathways based on the expected contribution to the impacts and the influence on the conclusions of the assessment. Radionuclides and pathways that do not contribute significantly to the project dose and influence the decision are documented. A method to track changes in assumptions (e.g., unexpected increase in inventories, changes in conceptual models) that could change the results of screening and, for example, cause a radionuclide or pathway that had been screened to be included in the full PA is described.* (2.2.3.3 or 2.2.4 as applicable)		
PA-9	The characteristics of the waste are adequately described and provide a defensible basis for the conceptual model for the source term. *The physical and chemical characteristics of the waste that may affect the release of*		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
	radionuclides including the potential interactions of chemical or hazardous constituents are adequately described. The physical and chemical characteristics of the waste form, including any waste treatments that affect contaminant release, are fully documented, and supported by laboratory or field studies. The expected effects of waste form and container degradation are incorporated in the analysis as necessary to support the intended use of the PA. Characteristics that are not credited in the analysis are identified to provide perspective on conservatisms. The basis for the assumptions is clearly described. (2.2.3, 2.2.4.1, 2.2.4.2.1, 2.2.5.1)		
PA-10	The conceptual models for the source term, disposal facility and engineered features, and the natural system are adequately described and defensible. The description is sufficient to support selection of the mathematical models and development of the overall modeling approach. The interfaces between the source term, facility features, natural system and exposure pathways are clearly described. *The PA provides a clear description of the conceptual model of the disposal facility and site, and constitutes a reasonable interpretation of the existing geochemical, geologic, meteorologic, hydrologic, and ecologic data for the site and disposal facility. The conceptual model accounts for all relevant processes for the release of radionuclides from the waste materials and these processes are justified by reference to relevant studies, available data, or supporting analyses in the PA in a manner sufficient for the intended use of the PA. The conceptual model incorporates alternative interpretations of the composite processes that control the release and transport of radionuclides at the disposal site as applicable.*		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
	The conceptual model constitutes a reasonable interpretation of the source term and releases, the design features of the disposal facility, the operational procedures used in disposing of waste, and the interim and final closure configurations identified in the closure plan that is sufficient for the intended use of the PA. Credit taken for the performance of engineered features is based on data derived from laboratory and field studies or documented sources of information that are relevant to the disposal site and facility, and takes into account the degradation of the engineered features incorporates the design and engineered features of the facility, including closure plans or reasonable assumptions for facility closure. *The conceptual model includes assessment of natural processes that could affect the long-term stability of a disposal facility (e.g., flooding, mass wasting, erosion, and weathering) over the time period considered in the analysis. The conceptual models are justified based on referenced data, investigations and supporting analysis.* (2.2.4, 2.2.5)		
PA-11	The conceptual models and mathematical approach for the exposure pathways, scenarios and dose analysis are adequately described and defensible. *The PA provides a complete description of, and justification for, the selected exposure pathways and scenarios used to evaluate potential doses to receptors (members of the public). The dose analysis is conducted for reasonable and/or accepted scenarios for the setting of the facility and are consistent with site-specific environmental conditions and local and regional practices. If there is a link to a risk assessment, the relationship assumed between dose and risk is adequately described.*		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
	All assumptions regarding exposure (e.g., rates of ingestion, inhalation) and any representations of groundwater well performance (e.g., construction, diameter, yield, depth of penetration, screen length) are reasonable reflections of regional practices or bounding and are justified. *If radiation dose is used as a measure of groundwater resource protection, the exposure scenarios consider the ingestion of water (at 2 liters per day or an alternative rate, if a justification is included) at the point of assessment, which represents the location of maximum exposure and a well-developed using current practices typical for the local area.* (2.2.4.1, 2.2.4.2.3, 2.2.4.3, 2.2.5.6)		
PA-12	There is sufficient documentation and verification of the appropriateness of the analytical and numerical models used to provide reasonable confidence in the model results. The complexity of the mathematical models selected for the determination of compliance is commensurate with available site data and sufficient for the intended use of the PA. *The input data used in the analytical and numerical models are described and are traceable to sources derived from field data from the site, laboratory data interpreted for field applications, and referenced literature sources which are applicable to the site. Assumptions which are used to formulate input data are justified and have a defensible technical basis. The basis for distributions developed to support an uncertainty analysis is adequate and defensible to support the use of the uncertainty analysis results.* *The computational steps in the implementation of analytical and numerical models are clearly described and traceable. Linkages between the different models are clearly described.*		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
	The analytical and numerical models are tested, by comparison to benchmarked analytical calculations or results of other well-established models, and demonstrate that the results are consistent with the conceptual model, available site data or referenced documentation or literature. *The initial conditions, the boundary conditions, and the up scaling (i.e., normalization to field scale) of parameter data are applicable to the disposal facility and the expected ranges in the physical and hydrologic properties of the site over 1,000 years for the purpose of compliance. The PA includes a discussion of the methods used for the sensitivity and uncertainty analysis and identify the parameters and assumptions that when changed can influence the conclusions of the analysis.* (2.2.4.1, 2.2.4.2, 2.2.4.3)		
PA-13	Intermediate results for the source term, facility and environmental transport are described to highlight key features in the disposal system and to build confidence in the overall consistency of the results for the total system used to demonstrate compliance with the performance objectives. *The assessment includes intermediate results illustrating releases from the source term, effects of any barriers in the disposal facility, and the role of the natural system. These results can be in the form of concentrations or fluxes at key locations in the disposal system as a function of time. The magnitude and trends in intermediate results are discussed in the context of magnitudes and trends in subsequent steps (e.g., source term to disposal facility to natural system) to confirm that behavior is consistent and explainable for the total system. The results are also used to identify key aspects of the disposal system that have significant influence on the demonstration of compliance and as a quality assurance*		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
	check on the linking of different conceptual and mathematical models. (2.2.6, 2.2.7, 2.2.9)		
PA-14	The assumptions for the dose assessment are documented and defensible. The dose assessment results identify key radionuclides, pathways and scenarios and are sufficient to support a determination of reasonable expectation that the performance objectives will be met. *DOE-approved dose coefficients and defensible data for transfer factors, external exposure rates, inhalation and other inputs are used. All radionuclides and pathways that were identified in the screening are addressed in the analysis. The dose analysis considers the exposure pathways and transfer factors between media and calculates the maximum dose using acceptable methodologies and parameters. The radionuclides, pathways and exposure scenarios resulting in the peak doses are identified.* *For probabilistic analyses used for compliance, the mean and median doses as a function of time are provided and peaks for both are identified. The maximum projected dose, flux, or radionuclide concentration and time of occurrence during the compliance period is presented in the PA. Potential peaks impacts after the compliance period are also identified.* (2.2.2.6, 2.2.4.1, 2.2.4.2.3, 2.2.6.3, 2.2.9, 2.2.10)		
PA-15	Sensitivity and uncertainty analyses are documented and conducted at a sufficient level of detail to increase confidence in model results and identify critical aspects of the assessment in the context of the demonstration of reasonable expectation of compliance. *Acceptable methods (deterministic and/or probabilistic) of sensitivity analysis are*		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
	used to identify important assumptions and parameters based on their influence on the conclusions of the analysis at a sufficient level of detail to use the results to prioritize future data or model refinements or to confirm the sufficiency of existing information. Efforts are made to apply sensitivity and uncertainty analysis across key components of complex models to address expected variability and sufficiently identify the assumptions and processes that are most significant in the context of demonstrating compliance. Assumptions and parameters that lead to results in the uncertainty analysis that are important to the conclusions are justified as reasonable for the site and facility using data or related laboratory/field investigations and are sufficient for the intended use of the PA. *The results of the sensitivity and uncertainty analyses are sufficient to support the discussion of the effects of uncertainty on interpretations of model results. The results of the analysis are used to test and build confidence in the assumptions and conclusions of the PA.* *Estimates of the uncertainty in disposed and forecast waste inventory are adequately described along with the methods used to quantify uncertainty, including decay corrections.* (2.2.6, 2.2.7, 2.2.9)		
PA-16	The analysis of potential inadvertent intrusion is adequate and defensible. The results are provided in a manner to support identification of potential operational, design, or closure features to reduce the potential for or consequences of intrusion. *Acute and chronic exposure scenarios for hypothetical inadvertent intrusion are reasonable, justified and consider direct intrusion into the disposal site and exhumation of accessible waste material.*		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
	The hypothetical inadvertent intruder analysis considers the natural and man-made processes that impact the possible exposure to an intruder and calculates the dose using acceptable methodologies and parameters. Exposure pathways from inadvertent intrusion into the waste disposal units identify the chronic (no more than one year) and acute exposure pathways for each of the exposure scenarios considered. The exposure pathways include all relevant ingestion, external exposure, and inhalation pathways for each exposure scenario. The hypothetical inadvertent intruder analysis accounts for naturally occurring processes (e.g., erosion, precipitation, flooding) and the degradation of engineered barriers in the calculation of results. *The hypothetical inadvertent intruder analysis specifies the reductions in concentrations of radioactive material from mixing with uncontaminated material or the transport of radionuclides from the disposed waste mass, and justifies the parameters used in the analysis with site data, supporting analysis or referenced information.* *The hypothetical inadvertent intruder analysis calculates the maximum dose from disposed waste during the period from the end of active institutional controls to 1,000 years after site closure using DOE-approved dose coefficients from recognized published sources. In the hypothetical intruder assessment, institutional controls are assumed to be ineffective in preventing temporary intrusion after 100 years following disposal facility closure; longer periods may be assumed with justification (e.g., land use planning, passive controls).* (2.2.2.7, 2.2.2.8, 2.2.3.2, 2,2,8, 2.2.10)		
PA-17	The body of evidence in the PA provides a sufficient understanding of the behavior of the disposal system and the radionuclides, pathways and features of the engineered and		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
	natural system that have the greatest influence on the determination of compliance. *The results presented in the PA are consistent with the site characteristics, the waste characteristics, and the conceptual model of the facility. The demonstration of consistency is supported by available site monitoring data and supporting laboratory/field investigations. The results of the analyses for transport of radionuclides and the hypothetical inadvertent intrusion into the disposal facility, and the sensitivity and uncertainty of the calculated results are sufficiently comprehensive representations of the existing knowledge of the site and the disposal facility design and operations for the intended use of the PA.* *Inventory limits are developed from reasonable projections of waste to be disposed and analyses that consider the physical and chemical characteristics of the wastes if those characteristics affect the release and transport of the radionuclides as necessary to support the intended use of the PA.* *The conclusions of the PA address and incorporate any constraints included in any Federal, state, and local statutes or regulations or agreements that impact the site design, facility design, or facility operations. The conclusions also address any procedural or site documentation changes or constraints due to the results of the facility PA. Reasonable assurance exists that these constraints and impacts are appropriately addressed in the PA.* *The PA integrates the results of the analysis, key assumptions made in the analysis, the sensitivity and uncertainty analysis, the comparisons with the performance objectives, WAC, operating procedures, and applicable*		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
	regulations/policies to formulate conclusions. *The PA conclusions incorporate the findings of the calculated results for the all pathways analysis, air pathway analysis, groundwater resource protection analysis, hypothetical inadvertent intruder analysis, protection of individuals during operations, and sensitivity and uncertainty analysis. The results are interpreted and integrated to formulate conclusions which are supported by the results and the uncertainties in the results. The conclusions are consistent with the uncertainty of the results.* *The analysis, results, and conclusions of the PA provide both a reasonable representation of the disposal facility's long-term performance and a reasonable expectation that the disposal facility will remain in compliance with applicable performance objectives of DOE O 435.1A during the compliance period.* *If peak impacts calculated by the performance assessment occur beyond 1,000 years, then those results are interpreted in an increasingly qualitative manner recognizing the increasing speculation and uncertainty at later times. The intent is to identify trends that suggest the potential for catastrophic effects and to support decision-making regarding recommendations for design or operational improvements.* (2.2.9, 2.2.10)		
PA-18	The body of evidence in the PA is sufficient to provide a reasonable expectation of compliance with the performance objectives in DOE O 435.1 and other regulatory constraints/objectives specific to the facility. *The PA provides a defensible approach for the application of the results to develop WAC or operational limits for the facility and includes a discussion of how ALARA principles have been addressed.*		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
	The performance objectives used in the PA are identified and are consistent with those found in DOE O 435.1. Compliance with all of the objectives for the 1,000-year compliance period is confirmed in a summary table (other time frames are also addressed as applicable). The PA identifies and justifies any site-specific determinations/assumptions related to the specific objectives for groundwater resource protection. For example, a PA for tank closure, as appropriate, includes a determination of reasonable assurance that exposures to humans are within the limits established in the performance objectives of 10 CFR 61 (sections 61.41 through 61.44). *The hypothetical inadvertent intruder results demonstrate reasonable expectation that doses will be less than 100 mrem/year total effective dose for chronic exposure and 500 mrem total effective dose for acute exposure are met within the disposal facility over the assessment period after the end of active institutional controls. Potential for doses in excess of those values is discussed from the perspective of optimization of the disposal system.* *The PA adequately addresses ALARA requirements.* (2.2.1, 2.2.6, 2.2.7, 2.2.8, 2.2.9, 2.2.10)		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
PA-19	Appropriate QA associated with the PA has been implemented for data, software, models, and records consistent with the requirements of DOE O 414.1D, DOE G 414.1-4 and EM-QA-001. *The input data used in the analytical and numerical models are described and are traceable to sources derived from field data from the site, laboratory data interpreted for field applications, and referenced literature sources which are applicable to the site. Assumptions which are used to formulate input data are justified and have a defensible technical basis.* *The computational steps in the implementation of analytical and numerical models are clearly described and traceable.* *Intermediate calculations are performed and results are presented that demonstrate, by comparison to site data or related investigations, the calculations used in the PA are representative of disposal site and facility behavior for important mechanisms represented in the mathematical models.* *The analytical and numerical models are tested, by comparison to benchmarked analytical calculations or results of other well-established models, and demonstrate that the results are consistent with the conceptual model, available site data or referenced documentation or literature.* (2.2.4.3, 2.2.11)		

Attachment 2.1. Example Structure for Systems Evaluation

This attachment can document the systems evaluation that is required for each new disposal facility, if the system evaluation was not conducted as part of the sensitivity analysis. A disposal system should consider a combination of natural and engineered barriers. Engineered barriers include but are not limited to waste forms, containers, vaults, caps, liners and berms. The design process for new facilities should evaluate the performance of the disposal system against the performance objectives. The evaluation should consider the effects of natural and engineered barriers on the performance of the disposal system during all phases of facility life (i.e., short and long term, intact and altered). The effects of engineered barriers on inadvertent intruder protection should also be addressed. Engineered features determined to compromise the performance of the natural disposal system should not be incorporated in the design. The basis for the facility design, including the evaluation of the roles and effectiveness of natural and engineered barriers from a short and long term systems performance perspective, should be documented in the PA.

The following is an example outline to use for a systems evaluation report that would comprise this attachment where applicable.

I. Introduction
   a. Background
      i. Summary of previous disposal concepts as appropriate
      ii. Overview of site features and facility design concept

II. Site and Design Features Contributing to Protection of Human Health and the Environment
   a. Natural System
      i. Describe key drivers in the natural system that influence performance and key features of the natural system in terms of limiting migration and potential exposures
   b. Waste Characteristics
      i. Describe the drivers for releases from containers and different waste forms and roles in terms of limiting releases (can also be included in Facility Description)
   c. Facility Characteristics
      i. Describe the drivers for releases (infiltration, biota) through different facility design features (interim and final covers, vaults) and roles of the features in terms of limiting releases to the natural environment.

III. Total Systems Performance Perspective

a. Describe how the waste forms and containers, facility design features and the natural system perform as a system to limit releases of radionuclides. The discussion should address the drivers for releases and roles and functions of different design and natural features to address those drivers.

IV. Consideration of Alternative Design Features

a. Describe design alternatives that have been considered to address the drivers for releases and discuss their effectiveness in terms of limiting releases and eventual doses to a receptor. Depending on the complexity of the situation, this can be self-contained or could refer to a more detailed analysis of alternatives.

b. Provide a summary of the alternatives considered and their effectiveness in terms of impact on dose to a receptor and/or releases of radionuclides to the environment, as appropriate, including any cost, implement ability, or other factors.

V. Recommended Design

a. Provide a discussion of the preferred alternative and the basis for the selection of that alternative.

VI. References

a. PA or CA

b. UDQE, if applicable

c. Database sources for material properties

d. Other applicable documents

CHAPTER 3. COMPOSITE ANALYSIS GUIDE

3.1. Introduction

Goal

The goal of this guide is to support the U.S. Department of Energy's (DOE's) initiatives to improve and maintain the highest quality radioactive waste management standards and activities throughout the DOE complex.

The primary audience of this guide is the Federal Project Director and other DOE Federal/contractor employees involved in the disposal of low-level waste (LLW) and tank closure.

Objective

This chapter provides guidance to preparers of DOE or the National Nuclear Security Administration (NNSA) LLW, mixed low-level waste (MLLW), and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) disposal facilities and liquid waste tank closure composite analyses (CAs) required by DOE O 435.1, *Radioactive Waste Management*. Key objectives for the preparation and associated Low-Level Waste Disposal Facility Federal Review Group (LFRG) review process are to ensure CAs are:

- Complete and thorough;
- Reasonable and logical;
- Technically correct and defensible; and
- Conclusions are valid and acceptable.

Guides do not impose requirements but may quote requirements if the sources are adequately cited. This guidance follows the format of an objective statement, discussion, examples, a statement of one way to measure compliance, and supplemental references. Following this Guidance provides a consistent approach for compliance with the requirements of DOE O 435.1. If the Guide has not been followed, then an explanation/justification as to why a different approach is acceptable should be provided.

The LFRG, functioning as the DOE regulatory authority, is the independent organization responsible for performing oversight of LLW disposal and tank closure in accordance with DOE O 435.1 [DOE Manual (M) 435.1-1, *Radioactive Waste Management Manual*, Chapter I, 2.E(1)(a)]. Therefore, the LFRG members utilize this Standard as guidance in performing oversight functions and judging compliance with the requirements of DOE O 435.1 (See LFRG Execution Plan for details of LFRG roles, responsibilities and processes).

Background

The Department of Energy conducts activities, including disposal of LLW and remediation of radioactive contamination at DOE sites that could potentially result in long-term radiological exposure to future members of the public. These activities should, therefore, be conducted in a manner that is not only protective of the public during facility operations, but also ensures that future members of the public will be protected from the aggregate of all residual radioactive material on a DOE site. CAs (and PAs) are conducted as part of the process employed by DOE to address future radiological protection of the public. The Defense Nuclear Facilities Safety Board (DNSFB) in Recommendation 94-2, *Conformance with Safety Standards at DOE Low-Level Nuclear Waste and Disposal Sites*, raised concerns about potential cumulative impacts associated with interactions between contamination from the disposal facility and other residual radioactivity at the site. DOE committed to require CAs to address this recommendation.

DOE M 435.1-1 states that CA results are used for planning, radiation protection activities, and future use commitments to minimize the likelihood that current low-level waste disposal activities will result in the need for future corrective or remedial actions to adequately protect the public and the environment consistent with the public dose limit in DOE O 458.1, *Radiation Protection of the Public and the Environment*. DOE M 435.1-1 places emphasis on the use of a CA to assess the potential for the disposal facility or tank farm to lead to a need for future remediation, when considered cumulatively with other sources that can significantly interact, rather than a role to provide a site wide assessment of cumulative doses. Based on the results of the CA, the LFRG could recommend siting the disposal facility in a different location, if the CA results are unacceptable. The LFRG could also identify other potentially interacting sources that, if not remediated, could lead to potential cumulative impacts of concern.

CAs are reviewed by LFRG and approved by the responsible DOE Headquarters (HQ) manager. The CA becomes part of the technical basis for the DAS and the radioactive waste management basis (RWMB) containing conditions for operation and waste receipt at the disposal facility being evaluated. It is not possible to provide absolute assurance of the performance of the disposed waste and various sources of radioactive material at some future time. Rather, CAs are prepared to provide a reasonable expectation that the performance measure will not likely be exceeded.

CAs are closely linked with performance assessments (PAs), which DOE uses to demonstrate that there is a reasonable expectation that the DOE O 435.1 performance objectives will be met. CAs may be documented in a companion report to the PA or integrated in the same the report with a PA. If the CA and PA are combined, it will be necessary to include additional sections, as appropriate, with the information needed to ensure that the content requirements and review criteria for both the CA and PA are satisfied.

Much of the information needed for the CA will have been developed for other analyses. Specifically, information related to the LLW disposal facility will have been developed for the PA of the facility and information related to other contributing sources may have been developed under other programs [e.g., CERCLA, Resource Conservation and Recovery Act (RCRA), National Environmental Policy Act (NEPA), facility decommissioning, etc.]. In the case of source terms that have not been remediated, if specific plans have been identified for remediation, the CA may assume that the plans will be implemented, but there is a need to confirm that remediation was conducted as planned as part of CA maintenance. If the source is not remediated as planned, it will be necessary to assess whether the change in assumption will impact the conclusions of the CA (see Chapter 8). In cases where plans are not available, it is necessary to estimate the source that would be expected to illustrate the potential impacts in the CA and then reassess the assumption when remediation is conducted. The primary difference between the CA and these other facility-specific analyses is development and integration of the source terms used for the CA. Therefore, much of the detailed guidance in this Chapter focuses on source term development. The reader is directed to Chapter 2 for guidance that is common to PAs and CAs.

This guide follows the format of an objective statement, discussion, examples, a statement of one way to measure compliance, and supplemental references. The annotated outline should be followed when developing a CA, unless the DOE disposal facility staff request and receive approval from the LFRG co-chairs for the use of an alternate outline. CERCLA disposal facilities should also use this outline, but they may provide a summary in the CA with a specific section reference for more detailed information in the CERCLA document(s) to meet the requirements for information identified in the annotated outline.

Example:

> *A disposal facility is developed in a location where there is potential overlap with plumes from other facilities that have been addressed in an existing, LFRG approved CA prepared for another disposal facility. The PA for the new disposal facility provides results projecting doses resulting from the new facility below 1 mrem/yr at any location where potential interactions with other plumes could occur. Given the low doses associated with the facility at points of potential interaction with other plumes, the potential for this facility to impact other cleanup decisions at downstream facilities is limited. Given the insignificant interaction associated with the plumes from the new facility, the results for the existing, approved CA serve as the basis for screening the need to address downstream impacts separately in a new CA and allow the CA requirements for the new facility to be addressed as an appendix within the PA for the new facility.*

3.2. Annotated Outline for Composite Analyses

3.2.1. Executive Summary

The Executive Summary of the CA should provide a summary of the CA highlighting the features of each section, the results, and conclusions. Key elements of the Executive Summary include:

- A comparison of the CA results with the performance measures during the compliance period
- The primary public dose limit [100 mrem/yr (1 mSv/yr)];
- The administrative dose limit [30 mrem/yr (0.3 mSv/yr)];
- A discussion of potential peaks beyond the compliance period;
- The major sources, radionuclides, and pathways contributing to the projected dose;
- The contribution of the PA facilities to the projected dose; and
- A summary of the analysis conclusions.

Objective

The objective of this guide is to describe the results of the CA compared with the appropriate performance measures. The Executive Summary also identifies key assumptions and provides a summary of the conclusions of the CA.

Discussion

This guide provides a concise summary of the results and conclusions from the CA. Results from the analysis are provided in a table for quick reference (see example in Table 3-1). The table includes peak impacts during the compliance period and includes some description of peaks that may occur after the compliance period, which may be quantitative or qualitative depending on the timing and site specific considerations (see discussion in "Compliance Period"). It can be helpful to also include a column in the table identifying the source terms, pathways and radionuclides that are the primary contributors to peak impacts or this can be described in the text. For cases where the 30 mrem/yr goal is exceeded, any conclusions from the options analysis are also included.

Table 3-1. Example Table with CA Results for the Executive Summary (from SRS CA)

Point of Assessment	Maximum Cumulative[1] Dose mrem/yr 2025 to 3025	Maximum Cumulative[1,5] Dose mrem/yr 3025 to 12025	Major Contributing Source[2]	Major Contributing Radionuclide	Major Exposure Scenario/ Pathway
Upper Three Runs (TR)	1.06	0.40	H-Canyon	Np237	Recreational/ Fish Ingestion
Four Mile Branch (FMB)	2.16	0.14	FMB IOU[3]	Cs137	Recreational/ Fish Ingestion
Steel Creek)/ Pen Branch	0.42	0.05	SC IOU	Cs137	Recreational/ Fish Ingestion
Lower Three Runs (LTR)	2.97	0.05	LTR IOU	Cs137	Recreational/ Fish Ingestion
Savannah River (SR)	0.17[4]	0.05[4]	LTR IOP	Cs137	Residential/ Vegetable Ingestion

1. Sum of doses from the residential and recreational exposure scenarios, using the respective stream flow rate for recreational dose and the Augusta, GA. River flow rate, unless otherwise noted, for residential dose.
2. See Table C-1 for Source Identification corresponding to abbreviations given below.
3. IOU stands for Integrator Operable Unit, which are the stream and river beds.
4. Both residential and recreational doses are cumulative from all sources; the Highway 301 bridge flow was used.
   In all cases, the maximum dose in the 9,000 years beyond the 1,000-year assessment period occurred in year 3025.

If changes were made to approved regulatory analyses for the purposes of the CA, for example, to reduce pessimism or include new information, they need to be discussed in the Executive Summary. Key assumptions that can influence the conclusions of the CA need to be protected in land use planning, remediation goals, closure strategies, etc. are also discussed. Note the emphasis is on assumptions that could change the conclusions regarding compliance rather than simply assumptions that have a significant impact on the results. This discussion includes assumptions or parameters identified in a sensitivity or uncertainty analysis (e.g., groundwater flow, closure inventories, etc.) that were credited in the CA.

3.2.2. Introduction

The introduction should provide background documenting why the CA was needed and an overview of the CA. If it is a CA revision, the major changes from the previous version of the

CA and reason for those changes should be outlined. Other analyses to which the CA may be compared should also be identified. If there are significant differences in assumptions compared to other modeling efforts, those differences should be identified. The CA overview should address the PA facilities supported by the CA, the other interacting end state radionuclide sources addressed, and the general CA approach and methodology.

3.2.2.1 Basis for Composite Analysis

This section should summarize the reason necessitating the CA. It should include background material about the relevant disposal or other facility necessitating the CA with reference to previously published documents with more detail (e.g., the PA). The summary should also define the scope of the CA and changes in assumptions from existing PA/CAs, as applicable. The relationship with any other CAs at the same site should also be addressed as applicable.

Objective

The objective of this guide is to serve as a reference point identifying the underlying basis for the CA and identification of previous CAs and the presence of other analyses to which the CA may be compared.

Discussion

Similar to the PA, this subsection provides a frame of reference for the need for the CA and provides a single place for a reviewer to be made aware of previous CAs and other assessments. If the CA is a revision to close any outstanding secondary issues from an earlier CA, the issues should be specifically identified. If there is potential for the CA to be compared with other analyses, this section should refer the reader to "Other Related Analyses" for a description of those analyses. The emphasis at this point is on identification and awareness of differences from previous CAs and other analyses (Table 3-2). Detailed descriptions of modeling assumptions, etc. will be provided later in the CA, but general statements about the impacts of changes in assumptions on results of the CA are helpful in this overview.

Table 3-2. Example Table Highlighting Changes in the Updated Version of a CA

1997 Original CA	2009 CA Revision
The original CA was performed to support LLW disposal within the E Area Low-Level Waste Facility (ELLWF) and Saltstone Disposal Facility (SDF)	The revised CA was performed to support LLW disposal within the ELLWF and SDF, closure of the F and H-Area radioactive liquid waste storage tanks, potential disposal of TRU Pad 1 waste in-place, and for potential in-situ disposal of TRU material.
Considered GSA portion of SRS.	Considered entire SRS.

1997 Original CA	2009 CA Revision
SRS land use planning based upon: • Savannah River Future Use Project Report (DOE 1996c).	SRS land use planning based upon: • Savannah River Site Comprehensive Plan/Ten Year Site Plan (SRNS 2009b) • Savannah River Site End State Vision (DOE 2005)
POAs included Upper Three Runs (UTR), Four Mile Branch (FMB) and the Savannah River.	Expanded the POAs to Include UTR (Upper Three Runs), FMB, Steel Creek (SC), Lower Three Run (LTR), and the Savannah River.
Base case exposure scenarios: • Recreation in mouth of UTR and FMB; and • Recreation plus drinking water in Savannah River at U.S. Highway 301 Bridge.	Base Case exposure scenarios: • Recreation in mouth of UTR, FMB, SC, and LTR plus residential with Savannah River water; and • Recreation in and residential with Savannah River at U.S. Highway 301 bridge.
Inventory for projected end state source locations within the GSA portion of SRS (CDM 1996, CDM 1997).	Revised inventory based upon most up-to-date data available for projected end state source locations within the entire SRS (Hiergesell et al. 2008).

3.2.2.2 Regulatory Context

This section should describe the regulatory considerations that establish the context for the CA. It should:

- Provide the site-specific regulatory context, as well as sufficient information regarding other DOE programs and plans; Federal, state, or local statutes, regulations, or agreements to inform their potential impact (results, objectives, constraints, or milestones) on the CA;
- Describe any institutional relationships, agreements, or commitments that may affect the analysis context (i.e., performance measures, point(s) of assessment, and assessment period for the CA);
- Provide context to support the justification for the end state land use, assumed end of disposal facility's operations, the end state date, end state radionuclide sources and their conditions, configurations, and inventories; and
- Include background information and references, if relevant to the CA.

3.2.2.2.1 Performance Measures

The performance measures section should clearly present the performance measures drawn from DOE O 458.1, against which the CA results are evaluated. The CA results should provide

reasonable expectation that public exposures will not exceed the DOE O 458.1, primary limit of 100 mrem/yr (1 mSv/yr) total effective dose to the representative person or maximally exposed individual (MEI), excluding contributions from radon and its decay products. Note that the primary limit excludes dose received by patients from medical sources of radiation, and by volunteers in medical research programs; dose from background radiation; and dose from occupational exposure under Nuclear Regulatory Commission (NRC) or Agreement State license or to general employees regulated under 10 CFR Part 835, *Occupational Radiation Protection*.

A CA-specific administrative limit for public exposures of 30 mrem/yr (0.3 mSv/yr) total effective dose from DOE-sources to the representative person or MEI is also applied (excluding contributions from radon and its decay products). If doses associated with DOE sources are above the administrative dose limit, an options analysis should be prepared to consider actions that could be taken to reduce the calculated dose and to consider the cost of those actions. Furthermore, if the CA dose exceeds 25 mrem/yr total effective dose (TED) for DOE sources, potential interacting non-DOE sources (excluding dose from radon and its decay products, medical exposures, background radiation, and occupational exposures) that could significantly contribute to doses at a receptor also should be considered. Additionally, any other performance measures deemed pertinent to the CA due to any site-specific institutional relationships, agreements, or commitments should be identified.

3.2.2.2.2 Points of Assessment and Compliance Period

The Points of Assessment and Compliance Period section should justify the assumed location of the DOE site boundary using site-specific land use plans, land use control plans, institutional control plans, strategic plans, site mission plans, or other pertinent documents (see "Land Use and Institutional Controls"). If such information does not exist, or the location of the boundary is uncertain, clearly state and justify the assumptions used to define the site boundary over the period of assessment.

The location of point(s) of assessment for exposures of the representative person or MEI should be identified and justified over the assessment period based upon the location of other projected residual sources of radioactivity, DOE site characteristics, including the overall site conceptual model, the CA transport pathway(s), and the CA conceptual model, clearly identifying and justifying all assumptions associated with point(s) of assessment selection. All current and potential residual sources of radioactivity at the DOE site that could significantly interact with radionuclides from the disposal facility should be considered.

Prior to implementing changes to a DOE site's future land use plans that impact the boundary of land controlled by DOE and exclusion of public use of DOE-controlled land, an evaluation should be conducted to ensure that the proposed changes do not alter assumptions that impact the CA results and conclusions. As remedial actions are completed, facilities are closed, new

facilities are developed, or any other changes from assumptions in the CA need to be documented and impacts to the CA should be considered through the CA maintenance program.

A 1,000-year compliance period, following closure of the disposal facility/facilities and/or tank closure(s) for which the CA is being prepared, should be used for direct comparisons of results with the 100 mrem/yr performance measure and 30 mrem/yr administrative dose limit in the context of a reasonable expectation of future protectiveness.

In order to support an assessment period greater than 1,000 years, documentation should be provided and the results for the 1,000-year compliance period should continue to be reported in addition to other time frames that may be addressed. As part of the sensitivity analysis, peak impacts that may occur beyond 1,000 years should be discussed.

Objective

Site specific implementation of the performance measures that serve as the basis for determination of protection of human health and the environment at the point of assessment (POA) during the time of compliance are described.

Discussion

The performance measures provide a point of comparison to assess whether there is a reasonable expectation that the cumulative impacts associated with the disposal facility and other residual sources will not exceed the dose limit in DOE O 458.1. The performance measures are evaluated in the context of the compliance period.

Probabilistic Results. If calculations are performed probabilistically, the peak of the mean or median of the distribution of results, whichever is higher, should be used to compare with the performance measures over the compliance period. Other results from the distribution and potential peaks beyond the compliance period should be used to inform the decision in conjunction with the results of sensitivity analyses and to assess a need to manage uncertainty via PA and CA maintenance, but no specific numerical criterion should be applied to other percentiles. Other indicators, such as the mean of the peaks, are not appropriate for the purposes of demonstrating reasonable expectation of meeting the performance objectives.

Example:

> *The Site X CA was performed probabilistically. The results of the exposure calculations over the 1,000-year assessment period are that the peak of the median of the dose distribution is 15 mrem/year, the peak of the mean is 18 mrem/year, and the 95th percentile is 110 mrem/year. Sensitivity and uncertainty analysis results were used to address the 110 mrem/yr dose. The combinations of assumptions resulting in the 95th percentile results were reasonably unlikely and*

it was determined that a reasonable expectation of compliance was demonstrated. Thus, the CA results are compliant with the 30 mrem/year performance measure.

NRC guidance supports the use of central tendencies for distributions (i.e., mean, median) when comparing probabilistic results with deterministic standards. Some rationale for NRC opinions is explained in SECY-97-221, *Acceptance Guidelines and Consensus Standards for Use in Risk-Informed Regulation* and further elaborated in NRC Regulation Guide 1.174, *An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis* (e.g., pages 1.174- 21 & 22). In these documents, it is stated that the use of central tendencies as a basis of comparison should be supplemented by qualitative judgments and sensitivity analyses to address uncertainties associated with, e.g., the model and overall completeness of the analysis. In this respect, it is emphasized that simply showing the mean or median is below the standard is not sufficient in itself. There is a need to convince the reviewers that the sensitivities and uncertainties are understood and there may be a need to address cost/benefit of reducing uncertainty via the PA and CA maintenance process. Sensitivity and uncertainty analysis should address those concerns.

The assessment serves as a tool to support decision making involving many considerations, not as a specific decision maker. Thus, it is important to maintain some subjectivity regarding interpretation of the distribution of results recognizing the many different factors, biases, and different types of uncertainties that can affect the distributions of results.

All Pathways Dose. All pathways include the modes by which a receptor at the point of presumed public access could reasonably be exposed to radioactive material migrating, via environmental media (e.g., water, soil, biota, air), from the disposed waste. "Reasonably exposed" in this context refers to the acceptable practice of using stylized representations of typical exposure pathways and scenarios representative of current habits and technologies in the region and should not be perceived to involve worst case or highly unlikely exposure scenarios. Radon and its decay products are considered separately from other radionuclides in the all pathway calculations consistent with 10 CFR Part 40, *Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material From Ores Processed Primarily for Their Source Material Content* (Appendix A, Criterion 6), 40 CFR Part 190.10(A), *Standards for Normal Operations* and 10 CFR Part 20, Section 1101(D), *Radiation Protection Plans*.

The performance measure is applied in terms of dose to a representative member of the public to indicate the dose measure is not intended to be applied for assumptions regarding the age, sex, or assumed activities of any specific member of the public [International Commission on Radiological Protection (ICRP) Publication 101, *Assessing Dose of the Representative Person for the Purpose of Radiation Protection of the Public and Optimization of Radiation Protection: Broadening the Process* (ICRP 2006)]. The ICRP terminology used for this representative

member of the public at the time this document was prepared is "Representative Person." [DOE O 458.1, ICRP Publications 101 and ICRP Publications 103, *The 2007 Recommendations of the International Commission on Radiological Protection* (ICRP 2007)]. The use of the "representative person" construct addresses the fact that the performance objectives are generally applied, through the PA process, to hypothetical future members of the public, rather than to known and identified individuals. Use of the Representative Person construct is consistent with the use of the current recommended ICRP dose coefficients that have been developed for a "reference person" (see DOE-STD-1196-2011, *Derived Concentration Technical Standard*).

Point of Assessment. DOE is required to maintain control over land containing radionuclide sources until the land can be safely released pursuant to DOE O 458.1 or transferred to another authorized party. The information in Land Use and Institutional Controls is used to provide the basis for the assumptions regarding the location of receptors. For a CA, this is generally assumed to be the site boundary (Figure 3.1). The use of peak concentrations in space and time around the facility implements the ICRP expectation to consider more highly exposed members of the public. The POA can change as a function of time with changing locations of peak concentrations depending on the nature of the releases from a disposal facility and evolution of the plume. The POA may also change in a prescribed manner consistent with documented land use plans for the site (e.g., the site boundary may be planned to converge over time to a limited area of the site).

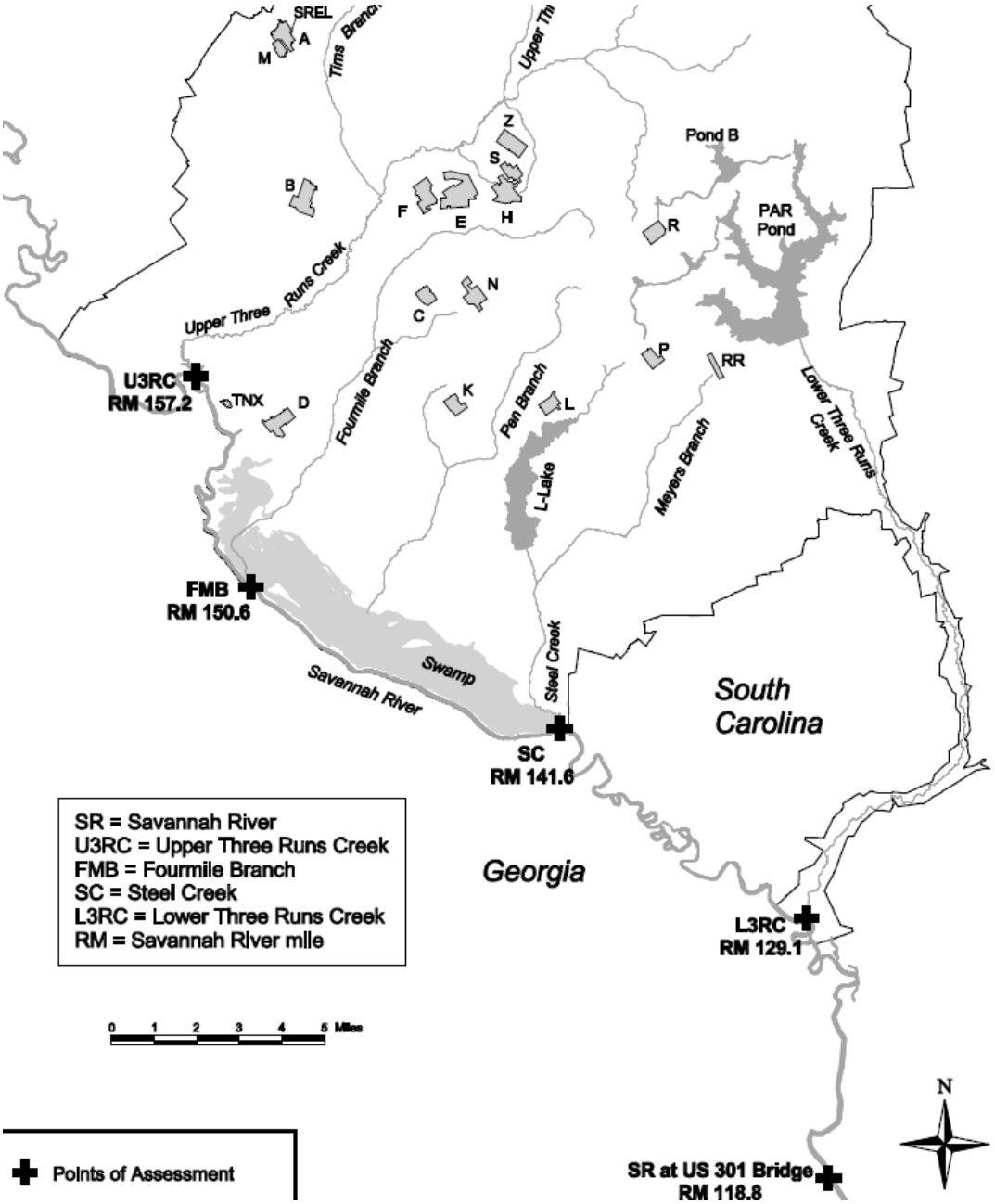


Figure 3-1. Example Points of Assessment for Streams Discharging to the Savannah River at the Site Boundary (SRS CA)

Compliance Period. The compliance period is defined as a 1,000-year period after the assumed closure of the disposal facility/facilities or tanks addressed in the CA. A 1,000-year compliance period should be used for direct comparisons of results with the performance measures in the

context of compliance. 1,000 years is viewed as a reasonable time frame over which calculations have sufficient credibility and meaningfulness on which to base decisions regarding quantitative compliance. Beyond 1,000 years, assumptions and calculations become increasing speculative and uncertain and results need to be viewed with increasing caution. It is recognized that there may be circumstances where a regulator or other stakeholder requests calculations for a different time frame. In such a case, the basis for the different time frame needs to be described to clarify the purpose of the calculations. Further details on this topic are provided in the PA technical standard Guide.

3.2.2.3 Other Related Analyses

This section should identify previous or on-going PA/CA-related analyses or other analyses at the site (e.g., risk assessments, NEPA, etc.) that could be compared with the CA. Citations to relevant documents should be included. Any significant differences in assumptions and results that may exist between the CA and any other pertinent modeling activities that may be compared with the CA should be identified and summarized to:

- Help reviewers focus on un-reviewed aspects that have changed from previous modeling efforts; and
- Address any differences in assumptions/results that could be seen as inconsistencies.

Objective

This guidance identifies other modeling efforts that could be a point of comparison for modeling in the CA and serves to identify and explain different assumptions that may have been made.

Discussion

Multiple modeling efforts may be underway at a DOE site at any given time, especially larger sites, and assumptions may change when a CA is updated. There are often differences in the level of detail or general approach taken for modeling depending on the purpose. The modeling may support different regulatory programs, be overseen by different DOE Field Offices at the site, and be conducted by different contractors or even different groups within a contractor. Inevitably, assumptions, approaches, and results from the CA will be compared with other similar efforts that may have been conducted at a given site [e.g., previous PAs, environmental impact statements (EISs), risk assessments]. These factors lead to a potential for apparent inconsistencies in modeling results, if the context of the modeling is not explained. It is important to acknowledge those differences and be prepared to explain the basis and significance.

This subsection includes a list of categories of other modeling efforts that could be compared with the CA and identifies specific assumptions in the CA that differ from other modeling efforts

and a brief discussion of the impacts on the results. From a general perspective, the intent is to demonstrate an awareness of other modeling efforts and an understanding of any significant differences. In general, results from approved regulatory analyses addressing other residual sources at the site should be used for the CA and it should not be necessary to modify those analyses for the purposes of the CA (i.e., it is preferable to remain consistent). However, if changes are made to existing analyses for the purposes of the CA (e.g., refinements, addressing new information), the changes should be introduced here and described in detail as part of the source term description in the Analysis of Performance.

3.2.2.4 Land Use and Institutional Controls

This section should summarize the future assumed predominant land use assumptions that influence the timing and location of points of assessment used for compliance and any assumptions that influence selection of exposure scenarios. The summary should include citations or reference to relevant documents detailing land use and institutional control.

Objective

Identify and describe land use and institutional control assumptions that form the basis for the selection of the POA as a function of time.

Discussion

DOE should maintain control over land with residual radioactivity until it can be released in accordance with DOE O 458.1. This section summarizes information on land use in the area of the site to provide perspective on the likelihood and types of potential exposure scenarios in the area and when and where those exposures could occur. This section should also describe any institutional relationships, agreements, or commitments that may affect the performance criteria for the CA. As appropriate, the following examples should be discussed:

- The annual site environmental report, which will be helpful in defining point(s) of assessment, potentially exposed populations, and exposure scenarios;
- Any relevant agreements between the DOE, the EPA (or other Federal agency) or the state, including agreements or Records of Decision (RODs) for environmental restoration of waste disposal sites under CERCLA, agreements for corrective actions under RCRA, or agreements on groundwater protection, and any other relevant agreements;
- Any planned or completed evaluations or documents prepared in order to comply with NEPA, with mention of the specific activities evaluated in each document; and
- Any safety analysis reports (SARs) in accordance with DOE Order requirements, and any operational requirements or information relevant to the closure, or long-term performance of the disposal facility or other potential sources of radioactive material.

3.2.2.5 Summary of Key Assumptions

This section should highlight key assumptions used in the CA that are important to the conclusions based on the analysis. Explain the assumptions' relevance to the controlling pathways or scenarios analyzed and present the implications of the uncertainty and the actions needed to manage it. Assumptions regarding the end state and inventories for operating facilities or sites where remediation has not been completed should also be tracked for confirmation when final remediation or closure occurs.

Specific uncertainties and data gaps that need to be addressed should also be identified so that these efforts can be planned and implemented as part of the CA maintenance process. Note that all key assumptions should be controlled following the process described later in Chapter 8 of the Standard (Change Control).

Objective

Identify and describe key assumptions that have the greatest influence on the conclusions of the CA. Specifically identify assumptions that need to be protected in land use and plans for remediation or closure of facilities at the site and assumptions that are being addressed through the CA maintenance process (e.g., to address secondary issues from an LFRG review team).

Discussion

This section should highlight key assumptions used in the CA that are most critical to the analysis of performance. This could include, for example, the assumed future boundary of land controlled by DOE, assumed end states for sources of residual radioactivity, assumptions regarding institutional control at the disposal site following closure, or simplifying assumptions made to facilitate groundwater flow and transport modeling. The significance of these assumptions should be put into context by explaining their relevance to the controlling pathways or scenarios analyzed.

Certain key assumptions may be associated with uncertainties or data gaps identified in Secondary Issues from an LFRG review that will be addressed as part of the maintenance process. These assumptions should be presented in such a way that the implications of the uncertainty and the actions needed to manage the uncertainty are clearly understood. This information can then be readily used to support the CA maintenance process. Specific uncertainties and data gaps that need to be addressed through research and development should be highlighted so they can be documented in the PA/CA Maintenance Plan (MP).

3.2.3. Site and Facility Characteristics

This section should provide sufficient background information to establish necessary general context to support an understanding of the CA scope. This includes providing descriptive

information about the PA facilities, DOE site operations, DOE site characteristics, and related documentation.

3.2.3.1 Performance Assessment Facilities

Sufficient information should be provided about the PA facilities for which the CA is being performed to facilitate an understanding of the CA scope, basis for CA preparation, and the CA in general, in regards to the consistency of the CA with the associated PA(s). This should include a concise description of the PA facilities, including location on the DOE site and proximity to potential interacting end state radionuclide sources, including other PA facilities.

For additional context, a brief overview of the historical development of the PA facilities and use, and an overview of the PA results should be provided.

3.2.3.2 DOE Site Operational Description, History, and Future

This section should include:

- Sufficient information to document that all end state sources with potential or existing residual radioactivity are identified;
- Sufficient information relative to the DOE site overall operations, history, and future to support the justification, provided later in the CA, that all end state radionuclide sources that could potentially interact with radionuclide migration from the PA facilities at the points of assessment over the compliance period and significantly affect the projected dose relative to the performance measures are appropriately considered within the CA; and
- Information on non-DOE sources (e.g., commercial nuclear facilities) that may result in radionuclide migration in the environment at the DOE site.

The end state associated with the projected residual sources of radioactivity should be justified and supported with pertinent site documentation such as DOE-approved CAs, Land Use Plans, Site Strategic Plans, Site Mission Plans, Federal Facilities Agreement (FFA), Consent Orders, CERCLA/RCRA regulatory documents, Formerly Utilized Sites Remedial Action Program (FUSRAP)/Decontamination and Decommissioning (D&D)/tank closure/Site Treatment/Groundwater Protection programs and plans, and NEPA documentation. If a DOE site is assumed to have an enduring mission or if justification of an end state date is lacking, a conservative end state date assumption should be made.

3.2.3.3 DOE Site Characteristics

This section should support the justification of assumptions and parameter values for the CA by providing sufficient information regarding the DOE site characteristics, including the overall site conceptual model. This information should provide information to support the following:

- Selection of the points of assessment;
- Selection of transport pathways;
- Selection of all end state radionuclide sources that could significantly interact with radionuclide source release and migration from the PA facilities; and
- Details to support development of the CA Conceptual Model.

A basic overall description of the DOE site should be presented by addressing the following topics on both a site and regional basis:

- Geography;
- Demography;
- Land Use Patterns;
- Ecology;
- Soils;
- Geology and Topography;
- Seismology and Volcanology;
- Meteorology and Climatology;
- Background Infiltration and Water Balance;
- Surface Water Hydrology;
- Groundwater Hydrology;
- Natural Resources, including geologic resources and water quality and usage;
- Natural Background and Anthropogenic Sources of Radiation; and
- Overall Site Conceptual Model.

Objective

This Chapter provides the detailed information about the site, disposal facility and other sources of residual radioactivity that form the basis for development of the conceptual models. Uncertainties and potential alternative representations of key components of the system are also described.

Discussion

This Chapter should provide descriptive information and data for the DOE site, environment, LLW disposal facility, and locations of other residual sources to provide the basis for the

conceptual model of the disposal facility and site, and to support a thorough understanding of the method of analysis. The information in this section comprises a description including specific sources for data and uncertainties associated with the data, including potential alternative interpretations that may need to be considered. Figure 3-2 and Figure 3-3 illustrate the locations and contaminants for sources at a site followed by a mapping of the exposure pathways from the different source areas to the exposure points. Additional information regarding expectations for site and facility descriptions are provided in Chapter 2, "Site and Facility Characteristics." Note that the general level of detail for discussions in the CA will be less than is expected for the PA and will reflect the broader perspective of multiple source terms rather than a focus on one facility.

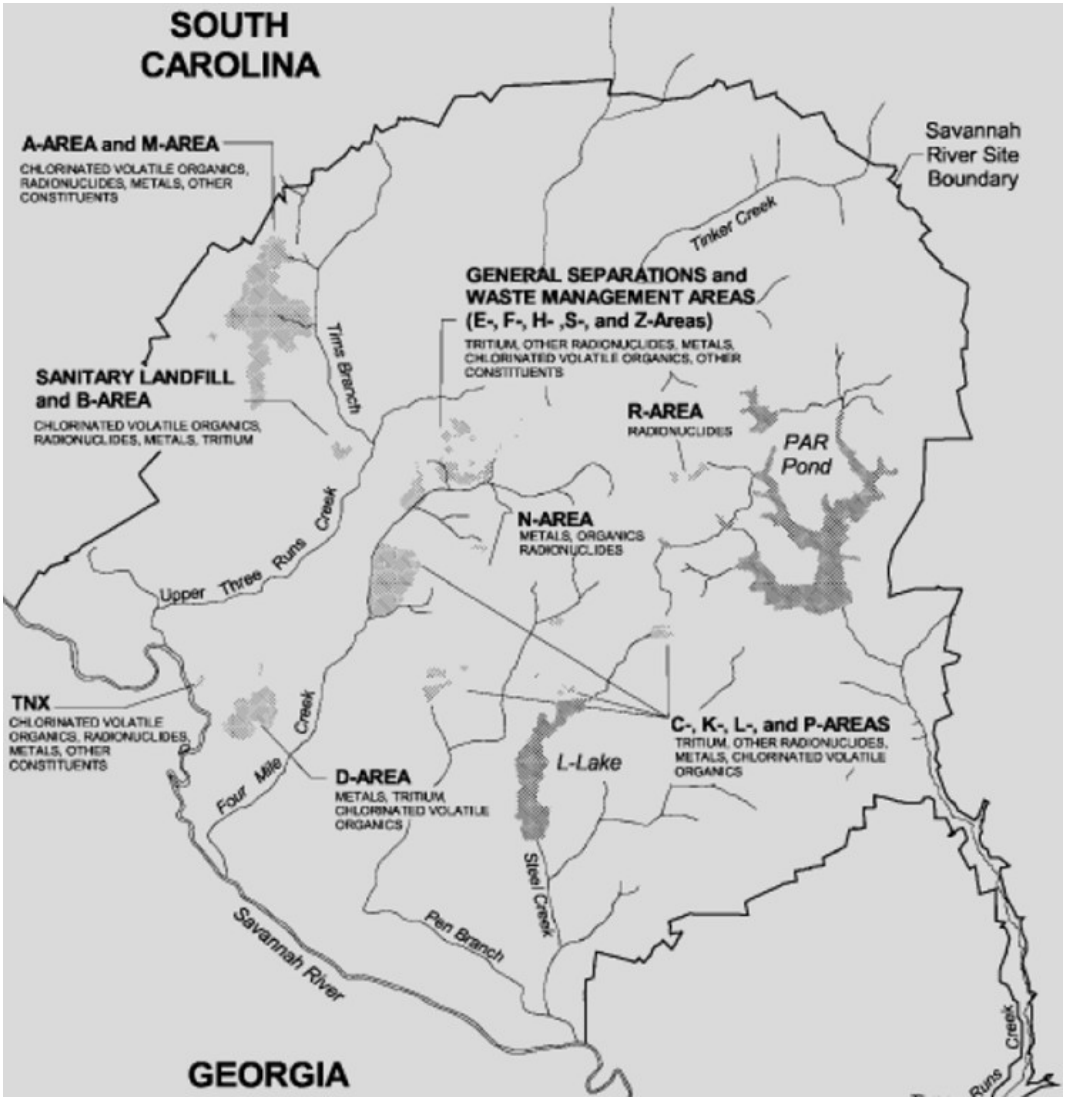


Figure 3-2. Example Summary of Operating Areas and Types of Residual Contamination at a Site

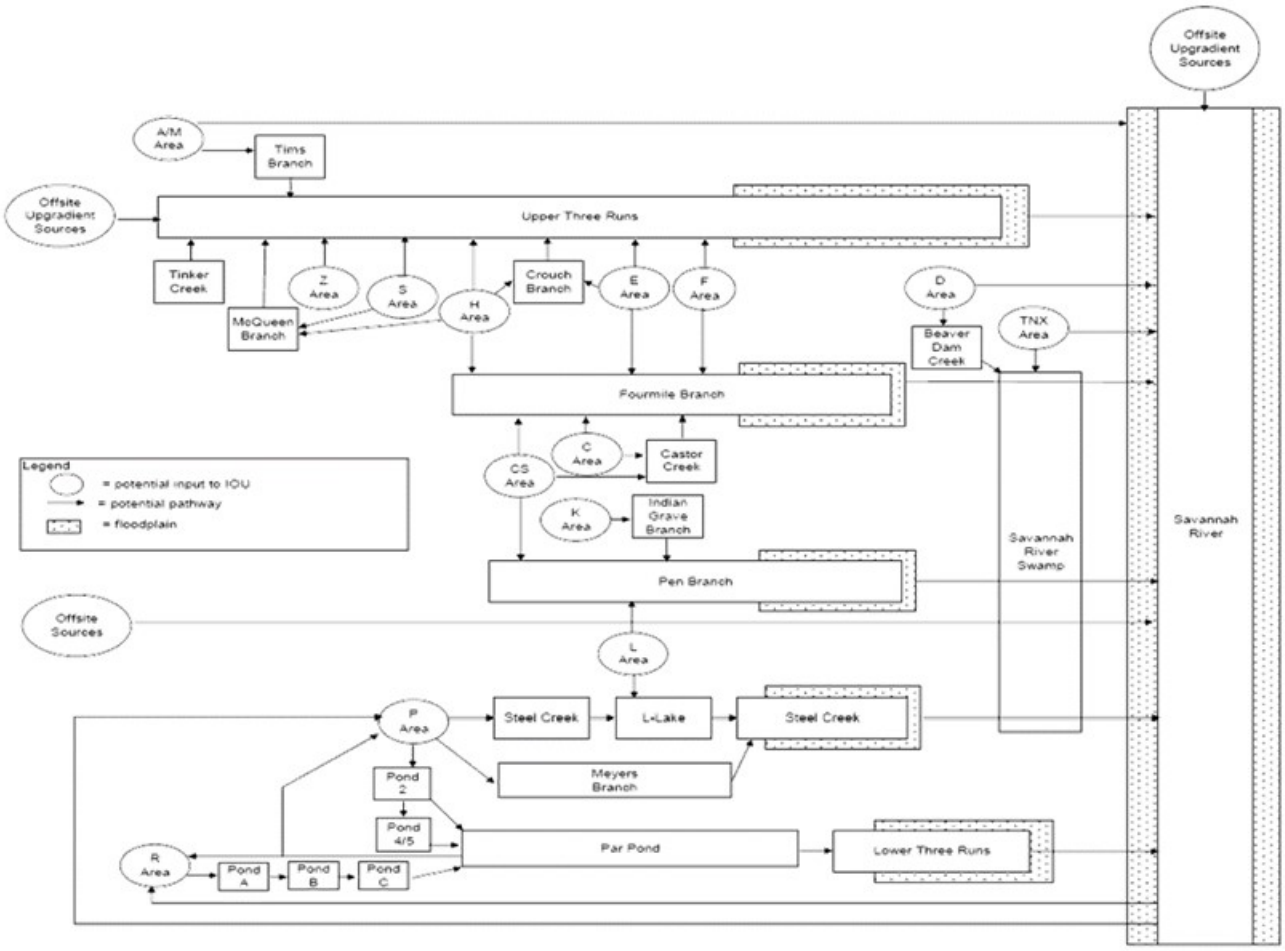


Figure 3-3. Mapping of Sources to Different Transport Pathways to the Receptors at the Points of Assessment

The operational history discussion should provide the baseline for the parts of the site and sources that are addressed in the CA and the general basis for assumptions related to the end states. An overview of existing analyses that may be used in lieu of new calculations in the CA should also be provided to provide general perspective of the types of analyses that may be available and the references that can be used. The intent here is to describe the general types of analyses that may be used rather than a detailed list, which will be provided later. Operating facilities and facilities where remediation has not been completed where end state information may be incomplete should also be identified (Figure 3-4).

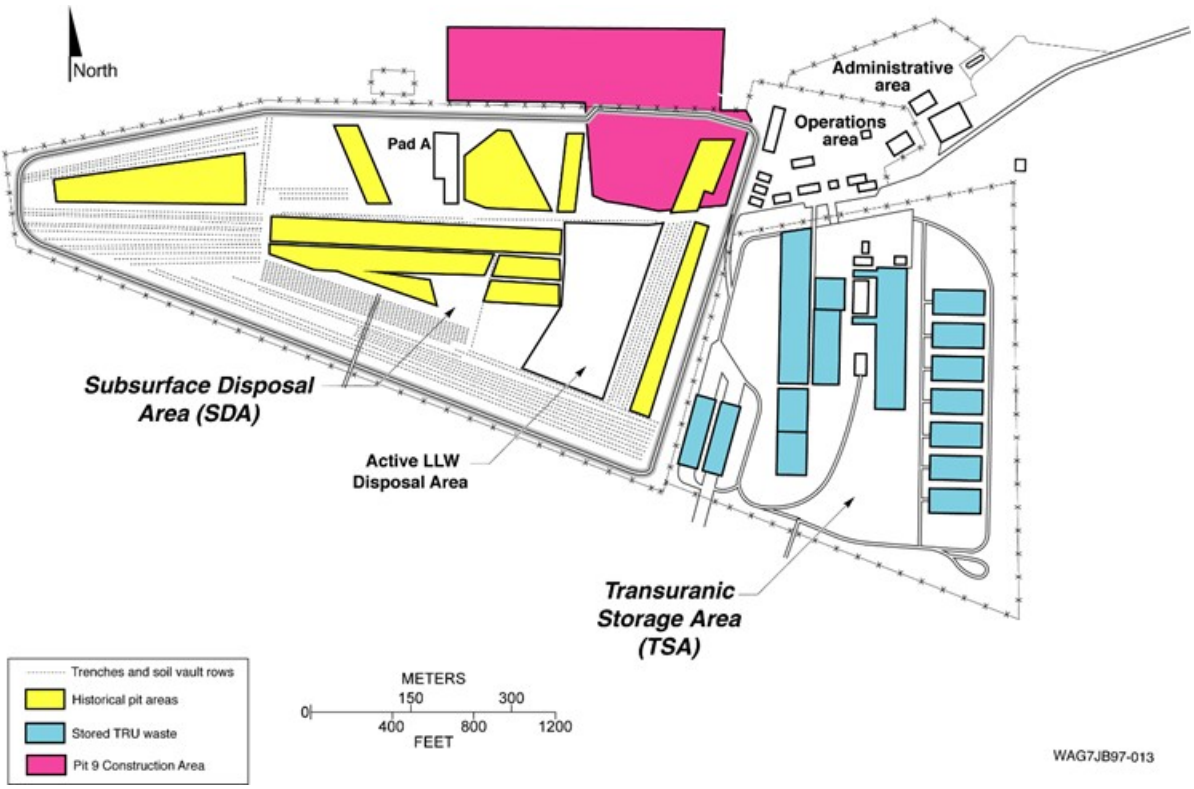


Figure 3-4. Example of Active Disposal Facility and Co-Located Historical Disposal Locations

A graded approach should be used to assure that an appropriate level of detail commensurate with the relative importance and quantity and quality of available information is presented. For example, if a CA, PA, or other assessment has previously been performed, it is possible to summarize the information and cite the other reports for the detailed description. In any event, the level of detail provided (either directly, in appendices, or references) should be sufficient for the level of modeling conducted for the CA and to allow an independent reviewer to conclude that the site-specific analysis of performance is complete, logical, technically correct, rigorous, and defensible. Probabilistic approaches for the CA or the sensitivity and uncertainty analyses will require distributions for key parameters and may also consider alternative conceptual models. The basis for any distributions provided will need to be justified, especially considering the quality and applicability of the information on which the distribution is based. Often simplified distributions are selected reflecting a lack of information. The potential for risk dilution should be considered when estimating distributions.

As CAs will be updated as part of the maintenance process, it is very important that all sources of information presented in this section be clearly referenced (page, section, and table/figure

specific references), including the date of the information. This will help assure that updates incorporate the most recent data.

3.2.3.4 Source Terms and Radionuclide Inventories

This section should describe or provide reference to discussions of the following:

- The complete list of end state source terms addressed by the CA, including currently operating facilities and facilities or areas that are awaiting final closure;
- The graded process to eliminate source terms and radionuclides from further consideration in the CA (e.g., screening), as applicable; and
- Description of the end state source terms and inventories to be considered further in the CA.

This section should identify and list all sources addressed by the CA or provide a reference to that information. The list should serve as a point of reference to assess the comprehensiveness of the analysis (e.g., has anything been missed). Detailed descriptions are not necessary for this initial list. The descriptions and assumptions in the subsections below should be consistent with documentation of projected LLW disposal/CERCLA/RCRA/D&D/tank closure actions or any significant differences should be explained.

3.2.3.4.1 Radionuclide Screening Approach

If radionuclide screening is conducted, this section should document the approach and basis for eliminating radionuclides from further consideration in the CA starting from a list of radionuclides that could be present at the site. Following any screening, the list of radionuclides that will be addressed in the CA should be identified. For screening involving any calculations or software tools, quality assurance (QA) provisions should be documented.

3.2.3.4.2 Graded Approach to Source Term Screening

Starting from the comprehensive list of sources, this section should document the approach(es) for selection of projected end state radionuclide source terms for inclusion in and exclusion from further consideration in the CA modeling. The basis for including and excluding sources from further consideration should be described and justified using a graded approach. Individual subsections are used for each step in a graded screening process.

Initially, source terms with no or insignificant residual radioactivity, designated as non-radiological facilities or with regulatory commitments for clean closure should be eliminated from further consideration in the CA. In making this determination, documentation of residual inventories from remedial actions, regulatory documents governing closure activities, facility descriptions, etc. should be cited as the basis for exclusion. Existing documentation of screening

efforts previously conducted for residual sources should also be considered and cited, as appropriate, as a basis for elimination of a source term from consideration in the CA.

For screening involving simplified conceptual models and/or software tools, a defensible technical basis or justification for the assumptions, data sources, derivation, calculations, QA, and references for the inventory estimates and distributions, as applicable, should be clearly identified and documented. Software QA should also be documented for any software tools that are used. Inventory descriptions should address and justify extrapolations from known data to estimate radionuclides and inventories where clear information does not exist or a facility is not closed; account for source decay from the inventory estimate date to the simulation start date, including potential in-growth of radioactive decay products; and, list the inventory estimates and distributions in the CA, provided as an appendix to the CA, or specified within a referenced document(s).

The list of source terms to be carried forward for additional screening or for the CA modeling should be identified at each step in the graded approach. For additional iterations of CA screening involving the use of simplified conceptual models and/or software tools, the basis for the screening model, assumptions used, and QA for any tools should be discussed. The inventories and conditions assumed for source terms for facilities that are currently operating or have not been closed should be documented as part of the screening process. These assumptions and the potential influence on the conclusions of the CA should be confirmed when the facilities are closed.

3.2.3.5 Source Terms to be Considered in Composite Analysis

The description of sources to be considered further in the CA should include the projected end state condition and configuration of the radionuclide sources, including the PA facilities, and relevant features that could influence radionuclide source release and migration (e.g., barriers, waste forms, remedial measures, geochemistry) with a view towards supporting development of the conceptual model for each source term. References to more detailed descriptions and results of modeling (e.g., risk assessments) to be used as inputs for the CA modeling, as applicable, should be provided. Assumptions regarding the radionuclide inventory for each source term should be provided in a manner that is sufficient for the modeling approach in "Analysis of Performance."

Objective

This Chapter identifies the sources that are considered in the CA and the approach to screen inconsequential radionuclides and sources from detailed consideration in the analysis of performance. The final list of end state sources to be considered in the more detailed analysis of performance is identified.

Discussion

The purpose of this section is to determine which sources of radioactive material should be considered for inclusion in the CA and to screen inconsequential radionuclides and sources from detailed consideration. An example of a three-step approach is illustrated in Figure 3-5. This first step should include all sources in the vicinity of the low-level waste disposal facility/facilities, as well as other sources that may contribute to the calculated dose (e.g., those that are upstream and downstream in the same watershed as the LLW disposal facility/facilities). Detailed information is not needed at this step, just a list of the sources that are considered as a means to assess completeness of the analysis.

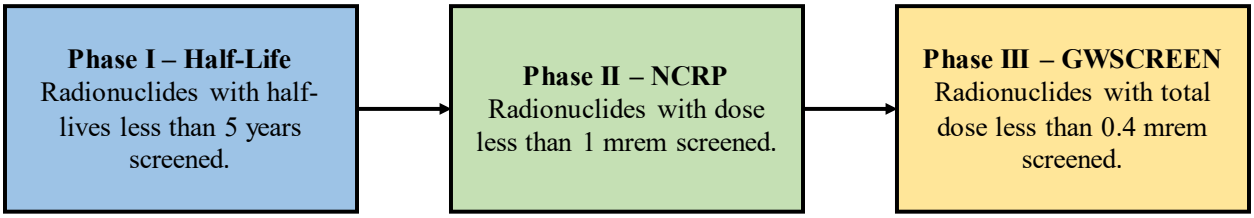


Figure 3-5. Example 3 Phase Radionuclide Screening Approach with Third Step Using a Generally Accepted Risk Assessment Screening Model Used at the Site

No source of radioactive material should be excluded from consideration in the composite analysis because its future fate is uncertain.

Facilities

Radioactive material in facilities (e.g., buildings) need not be considered as a potential source if D&D activities are expected to remove all the radioactive material. However, if D&D activities are expected to leave some of the radioactive material in place, the residual radioactive material should be considered as a potential source unless the property is expected to be released for public use. Additionally, where no remediation decisions have been made, the existing source term may need to be assumed to be present at the facility end state. Radioactive material in the ground resulting from operations in facilities (leaks, spills, etc.) should be considered. Radioactive material in below-ground storage tanks (or other modes of storage) also need not be considered unless the waste in the tanks (or some portion of it) is to be left in place. If the amount of radioactive material to be left in place is uncertain, a few cases could be considered to bound the eventual disposition. Alternatively, a conservative assumption (such as no remediation) could be made to facilitate completing the

first iteration of the composite analysis. If the sensitivity/uncertainty analysis indicates that the uncertainty of the facility source term data used for the first iteration should be reduced, this will be accomplished through the CA maintenance process.

Commercial Nuclear Operations

It may be necessary to consider sources of radioactive contamination from commercial nuclear operations, such as a commercial LLW disposal facility or a commercial power reactor. Consistent with requirements in DOE Order 458.1, doses from non-DOE sources of exposure need to be considered only when 1) the DOE-related CA dose is greater than 25 mrem in a year and 2) the non-DOE source has the potential to interact with the source term from the disposal facility at the point of projected highest dose to a member of the public. That is commercial nuclear operations only need to be included when an Options Analysis is required.

DOE is committed to retain control of radioactively contaminated lands until they can be released under the radiological release criteria for radioactively contaminated property provisions of DOE Order 458.1. Real property released for public use need not be considered as a potential source in the CA, even if the released property has some residual radioactive material, because the release criteria ensure that the dose from the released property could be only a small fraction of the primary public dose limit.

Radionuclide Screening. The second step is to provide a complete discussion and justification for the selection of radionuclides to be modeled within the CA, i.e., those that would produce the reasonably expected peak dose to a hypothetical, future member of the public over the compliance period. All assumptions associated with the selection of CA radionuclides should be clearly identified and justified. The radionuclides modeled within the CA need to be, as appropriate, consistent with those modeled within the PA facility/facilities and with other regulatory analyses that have been conducted for other sources. Some differences between the PA and CA radionuclides modeled may be appropriate due to differences in performance objectives/measures or point(s) of assessment. Those radionuclides shown to result in negligible doses within the PA(s) may be excluded from CA modeling if justified.

If radionuclide screening is conducted to limit the radionuclides to be modeled within the CA, the screening should exclude radionuclides from the analysis on the basis of their insignificance as a dose contributor, adequately justify such exclusion, and identify the excluded and included radionuclides. The PA technical standard guidance includes suggestions for radionuclide screening approaches (Figure 3-6) that can be considered for a CA. For the CA, the potential for different travel times depending on the location of a source and the POA needs to be considered if a travel-time based screening approach is used.

The definition of "insignificant as a dose contributor" is somewhat subjective and needs to be justified based upon demonstrating that the cumulative dose from all excluded radionuclides would still be 1) insignificant relative to the dose from the included radionuclides; and 2) insignificant relative to causing the total projected dose to approach the 30 mrem/yr (0.3 mSv/yr) administrative dose limit.

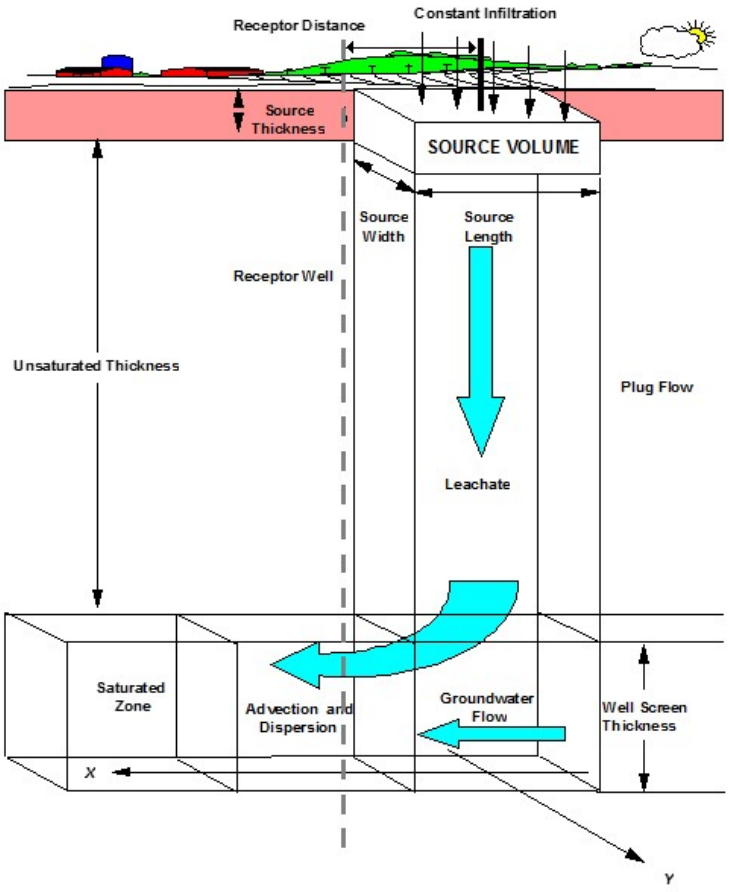


Figure 3-6. Example Conceptual Model for Model-Based Radionuclide Inventory Screening

Source Screening. The next steps address screening of radionuclide sources, if any, and documenting sources that were not considered in the CA and provide a concise explanation and justification why they were excluded or screened out. Note that screening may be described here or as part of the graded approach for the Analysis of Performance. The basis for the end state for screened sources should be identified. If it is an operating facility or a source that has not reached its end state, the basis for the assumed inventory and end state need to be tracked for confirmation when remediation or closure are complete. Different end states can be considered to reflect uncertainty in cases where final remediation is not complete. If the end state in the future is different than the assumptions for screening, the source may have to be reconsidered. The CA should consider radionuclide sources that do not have documented closures plans or are

projected to remain at the DOE site's end state, i.e., after all LLW disposal, CERCLA, RCRA, D&D, and tank closure activities are assumed to have been completed and all DOE operations have ceased.

Examples of Sources:[18]

- *Pre-1988 LLW. If the active LLW disposal facility was in operation prior to September 26, 1988, (the effective date of DOE O 5820.2A, Radioactive Waste Management, the first DOE Order requiring LLW disposal performance assessments), waste disposed before this date needs to be considered as a source in the composite analysis.*

- *Other LLW Disposal Facilities. Other active LLW disposal facilities and any planned low-level (or mixed low-level) waste disposal facilities are considered as potential sources. Facilities that are expected to be developed (i.e., those in DOE long-range plans) also need to be considered; potential disposal facilities, such as those identified conceptually in the Programmatic Environmental Impact Statement (PEIS) or by the Federal Facility Compliance Act of 1992 (FFC Act) Disposal Working Group, but not yet actually planned, need not be considered, but should be tracked as part of maintenance. Inactive or closed LLW disposal facilities should also be considered as potential sources.*

- *TRU and Alpha LLW. Transuranic waste (TRU), suspect transuranic waste, or buried transuranic-contaminated waste should also be considered as potential sources unless a decision has been made to remove the waste. If the eventual disposition of such waste is uncertain, the composite analysis could consider a few cases, based on potential actions, to bound (estimate the maximum impact) the eventual disposition of the waste. Alternatively, a conservative assumption, such as leaving the entire TRU inventory in place, could be made to facilitate completing the first iteration of the composite analysis. If the sensitivity/uncertainty analysis indicates that the uncertainty of the TRU inventory data used for the first iteration should be reduced, this will be accomplished through the composite analysis maintenance process.*

- *TRU in the ground in a storage configuration that DOE plans to recover for shipment to a transuranic waste repository should not be included as a potential source. However, LLW generated in recovery of TRU should be considered as a potential source (assuming that it is to be disposed in the*

[18] Note that no source of radioactive material should be excluded from consideration in the composite analysis because its future fate is uncertain.

LLW disposal facility), as should residuals from the recovery (assuming that radionuclides released from the residue would interact with those released from the LLW disposal facility). Low-level waste containing transuranic radionuclides (commonly referred to as 10 to 100 nCi/g waste, or alpha LLW) should be considered as a potential source as well.

- *Environmental Remediation Activities. Radioactive material in the ground (or groundwater) as a result of DOE operations, such as liquid waste disposal by cribs, ponds, seepage basins, etc., should be considered as potential sources. Radioactive material in the ground from spills or leaks from DOE operations, or residues from remediation of such sources, should also be considered as potential sources.*

- *If remediation plans are not certain, a few cases, based on potential remedial actions, could be analyzed to bound the contribution (estimate the maximum contribution) from each source. Alternatively, a conservative assumption (such as no remediation) could be made to facilitate completing the first iteration of the composite analysis. If the sensitivity/ uncertainty analysis indicates that the uncertainty of the environmental restoration site source term data used for the first iteration should be reduced, this will be accomplished through the composite analysis maintenance process.*

- *If remediation plans have been decided (such as in a CERCLA ROD or by some other means, where cleanup levels are negotiated and accepted by regulatory authorities), or if the remediation has been accomplished, the effect of the remediation (reduction of infiltration by capping, removal of some of the radioactive material, treatment of radioactive material left in place to reduce its mobility, etc.) should be included in the estimation of the source term. Real property released for public use (e.g., industrial, commercial, recreational, residential, etc.) need not be considered as a potential source, unless a potential use (such as irrigation) could impact the dose to a hypothetical future member of the public.*

- *Facilities. Radioactive material in facilities (e.g., buildings) need not be considered as a potential source if D&D activities are expected to remove all the radioactive material. However, if D&D activities are expected to leave some of the radioactive material in place, the residual radioactive material should be considered as a potential source unless the property is expected to be released for public use. Additionally, where no remediation decisions have been made, the existing source term may need to be assumed to be present at the facility end state. Radioactive material in the ground resulting from*

operations in facilities (leaks, spills, etc.) should be considered. Radioactive material in below-ground storage tanks (or other modes of storage) also need not be considered unless the waste in the tanks (or some portion of it) is to be left in place. If the amount of radioactive material to be left in place is uncertain, a few cases could be considered to bound the eventual disposition. Alternatively, a conservative assumption (such as no remediation) could be made to facilitate completing the first iteration of the composite analysis. If the sensitivity/uncertainty analysis indicates that the uncertainty of the facility source term data used for the first iteration should be reduced, this will be accomplished through the CA maintenance process.

- *Non-DOE Sources. It may be necessary to consider sources of radioactive contamination from non-DOE sources, such as a commercial LLW disposal facility or a commercial power reactor. Consistent with requirements in DOE Order 458.1, doses from non-DOE sources of exposure need to be considered only when 1) the DOE-related CA dose is greater than 25 mrem in a year and 2) the non-DOE source has the potential to interact with the source term from the disposal facility at the point of projected highest dose to a member of the public. That is commercial nuclear operations only need to be included when an Options Analysis is required.*

- *Release of DOE Property. DOE is committed to retain control of radioactively contaminated lands until they can be released under the radiological clearance criteria for radioactively contaminated property provisions of DOE Order 458.1. Real property released for public use need not be considered as a potential source in the CA, even if the released property has some residual radioactive material, because the release criteria ensure that the dose from the released property could be only a small fraction of the primary public dose limit.*

Existing site information should be used for the development of end state source locations, source terms and releases. The identification of projected end state radionuclide sources and the exclusion of current sources, which will no longer be present at the DOE site's end state should be justified and supported by pertinent site documentation such as PAs, other DOE approved CAs, Land Use Plans, Site Strategic Plans, Site Mission Plans, FFA, Consent Orders, CERCLA/RCRA regulatory documents, NEPA documentation, FUSRAP/D&D/tank closure/Site Treatment/Groundwater Protection programs and plans, environmental monitoring reports, groundwater modeling reports, process knowledge, and SAR reports.

In addition, the following sources should not be included in the CA modeling, consistent with expectations in DOE O 458.1:

- Dose from radon and its decay products in air;
- Dose received by patients from medical sources of radiation, and by volunteers in medical research programs;
- Dose from background radiation;
- Dose from occupational exposure under NRC or Agreement State license or to general employees regulated under 10 CFR Part 835;
- Dose from the use of consumer products;
- Dose from global fallout from past nuclear accidents and weapons tests exposure; and
- Dose from naturally occurring radioactive material exposure, however DOE activities resulting in doses from Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) need to be included.

It is recognized that this existing information on past activities and expected future activities has differing degrees of uncertainty. As part of the CA maintenance process, the need to refine or modify the CA based on new information is routinely assessed. Sources that are identified within the CA sensitivity and uncertainty analysis as primary dose contributors with significant uncertainty relative to the 30 mrem/yr dose constraint should be added to the CA maintenance process for further evaluation to manage uncertainty.

If projected end state radionuclide source exclusion/screening is conducted, the rationale, approach, methodology, results, and conclusions are discussed and technically justified, and all assumptions associated with the source exclusion/screening clearly identified and justified.

A graded and iterative approach should be applied for source screening. As a basic first step to screening, all current sources projected to no longer be present at the DOE site's end state should be screened (excluded) from further consideration within the CA based upon the adequate justification from pertinent site documentation.

Additional steps in source screening can be conducted on the basis of insignificance as a dose contributor and/or lack of potential interaction. If the results of source screening show that the combined dose at the POA(s) at any given time over the 1,000-year compliance period from all potential interacting sources plus that of the PA facility/facilities is insignificant relative to the 30 mrem/yr administrative dose limit, then in line with the use of a graded approach to modeling such screening can be sufficient to constitute the CA base case modeling effort, if appropriately justified. For example, if the combined dose from screening of the contributing sources is less than 1 mrem/yr or 30 times less than the administrative dose limit, the dose would be considered

insignificant (other fractions or points of comparison can be used with proper justification). Potential uncertainties should be considered when conducting such screening. In cases where there is potential for more significant interactions, the note below provides some additional information and examples that may be considered.

Screening approaches may make use of existing RCRA/CERCLA screening and/or risk assessments, the screening or source modeling from other DOE-approved CA at the site, or other applicable screening or modeling. It is common to have a screening tool at a site that is used to determine if further remedial action is required. Such tools typically have a level of acceptance with regulators under the RCRA/CERCLA process. Documentation associated with the use of such screening tools in association with potential end state radionuclide sources is generally considered a sufficient basis to screen (exclude) sources from further consideration within the CA. In particular, if such screening documentation justified "no further action" or indicated minimal impacts to groundwater then it may be sufficient as a basis for screening a source from further consideration in a CA, if appropriately justified.

Example:

> *Results and conclusions from baseline risk assessments may be used to screen a source from further consideration in a composite analysis, if appropriately justified. Care should be taken to ensure that the combined impacts from multiple screened sources are not significant. To address this, it should be demonstrated that the cumulative dose from all excluded sources would still insignificant relative to causing the total projected dose to approach the 30 mrem/yr administrative dose limit.*

Effective screening is critical to development of an efficient CA in cases involving many potential sources. After the first two levels of screening are conducted, further consideration can be applied considering the potential for a source to interact with the PA facility/facilities and significantly affect the projected dose to a hypothetical future member of the public at the points of assessment over the assessment period. The projected end state radionuclide sources may be excluded/screened out from the CA based and justified upon one or both of the following two criteria: (1) Insignificance as a dose contributor; and/or 2) Lack of potential interaction at the points of assessment over the compliance period with radionuclide source release and migration from the PA facility/facilities for which the CA is being conducted. The level of detail in the inputs should be commensurate with the level of detail in any modeling conducted for this screening. Considerations for these two types of screening are provided in the next sections.

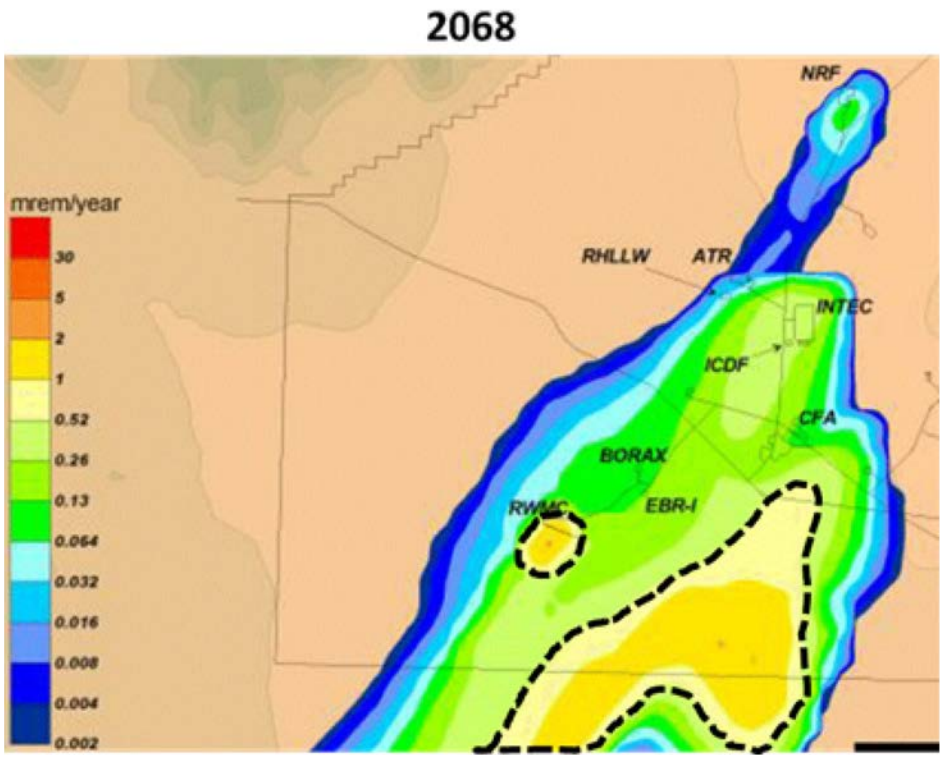
To optimize and facilitate additional source screening, consideration should be given to conducting screening in the following order, as appropriate: 1) lack of potential interaction; 2)

insignificance as a dose contributor; and 3) current source which will not be an end state radionuclide source.

Insignificant as a Dose Contributor. Reasons that a source could be an insignificant dose contributor include (but are not limited to) the following:

- If the projected end state radionuclide inventory of the source is small enough that, given reasonable release mechanisms, the source could contribute only a very small fraction to the dose to a hypothetical future member of the public resulting from the PA facility/facilities and the included other interacting end state radionuclide sources over the compliance period, the source can be excluded/screened out. The definition of "a very small fraction to the dose" is somewhat subjective and should be justified based upon demonstrating that the cumulative dose from all excluded sources would still be insignificant relative to causing the total projected dose to approach the 30 mrem/yr (0.3 mSv/yr) administrative dose limit.
- If the source is projected at its end state to contain only radionuclides that have been shown to not contribute significantly to calculated doses (e.g., from radionuclide screening), the source may be excluded/screened out.

  If the distance from the source to the points of assessment is sufficiently long so that dispersion in the environment and/or radioactive decay during transit would reduce the contribution from the source to a small fraction of 30 mrem per year, the source can be excluded/screened out (Figure 3-7). Alternatively, if the rate of radionuclide migration (e.g., through the vadose zone at arid sites) is so slow that radioactive decay during transit would reduce the contribution from the source to a small fraction of 30 mrem per year, the source can be excluded/screened out.



Note: Although the contours show interactions, the black dashed outlines on the graphic highlight the contours for doses roughly equivalent to 0.5 mrem/y.

Figure 3-7. Example Considering the Magnitude of Interactions as a Result of Dispersion Over Long Distances

Lack of Potential Interaction. The determination of a lack of potential interaction considers all the transport pathways (e.g., water, air, biotic) determined that have been selected for modeling within the CA. The lack of potential interaction can consider both spatial and temporal nature of potential interaction. Examples of reasons that a source could have a lack of potential interaction include (but are not limited to) the following:

- *Natural features/barriers may prevent radionuclide release and migration from a source from contributing to the potential dose from the PA facility/facilities to a hypothetical future member of the public. The natural hydrogeology (i.e., flow directions) may prevent interaction. The natural meteorology (i.e., predominate wind directions) along with the location of a potential end state source versus the PA facility/facilities may also prevent interaction. However, because of the lengthy time-frame considered, it should be kept in mind that the efficacy of natural features/barriers may change over time; also, some uses of lands surrounding disposal areas may compromise the ability of natural features/barriers to keep sources of radioactive*

contamination from interacting. Justification for excluding a source, based on natural features/barriers, should demonstrate a detailed and thorough knowledge of the hydrogeology, meteorology and climatology, land use etc. that could affect such natural features/barriers. Excluding a source, based on natural features/barriers should take into consideration both local and regional flow systems (groundwater and surface water) and local and regional meteorology and their potential interactions. Natural features/barriers that could be considered include (but are not limited to) the following.

- *A groundwater divide which lies between the PA facility/facilities and another source may prevent the interaction of radionuclides released from the PA facility/facilities with those released from the other source. If a groundwater divide is used as justification for excluding/screening a source, the justification should: 1) provide sufficient information to demonstrate that the groundwater divide prohibits interaction in both the groundwater and surface water flow systems over the assessment period; and 2) describe why the groundwater divide is likely to exist over the assessment period (i.e., it is not the result of short-term effects such as artificial recharge or discharge). The exclusion or inclusion decision associated with sources adjacent to or on a groundwater divide should be reasonable and justified and not be biased toward exclusion.*

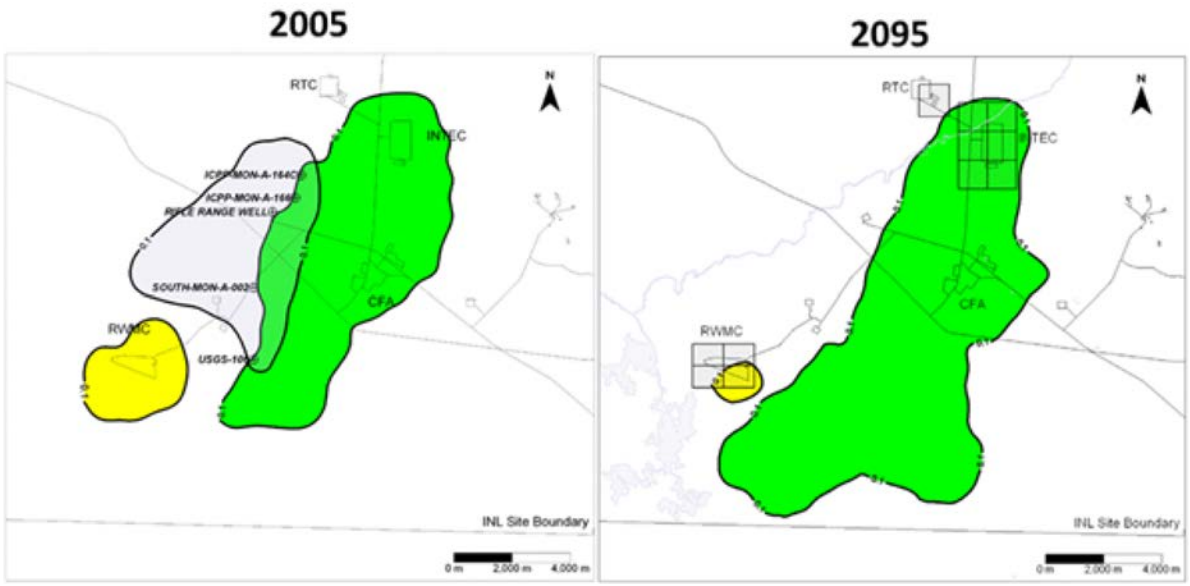
- *A surface stream which lies between the PA facility/facilities and another source, and which intercepts groundwater, may prevent the interaction of radionuclides released from the PA facility/facilities with those released from other sources. If groundwater discharge to a surface stream is used as justification for excluding/screening a source, the justification should: 1) provide sufficient information to demonstrate that the groundwater discharge prohibits interaction downstream over the assessment period; and 2) describe why the groundwater discharge is likely to exist over the assessment period (i.e., it is not the result of short-term effects such as artificial recharge or discharge).*

- *Groundwater flow may be in one predominant direction. If so, and the PA facility/facilities is situated so that another source being considered is neither upstream nor downstream from it (i.e., the shortest distance between the PA facility/facilities and the other source is in a direction approximately perpendicular to the groundwater flow direction), contaminants released from the source may not converge with those released from the PA facility/facilities. Thus, it may be justified to exclude the source from*

consideration. The parallel flow paths should be likely to persist over the assessment period and not change direction due to changes in recharge sources or for other reasons. If, however, the POA is at a distance (such that contamination plumes from the two sources could mix) or at a place (such as a river or stream) where radionuclides released from the two sources would converge, the source should be considered.

- *Predominant wind directions (i.e., natural meteorology) along with the location of a potential end state source versus the PA facility/facilities may prevent significant interaction.*

- *The temporal nature of potential interaction may be considered, as appropriate, when making a determination of lack of potential interaction to exclude a source (Figure 3-8). Potential interacting sources may consist of past practices such as the use of injection wells, unlined basins, unlined landfills, etc. Such past practices may have resulted in present day groundwater contaminant plumes. LLW disposal facilities (i.e. PA facilities) built in accordance with DOE O 435.1 are often very robust facilities from which significant radionuclide release and transport is not anticipated for hundreds of years as demonstrated by their PAs. If it can be demonstrated that there is a reasonable expectation that the current groundwater plumes associated with past practices will dissipate to insignificance at the POA(s) prior to contaminant transport from the PA facility/facilities reaching the POA(s), a basis exists to exclude the past practice facilities and waste sites. Excluding a source based upon a lack of interaction from a temporal perspective should take into consideration the certainty associated with the timing of contaminant transport both from the potential interacting source and the PA facility/facilities and the significance of any potential interaction that might be anticipated occur (Insignificant as a Dose Contributor within this note).*



Note that there were interactions in 2005, but in 2095 there are no significant interactions expected.

Figure 3-8. Example of Changing Interactions Over Time from NEPA Analysis Considering Potential Interactions to Support Siting of a Facility (Contours for 1/10th of the MCL)

Sources and Inventories for Analysis of Performance. The conclusion for this chapter is the listing of the end state radionuclide sources considered within the Analysis of Performance along with information pertinent to the CA on the sources and information on the associated radionuclide inventory estimation. A list may be provided here and detailed information can also be provided as part of the conceptual model or in a separate reference based on site specific considerations (e.g., level of modeling detail needed, number of sources to be considered).

The source description includes the projected end state condition and configuration of the radionuclide sources, including the PA facilities. Relevant features should also be identified that could influence radionuclide source release and migration (e.g., waste forms, containers, barriers, entombment) and how they are or are not considered consistent with the level of detail in the analysis. The projected end state conditions and configurations of the PA facility/facilities should be consistent with the respective PAs. Assumptions associated with selecting sources for inclusion and the projected end state radionuclide source condition and configuration are identified and justified.

The bases, assumptions, data sources, derivation, calculations, and references for the inventory estimates and distributions should be clearly identified and have a defensible technical basis or justification. The bases may include existing inventory estimates from referenced documents;

existing site investigation data summaries from referenced documents or presented in the CA; inventories of similar facilities/waste sites; waste disposal records or projections; production histories, effluent or environmental monitoring data, other existing records; process knowledge; site history; safety analysis documentation, and any other information that may be relevant. Extrapolations can be made and justified from known data to estimate radionuclides and inventories where clear information does not exist. Consideration should be given to the need to account for source decay from the inventory estimate date to the simulation start date, including potential in-growth of radioactive decay products.

Either best estimate inventories with distributions or bounding (conservative) inventories may be utilized. A graded approach based upon the significance of the base case dose relative to the 30 mrem/yr administrative dose limit should be implemented relative to the inventories utilized. In general, the use of bounding (conservative) inventories becomes more acceptable the lower the base case maximum dose is from 30 mrem/yr, with its use. As the base case maximum dose using bounding (conservative) inventories approaches or exceeds 30 mrem/yr, the more important it becomes to use best estimate inventories with distributions. In general, if the compliance case model is performed probabilistically, the inventory distributions would also be utilized in the base case modeling with the best estimate inventories forming the central tendency.

Inventory estimates and distributions, where possible, should be made from existing data and not from new sample collection and analysis. If the sensitivity/uncertainty analysis indicates that the uncertainty of the initial radionuclide inventory could be important, this will be accomplished through the CA maintenance process.

QA measures implemented for development of inventory estimates and distributions should be documented either within the CA itself or referenced documents. Inventory estimates and distributions should be traceable, qualified, controlled, and archived.

3.2.4. Analysis of Performance

This chapter should provide a detailed description and basis for the conceptual and mathematical models/modeling tools and how they are applied for the analysis of performance. This includes documentation of the use of a graded approach, as applicable, including different conceptual models that may be applied for different types of source terms and how the contributions from the different source terms are integrated for flow and transport in the groundwater system. Exposure pathways and scenarios that are used for the dose assessment and comparison with the performance measures should also be described and justified. The mathematical and numerical models and modeling tools, as applicable, should be summarized, including a summary of how the source terms and conceptual models are implemented to calculate doses for comparison with the performance measures.

3.2.4.1 Overview of Analysis of Performance

This introductory section should provide a roadmap for more detailed descriptions and reference material for each component of the total system model, including a "higher-level perspective" of the different system features that are represented in the conceptual models described in more detail below. It should generally describe the linkages between conceptual models for the different source terms and components of the total system (e.g., waste form, facility, natural system, and other relevant components).

This section should also include a description of the compliance case, including exposure pathways and scenarios, and alternative scenarios chosen and the general approach for the integration of the conceptual models. The methods used to select the exposure pathways and features, events and processes (scenarios) to be considered in the conceptual models and those to be screened should be summarized with reference to more detailed documentation in an appendix and/or separate report(s). The analysis approach should be developed in a manner that will allow the source terms, pathways and radionuclides that are the primary contributors to the peak dose can be identified.

Objective

This section provides introductory information with a general overview of the different conceptual models that will be described and how those models are linked. This section is also where the approach to identify the scenarios, including the compliance case and any alternatives, to be considered in the CA is described.

Discussion

The purpose of the analyses in the CA is to provide the technical basis for the determination of a reasonable expectation of acceptable performance of the disposal facility over time, based on the total radionuclide inventory in the sources analyzed. The analysis of performance discussion should include a sufficient amount of documentation to allow an independent reviewer to conclude that the site-specific analysis of performance is complete, logical, technically correct, rigorous, and defensible.

The public dose limit applies only to members of the public. Thus, it applies only beyond the boundary of land controlled by DOE. Currently, land controlled by DOE extends to the boundary of the entire DOE site. However, the land controlled by DOE for purposes of radiation protection of the public may be assumed for the CA to shrink in the future and should be consistent with site-specific plans required by DOE policy for land and facility use. Site-specific plans for land and facility use should be referenced in the CA. If plans for long-term land and facility use are not available, reasonably conservative assumptions should be made (and

justified) to determine the point(s) of assessment for the CA. The CA is also used to evaluate the impact of different site boundary assumptions (timing, location).

Radiological release criteria for contaminated property are provided in DOE Order 458.1. Real property released for public use need not be considered as a potential source in the CA, even if the released property has some residual radioactive material, because the release criteria ensure that the dose from the released property could be only a small fraction of the primary dose limit. Released property may need consideration in the analysis as a non-DOE source if total doses from all DOE sources exceeds 30 mrem in a year and the doses from non-DOE sources including the released property, exceeds 30 mrem in a year.

The all-pathways analyses conducted for the CA should be used to determine the peak exposure to a hypothetical future member of the public outside of the land controlled by DOE. Although in some complicated configurations, especially in the absence of information about other sources of radiation within a controlled area, a more conservative POA might be selected for a given facility to provide greater assurance that total doses will not exceed the primary dose limit.

DOE is committed to retain control of contaminated lands until they can be released under the provisions of DOE Order 458.1. However, despite the great uncertainty in dose projections made over very long times, the CA should present the maximum calculated dose to hypothetical future members of the public, over a time period of 1,000 years (peak impacts beyond 1,000 years are also addressed either with the analysis of performance or with the sensitivity analysis). The total dose from all the sources together should be reported as a function of time. Maximum calculated doses from different sources will likely not occur at the same time.

The first part of this section provides a single location where reviewers can find an overview of the different conceptual models to be described and a mapping to where those conceptual models are described in the following subsections. Most importantly, this overview should provide an integration of the data presented concerning the site and the other sources significant to the analysis. This description should provide the scope and framework for the conceptual model(s), and the detailed conceptual models and analysis which follows.

The general modeling approach should be introduced and linkages between individual conceptual models and between the conceptual and mathematical modeling tools are also introduced. If a structured approach is adopted for the graded approach (e.g., first level of modeling uses results from existing modeling efforts as input to the CA model, second level is a generic approach assuming the inventory is distributed on the ground, and third level of modeling allows consideration of waste forms and barriers). In general, the content expectations are similar to a PA as discussed in the PA guidance, although there will be less emphasis on individual sources and more emphasis on the general approaches applied to classes of sources. For a CA, it is not generally expected to include an extensive discussion of safety functions and

FEP, except in cases where more detailed modeling may be required based on the amount of radioactivity associated with a specific source.

As appropriate, the CA conceptual model and modeling methodology (i.e. for source release, fate and transport, and all-pathways dose simulations) should be consistent with that of the associated PA(s). However, differences between the CA conceptual model and modeling methodology from that of the PA may be warranted and appropriate based on the different purposes for the two types of analyses. Notably, a CA typically considers many more sources than the PA. Additionally, the CA POA is typically associated with the projected DOE site boundary based upon land use documentation, whereas the PA POA is typically 100 meters from the disposed waste of the low-level waste disposal facility. These fundamental differences generally mean that the domain of the CA conceptual model and mathematical model are significantly greater than that of the PA (e.g., the CA tends to represent a site/regional-level of groundwater flow and transport). These differences in the number of sources considered, location of the POA, and scale of the model between a CA and its associated PA(s), may require differences in the CA and PA conceptual models and modeling methodologies.

Furthermore, the increased scale and number of sources considered within a CA often make simplifications of the CA conceptual model and modeling methodology relative to that of the PA acceptable and appropriate. In particular, there may be a lack of data for the representation of the other interacting end state radionuclide sources relative to that of the low-level waste disposal facility as represented within the PA. This lack of data may result in the need for simplifications to the conceptual models and source release models for these sources relative to the low-level waste disposal facility. Also, the increased number of sources and greater scale considered within a CA may mean that simplifications relative to that of the PA are required in order to expedite calculations. The difference in the points of assessment between the PA and CA may also result in differences between the PA and CA exposure scenario(s) considered with the PA and CA all-pathways dose simulations.

Example:

> *The predominant PA all-pathways transport pathway for low-level waste disposal facility G is through the groundwater to the PA POA at the 100 m well. The CA all-pathways transport pathway for facility G is through the groundwater to an outcrop to a surface stream and then to the CA POA at the DOE site boundary. These differences in the PA and CA transport pathways and points of assessment result in differences between the PA and CA models. The groundwater portion of the CA model may be simplified relative to that of the PA, because groundwater concentrations are not required; however, the CA should consider concentrations and transport within the stream that the PA does not have to consider.*

Additionally, the CA should consider recreational uses of the surface water (e.g., boating, fishing, swimming) that the PA does not have to consider.

A graded approach to overall CA modeling and the modeling of individual sources can be justified based upon dose significance (Figure 3-9). In general, a more conservative, less complex modeling approach overall may be appropriate where the maximum combined dose at any given time is considered insignificant (i.e. less than 1 mrem/yr). Whereas a best-estimate, more complex modeling approach overall may be appropriate as the maximum combined dose approaches the 30 mrem/yr administrative dose limit. Likewise, more pessimistic, less complex modeling of sources with little dose significance and best-estimate, more complex modeling of sources with greater dose significance is generally appropriate. In many cases, it is expedient and defensible to use results from existing modeling efforts within the CA analysis in place of conducting new calculations for all sources. In practice, a CA can include, for example, the use of flux to water table calculations obtained from a PA or from modeling supporting a remedial action under CERCLA. Such an approach provides for consistency with existing modeling efforts by using results from those efforts, while providing the inputs necessary to support consideration of cumulative impacts from multiple sources.

Example:

The flux to the water over time was obtained from the PA for low-level waste disposal facility M as input to the associated CA. The PA utilized a 2-dimensional finite element combined source and vadose zone model considering closure cap degradation and increasing infiltration over time, concrete vault degradation, and activated metal corrosion all as part of the source release mechanism. Many of the interacting facilities and waste sites have been evaluated for impact to the groundwater under CERCLA using a simplistic but conservative 1-dimensional model which has received approval by the regulators. The flux to the water table for these interacting facilities and waste sites from the CERCLA approved models has also been used as input to the CA.

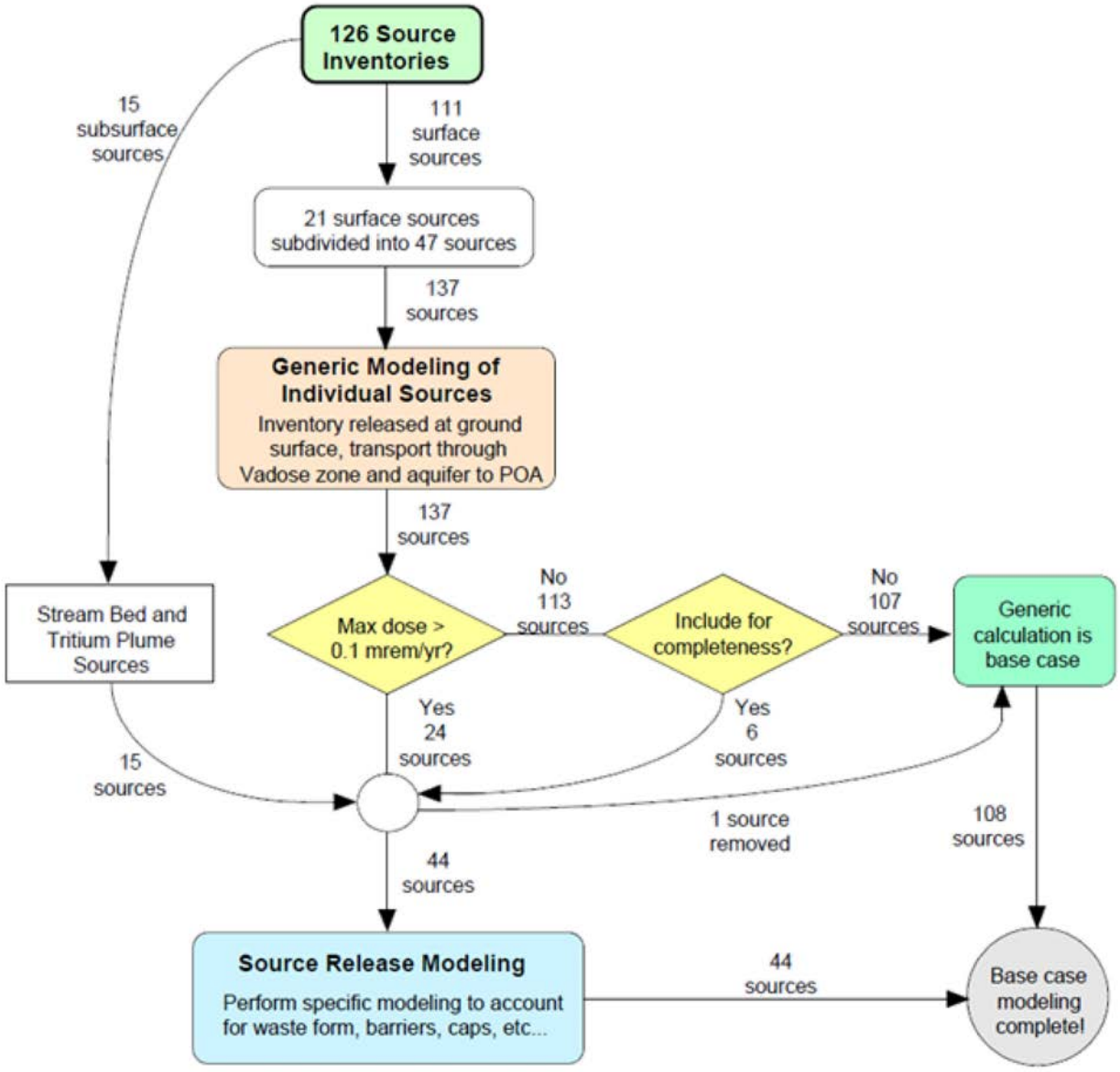


Figure 3-9. Example Flow Chart for Graded Approach to Consider Individual Sources

3.2.4.2 CA Conceptual Model

This introductory section should provide a summary, including a "higher-level perspective," of the different system features that are represented in the conceptual models described in more detail below. This section should provide a description of any alternative conceptual models that are included. Each subsection should identify and sufficiently justify assumptions, simplifications and limitations of the approach and processes, and parameter values included in the conceptual model. Justification for initial conditions, boundary conditions, and changes in

assumptions or properties with time that are derived from existing site data or information should be presented.

Uncertainties associated with gaps in knowledge in the behavior of the engineered and natural systems should be identified in each subsection and the approach for managing the uncertainties should be described. The use of a graded approach, including the degree of conservatism and processes considered/not considered should be described, as applicable. Reasonably foreseeable natural processes that might disrupt natural and engineered barriers against release and transport of radioactive materials should be identified and justified ensuring that source release simulation is consistent with the CA conceptual model, the methodology used within the associated PAs, and the projected end state condition and configuration of the radionuclide sources. If developed in support of a revised CA, the conceptual model descriptions should provide a rationale for changes in transport mechanisms, receptor locations, exposure media, and uptake pathways from the previous CA.

If probabilistic approaches are used, the basis for selecting parameters to be included and the ranges and distributions of parameter values should be provided. The descriptions in each subsection should provide the basis for and description of any alternative conceptual models that are included. The information should provide sufficient justification and description of the conceptual models to support implementation in the mathematical models and modeling tools.

Where different levels of modeling detail are applied to provide the basis for assumptions in a less detailed system level model (e.g., hybrid modeling approach), this section should describe how insights from the more detailed models are implemented in the total system model. Describe any conceptual models and references to any computer codes used to develop assumptions about the disposal site geochemistry or other more detailed phenomena that serve as technical underpinning for the compliance-related conceptual model, including any related information on data bases, input and output data, and interpretation of results. The basis for the linkage between the detailed and higher level models should be documented including key uncertainties associated with the integration of the different conceptual models. As applicable, describe the relationship between the current CA and previous existing CAs and other related assessments and discuss the significance or insignificance of the differences in the approaches.

The CA conceptual model(s) should be consistent with and justified by the overall DOE site conceptual model(s) and with the associated PA or other risk assessment conceptual model(s), as appropriate. The CA conceptual model(s) should encompass a domain that includes applicable PA facilities and all other interacting end state radionuclide sources that have not been excluded/screened out; and it should ensure the CA conceptual model(s) considers, as appropriate, projected LLW disposal/CERCLA/RCRA/D&D/tank closure actions, which are supported and justified by referenced documentation.

3.2.4.2.1 Source Term Release

This section should identify and describe the assumptions associated with assessing the release from each source term and linkage of the release results to the radionuclide transport pathways in the natural environment (e.g., source term linked to vadose zone in CA or source term includes migration from vadose zone to aquifer). In cases where release rates from modeling approved separately from the CA (e.g., PA or risk assessment) are used as the source term for the CA, reference should be provided to the documentation of the assumptions and methods used to calculate the release rate and the assumed release rate should be presented in the CA. For source term modeling conducted in the CA, covers, generic or specific waste forms, containers, backfill and engineered features associated with each source term (e.g., liners, vaults) should be addressed, as applicable. Assumptions related to timing and changes in material properties, chemistry, etc. and use of conservatism or alternative models to address uncertainty should also be described. Specific assumptions related to releases of potentially volatile radionuclides to the atmospheric pathway, if not previously screened, should also be addressed in this section.

3.2.4.2.2 Radionuclide Transport

This section should present the conceptual model(s) for transport of radionuclides released from the source terms through the environment to the points of exposure, including the analysis for atmospheric, biotic and hydrologic transport, if not screened from detailed consideration. The relationship between the conceptual model and the available geochemical, geologic, meteorological, and hydrologic data and other related investigations should be included and any alternative conceptual models or conservatisms built into the conceptual models should be discussed.

Water Pathway. The discussion of radionuclide transport in the water pathway should include projected transport mechanisms of radionuclides through unsaturated and saturated media, as applicable, including the basis for choices of mechanisms that are included or excluded. Details regarding the parameterization for unsaturated and saturated flow and transport models should be provided in a manner sufficient to support the implementation of the modeling tools used for the CA. The assumptions to identify the concentrations used in support of the all pathways analysis should be described.

Atmospheric Pathway. The discussion of radionuclide transport in the air pathway should include the assumptions regarding volatilization; migration through the waste zone, engineered features and cover; and assumptions required to determine the concentration in air assumed for exposures, including the basis for choices of mechanisms that are included or excluded. Details for parameterization of the models should be provided in a manner sufficient to support the modeling approach described in "Implementation of the Modeling." The assumptions for determining the concentration in air used for compliance with the air pathway objective should be described.

Biotic Pathway. Describe the conceptual model for potential biotic transport including transport via uptake in flora and potential contact and transport of waste through burrowing animals (e.g., ants, mammals). The basis for assumptions for the depths of root penetration and depth and volume of disruptions related to animal burrowing should be provided, as applicable. The assumed role of engineered features (e.g., structures, covers, remedial measures) in delaying or preventing biotic pathways should also be discussed. The assumptions to determine the concentrations in media used as part of the all pathways exposure and dose calculations should be described.

3.2.4.3 Exposure Pathways and Scenarios

This section should describe the basis for the inputs and assumptions for the exposure pathways in the conceptual model and method(s) for evaluating the potential doses to a hypothetical, individual member of the public. It should include exposures that represent reasonable actions of a group of individuals performing activities that are consistent with regional social customs, work, and housing practices, and include the expected regional environmental conditions at the time of the exposure scenario. The approach to address the more highly exposed members of the representative group should be identified (e.g., assumption that point of assessment is selected such that exposure occurs at the time and location of peak concentration).

This section should justify selection of the use of a representative person or maximally exposed individual to be considered in the analysis. It should include receptor locations, exposure media, and uptake pathways and the parameters necessary to implement the modeling tools used for exposure assessments. The rationale for assumed changes in these factors over time and methods to manage uncertainty should also be addressed.

Objective

These sections describe the details for the conceptual models that are applied for the CA and provides the basis for selection of modeling tools and implementation of the modeling.

Discussion

This section describes the conceptual model(s) of facility performance with sufficient information to understand the relationship between the detailed elements of the analysis of performance, and to clearly understand the basis for the choice of conceptual models/scenarios, logic and rigor of the method of analysis in the context of the use of the results. The conceptual model (Figure 3-10) should address all the elements to be considered for all the pathways from the source term to the evaluation of dose to the exposed individuals for the sources considered in the Analysis of Performance. The conceptual model discussion should include references and citations to geochemical, geologic, meteorological and hydrologic data, and to other analyses or investigations that justify the conceptual model as being technically correct and rigorous.

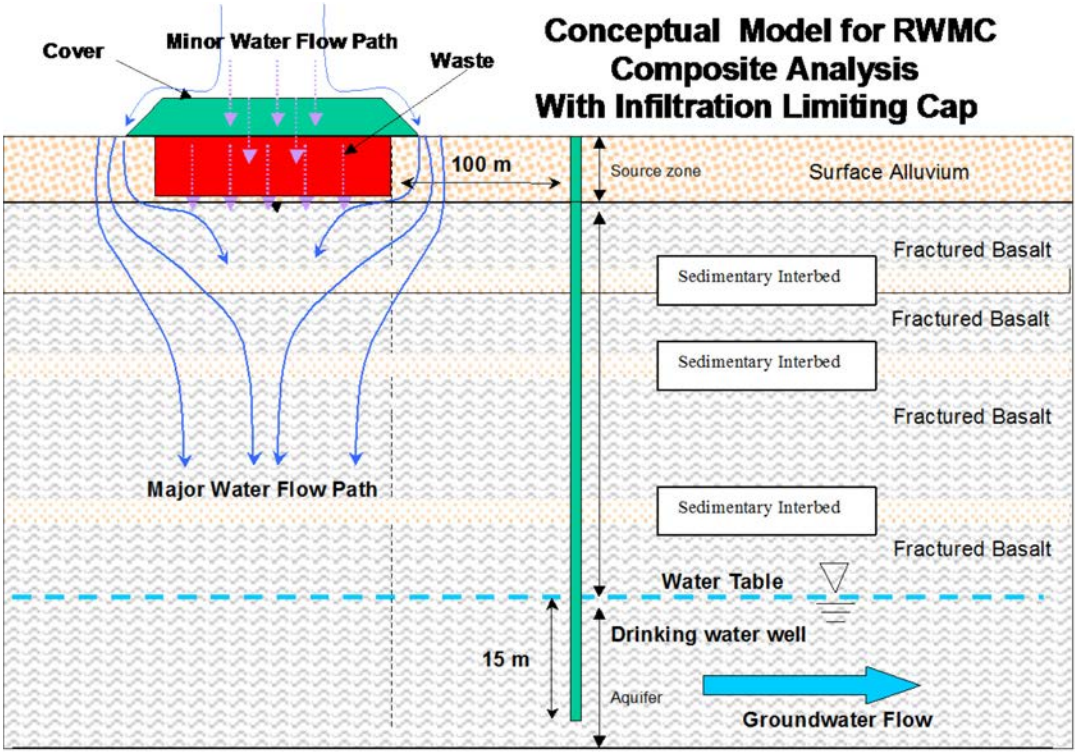


Figure 3-10. Example General Conceptual Model for a Source

The expectations for the information are similar to those identified in the PA guidance, recognizing the graded application where a CA will often use less detailed models applied to many sources. The CA is also expected to rely on existing analyses for some sources. The use of existing analyses would replace the source term and all or parts of the radionuclide transport conceptual models with actual results from other modeling efforts (e.g., source term and vadose zone release to the aquifer from an existing PA or risk assessment).

In general, these CA transport pathways and exposure scenarios should be consistent with those in the associated PAs; however, some differences between these PA and CA parameters may be appropriate due to differences between the PA and CA Performance Objectives; or the PA POA and the CA POA. For example, surface water may play a more significant role in a CA based on the POA (e.g., site boundary) selected (Figure 3-11). Such differences should be explained.

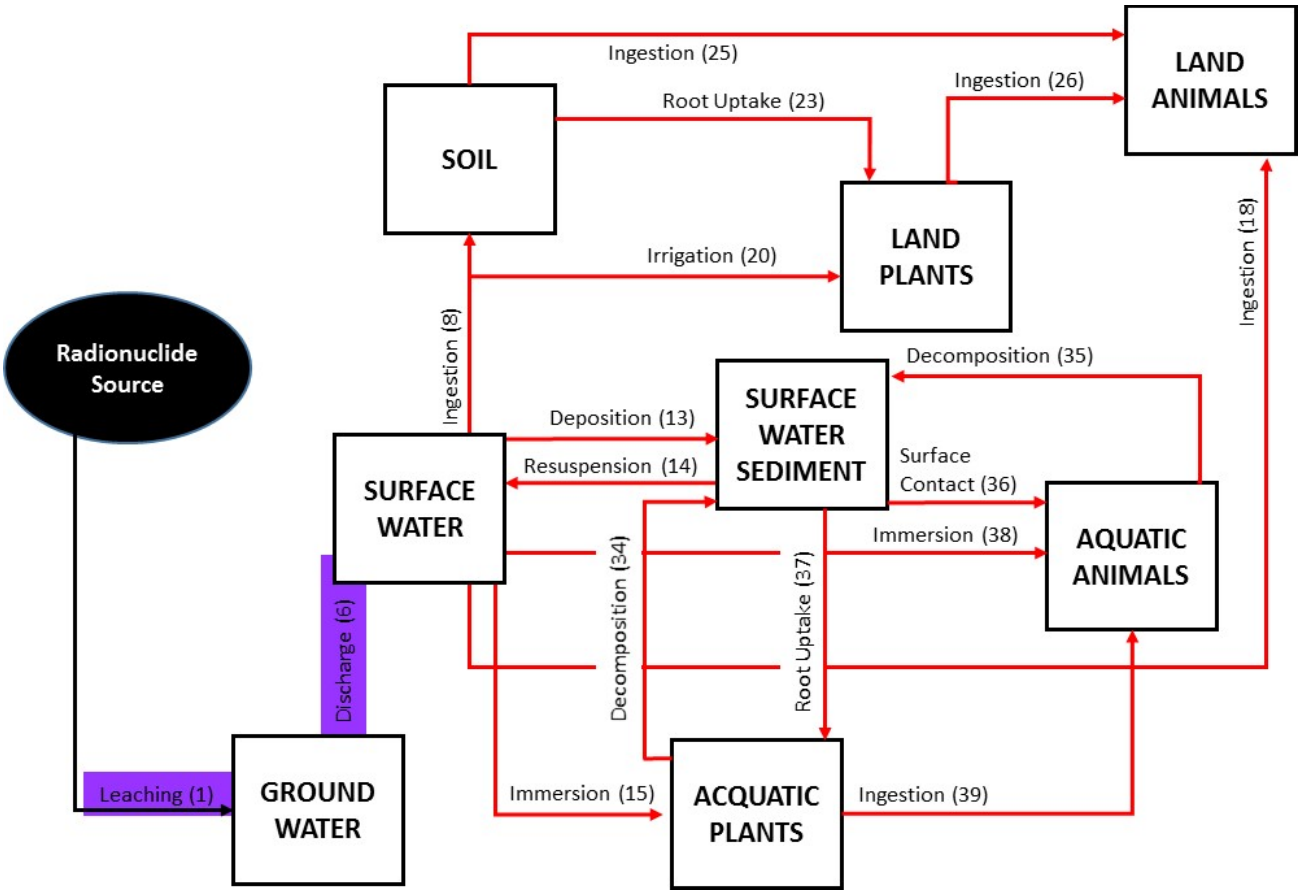


Figure 3-11. Example Summary of Pathways Considered in a CA

Important assumptions and simplifications of natural processes incorporated into the conceptual model need to be identified and justified. Uncertainties in the behavior of the site or the disposal facility included in the conceptual model that are associated with gaps in knowledge should also be identified, and the potential significance of the uncertainties discussed, as applicable. The conceptual model description should also include detailed information about the parameter values and other alternative models and scenarios that are considered. Key assumptions linked to the mathematical models should be described along with potential limitations of the models.

3.2.4.4 Modeling Tools

This section should include a description of the modeling tools and their implementation for the CA. The descriptions should reflect the practical implementation of the conceptual models described in the Conceptual Model section, including source terms, radionuclide transport, exposure pathways and scenarios. The dose assessment modeling tools should also be described. The introductory discussion should include a summary of the general linkages between the

modeling tools, the flow of information, and how the tools are integrated to provide the overall model of system performance.

The primary modeling tools and any other tools used for supporting calculations including sensitivity and uncertainty analysis should be separately described in the subsections. The description for each tool should address the mathematical models, their limitations, and basis for selection of the modeling tool with supporting information presented in the appendices and/or supporting document(s). Document that the modeling tools selected for the analysis are sufficient for the use to implement the conceptual models.

For each modeling tool, documentation of the QA in accordance with procedures for computer code selection, use, modification and application should be presented in the CA or appendices. For the purpose of confidence building, also summarize available activities to build confidence in the results from the modeling tools (e.g., references to plume matching efforts, natural analogs, benchmarking studies, or model validation activities).

Objective

This section provides the description of the modeling tools used for the CA, including the basis for selection and QA.

Discussion

Each of the modeling tools used in the CA and linkages between the models (Figure 3-12) should be described. The basis for selection of each of the modeling tools should be presented, with supporting information presented in the appendices or supporting documentation. The use of the modeling tools should be justified in the context of the adequacy to consider the processes and features described in the conceptual models. In general, the complexity of the models selected should be commensurate with the available data. As applicable, models should be documented and verified in referenced publications or supporting documentation for the CA. The QA procedures for model selection, use, and application should be identified with citations for additional detail. If the modeling tools differ from those used for an earlier version of the CA, then some discussion of the basis for the change should be provided.

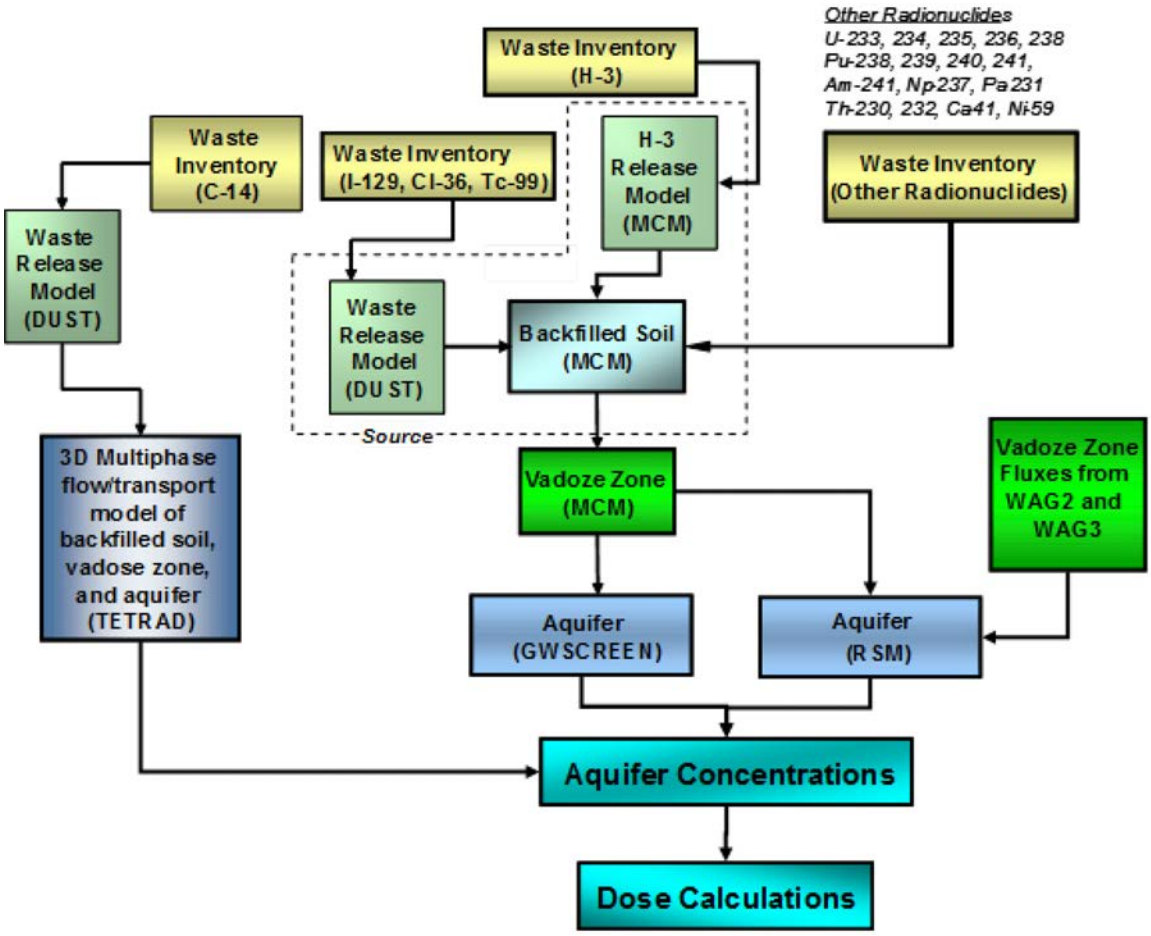


Figure 3-12. Example Illustration of the Models Selected for a CA and How They are Applied

Verification and validation in the form of confidence building to the extent practicable of the mathematical models for the transport of radionuclides in the atmospheric and hydrologic environments for the site specific application should be presented, including comparisons to existing data or related investigations, e.g., CERCLA groundwater modeling, environmental monitoring data, field, and laboratory experiments. Such validation can include comparisons with associated CA results, DOE Order 458.1 monitoring data and dose projections, other site-specific monitoring data. Such validation may require that intermediate modeling outputs, i.e., those prior to calculation of the projected annual dose, associated with the source release, fate and transport, and all-pathways dose modeling are saved for appropriate comparisons.

The benchmarking will emphasize a comparison of the models, but additional description should also be provided to discuss how each model represents behavior in the natural and engineered system.

3.2.5. Implementation of the Modeling

This section should provide the description of the implementation of the modeling efforts, including production of any intermediate results. Results that are passed between different tools and how those linkages are implemented (e.g., scripts, manually, integrating platform) should also be described in the CA or supporting documentation. Each subsection should include a description of methods of analysis, including a description and justification of any credit taken for engineered features, land use assumptions, or documented site CPs included in the modeling and references for QA documentation for models and simulations.

The individual subsections should describe key assumptions associated with the mathematical model(s), limitations of the models and a description of input data not presented with the conceptual model but used for the implementation of the mathematical models. Justification and verification of initial conditions, boundary conditions, and changes of properties with time derived from existing site data or information should be included. For probabilistic simulations, the basis for the selected modeling approach, implementation of parameter distributions, and the justification for the number of realizations considered for the probabilistic analysis should be included. The rationale for any additional sensitivity cases to describe alternative scenarios or representations should also be provided as applicable. The descriptions in the CA and supporting documentation should be sufficient for a reviewer to understand and assess the validity of the approach.

Include justification of the dimensionality of the model(s), the necessary geometry and mechanisms associated with radionuclide source release, radionuclide fate and transport, and dose modeling. In cases where abstractions are used to produce simplified representations of more detailed models (e.g., where a deterministic model is used as a basis for parameterization of a simplified representation to conduct many simulations for a probabilistic model or in cases where a differing levels of detail are used in a probabilistic framework), benchmarking documentation of the two modeling approaches should be provided to demonstrate that the simplified (abstracted) model adequately captures the behavior of the system for the purposes of the uncertainty analysis. Time steps for each simulation based on the ability to appropriately capture peak doses should be described and justified.

3.2.5.1 Source Term

This section should present the approach for each of the source terms in the CA, including the approach to address engineered aspects of the system to quantify the release rates from each source. These features may include covers, waste forms, containers, backfill, and engineered barriers (liners, vaults, tanks, etc.), as applicable. Approaches to represent any specific engineered features that were modeled in detail should be summarized with details provided in the CA or a citation to the detailed description. If release rates for specific sources were used from other modeling efforts with reference provided in “Other Related Analyses,” the specific

release rate used for the CA should be documented in this section. Assumptions and the rationale for the method to implement changes in chemistry and material properties over time should be described, including any use of alternative conceptual models or scenarios to address different potential evolution of the system. Method(s) for addressing non-linear mechanisms (e.g., unsaturated moisture characteristic for soils and engineered features or solubility assumptions) should be addressed.

3.2.5.2 Atmospheric, Biotic and Groundwater Pathways

This section should present the approach for implementation of the modeling for air, biotic and water transport pathways, if not previously screened, following release from all source terms considered in the CA. It should provide a comparison with other related modeling efforts at the site and discuss the basis for any significant differences in the approach. Consistency of the modeling with known plumes at the site should also be addressed as applicable.

This section should demonstrate model capability to analyze radionuclide transport in the environment consistent with the conceptual model, including model suitability to estimate the time history of contaminant transport (to maximum concentrations) for each radionuclide. Method(s) for addressing non-linear mechanisms included in contaminant transport (e.g., unsaturated moisture characteristic for soils) and parametric representations of natural processes in the mathematical models should be presented. A demonstration of the model(s) capability to provide the necessary output to support dose estimation at the POA for the all-pathways and air pathway performance measures should be included.

3.2.5.3 Exposure and Dose Analysis

This section should include a description and justification of the models and parameters used for each radionuclide for each pathway and scenario considered in the dose analysis (e.g., transfer factors between media, consumption rates of radioactively contaminated materials, inhalation rates of contaminated materials, and external exposure rates and conditions). DOE-approved dose coefficients and all transfer factors between media, consumption rates of radioactively contaminated materials, inhalation rates of contaminated materials, and external exposure rates and condition should be included for all radionuclides, including short-lived radionuclides not included with the parent.

The dose analysis should be capable of providing:

- Maximum projected dose at the POA and time of occurrence during first 1,000 years;
- Discussion of potential peaks that may occur beyond 1,000 years;
- Dominant source term(s) contributing to the dose;
- Dominant pathway contributing to dose; and

- Radionuclides responsible for dose.

Objective

This section provides the details regarding the implementation of the conceptual models in the modeling tools.

Discussion

This section should contain a description of the implementation of the conceptual models in the modeling tools, the methods used to simulate radionuclide transport and migration, and the input parameters used in the transport analyses. The CA should contain justification of the methods used to simulate transport of radioactivity, discuss the theoretical basis of the methods, and discuss the limitations of the methods. It is becoming common to use more detailed models to describe multi-dimensional processes and then those results are used to define a simplified flow field, for example, 3D velocity fields are converted to 1D path-lines from individual sources that can be used in a more simplified model (Figure 3-13). This approach allows more simplified models to be used for a formal uncertainty analysis and/or implement a probabilistic approach to demonstrate compliance. When a combination of detailed and less detailed models is used, benchmarking needs to be provided to demonstrate that the less detailed model is capable of sufficiently representing results obtained by the detailed model for the purpose of the assessment, for example:

- A 3D model is used to define flow and transport, then a 1D simplification is used for production runs; and
- Fluxes and concentrations from the two models are compared (see Figure 3-14).

Expectations for content and justification of approaches are similar to the expectations identified in the PA guidance, recognizing the graded approach.

Because the CA typically considers many more sources than the PA, the CA fate and transport simulation may be simplified relative to that of the PA to expedite calculations, so long as the simplification is adequately justified and representative. Some differences between the PA and CA fate and transport simulation may be appropriate due to differences between locations of the PA POA and the CA POA.

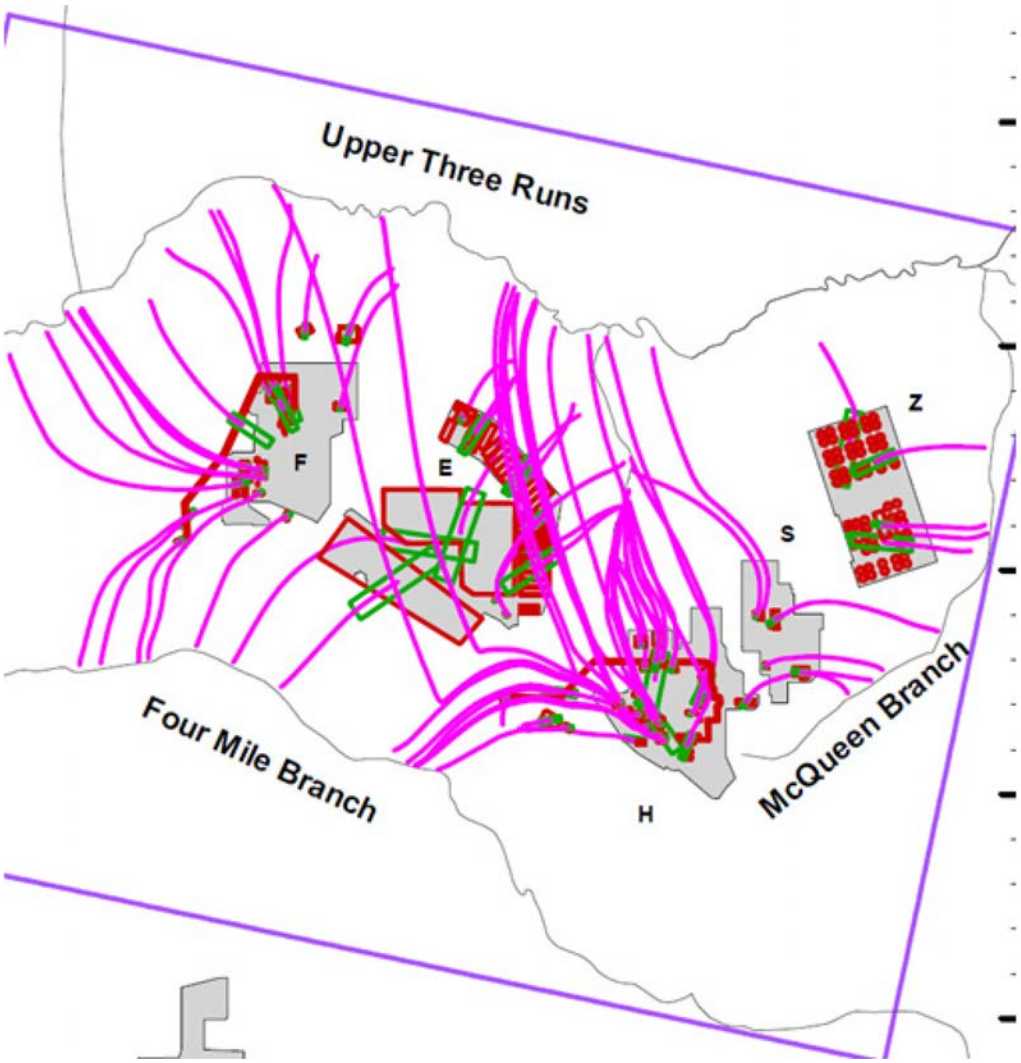


Figure 3-13. Example Showing 1D Path-Lines Derived from a 3D Flow Model Representing Transport from Individual Sources to Discharge Points in Different Streams

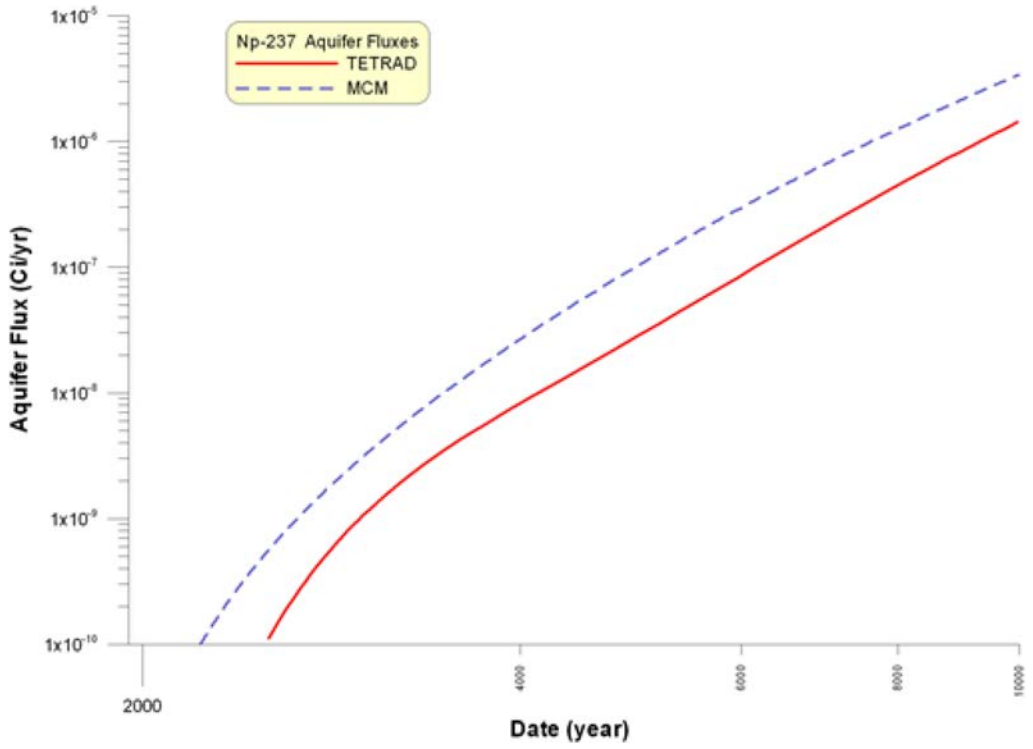


Figure 3-14. Example Results Comparing Fluxes Obtained from a 3D Model with Fluxes Predicted Using an Abstraction to an 1D Equivalent Model and Illustrating Pessimistic Bias of the Simplified Model

3.2.6. Results of Analysis

This section should provide, as applicable, intermediate results from the various models in the analysis for key contributors to the all pathways dose (i.e., those prior to calculation of the projected annual dose associated with release rates or media concentrations) and results directly needed to support a comparison of the projected peak dose at the POA during the compliance period with the performance measures. Detailed descriptions of calculations and results should be provided in the text or citations provided for detailed descriptions in an appendix or separate reference.

A combination of tabular and graphical information should be provided as applicable for each subsection to provide a sufficient basis to evaluate the adequacy of the modeling approaches, identify trends, support integration and interpretation of results, and support the assessment of compliance with the performance criteria. Any insights that can be provided regarding source terms, assumptions and processes with the greatest influence on the results should be included. A presentation of maximum doses during the compliance period at the POA should be provided for deterministic simulations. For probabilistic approaches used for compliance, graphics and tabular information for the mean and median concentrations/flux/doses as a function of time should be provided. Provide results on the tails of the distribution for information (e.g., range

between 5 and 95 percentiles). The results of sensitivity cases and any alternative scenarios that were considered should also be provided here or cross referenced to the sensitivity and uncertainty analysis section.

The results should address the full compliance period (1,000 years after facility closure). For results that are expected to peak after the compliance period, the potential peaks should be addressed to identify the source terms leading to those peaks, consider the potential for catastrophic impacts later in time and the robustness of the models, and to identify assumptions that may influence the timing of the peaks, especially assumptions that could result in peaks shifting into the compliance period.

3.2.6.1 Source Term

This section should describe the results of modeling for the source terms considered in the CA and identify information that is passed to the transport models. For key contributors, the impacts of assumptions related to any remedial actions and engineered features should be addressed. Presentation of the source term analysis results, including tabular and graphical presentations of key input parameters and output for source term calculations should be included, as applicable, with additional details included in appendices or supporting documents. Results for all radionuclides and sources for which source term release calculations were conducted should be addressed (e.g., cases with specific assumptions about waste forms, barriers, etc.) A time history of the release of radionuclides from the source terms to the environment should be included for sources with non-trivial releases. For sources considered with a more generic source model not incorporating any barriers or waste form considerations, results may be provided in "Radionuclide Screening Approach."

Identification of the most significant source terms (radionuclides and wastes) and explanation of how uncertainties are addressed (e.g., uncertainty analysis, conservatism) should be included to provide perspective to support the integration and interpretation of results. A demonstration that the results are consistent and defensible based on results from other relevant modeling efforts, site monitoring data and field investigations, or an explanation of any inconsistencies should be presented (e.g., credit taken for specific features not credited in another analysis).

3.2.6.2 Environmental Transport of Radionuclides

This section should provide results describing the migration of radionuclides through the natural environment with separate subsections for groundwater and air, if applicable. The results should include sufficient information to justify the selection of the POA that will be applied for the comparison with the performance measures (e.g., location of peaks). Source and radionuclide-specific time histories at the POA should be provided for all radionuclides with non-trivial contributions to serve as inputs for the exposure and dose calculations for the comparison with

performance criteria. Include appendices or reference supporting documents, as appropriate, for additional detailed listings of inputs and outputs of the analysis.

This section should include a discussion of significant radionuclide concentrations, dominant transport processes, and an explanation of how uncertainties are addressed (e.g., uncertainty analysis, conservatism) to provide perspective to support the integration and interpretation of results. A discussion of the consistency of results with other modeling and monitoring results and supporting field investigations should be provided. Descriptions of the basis for inconsistencies should also be provided.

3.2.6.3 Exposure and Dose

This section should provide time histories of results from the dose analysis for the source terms, radionuclides, exposure pathways and scenarios contributing to the total dose (source terms and radionuclides shown to be trivial contributors in Sections 4.1 and 4.2 are not included). A presentation of dose associated with each of the performance criteria in tabular form should be provided that identifies the source terms and radionuclides that are primary contributors to the peak dose as well as the dominant pathways and scenarios. A presentation of maximum doses during the compliance period for the projected inventory for the end state sources should be provided for deterministic simulations. For probabilistic simulations, the peak of the mean and median dose from the distribution of results should be provided to demonstrate compliance and the ranges of values provided for information. Potential peaks beyond the compliance period should also be described.

Objective

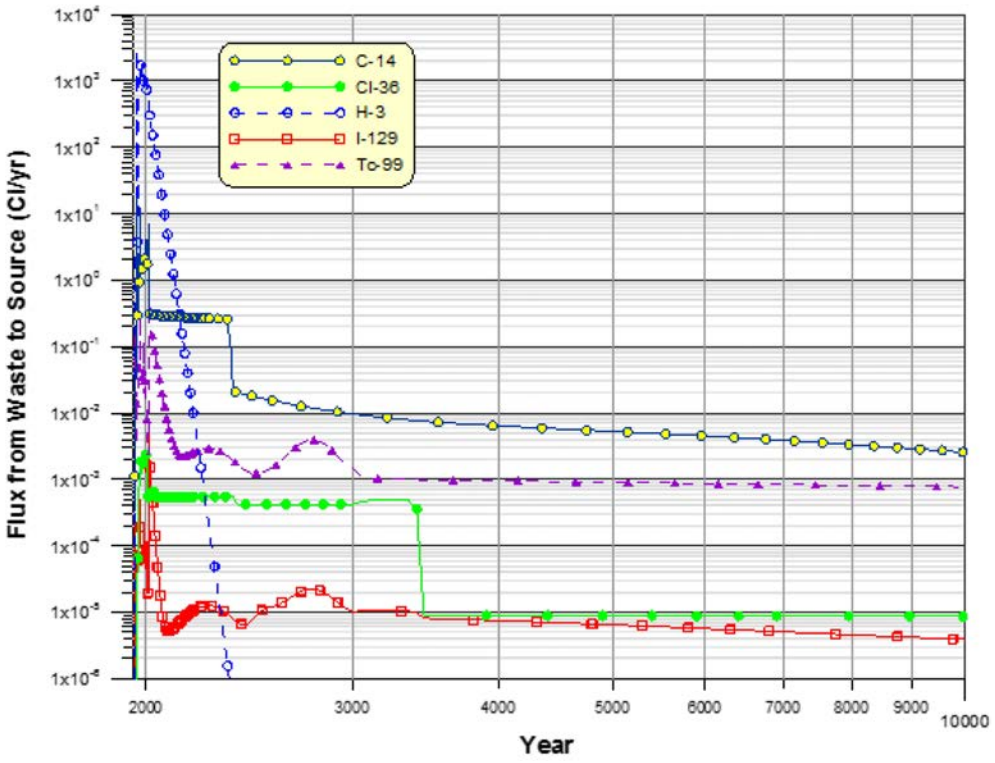
This section provides the results of the analysis, including intermediate results from the source term, radionuclide transport and exposure pathway calculations, for the scenarios and pathways identified in the conceptual modal for all radionuclides that were not screened.

Discussion

This section includes the results of the CA modeling described in the “Implementation of Modeling.” The peak results during the compliance period for all sources and radionuclides that were not screened are provided for completeness, but most of the tables, graphics and text will focus on those source terms and radionuclides making the primary contributions to the determination of compliance or with significant peaks after the compliance period. Intermediate results from the various models in the analysis are provided to gain insights into the relative importance of the different components of the CA in terms of determining the peak dose. For peaks occurring at increasingly long times after the compliance period, alternative indicators may be used rather than a calculation of dose. This is consistent with the decreasing relevance of dose as an indicator of health effects in the far future. The information in this section should be

used to support the choices made for the sensitivity and uncertainty analysis and will also provide the comparison of results with the performance objectives that will be used as the basis demonstrating compliance.

Source Term. Tabular and graphical presentations of the key input parameters and output from the calculations for the source term are presented, as applicable, with references to the appendices or other documentation for additional detailed listings of inputs and outputs of the analysis. In some cases, the source term will simply be the results from another analysis. For key contributors, the flux values as a function of time or other inputs should be presented. Examples of information to be presented can include: figures or tables with fluxes and concentrations as a function of time (Figure 3-15), figures illustrating failure times/rates for different barriers or containers, evolution of the physical or chemical properties as a function of time, and/or figures illustrating velocity vectors as a function of time. Explanations of the results should be included to identify the most significant source terms and key assumptions and provide an understanding of the linkage of these results with the other CA results presented in this and other sections. The discussion should demonstrate that the results are consistent with available site monitoring data, supporting field investigations that have been completed to the extent possible, and are defensible representations of performance.



The Secondary Peaks for I-129 and TC-99 Highlight the Influence of Multiple Release Types in the Source Term.

Figure 3-15. Example Figure Illustrating Projected Flux from the Source to the Vadose Zone Soil for a Source

Radionuclide Transport. Tabular and graphical presentations of the summary of the results for the various transport calculations in water and air are presented with references to the appendices or other documentation for additional detailed listings of inputs and outputs of the analysis. Explanations of the results should be included to provide an understanding of the linkage of these results with the other CA results. The discussion also includes demonstrations that the results are consistent with available site monitoring data and supporting field investigations, as applicable. The discussion needs to demonstrate the results are defensible representations of performance in the context of the conclusions of the analysis and provide insights into key assumptions.

The presentation of results for all radionuclides that were not screened includes separate results for the hydrologic and atmospheric transport of radionuclides, radon releases, and biotic pathways, as applicable. The results include a time history of the concentrations (or flux for radon) of radionuclides in the environment in air, water and/or soil, as applicable, at the POA that are used for the exposure and dose calculations.

Exposure and Dose Analysis. Tabular and graphical presentations of the summary of the results for the various exposure pathways and sources considered in the analysis should be provided, with references to the appendices for detailed explanations and calculations. The contributions from the PA facility/facilities need to be specifically provided (Figure 3-16). The results are presented in tabular form the dose or other criteria associated with each of the performance criteria and should identify the radionuclides and source terms that are primary contributors to the peak dose or other criteria and which pathways, radionuclides and source terms resulted in the peak dose. These details will focus the reviewer on the aspects that are most important. Potential peaks beyond the compliance period are addressed on a case-by-case basis with a primary focus on peaks occurring shortly after the compliance period or peaks for which different assumptions regarding travel time could potentially shift a peak into the compliance period. Additional considerations for peaks beyond 1,000 years were described in the PA guidance in “Compliance Period.”

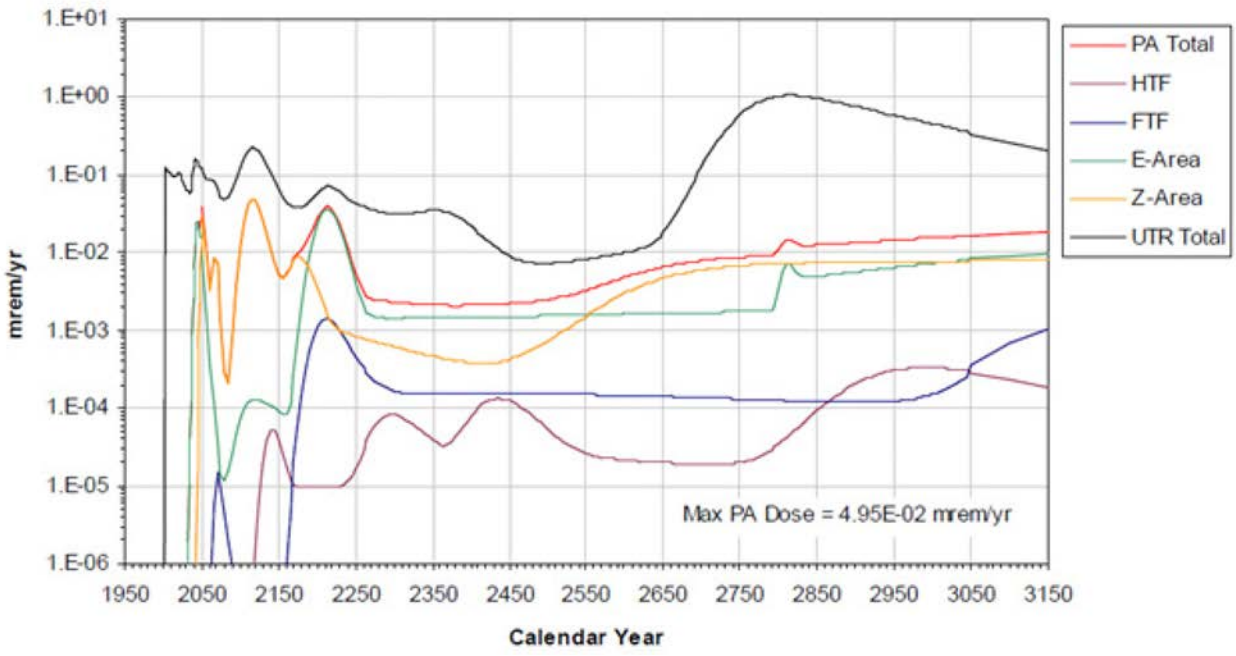


Figure 3-16. Example Showing the Results from Multiple PA Facilities Considered in a CA

Example:

It is beneficial to provide detailed summary tables or graphs that include peaks or dose versus time plots for all of the radionuclides that were not screened in the Screening Approaches section. The source terms, exposure scenario(s) or pathway(s) and radionuclides that contribute the largest dose for each of the performance criteria are identified either in figures or tables (Figure 3-17 and Figure 3-18)

*(**Note**: UTR, FMB, UTR, SC, and SR refers to different streams that are considered points of assessment).*

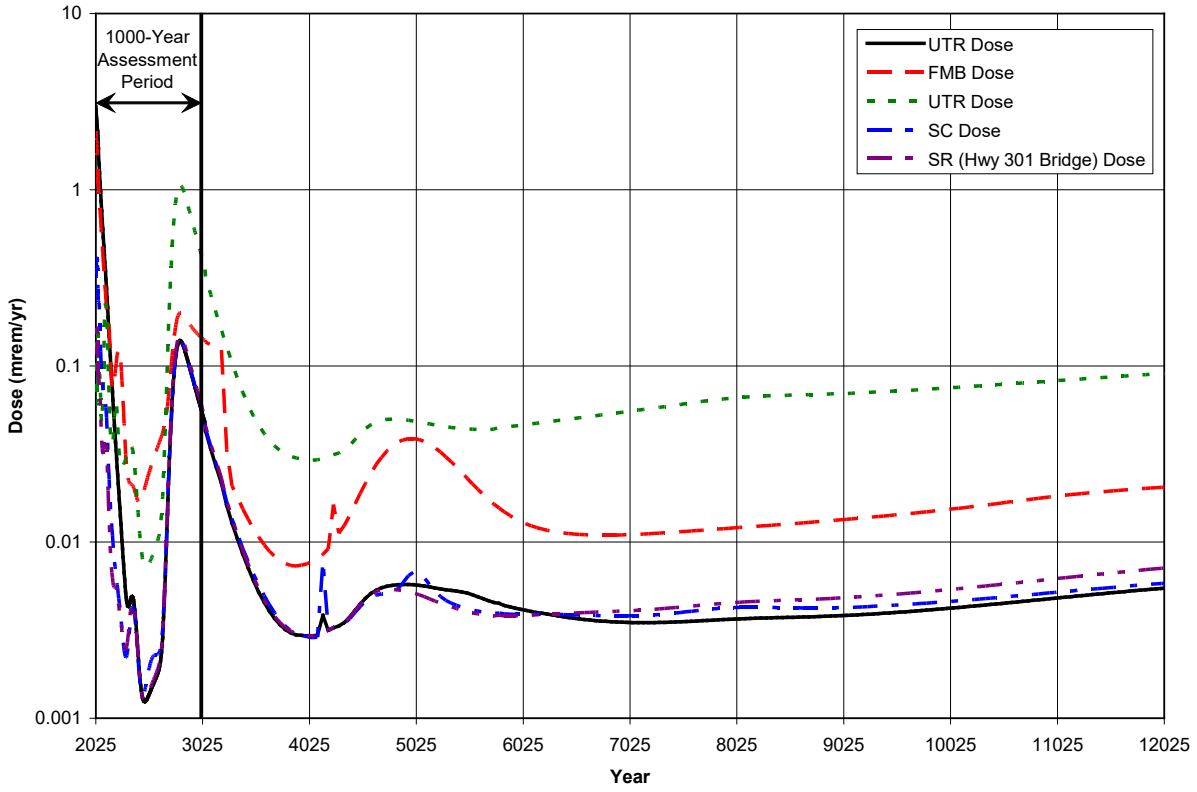


Figure 3-17. Example Figure Illustrating Projected Doses at Different Receptor Locations Considered in a CA

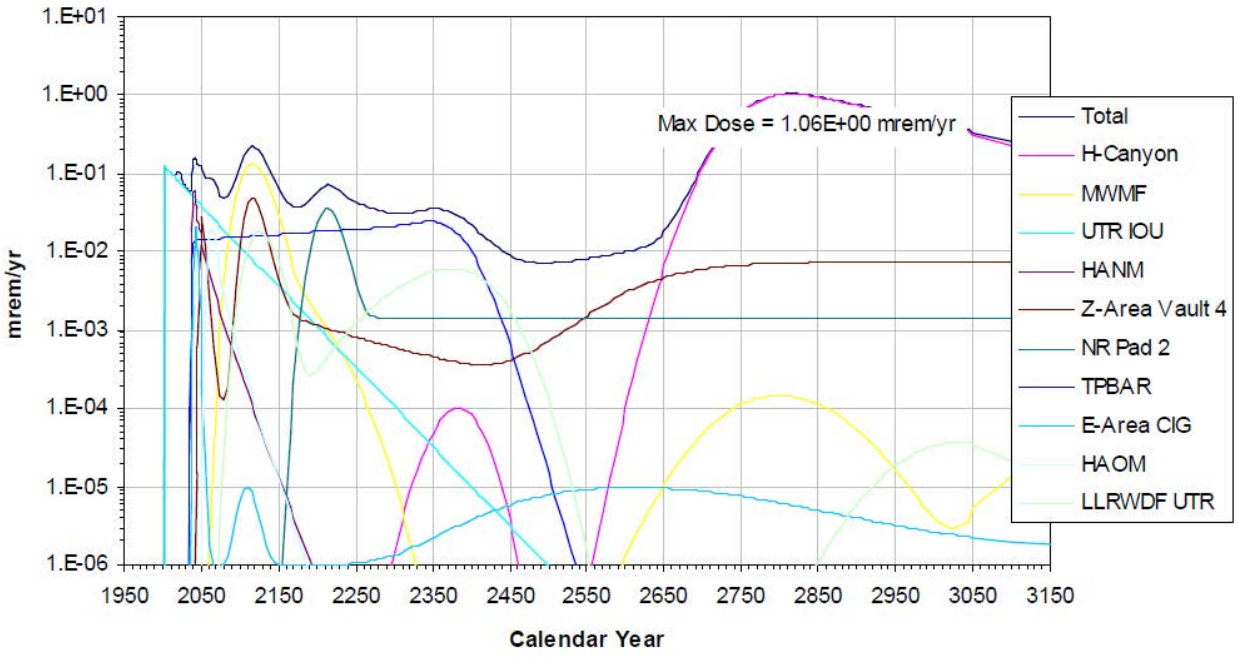


Figure 3-18. Example Source Term-Specific Doses to Identify Key Contributors to Dose

3.2.7. Sensitivity and Uncertainty Analysis

This chapter should provide a description of the methods used for the sensitivity and uncertainty analyses. If a probabilistic approach was used for the compliance calculations, then much of the information for the uncertainty analysis will be addressed in that discussion and methods/assumptions do not need to be repeated here. The parameters and assumptions most important in the determination of compliance with CA performance criteria and identification of sources with the greatest contribution to dose should be identified. This section should identify confirmatory activities for the PA MP and monitoring needs to be included in the PA/CA monitoring plan (MonP) based on the results.

Sensitivity and uncertainty analysis results should be used as a basis to demonstrate an understanding of the contributions of different sources and general migration in the environment, especially the assumptions and parameters that have the greatest influence on the results and conclusions. Thus, the results are a key consideration to support development of the section on Integration and Interpretation of Results. This section should also describe any linkages between the sensitivity and uncertainty analysis and formal decision tools that are applied to support prioritization of disposal or remediation activities and to support integration of stakeholder input to support decision making.

3.2.7.1 Sensitivity Analysis

This section should include a discussion of the methods used for the sensitivity analysis and should identify the parameters, assumptions and strategic considerations (e.g., land use, remedial end states) that when changed have the potential to influence the conclusions of the analysis. This section should provide the results in graphical and tabular form to identify the radionuclides, pathways, model parameters and/or conceptual model alternatives that could significantly influence the conclusions of the CA.

A discussion of the methods used to identify parameters and assumptions most sensitive to change and their influence on the conclusions should be provided, including any modeling tools used, the basis for their selection, limitation for the approaches and QA information.

3.2.7.2 Uncertainty Analysis

This section should provide a description of the method used for uncertainty analysis, including both model uncertainty and data uncertainty. This section should include a discussion of whether the uncertainties are epistemic (due to a lack of knowledge) or aleatory (subject to chance). Input distributions should be described in tabular form, if not addressed in earlier sections of the CA. As applicable, methods for defining and implementing distributions for input variables, sampling, analytical approach for uncertainty analysis and basis for determination of number of realizations run to yield reliable statistics should be included. This section should provide results of uncertainty analysis in tabular and graphical form as applicable to illustrate variability of inputs and uncertainties on dose.

A comparison should be made between the deterministic compliance case model and probabilistic model(s), as applicable, including perspective between the deterministic inputs and the input data distributions utilized in the probabilistic uncertainty modeling. This section should identify assumptions and parameter values associated with realizations yielding doses at the extremes of the outputs and the potential for those combinations. If a probabilistic approach was used for the compliance case, this section should address any additional calculations conducted to enhance the uncertainty analysis and any different assumptions, modeling tools, and approaches that may have been used for the supplemental calculations.

Objective

This section provides a description of the sensitivity and uncertainty analyses implemented in the PA and the conclusions regarding assumptions and parameters with the greatest impact on the results.

Discussion

To facilitate interpretation of the results of the CA, a limited sensitivity or uncertainty analysis should be carried out. The analysis should generally be limited to consideration of the inventories and other assumptions associated (Figure 3-19) with sources other than the LLW disposal facility, general regional groundwater flow assumptions and to land use controls, rather than an assessment of all parameters, assumptions, etc. (Figure 3-20). The sensitivity or uncertainty analysis should consider the impacts of reasonable alternative uses of land outside those areas assumed to be permanently controlled by DOE for radiation protection of the public. Some uses, such as large-scale irrigation, could influence the groundwater flow and consequently the performance of the disposal facility. Such uses could thus affect the calculated impacts from all sources of radiation exposure resulting from DOE activities that may contribute to the future dose from the LLW facility that may be received by a hypothetical future member of the public. Land use restrictions or other mitigative measures may be required. This analysis should be coordinated with the site's waste management, environmental restoration, facility decommissioning, and land-use planning organizations.

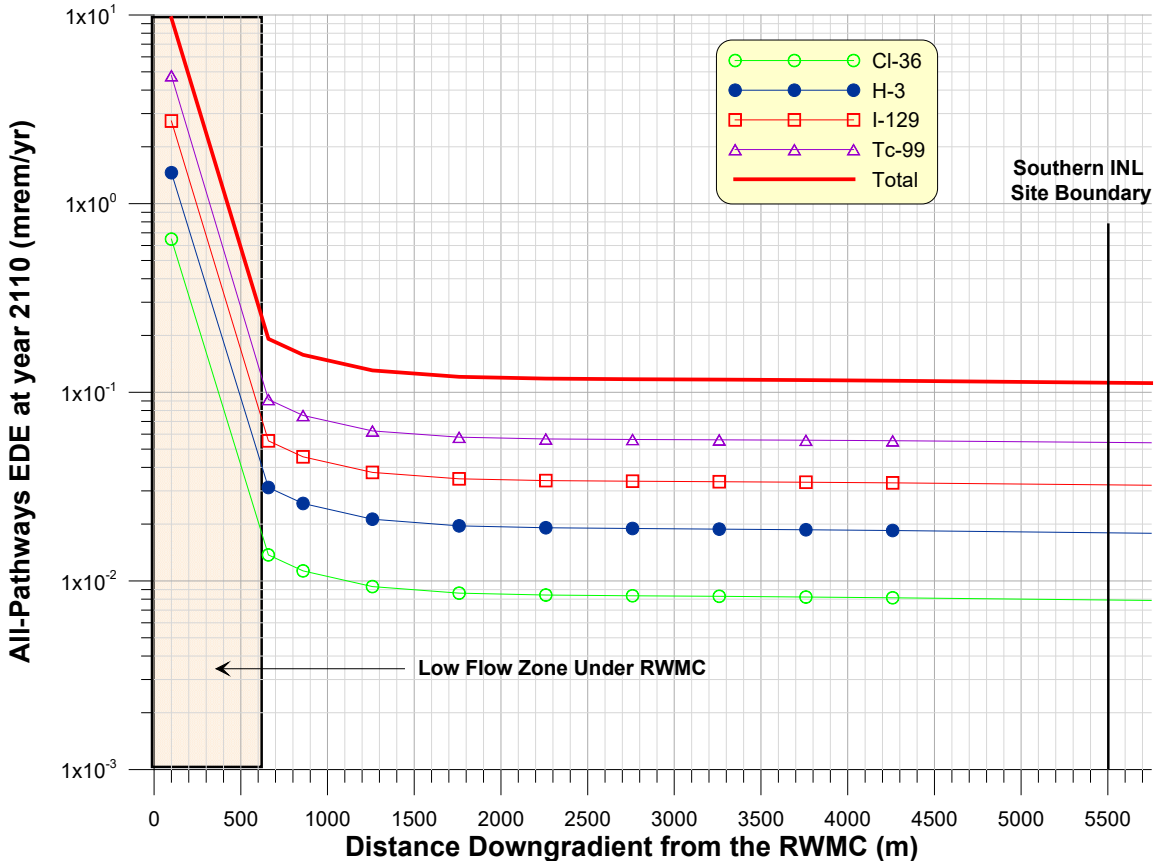


Figure 3-19. Example Illustrating the Range of Potential Results for Different Percentiles using a Probabilistic Approach

The analysis should also include a consideration of the uncertainty in the estimate of source term (inventory and release rate) for the sources considered in the CA. For those sources which are, or can reasonably be expected to be, the subject of remedial action under CERCLA, but for which a ROD has not been rendered, varying remedial actions could be hypothesized for each source. Then, the effect of the remedial action (reduction of infiltration by capping, removal of some of the radioactive material, treatment of radioactive material left in place to reduce its mobility, etc.) would be included in the calculation of the dose resulting from the source. Alternatively, a pessimistic, bounding assumption could be made to assess the maximum potential impact of the source. Although remediation decisions for the other sources may be influenced by this CA, final decisions will be made through the CERCLA process, consistent with DOE requirements, including the CA. Generally, source term information obtained from approved remediation decision documents is not considered uncertain in the context of the CA. However, it is possible to assess the level of pessimism built into a risk assessment for a remediation decision if the source is a significant dose contributor to the CA.

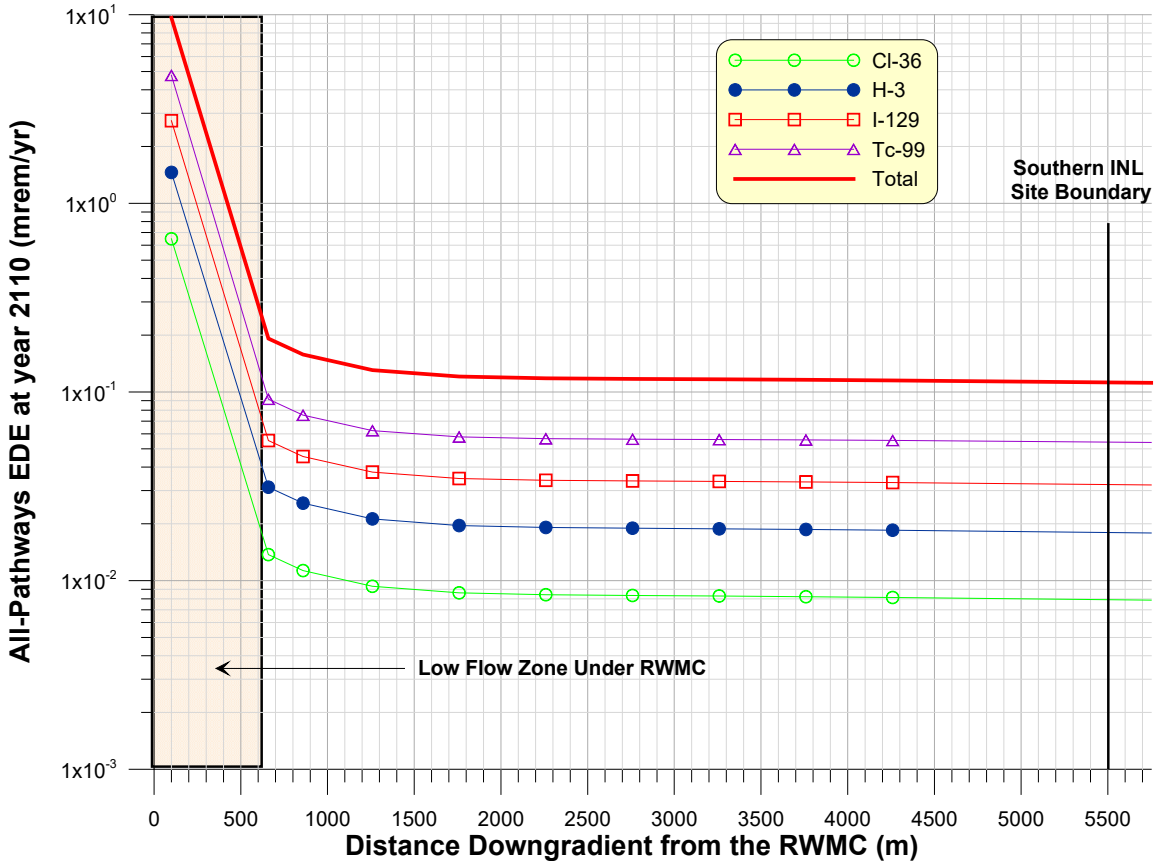


Figure 3-20. Example Considering Different Locations of the Site Boundary

The primary purpose of the sensitivity and uncertainty analysis is to support the determination that the results of the CA lead to a conclusion that there is a reasonable expectation of meeting the performance objectives. As with the PA, the sensitivity/uncertainty analysis should include consideration of the peaks that may occur beyond the compliance period, in an increasingly qualitative manner, regardless of the time at which the maximum occurs. These calculations may increase the understanding of the models used, but are not used for determining compliance with the dose limit and constraint. Caution should be used in interpreting results calculated to many thousands of years due to compounding of rounding and truncation errors.

More specific information about the conduct of sensitivity and uncertainty analyses is provided in the PA guidance with the understanding that the extent of analysis expected for PA is more detailed than the expectations for a CA.

3.2.8. Integration and Interpretation of Results

The objective of this section is to integrate the information, calculations, and results of the CA in order to demonstrate a sufficient understanding of the sources and the natural system to build confidence in the conclusions regarding meeting the performance measures. An evaluation of the sensitivity and uncertainty analyses results identifying the assumptions and parameters that have the greatest influence on the decision to be made should be included. Assumptions expected to add conservatism to the results (e.g., processes not credited) and key assumptions that need to be considered as part of CA maintenance should be identified and discussed.

This section should identify and explain key sources and critical assumptions associated with the ability to meet the performance measures based on sensitivity and uncertainty analysis results. The section should provide a rational basis to conclude:

- Factors influencing behavior of the system are sufficiently understood;
- Assumptions with the potential to change conclusions have been identified and are sufficiently addressed;
- The source terms and end states have been sufficiently addressed for the use of the results;
- The analysis is logically interpreted; and
- The results sufficiently capture system performance for their intended use.

This section should provide a consolidated summary of the relationship of the CA modeling to the associated PA modeling. It should address the consistency, as appropriate, between the CA and PA in relation to conceptual models, transport pathways, exposure scenarios, radionuclides modeled, radionuclide inventory, source release modeling fate and transport modeling, dose modeling, and sensitivity and uncertainty analysis.

Consistent with the view of a CA as a planning tool, insights related to potential decisions for remediation or closure activities in the context of cumulative impacts are also provided in this section, as applicable.

Objective

This section provides the demonstration of an understanding of the disposal system sufficient to confirm compliance with the performance objectives.

Discussion

This section should provide an interpretation of results. The intent is to provide a demonstration of the relative contributions of different sources and the features that have the greatest influence on the ability to meet the performance objectives. The different results presented in the PA should be reviewed and consolidated to provide a reasoned basis for evaluating the performance of the disposal facility. The table summarizing the results used in the Executive Summary is often included in this section. The interpretation of results should address the findings of the sensitivity and uncertainty analyses to provide describe defense-in-depth considerations and an overall summation of the expected performance of the disposal facility that is defensible for each of the performance criteria. The interpretation of results should provide a rational basis to conclude the performance measure and CA expectations have been completely addressed, the analysis is logically interpreted, the results are correct representations of performance, and the results are sufficiently rigorous. Considerations related to land use or expected cleanup of other sources should also be identified.

3.2.9. Performance Evaluation

This section should present a comparison of the CA results with the performance measures and describe the implication of the CA results for operations of disposal facilities, tank closure assumptions, land-use planning or decisions for remedial actions.

This section should highlight key assumptions used in the CA that are important to the results of the analysis whether within the CA or as an appendix. It should explain the assumptions relevant to the controlling pathways or scenarios analyzed.

The implications of uncertainty, potential for reduction of uncertainty, and the actions needed to manage the uncertainty should be identified. Areas where conservative-bias is used to manage uncertainty should be identified (e.g., processes or barriers not considered). Additionally, this section should identify specific uncertainties and data gaps that need to be addressed through added site characterization, monitoring, or research and development so that these efforts can be planned and implemented as part of the CA maintenance process. Details are provided in the Future Work section.

3.2.9.1 Options Analysis, if Needed

An options analysis should be prepared if the dose calculated in the CA exceeds 30 mrem in a year. The analysis is to consider actions that could be taken to reduce the calculated dose and to consider the cost of those actions. The options analysis should describe those options considered for control or mitigation of the doses, identify which control alternative(s) has been selected for implementation, and provide the basis and justification for selection of the alternative(s).

The analysis should compare alternatives on the basis of the extent of dose reduction and a qualitative judgment as to the cost of implementation and be prepared using the ALARA process, considering alternatives which are technically feasible and demonstrated to be effective in reducing doses to the public at the points of assessment over the compliance period considered.

Alternatives that could be implemented to reduce the dose for analyses that exceed the administrative dose limit of 30 mrem/yr (0.3 mSv/yr) but are less than the primary public dose limit of 100 mrem/yr (1 mSv/yr) should be identified and discussed. A cost-benefit analysis based on the cost of dose-reduction should be conducted, consistent with requirements for DOE O 458.1 and the preferred action should be identified and justified in the options analysis.

3.2.9.2 Future Work

This section should describe specific ongoing and additional investigations (e.g., source term refinement, performance monitoring, compliance monitoring, and laboratory experiments) required to address uncertainties in the CA and to provide additional assurance the performance measures will be met. It should present information describing future work and the basis for the need for the work, so as to allow incorporation into the CA MP. Items that are required to address specific review issues should be clearly identified. A schedule(s) for implementation of required investigations and any CA revisions that may be necessary as a result of these investigations should be included.

Objective

This section provides the final comparison of the results with the performance objectives and is the ultimate demonstration of compliance. If an options analysis is needed, it is also documented in this section. The use of the results and any future work to address outstanding issues are also described.

Discussion

This section represents the formal demonstration of compliance with the performance measures and also serves as a reference point for information necessary for development of documentation associated with the DAS and a summary of key assumptions and other information that need to

be protected in other documentation (institutional controls, land use, site boundary, facility closure assumptions). Future work to address any outstanding issues is also identified to be transferred to the MP.

The purpose of an options analysis is to consider those actions that could be taken to reduce the calculated dose, if it exceeds 30 mrem per year, and their costs. It is essentially an optimization process in the context of radiation protection. An options analysis focuses on those sources making the most significant contribution to dose. An example format for an options analysis is provided as an Attachment 3-1 to this guide. Consistent with international and national recommendations, the DOE's radiation protection system encompasses two principal elements: dose limits and optimization. Dose limits constitute allowable or tolerable doses that are not to be exceeded under normal conditions. The 100 mrem in a year dose is the primary dose limit for protection of the public from all sources and pathways. Optimization is effectively the reduction of public doses to levels as far below dose limits or constraints as is practicable giving due consideration to collective impacts, costs, and other factors, using the ALARA process.

The CA process incorporates the elements of the radiation protection system as benchmarks to aid environmental management. The CA uses long-term projections of potential doses to support systematic environmental management of waste management and restoration sites. In considering the implications of the CA results, there are two decision criteria, based on whether the results exceed the primary dose limit in DOE Order 458.1.

The first decision criterion is: "Is the total dose or peak of the mean or median dose projected for the CA expected to be greater than 100 mrem in a year?" If the answer to this decision criterion is "yes", then it is an indicator of a potential future problem that should be corrected or mitigated before it occurs. In this case, an options analysis would be conducted to identify alternatives for reducing future doses (before they occur) to tolerable levels. If the answer to the first decision criterion is "no", then the CA results are reviewed to determine if there is potential for exceeding the DOE administrative performance measure of 30 mrem in a year.

The second decision criterion is: "Does total dose or peak of the mean or median dose from the CA exceed 30 mrem in a year?". If the answer is "yes", then the options analysis is conducted and potential alternatives are considered to determine what actions are reasonable to reduce potential future public doses.

In identifying the options, only alternatives that could significantly reduce the dose should be considered in detail. For example, if there are five different sources interacting in the area covered by the CA and two of the sources represent 90 percent of the dose, control alternatives should be considered for the significant sources only. If the LLW facility is not a major contributor to the projected dose to the hypothetical receptor, then the LLW facility design and WAC would likely be based on the DOE O 435.1 PA and would likely not be influenced by the CA.

The options for control or mitigation of the doses should then be assessed and compared and control alternatives selected. Alternatives should be compared on the basis of the extent of dose reduction and a qualitative judgment as to the cost of implementation. An approach similar to the ALARA process for DOE Order 458.1 can be applied. The options analysis will serve to justify and support the determination of reasonable action (or no action). In the case where the 100-mrem annual dose limit is potentially exceeded, "no action" is not an acceptable alternative. A mitigating or corrective action will be taken before the projected dose becomes an actual dose. Consideration may also be given to use of additional monitoring, data collection, or modeling to develop more realistic dose estimates.

Potential mitigating actions that should be considered include refining the analysis to reduce conservatism, improving the design of the LLW disposal facility, limiting the receipt of waste to be disposed in the LLW disposal facility, or requiring waste form performance for waste to be disposed in the LLW disposal facility, and remediating the other sources (such as in-situ stabilization or capping, partial or full removal of the radioactive material, etc.). Optimizing the long-term land use boundary should also be considered. In an extreme case, termination of disposal in the LLW disposal facility may be considered to ensure meeting the primary dose limit; however, the costs and benefits of such an action should be considered along with other site-wide alternatives.

The options analysis should identify the preferred action and justify the choice. The justification should be based on the cost/benefit analysis conducted, the level of uncertainty inherent in the CA, the number of CERCLA actions still to be completed on the site, and other factors. A description of the implementation of the preferred option should be included. The implementation plan can address inclusion of the CA results in future CERCLA actions, into the Environmental Radiological Protection Plan, or into the future land use planning efforts at the site. The preferred option and the implementation plan for that option will be considered by the LFRG review of the CA.

3.2.10. Quality Assurance

A summary of the QA requirements and site procedures implemented during the preparation and documentation of this analysis should be included. QA requirements associated with inventories, input data, software, models, output data, records, documentation, and data management should be documented in this section. This section should document (by appendices or references) the basis for:

- Ensuring radionuclide inventories, model input data and distributions are traceable, qualified, controlled, and archived;

- Ensuring software used was evaluated for functionality regarding the problem being solved, was verified prior to use, is under configuration control, is managed under a software problem reporting system, and is archived;
- Ensure development and use of models is documented, verified, under configuration control, and archived in accordance with DOE O 414.1, *Quality Assurance,* and DOE G 414.1-4, *Safety Software Guide for Use with 10 CFR 830, Subpart A, Quality Assurance Requirements, and DOE O 414.1C, Quality Assurance*; and
- Document activities for confidence building (e.g., model evaluation) to the extent practicable and appropriate

An archive should be established, as appropriate, and include inventory, input data, software, models, output data, the CA, and associated records, documents, and references.

Objective

This section documents the QA program used for development and documentation of the CA.

Discussion

QA procedures and record keeping provisions associated with the CA program are described. The emphasis of this section is documentation of the QA program and how it was implemented. References to the procedures will be provided.

Compliance Demonstration

Compliance with the requirement in DOE O 435.1 to develop a facility-specific CA can be demonstrated by a site developing a CA that is in compliance with the performance measure in DOE M 435.1-1, has been reviewed by the LFRG, and approved by DOE management. The LFRG review will consider the review criteria and consistency with the guidance in this chapter or approved modifications. Key assumptions driving the CA (e.g., land use plans, facility/remediation end state assumptions) should be tracked via the maintenance plan in Chapter 7. In addition, key assumptions should be maintained in accordance with monitoring (Chapter 5), and facility/remediation changes (Chapter 8).

Copies of this information should be included in the applicable facility Radioactive Waste Management Basis (RWMB).

3.2.11. Preparers

A list of the preparers of the PA, including a brief overview of their qualifications and experience should be included.

3.2.12. References

This section should include a complete list of citations for materials referenced in the CA.

3.2.13. Appendices

Include appendices to the PA as necessary to provide technical details supporting the data and analyses presented in the PA.

3.3. Attachments

Attachment 3-1. Example Options Analysis Outline

3.4. References

10 CFR Part 20, Section 1101(d), *Radiation Protection Plans*

10 CFR Part 40, (Appendix A, Criterion 6), *Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material from Ores Processed Primarily for Their Source Material Content*

10 CFR Part 830, Nuclear Safety Management, Subpart A, Qual*ity Assurance Requirements*

10 CFR Part 835, *Occupational Radiation Protection*

40 CFR Part 190.10(a), *Standards for Normal Operations*

DOE Order 414.1D, *Quality Assurance*, April 25, 2011

DOE Order 435.1, Chg 1, *Radioactive Waste Management*, July 09, 1999

DOE Order 458.1, *Radiation Protection of the Public and Environment*, February 11, 2011

DOE Order 5820.2A, *Radioactive Waste Management* (canceled by DOE Order 435.1)

DOE Guide 414.1-4, *Safety Software Guide for Use with 10 CFR 830, Subpart A, Quality Assurance Requirements, and DOE O 414.1C, Quality Assurance*, June 17, 2005

DOE Guide 435.1-1, 1 Admin Chg 2, *Implementation Guide for Use with DOE M 435.1-1*, July 09, 1999

DOE Manual 435.1-1, Admin Chg 2, *Radioactive Waste Management Manual*, July 09, 1999

DOE-STD-1196-2011, *Derived Concentration Technical Standard*, U.S. Department of Energy Technical Standard, Washington DC, April 2011

ICRP Publication 101, *Assessing dose of the representative person for the purpose of radiation protection of the public and optimization of radiation protection: Broadening the process*, International Commission on Radiological Protection, 2006

ICRP Publication 103, *The 2007 Recommendations of the International Commission on Radiological Protection*, (ICRP 2007)

NRC. *Acceptance Guidelines and Consensus Standards for Use in Risk-Informed Regulation*, SECY-97-221, Nuclear Regulatory Commission, September 30, 1997.

NRC. *An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis,* Regulatory Guide 1.174*,* Nuclear Regulatory Commission, Revision 1, November 2002

NRC. *NRC Staff Guidance for Activities Related to U.S. Department of Energy Waste Determination*, NUREG-1854, U.S. Nuclear Regulatory Commission, August 2007

Recommendation 94-2, *Conformance with Safety Standards at DOE Low-Level Nuclear Waste and Disposal Sites,* Defense Nuclear Facilities Safety Board, December 1999

3.5. Composite Analysis Review Criteria

The Table 3-3 may be used to evaluate whether the document contents are complete and thorough and the document is technically adequate and defensible. Review criteria may be changed according to the scope and facility being reviewed. However, the LFRG Co-Chairs must approve the review criteria being used in the LFRG Review Plan for a specific facility.

Note: Numbers in parentheses refer to the section number in the chapter.

Table 3-3. Composite Analysis Review Criteria

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
CA-1	The CA adequately describes the reason the CA is required and describes the significance of major changes and/or differences and the relationship with any previous CA or other existing CA at the same site. (3.2.2, 3.2.2.1, 3.2.2.3)		
CA-2	The CA provides sufficient background information regarding the PA facility/facilities for which the CA is being performed to provide necessary context to support an understanding of the CA scope. (3.2.2.1, 3.2.2.2, 3.2.2.3)		
CA-3	The CA results are evaluated in the context of the DOE O 458.1 100 mrem/yr (1 mSv/yr), total effective dose, primary public dose limit and the 30 mrem/yr (0.3 mSv/yr), total effective dose, administrative dose limit. (3.2.2.2)		
CA-4	The CA point(s) of assessment is the publicly accessible location of maximum dose reasonably expected to a hypothetical, future member of the public over the assessment period, resulting from radionuclide source release and migration from the PA facility/facilities and interaction with radionuclide source release and migration from all other significant end state radionuclide sources. Point(s) of assessment selection is justified and supported by land use plans or reasonably conservative and justified land use assumptions, the DOE site characteristics, the CA transport pathway(s), and the CA conceptual model. Assumptions associated with point(s) of assessment selection are clearly identified and justified. Any changes in the point(s) of assessment location(s) as a function of		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
	time are justified and supported by land use plans, other pertinent documents, or necessarily conservative assumptions. (3.2.2.2.2, 3.2.2.4)		
CA-5	The CA assessment period is a 1,000-year period after the assumed DOE site end-state date. The assumed DOE site end state date is justified and supported by pertinent site documentation. (3.2.2.2.2, 3.2.2.4)		
CA-6	The CA provides sufficient background information regarding the DOE site overall operations, history, and future to provide necessary context to support an understanding of the CA scope, basis for CA preparation, and the CA in general, in regards to potential interacting end state radionuclide sources. (3.2.3.2)		
CA-7	The CA provides sufficient background information regarding the DOE site characteristics to provide necessary context to support an understanding of the CA scope, in regards to point(s) of assessment selection, transport pathway(s) considered, the potential for interaction with other end state radionuclide sources, and the CA Conceptual Model. (3.2.3.3, 3.2.3.4)		
CA-8	The CA identifies other assessments and modeling activities that overlap and/or could help inform the CA effort. Results from existing approved analyses are used or significant differences in assumptions and results are explained. (3.2.2.3, 3.2.3.5, 3.2.4.1, 3.2.4.2)		
CA-9	The CA provides a listing of projected end state radionuclide sources, including the PA facility/facilities, to be modeled within the CA. A description of the included sources is provided that includes the projected end		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
	state condition and configuration, including relevant features that could influence radionuclide source release and migration. All assumptions associated with selecting sources for inclusion and the projected end state radionuclide source condition and configuration are clearly identified and justified. (3.2.3.4, 3.2.3.5, 3.2.4.1, 3.2.4.2.1)		
CA-10	End state radionuclide inventories and other input data are traceable to their source and listed within the CA and/or a referenced document. The inventory estimates and other input data are reasonable and justified based on the existing DOE site information and data, PA facility/facilities information and data, and other significant end state radionuclide source information and data. Assumptions associated with the inventory estimates and other input data are clearly identified, justified, and have a defensible technical basis. (3.2.3.4, 3.2.3.5, 3.2.4.2.1)		
CA-11	The CA provides an adequate justification for the selection of radionuclides to be modeled within the CA, and as appropriate includes all of the radionuclides included within the PA(s). If radionuclide screening was conducted, radionuclides screened out from the CA modeling are identified and an adequate justification for their exclusion is provided. All assumptions associated with the inclusion and screening of CA radionuclides are clearly identified and justified. (3.2.3.4, 3.2.3.4.1, 3.2.3.5)		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
CA-12	The body of evidence in the CA provides a sufficient understanding of the behavior of the disposal system and the radionuclides, pathways and features of the engineered and natural system that have the greatest influence on the determination of compliance. (3.2.3.4, 3.2.3.5, 3.2.4.2.1)		
CA-13	The CA provides a complete discussion of all important transport pathways and exposure scenarios and provides justification for the transport pathway(s) and exposure scenario(s) to be modeled within the CA as part of a graded approach. If transport pathway and exposure scenario screening is conducted, transport pathways and exposure scenarios screened out from the CA modeling are identified and an adequate justification for their exclusion is provided. All assumptions associated with the CA transport pathway(s) and exposure scenario(s) selection and screening are clearly identified and justified. (3.2.4.1, 3.2.4.2, 3.2.4.3)		
CA-14	The CA conceptual model appropriately represents and includes the major mechanisms affecting the radionuclide source release, radionuclide fate and transport, and potential all-pathways dose to the public at the point(s) of assessment from both the PA facility/facilities under consideration and the other interacting end state radionuclide sources at the DOE site. The CA conceptual model(s) is consistent with and justified by the overall DOE site conceptual model(s) and the associated PA conceptual model(s), as appropriate. The CA conceptual model is a reasonable representation based on the existing knowledge of the site, PA facilities, and other interacting end state radionuclide sources. Assumptions associated with the CA conceptual model are clearly identified and justified.		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
	(3.2.2.3, 3.2.4)		
CA-15	*The radionuclide source release, radionuclide fate and transport, and all-pathways dose simulations are consistent with the CA conceptual model and are a reasonable representation based on the existing knowledge of the site, PA facilities, other interacting end state radionuclide sources, point(s) of assessment locations, and exposure scenario(s). The simulation methods used are justified and consistent, as appropriate, with the methods used in the associated PA(s).* *The simulation dimensionality and time integration are technically appropriate and justified. Analytical and/or numerical models used to conduct the modeling are appropriate and are documented and verified either in referenced publications or in the CA itself. The radionuclide source release, radionuclide fate and transport, and all-pathways dose modeling are appropriately integrated with one another. All assumptions associated with the simulations are clearly identified and justified. The radionuclide fate and transport simulation addresses all necessary transport pathway(s). The all-pathways dose simulation addresses all necessary exposure scenario(s).* (3.2.4, 3.2.5)		
CA-16	The CA presents the maximum projected annual dose from all sources at the point(s) of assessment over the 1,000-year assessment period and provides a comparison to the 100 mrem/yr (1 mSv/yr) primary public dose limit and the 30 mrem/yr (0.3 mSv/yr) administrative dose limit. The CA appropriately describes and presents the CA outputs in a manner to identify the radionuclide(s), pathway(s) and source term(s) that are key contributors and facilitates the interpretation of result and inputs for the "Performance Evaluation."		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
	The CA base case modeling results are appropriate, reasonable, justified, and consistent with the available DOE site, PA facility/facilities, and other interacting end state radionuclide source information and data. (3.2.3, 3.2.6)		
CA-17	There is sufficient documentation and verification of the appropriateness of the analytical and numerical models used to provide reasonable confidence in the model results. The complexity of the mathematical models selected for the determination of compliance is commensurate with available site data and sufficient for the intended use of the CA. (3.2.4.4)		
CA-18	A sensitivity and uncertainty analysis has been conducted which addresses: (1) the importance, in terms of impact to the projected annual dose, of the various input parameters and model assumptions; and (2) the degree of uncertainty inherent in the analysis. The sensitivity and uncertainty modeling is consistent with the CA conceptual model, the CA base case model and the sensitivity and uncertainty methodology used within the associated PA(s), as appropriate. Analytical and/or numerical models used to c*onduct sensitivity and uncertainty modeling are appropriate, documented and verified either in referenced publications or in the CA itself. The sensitivity and uncertainty modeling is a reasonable representation based on the existing knowledge of the site, PA facilities, and other significant end state radionuclide sources. All assumptions associated with the radionuclide release, fate and transport simulation, and dose calculation are clearly identified and justified.* (3.2.2.3, 3.2.4.4, 3.2.7)		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
CA-19	The importance, in terms of impact to the projected annual dose, of the various input parameters and model assumptions and the degree of uncertainty inherent in the analysis is presented and summarized. The sensitivity and uncertainty analyses are a reasonable representation based on the existing knowledge of the site, PA facilities, and other significant end state radionuclide sources. Assumptions associated with the sensitivity and uncertainty analysis are identified and justified. (3.2.7, 3.2.8)		
CA-20	The CA modeling is consistent, as appropriate, with the associated PA modeling. (3.2.2.3, 3.2.3.1, 3.2.6, 3.2.8)		
CA-21	The CA provides DOE a management tool for evaluating proposed actions and determining appropriate actions to take relative to future radiological protection of the public. The body of evidence in the analysis and results of the CA are consistent with comparable results of the PA and provide a defensible and complete basis for an acceptable decision regarding compliance by DOE. *The CA presents the maximum base case projected annual dose from all CA modeled sources at the point(s) of assessment over the 1,000-year assessment period and provides a comparison to the 100 mrem/yr (1 mSv/yr) primary public dose limit and the 30 mrem/yr (0.3 mSv/yr) administrative dose limit. The CA base case modeling results are appropriate, reasonable, justified, and consistent with the available DOE site, PA facility/facilities, and other interacting end state radionuclide source information and data. The sensitivity and uncertainty analysis results are used to provide context relative to the dose limits. The CA results and conclusions are appropriate and reasonable and*		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
	incorporate any constraints resulting from other DOE programs or from any Federal, state, and local statutes or regulations or agreements that would influence the calculated results. The CA modeling and results discussion provides a sufficient amount of documentation to conclude that the site-specific analysis is complete and thorough; reasonable and logical; and technically correct and defensible; and that the conclusions are valid and acceptable. (3.2.8, 3.2.9)		
CA-22	When necessary, the options analysis, using the ALARA process, considers alternatives which are technically feasible and demonstrated to be effective in reducing doses to the public at the point(s) of assessment over the assessment period. The ALARA process uses a cost-benefit analysis based on the cost of dose-reduction in accordance with DOE Order 458.1. Implementation of the conclusions from the options analysis, if required, can be reasonably accomplished at the disposal facility or the other interacting end state radionuclide sources. *For analyses that exceed the administrative dose limit of 30 mrem/yr (0.3 mSv/yr) but are less than the primary public dose limit of 100 mrem/yr (1 mSv/yr), an options analysis is provided which identifies alternatives that could be conducted to reduce the dose to less than the administratively limited dose constraint. For analyses that exceed the primary public dose limit of 100 mrem/yr (1 mSv/yr), an options analysis using the ALARA process should be provided, which identifies alternatives that should be conducted to reduce the dose to less than the primary public dose limit.* (3.2.9.1)		
CA-23	The CA identifies future work, which if conducted, would address data gaps, reduce		

ID	Review Criteria	Criteria Met (Yes/No Comment)	Comments
	uncertainty, reduce the use of conservative parameters and assumptions, provide greater technical justification for assumption and parameters, and improve modeling. (3.2.9.2)		
CA-24	Throughout the CA assumptions made are identified, justified, and have a defensible technical basis. The key CA assumptions are consolidated and listed within a section of the CA or as an appendix to the CA. As appropriate the CA assumptions are consistent with those within the associated PA(s). The key assumptions are identified and protected by the change control program specified in Chapter 8 of the Standard. (3.2.2.5, 3.2.8)		
CA-25	Appropriate QA associated with the CA has been implemented associated with data, software, models, and records (EM-QA-001). (3.2.4.4, 3.2.10)		

Attachment 3.1. Example Options Analysis Outline

Summary and Conclusions

Identify the active or planned LLW disposal facility for which the options analysis is being prepared. Summarize the results of the options analysis.

State the conclusions of the options analysis. If the options analysis indicates the need for action, state the preferred action to be taken, with estimated cost and schedule, with any constraints.

Introduction

Identify the active or planned LLW disposal facility under consideration. Summarize the results of the CA.

Potential Mitigating Actions

Discuss each source that may cause the primary dose limit or the dose constraint to be exceeded. For each source, discuss the features of the source that are most likely to cause the exceedance (the magnitude of the inventory, the proximity to the LLW disposal facility, the proximity to the assumed future point(s) of public access, the uncertainty in the source, etc.).

For each source, present potential (or planned) actions that could be taken to reduce the source's impact. Actions to be considered include refining the analysis and/or obtaining data to reduce conservatism, improving the design of the LLW disposal facility, limiting the receipt of waste to be disposed in the LLW disposal facility or requiring waste form performance for waste to be disposed in the LLW disposal facility, and remediating the other sources (such as in situ stabilization or capping, partial or full removal of the radioactive material, etc.). Optimizing the long-term land use boundary should also be considered. In an extreme case, termination of disposal in the LLW disposal facility may be considered to ensure meeting the primary dose limit.

For each action, present the estimated impact of the action on the dose caused by the source and the impact on the total dose to the hypothetical future member of the public. Also, because a cost-benefit analysis may be a necessary part of the process for selecting a reasonable mitigative action, present an estimate of the cost of each action. Include the basis for the cost estimate and an assessment of the degree of uncertainty in the cost estimate. Also, present an estimate of the timing by which each action could be implemented and the potential constraints. Although remediation decisions for the various sources may be influenced by the CA process, final decisions will be made through the CERCLA process, giving due consideration to DOE requirements, including the results of the CA.

Preferred Action

Identify the action and provide justification for the selection. The justification should be based on the cost/benefit analysis conducted, the level of uncertainty inherent in the CA, the number of CERCLA actions still to be completed on the site, and other factors.

Plan for Implementing the Preferred Action

A description of the implementation of the preferred option, including schedule, should be included. The implementation plan should address inclusion of the CA results in future CERCLA actions, into the Environmental Radiological Protection Plan expected to be required by 10 CFR Part 834, and/or into the future land use planning efforts at the site, as appropriate.

CHAPTER 4. CLOSURE PLAN GUIDE

4.1. Introduction

Goal

The goal of this guidance is to support the U.S. Department of Energy's (DOE's) initiatives to improve and maintain the highest quality radioactive waste management standards and activities throughout the DOE complex.

The primary audience of this guide is the Federal Project Director and other DOE/contractor employees involved in the disposal of low-level waste (LLW) and tank closure.

Objective

The objective of this guide is to provide the objectives, additional rationale, examples, and measures of performance for a closure plan (CP) which is prepared to define the approach to be taken for ensuring the long-term protection of the public and the environment from disposed radioactive waste.

Guides do not impose requirements but may quote requirements if the sources are adequately cited. This guidance follows the format of an objective statement, discussion, examples, a statement of one way to measure compliance, and supplemental references. Following this guidance provides a consistent approach for compliance with the requirements of DOE Order (O) 435.1, *Radioactive Waste Management*. If the Guide has not been followed, then an explanation/justification as to why a different approach is acceptable should be provided.

The Low-Level Waste Disposal Facility Federal Review Group (LFRG), functioning as the DOE regulatory authority, is the independent organization responsible for performing oversight of LLW disposal and tank closure in accordance with DOE O 435.1 [DOE Manual (M) 435.1-1, *Radioactive Waste Management Manual,* Chapter I, 2.E(1)(a)]. Therefore, the LFRG members utilize this Standard as guidance in performing oversight functions and judging compliance with the requirements of DOE O 435.1 (See LFRG Execution Plan for details of LFRG roles, responsibilities and processes).

4.2. Annotated Outline for Closure Plans

4.2.1. Executive Summary

Define the approach to be taken for ensuring the long-term protection of the public and the environment from disposed radioactive waste at the end of disposal facility operations. The CP should identify and maintain key performance assessment (PA) assumptions including the projected or final closure inventory and configuration, and summarize the measures to be taken

to ensure long-term stability of the facility (maintenance, institutional controls), including the process to be followed for conducting corrective actions that may be required.

Objective

The objective of this guide is to provide a summary of the CP contents reflecting which phase of facility closure is being discussed.

Discussion

Summary information should include the closure approach, relationship to PA key assumptions, planned closure actions including schedule, compliance with performance objectives/measures as well as other statues and regulations [e.g., Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)] and what institutional controls have been or will be invoked.

4.2.2. Introduction

Describe the CP's purpose and scope, and clarify its relationship to the other technical basis documents [e.g., PA, CA, monitoring plan (MonP)], any related programs (long-term stewardship), waste management activities] [e.g., CERCLA, Resource Conservation and Recovery Act (RCRA)] or relevant plans (lands use plans, groundwater protection plans) at the site.

4.2.3. Summary Facility Description

This section should describe the following elements:

- Description and characteristics of the facility to be closed;
- Design features;
- Waste characteristics;
- Technical approach to closure;
- Compliance with performance objectives; and
- Interim & final detailed closure activities.

4.2.4. Summary Closure Approach

Because the CP is updated periodically during the operational phase of the facility life to reflect new information/data, or changes in planned design configuration or operations, all sources of information should be referenced and dated, including:

- Final closure inventory;
- Existing and planned modifications (e.g., facility design, closure concept, waste form);
- Measures taken to ensure long-term stability of the facility (maintenance, institutional controls); and
- Required corrective actions.

The proposed and discovered changes in the facility or Disposal Authorization Statement (DAS) technical basis documents are evaluated in accordance with the change control process described in Chapter 8.

4.2.5. Summary of Key Assumptions

Identify key closure assumptions from the PA and CA that need to be protected/maintained. Similarly, key assumptions within the other technical basis documents relevant to the CP should be discussed.

Objective

The objective of this guide is to provide summary level information of the facility description, closure approach and key assumptions.

Discussion

Summary level information provides individuals with the "big picture" of what the site is trying to accomplish during the closure phase of the facility. Understanding the closure plan "big picture", allows individuals to better relate to the details.

A preliminary CP is prepared during the planning and design phase of the disposal facility, providing the basis for PA-related performance assumptions and analyses. The plan is updated periodically during the operational phase of the facility life to reflect new information/data, or changes in planned design configuration or operations, such as modifications to planned waste forms. The proposed and discovered changes in the facility or DAS technical basis documents are evaluated in accordance with the change control process described in Chapter 8 of the Standard. The timing of updates is site-specific, but typically the CP is updated after the DAS is issued to incorporate relevant limits or conditions in the DAS and subsequently whenever there are sufficient inconsistencies with DAS technical basis documentation or the radioactive waste management basis (RWMB).

The final CP, which is prepared at the end of operations prior to conducting final closure activities, should reflect the final closure inventory and configuration, and summarize the measures to be taken to ensure long-term stability of the facility (maintenance, institutional

controls). This should include the process to be followed for conducting corrective actions that may be required. Because the CP is updated, all sources of information should be referenced and dated.

PA key closure assumptions are the basis for development of the CP as well as operation procedures that ensure the PA assumptions are maintained. Key assumption examples are listed below.

Key assumption examples:

Interim cover includes a two-foot soil cover placed over the vaults as they are filled to reduce the potential for airborne radioactive emissions.

Final cover will:

- *Limit the net infiltration rate to no more than 0.1cm/year for a period of at least 500 years after closure;*
- *Provide a physical barrier against intrusion;*
- *Include armoring on the sides to prevent wind and rain erosion;*
- *Configure to divert surface water away from the vaults and extend beyond the boundary of the facility;*
- *Provide the surface barrier so that the top of the waste is at least 4.6 m below the top of the surface barrier; and*
- *Retain moisture and encourage evapotranspiration, maintaining the average recharge through the surface barrier to less than 0.5mm/yr for 500 years under reasonably expected natural conditions.*

4.2.6. **Disposal Facility Summary**

4.2.6.1 Summary of Site Characteristics

Specify the location of the DOE site and the disposal facility on a regional map outlining the site boundaries, as well as projected site boundaries of DOE-controlled land. Provide a more detailed disposal site map with the boundaries of the existing or proposed disposal site clearly highlighted. Provide a general description of the disposal site and surrounding area. Identify and discuss any disposal site characteristics, natural features, or nearby land uses important to closure activities or potentially significant relative to the long-term performance (i.e., degradation, nearby dams, seismic faults, etc.) of the disposal facility. Discuss any foreseeable

natural processes and/or phenomena that are potentially significant to closure considerations. Present sufficiently detailed information to support the facility closure design and reference the PA for additional detail.

4.2.6.2 Summary of Facility Characteristics

Provide information on engineered facility features, including the type (e.g., landfill, vault, and tumulus), size, number of disposal units or cells, and general design and construction features. Update this section of the plan as operations/interim closures proceed and final configuration is provided in the final CP. Provide descriptions of how the design features perform the following functions:

- Manage the infiltration of water through disposal units - including features designed to direct onsite precipitation away from the disposal units, as well as those that direct the flow of offsite surface and groundwater away from the disposal facility or disposal units;
- Ensure integrity of disposal unit covers and limit the need for on-going maintenance - including erosion and long-term degradation protection of disposal unit covers;
- Provide for the structural stability of backfill, waste, and covers - including anticipated void volumes within and between waste containers that contribute to the subsidence potential and anticipated degradation of fill, waste forms, engineered features, and waste cover materials; and
- Preclude or delay inadvertent intrusion – assumed duration of effectiveness and degradation rates.

4.2.6.3 Summary of Waste Characteristics

Identify and summarize waste characteristics pertinent to closure (e.g., physical and chemical characteristics including potential relevant chemical interactions, waste forms or containers, volume, total and isotopic inventory, physical stability/void volume within waste and between containers, and subsidence potential).

Objective

The objective of this guide is to describe the site and facility characteristic to be used in the development of the CP as well as a description of the types, forms and inventories of waste to be disposed at the facility.

Discussion

The site characteristics should be described, in general, to provide an overall understanding of the type of location of the disposal site within the overall site boundaries and its relationship with other surrounding facilities. An overview of the natural characteristics of the DOE site and local

environment at the disposal facility that are considered as part of the closure design should be provided. The information should be presented in sufficient detail to understand the basis for closure assumptions. The description should include, for example, brief discussions of the following (citations for sections of the PA can be provided for more details):

1. Site conditions – Summarize general conditions like topography, flora and fauna, etc. that will influence design features to address, e.g., erosion, biotic intrusion, long-term evolution of the vegetation on the cover.
2. Climate and meteorology – Summarize assumptions for precipitation, natural evapotranspiration, extreme events (e.g., tornados, storms, wind), etc. that are considered for the cover and closure design.
3. Geology – Summarize the native soils and geology, including applicable information related to the history and frequency of regional natural process that are reasonably foreseeable (e.g., volcanic activity, earthquakes).
4. Hydrology – Summary surface water features in the vicinity of the facility (e.g., potential for surface water erosion or flooding, dams), and closure assumptions to address potential concerns.

Example of site characteristics discussion.

> *The environmental restoration disposal facility (ERDF) is a landfill authorized under DOE Order 435.1 and CERCLA for disposal of waste generated from remediation of waste sites within the Hanford Site. ERDF site is located in an area of the Hanford Site Central Plateau between the 200 West Area and the 200 East Area. The ERDF is constructed in a modular fashion so that added disposal space can be built on toward the east as needed (Figure 4-1). The first eight disposal cells were built in pairs located at the west end of ERDF. Each cell covers about 8 acres, 152 meters square at the bottom and 152 - by - 69 meters side slope. The current plan is to construct and add adjacent modules to the east as necessary. From a geologic point of view, the site falls within the Pasco Basin, which is part of the Yakima Fold Belt Subprovince of the Columbia basin. For further details, see HS-1234.*

Figure 4-1. Aerial View of ERDF with Cells Used for Disposal

The facility characteristics that contribute to the long-term isolation of the disposed waste should be discussed. These features serve to: 1) minimize the infiltration of water through disposal units; 2) ensure integrity of disposal unit covers; 3) provide for the structural stability of backfill, waste and covers; and 4) provide a barrier against intrusion. Subsections should include:

1. Water infiltration – describe how the infiltration of water into the waste zone below the cover is minimized by planting native vegetation on the cover, sloping the cover and providing an adequate cover thickness.
2. Erosion protection – describe how water and wind erosion of the surface cover material can impact the integrity of a surface cover and what is being done to minimize this impact.
3. Subsidence protection – describe the mitigation plan that reduces subsidence such as debris is mixed with soil and compacted to fill voids; drums will be crushed and compressed; drums that cannot be crushed will be filled with concrete.
4. Structural stability – describe how the design of the cap stabilizes the closed facility such as waste material being placed to form a crown and covered with a nominal thick layer of clean soil to provide a stable base for overlying final cover. Defining the final grade (e.g., 5 percent) for the cover ensures a minimum slope is maintained.
5. Bio-intrusion barrier – describe the likelihood and mitigation actions of plant roots penetration or burrowing animals intruding into the waste. Examples include the soil covers being composed of an admixture of silt and gravels that enhance the resistance to burrowing animals and long term wind erosion.

Waste characteristics include the maximum volume and activity level of waste that has been disposed as well as projected to be disposed. This section should include subsections describing:

1. Waste generation – include descriptions of waste from remediation activities or facility operations.
2. Waste types – include the types of LLW acceptable for disposal at the facility such as: soils, rubble (concrete, steel, wood, etc.) and metals (e.g., reactor parts).
3. Current and forecasted waste inventory – these two inventories are used to compare the status of the facility as it relates to the PA inventory. Normally a reference to other documents that contain this information is acceptable.
4. Waste forms – describe the physical form of the waste such as activated metal, untreated (bulk soil) and treated (solidified).
5. Waste compaction – if applicable, describes the method used to reduce void space and future long-term maintenance of the facility.

4.2.7. Approach to Closure

Describe the activities that will be conducted during each closure phase, including the role those activities play in ensuring compliance with performance objectives, assumptions, or other associated design requirements. Review the PA conceptual model(s) and results, including the sensitivity/uncertainty analysis, to identify the mechanisms for controlling future dose for each pathway. Identify the specific controls and features needed to provide a reasonable expectation of meeting the all-pathways dose performance objective.

4.2.7.1 Detailed Closure Actions

Provide a detailed description of the activities that will be conducted during interim (if applicable) and final facility closure phases as described below, including the materials for the cover. Update the preliminary CP with detailed engineering plans and specifications before interim closure of the first unit or cell occurs. Similarly, compare these plans and specifications against closure assumptions in the PA or change control (Chapter 8) documentation [e.g., special analysis (SA)] and if necessary update the PA to ensure the interim closure activities are consistent with long-term performance requirements for the disposal facility. Sufficiently demonstrate that closure conditions will achieve stability of the disposal facility, reduce the need for active maintenance, and meet the requirements of DOE M 435.1-1.

4.2.7.2 Closure Schedule

This section provides the closure schedule with actual and planned dates, including key decisions and milestones resulting from the PA maintenance process. Interim closure of a facility, if

necessary, should occur within two years of the final placement of waste into the facility unless a different schedule is approved and documented in the DAS (see DOE M 435.1-1).

4.2.7.3 Operational/Interim Closure

Provide a detailed description of operational and/or interim closure activities for disposal units or cells. Describe site conditions (e.g., grading and drainage) following interim closure of each unit/cell, if multiple disposal units or cells are to undergo interim closure over the life of the facility. Provide a description of how the interim closure of each unit/cell is integrated and supports the final closure design. Compare this plan and specifications against PA assumptions and if necessary, use plan and specifications to update the PA to confirm that the final closure configuration will provide a reasonable expectation of meeting performance objectives.

4.2.7.4 Final Closure

Provide a detailed description of final closure activities. Document a final updated radionuclide inventory of waste disposed in the facility, and basis for maintaining the reasonable expectation that the requirements in DOE M 435.1-1, *Radioactive Waste Management Manual,* IV.P(1) "Performance Objectives" will be met for the final closure configuration. Update and present detailed plans and specifications for final closure activities in the CP before final closure occurs.

Objective

The objective of this guide is to describe the activities related to the phases of closure and ensuring the final waste inventories will be compliant with the performance objectives/measures of DOE M 435.1-1.

Discussion

A preliminary CP is prepared during the planning and design phase of the disposal facility, providing the basis for PA-related performance assumptions and analyses. The plan is updated periodically during the operational phase of the facility life to reflect new information/data, or changes in planned design configuration or operations, such as modifications to planned waste forms. The proposed and discovered changes in the facility or DAS technical basis documents are evaluated in accordance with the change control process described in Chapter 8 of this Standard. The timing of updates is site-specific, but typically the CP is updated after the DAS is issued to incorporate relevant limits or conditions in the DAS and subsequently whenever there are sufficient inconsistencies with DAS technical basis documentation or the RWMB.

This section should provide a detailed description of operational and/or interim closure activities for disposal units or cells. The specific information presented in this section will depend on the type of disposal facility. In most cases, interim closure is expected to involve installation of

temporary barriers to provide isolation of the disposed wastes until final closure. Types of information that would typically be presented include:

- Engineering drawings, including grading plans, cross sections, drainage plans;
- Material and placement specifications (e.g., permeability, lift height, compaction, moisture content);
- Disposal cell survey specifications;
- Construction quality control plan;
- Records management plan; and
- Construction schedule.

If multiple disposal units or cells are to undergo interim closure over the life of the facility, site conditions (e.g., grading and drainage) following interim closure of each unit/cell should be described. A description of how the interim closure of each unit/cell is integrated and supports the final closure design should be provided. Similarly, this plan and specifications should be compared against PA assumptions and if necessary, used to update the PA to confirm that the final closure configuration will provide a reasonable expectation of meeting performance objectives.

Examples of updates to the preliminary CP:

Example 1:

> *A disposal facility is designed to accept radon bearing waste at a certain level, but as the facility is operated, increased levels of radon bearing wastes are proposed for disposal at the facility. Revisions to the performance assessment and preliminary closure plan are made to reflect the change in operations. As a result of the new analysis in the PA, a design change is made to accept the radon bearing wastes that includes an increase in the thickness of the cover and a corresponding increase in the depth of excavation of the disposal unit to maintain the same disposal capacity. The changes to the facility design are also reflected in the preliminary closure plan.*

Example 2:

> *During operations, monitoring program data reveal that moisture in the vadose zone beneath a disposal unit is greater than expected from a disposal unit subject to interim closure. Analyses in the performance assessment and preliminary closure plan are modified to test the impact of additional cover materials. As a result, the preliminary closure plan is updated to add additional material layers*

to the cover of the interim closed disposal units. Subsequent monitoring data indicate a reduction in the moisture content beneath the disposal unit subject to interim closure. The preliminary closure plan is updated to reflect the change in the interim closure plan.

Example 3:

A preliminary closure plan is prepared for a new low-level waste disposal facility and incorporated into the analyses performed for the performance assessment. The review of the (PA) and composite analysis (CA) for the disposal facility requires enhancements of the facility monitoring included in the preliminary CP to ensure protection of the environment, because of findings presented in the CA. The preliminary CP is updated following the issuance of the DAS to reflect the findings of the review and the performance assessment is reviewed to evaluate the need for revision. Any revisions to the performance assessment are performed through the performance assessment maintenance program.

Example 4:

The preliminary closure plan is prepared for an existing disposal facility that provides for interim closure of the disposal facility awaiting the completion of the CERCLA process for final closure. The performance assessment is prepared using the preliminary closure plan as a conservative basis for final closure. The DAS requires the revision of the preliminary closure plan after the Record of Decision is signed from the CERCLA process. The preliminary CP is then revised and the performance assessment is revised to reflect the CERCLA record of decision (ROD) as part of the performance assessment maintenance program.

Example 5:

The preliminary closure plan includes maps locating monitoring wells to be used throughout operations, interim closure and final closure. The closure plan includes the details of well construction, sampling frequencies, sampling methods, monitoring parameters, and methods of analysis for each monitoring well. Also included are the data management methods, data analysis methods, data reporting and remedial action plan associated with the monitoring wells for the disposal facility.

The final CP, which is prepared at the end of operations prior to conducting final closure activities, should reflect the final closure inventory and configuration, and summarize the measures to be taken to ensure long-term stability of the facility (maintenance, physical, administrative, and institutional controls), including the process to be followed for conducting

corrective actions that may be required. Because the CP is updated, all sources of information should be referenced and dated. Final closure activities may include:

- Engineering drawings, including grading plans, cross sections, drainage plans;
- Material and placement specifications;
- Specifications and plans for decontamination and decommissioning (D&D) of ancillary facilities;
- Procedures for radiological decontamination of equipment for release;
- Final disposal facility survey specifications;
- Permanent facility marker specifications;
- Construction quality control plan;
- Records management plan;
- Construction schedule; and
- Final inventory.

Examples of a final CP:

Example 1:

> *The closure plan identifies the number of lifts of cover material to be placed over disposal units and the thickness and geotechnical specifications for each lift. The specifications for geotextiles between the various layers of the cover are identified, and any vegetative or rock cover at the ground surface is also included in the closure plan. The closure plan includes a discussion of the expected performance of the cover design and provides performance indicators for the cover design consistent with assumptions in the PA and CA. The closure plan also provides a discussion of the corrective actions to be taken if the performance indicators are exceeded.*

Example 2:

> *The closure plan provides a crosswalk summary of the elements of the closure of the facility and the performance objectives for the closure of the facility. The relationship between each feature included in the closure plan and the corresponding purpose of the feature with respect to the short-term and long-term performance of the facility is explained; how the various elements of the closure plan interface with minimizing the potential for the transport of contamination is provided.; and the closure plan includes the schedule for facility closure and all*

milestones for facility closure. Steps for completing the closure of the facility are included with the dates for completion. The closure plan lists, as part of the schedule, all permits and documents to be completed as part of the closure of the disposal facility. Milestones are established for the completion of all documents and permits. The schedule includes allowances for review and approval of all documents and permits.

4.2.8. Compliance

4.2.8.1 Compliance with Performance Objectives

Compare this plan and specifications against PA assumptions and results. If necessary, update the PA based on the current plan and specifications to confirm that the final closure configuration will provide a reasonable expectation of meeting performance objectives.

All Pathways Dose. Identify key pathways and assumptions for all pathways dose in the PA and describe the site closure activities and design features that contribute to meeting the performance objective.

Air Pathway Dose. Identify key pathways and assumptions for air pathways dose in the PA and describe the site closure activities and design features that are critical for meeting the performance objective.

Radon Release. Identify key pathways and assumptions for radon flux in the PA and describe the site closure activities and design features that contribute to meeting the performance objective.

Water Resources. Identify key pathways and assumptions for water resources pathways dose in the PA and describe the site closure activities and design features that contribute to meeting the performance objective.

Hypothetical Inadvertent Intruder. Describe the relationship between site closure activities and design features and assumptions for the post-closure hypothetical inadvertent intruder dose evaluated in the PA. Summarize, for each feature, how future maintenance activities are to be minimized and how long-term stability consistent with intruder analysis assumptions is ensured.

4.2.8.2 Compliance with Other Requirements

Describe any other requirements related to facility performance or design that affect the closure approach such as:

- Design standards and other requirements associated with RCRA hazardous waste regulations or CERCLA disposal regulations;

- DOE O 458.1, *Radiation Protection of the Public and the Environment*, requirements;
- CERCLA remedial action and RCRA corrective action; and
- Long-term stewardship.

Objective

The objective of this guide is to ensure the facility is in compliance with the performance objectives/measures of DOE M 435.1-1.

Discussion

The final closure configuration of the disposal facility is important in ensuring that the performance objectives/measure will be met throughout the compliance period. The PA makes assumptions of the final closure configuration that may or may not align with actual closure. This section compares the PA results and assumptions to the actual closure configuration in context of ensuring there is a reasonable expectation of meeting the performance objectives/measures. The result of this comparison may require an update to the PA.

Table 4-1 is an example showing compliance with DOE M 435.1-1and that the PA should be revised to the final closure configuration.

Table 4-1. Compliance of the Performance Assessment with DOE M 435.1-1

Performance Objective/Measure	PA Results	Closure Results
All pathway dose – 25 mrem/yr	1.88 mrem/yr	15 mrem/yr
Air pathway dose – 10 mrem/yr	1.02 mrem/yr	1.02 mrem/yr
Radon - <20 pCi/m2/s	0.11 pCi/m2/s	0.11 pCi/m2/s
Protection of water resources	No release in 1K yrs.; maximum dose for Tc-99 =1.88 mrem/yr	No release in 1K yrs.; maximum dose for Tc-99 = 15 mrem/yr
Inadvertent intruder chronic dose – 100 mrem/yr	9.27 mrem/yr	30 mrem/yr
Inadvertent intruder acute dose – 500 mrem/yr	5.51 mrem	5 mrem

4.2.9. Institutional Controls

Provide a detailed description of institutional control activities that comply with the requirements of DOE M 435.1-1. Institutional controls at DOE disposal facilities should continue until the facility can be released pursuant to DOE O 458.1.

Objective

The objective of this guide is to identify the activities that will prevent or limit human intrusion onto the disposal site.

Discussion

Institutional controls include both active and passive controls. Active controls usually involve the presence of human involvement such as periodic inspections of fence integrity. Passive controls usually involve the presence of barriers (fence) and signage. Institutional controls are usually assumed to cover a 100-year period in the PA. However, shorter or longer periods may be justified through Federal and state agreements or through analysis. DOE G 435.1-1, *Implementation Guide for Use with DOE M 435.1-1,* describes institutional controls for long-term stewardship that are specific to radioactive waste disposal systems and that are based on DOE Policy (P) 454.1, *Use of Institutional Controls*. DOE G 435.1-1, references DOE O 435.1 and states "Institutional control measures shall be integrated into land use and stewardship plans and programs, and shall continue until the facility can be released pursuant to DOE 5400.5, *Radiation Protection of the Public and the Environment"* (now DOE Order 458.1).

4.2.10. References

Include a complete list of citations for materials referenced in the CP.

4.2.11. Appendices

Include appendices to the CP as necessary to provide technical details supporting the data and analyses presented in the CP.

4.2.12. Compliance Demonstration

Compliance with the requirement in DOE O 435.1 to develop a Closure Plan can be demonstrated by a site developing a CP to support the associated PA and CA, reviewed by the LFRG and approved by DOE management. The key assumptions should also be protected in site procedures to ensure that DOE O 435.1 performance objectives/measures continue to be met and that institutional controls are consistent with DOE P 454.1.

Copies of this information (at a minimum, the procedures that implement these requirements) should be included in the applicable facility RWMB).

4.3. References

DOE Policy 454.1, *Use of Institutional Controls*, April 9, 2003

DOE Order 435.1, Chg 1, *Radioactive Waste Management*, July 09, 1999

DOE Order 458.1, *Radiation Protection of the Public and Environment*, February 11, 2011

DOE 5400.5, *Radiation Protection of the Public and the Environment* (now DOE Order 458.1)

DOE Guide 435.1-1, 1 Admin Chg 2, *Implementation Guide for Use with DOE M 435.1-1*, July 09, 1999

DOE Manual 435.1-1, Admin Chg 2, *Radioactive Waste Management Manual*, July 09, 1999

4.4. Closure Plan Review Criteria

The Table 4-2 may be used to evaluate whether the document contents are complete and thorough and the document is technically adequate and defensible. Review criteria may be changed according to the scope and facility being reviewed. However, the LFRG Co-Chairs must approve the review criteria being used in the LFRG Review Plan for a specific facility.

Note: Numbers in parentheses refer to the section number in the chapter.

Table 4-2. Closure Plan Review Criteria

ID	Review Criteria	Criteria Met (Yes/No/)	Comments
CP-1	Define the approach to be taken for ensuring the long-term protection of the public and the environment from disposed radioactive waste at the end of disposal facility operations. The CP should identify and maintain key performance assessment (PA) assumptions including the projected or final closure inventory and configuration, and summarize the measures to be taken to ensure long-term stability of the facility (maintenance, institutional controls), including the process to be followed for conducting corrective actions that may be required. (4.2.1 Executive Summary)		

ID	Review Criteria	Criteria Met (Yes/No/)	Comments
CP-2	Describe the CP's purpose and scope, and clarify its relationship to the other technical basis documents [e.g., PA, CA, monitoring plan (MonP)], and any related programs (long-term stewardship), waste management activities] [e.g., CERCLA, Resource Conservation and Recovery Act (RCRA)] or relevant plans (lands use plans, groundwater protection plans) at the site. (4.2.2 Introduction)		
CP-3	Describe the following elements: • Description and characteristics of the facility to be closed; • Design features; • Waste characteristics; • Technical approach to closure; • Compliance with performance objectives; and • Interim & final detailed closure activities. (4.2.3 Summary Facility Description)		
CP-4	Because the CP is updated periodically during the operational phase of the facility life to reflect new information/data, or changes in planned design configuration or operations, all sources of information should be referenced and dated, including: • Final closure inventory and inventory; • Modifications to waste form; • Measures taken to ensure long-term stability of the facility (maintenance, institutional controls); and • Required corrective actions. (4.2.4 Summary Closure Approach)		
CP-5	Identify key closure assumptions from the PA and CA. Similarly, key assumptions within the PA, CA or other technical basis documents relevant to the CP should be discussed. (4.2.5 Summary of Key Assumptions)		

ID	Review Criteria	Criteria Met (Yes/No/)	Comments
CP-6	Specify the location of the DOE site and the disposal facility on a regional map outlining the site boundaries, as well as projected site boundaries of DOE-controlled land. Provide a more detailed disposal site map, with the boundaries of the existing or proposed disposal site clearly highlighted. Provide a general description of the disposal site and surrounding area. Identify and discuss any disposal site characteristics, natural features, or nearby land uses important to closure activities or potentially significant relative to the long-term performance (i.e., degradation, nearby dams, seismic faults, etc.) of the disposal facility. Discuss any foreseeable natural processes and/or phenomena that are potentially significant to closure considerations. Present sufficiently detailed information to support the facility closure design and reference the PA for additional detail. (4.2.6.1 Summary of Site Characteristics)		
CP-7	Provide information on engineered facility features, including the type (e.g., landfill, vault, and tumulus), size, number of disposal units or cells, and general design and construction features. Update this section of the plan as operations/interim closures proceed and final configuration is provided in the final CP. Provide descriptions of how the design features perform the following functions: • Managing the infiltration of water through disposal units - including features designed to direct onsite precipitation away from the disposal units, as well as those that direct the flow of offsite surface and groundwater away from the disposal facility or disposal units; • Ensure integrity of disposal unit covers and minimize maintenance - including erosion and long-term degradation protection of disposal unit covers;		

ID	Review Criteria	Criteria Met (Yes/No/)	Comments
	• Provide for the structural stability of backfill, waste, and covers - including anticipated void volumes within and between waste containers that contribute to the subsidence potential and anticipated degradation of fill, waste forms, engineered features, and waste cover materials; and • Preclude or delay inadvertent intrusion - duration of effectiveness and degradation rates. (4.2.6.2 Summary of Facility Characteristics)		
CP-8	Identify and summarize waste characteristics pertinent to closure (e.g., physical and chemical characteristics including potential relevant chemical interactions, waste forms or containers, volume, total and isotopic inventory, physical stability/void volume within waste and between containers, and subsidence potential). (4.2.6.3 Summary of Waste Characteristics)		
CP-9	Describe the activities that will be conducted during each closure phase, including the role those activities play in ensuring compliance with performance objectives, assumptions, or other associated design requirements. Review the PA conceptual model(s) and results, including the sensitivity/uncertainty analysis, to identify the mechanisms for controlling future dose for each pathway. Identify the specific controls and features needed to provide a reasonable expectation of meeting the all-pathways dose performance objective. (4.2.7 Approach to Closure)		
CP-10	Provide a detailed description of the activities that will be conducted during interim (if applicable) and final facility closure phases as described below, including the sources of materials for the cover. Update the preliminary CP with		

ID	Review Criteria	Criteria Met (Yes/No/)	Comments
	detailed engineering plans and specifications before interim closure of the first unit or cell occurs. Similarly, compare these plans and specifications against closure assumptions in the PA or Change Control documentation (e.g., SA) and if necessary update the PA to ensure the interim closure activities are consistent with long-term performance requirements for the disposal facility. Sufficiently demonstrate that closure conditions will achieve stability of the disposal facility, reduce the need for active maintenance, and meet the requirements of DOE O 435.1. (4.2.7.1 Detailed Closure Actions)		
CP-11	Sufficiently demonstrate that closure conditions will achieve stability of the disposal facility, reduce the need for active maintenance, and meet the requirements of DOE O 435.1. (4.2.7.1 Detailed Closure Actions)		
CP-12	Update this section with actual and planned dates, including key decisions and milestones resulting from the PA maintenance process. Interim closure of a facility, if necessary, should occur within two years of the final placement of waste into the facility, unless a different schedule is approved and documented in the DAS DOE O 435.1. (4.2.7.2 Closure Schedule)		
CP-13	Provide a detailed description of operational and/or interim closure activities for disposal units or cells. Describe site conditions (e.g., grading and drainage) following interim closure of each unit/cell, if multiple disposal units or cells are to undergo interim closure over the life of the facility. Provide a description of how the interim closure of each unit/cell is integrated and supports the final closure design. Compare this plan and specifications against PA assumptions and if necessary, use plan and specifications to update the PA to confirm that the final		

ID	Review Criteria	Criteria Met (Yes/No/)	Comments
	closure configuration will provide a reasonable expectation of meeting performance objectives. (4.2.7.3 Operational/Interim Closure)		
CP-14	Provide a detailed description of final closure activities. Document a final updated radionuclide inventory of waste disposed in the facility, and basis for maintaining the reasonable expectation that the requirements in DOE M 435.1-1, *Radioactive Waste Management Manual,* IV.P(1) "Performance Objectives" will be met for the final closure configuration. Update and present detailed plans and specifications for final closure activities in the CP before final closure occurs. (4.2.7.4 Final Closure)		
CP-15	Compare this plan and specifications against PA assumptions and results. If necessary, update the PA based on the current plan and specifications to confirm that the final closure configuration will provide a reasonable expectation of meeting performance objectives. (4.2.7.3 Final Closure)		
CP-16	Identify key pathways and assumptions for all pathways dose in the PA and describe the site closure activities and design features that contribute to meeting the performance objective. (4.2.8.1 Compliance with Performance Objectives)		
CP-17	Identify key pathways and assumptions for air pathways dose in the PA and describe the site closure activities and design features that contribute to meeting the performance objective. (4.2.8.1 Compliance with Performance Objectives)		

ID	Review Criteria	Criteria Met (Yes/No/)	Comments
CP-17	Identify key pathways and assumptions for radon flux in the PA and describe the site closure activities and design features that contribute to meeting the performance objective. (4.2.8.1 Compliance with Performance Objectives)		
CP-18	Identify key pathways and assumptions for water resources pathways dose in the PA and describe the site closure activities and design features that contribute to meeting the performance objective. (4.2.8.1 Compliance with Performance Objectives)		
CP-20	Describe the relationship between site closure activities and design features and assumptions for the post-closure hypothetical inadvertent intruder dose evaluated in the PA. Summarize, for each feature, how future maintenance activities are to be minimized and how long-term stability consistent with intruder analysis assumptions is ensured. (4.2.8.1 Compliance with Performance Objectives)		
CP-19	Describe any other requirements related to facility performance or design that affect the closure approach such as: • Design standards and other requirements associated with RCRA hazardous waste regulations or CERCLA disposal regulations; • DOE O 458.1, *Radiation Protection of the Public and the Environment,* requirements; • CERCLA remedial action and RCRA corrective action; and • Long-term stewardship. (4.2.8.2 Compliance with Other Objectives)		

ID	Review Criteria	Criteria Met (Yes/No/)	Comments
CP-21	Provide a detailed description of institutional control activities that comply with the requirements of DOE O 435.1. Institutional controls at DOE disposal facilities should continue until the facility can be released pursuant to DOE O 458.1. (4.2.9 Institutional Controls)		
CP-22	Include a complete list of citations for materials referenced in the CP. (4.2.10 References)		
CP-23	Include appendices to the CP as necessary to provide technical details supporting the data and analyses presented in the CP. (4.2.11 Appendices)		

CHAPTER 5. PA/CA MONITORING PLAN GUIDE

5.1. Introduction

GOAL

The goal of this guide is to support the U.S. Department of Energy's (DOE's) initiatives to improve and maintain the highest quality radioactive waste management standards and activities throughout the DOE complex.

The primary audience of this guide is the Federal Project Director and other DOE Federal/contractor employees involved in the disposal of low-level waste (LLW) and tank closure.

OBJECTIVE

The objective of this guide is to provide the objectives, additional rationale, examples, and measures of performance for a performance assessment (PA)/composite analyses (CA) monitoring plan (MonP). Monitoring programs will vary in accordance with sites and facility design, the environmental setting, and the associated PA or CA models developed to evaluate facility performance. Therefore, the specific manner and associated documentation in which individual sites address their monitoring needs will vary to some extent, particularly in those circumstances where regulatory requirements/guidance for other programs are applicable. Accordingly, the contents outlined in this guide, which are intended to capture both compliance monitoring to demonstrate compliance with regulatory standards/limits [e.g., maximum contaminant levels (MCLs)] and performance monitoring to build confidence that the facility is performing as projected in the associated PA and CA, may need to be supplemented with other regulatory requirements [e.g., Resource Conservation and Recovery Act (RCRA) hazardous waste management requirements].

Guides do not impose requirements but may quote requirements if the sources are adequately cited. This guidance follows the format of an objective statement, discussion, examples, a statement of one way to measure compliance, and supplemental references. Following this Guidance provides a consistent approach for compliance with the requirements of DOE Order (O) 435.1, *Radioactive Waste Management*. If the Guide has not been followed, then an explanation/justification as to why a different approach is acceptable should be provided.

The Low-Level Waste Disposal Facility Federal Review Group (LFRG), functioning as the DOE regulatory authority, is the independent organization responsible for performing oversight of LLW disposal and tank closure in accordance with DOE O 435.1 [DOE Manual (M) 435.1-1, R*adioactive Waste Management Manual*, Chapter I, 2.E(1)(a)]. Therefore, the LFRG members utilize this Standard as guidance in performing oversight functions and judging compliance with

the requirements of DOE O 435.1 (See LFRG Execution Plan for details of LFRG roles, responsibilities and processes).

5.2. Annotated Outline for PA/CA Monitoring Plan

5.2.1. Introduction

This section should briefly describe the purpose and scope of the MonP, and clarify its relationship to the technical basis documents [e.g., PA, CA, closure plan (CP), (PA/CA maintenance plan (MP)], and/or regulatory requirements (e.g., Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)/RCRA).

Describe:

- Key assumptions;
- Site description;
- Facility description;
- Basis for monitoring;
- Monitoring approach;
- Data evaluation; and
- Recommendations based upon data evaluations.

5.2.2. DOE Site Description

This section should briefly describe the general location of the facility and pertinent aspects of the environmental setting that influence the monitoring strategy (i.e., the basis for what, where, and when to monitor). Include only site characteristics that are significant to the monitoring program and reference the PA/CA for additional details as necessary. Include the following specific elements:

- Important physiographic features (e.g., description of general geology [volcanic, sedimentary, other], large scale structural features such as major faults);
- Important climate considerations (e.g., precipitation, evapotranspiration rates);
- Important geology/hydrogeology considerations (e.g., vadose zone characteristics, perched water, aquitards and aquifers); and
- Maps, schematics, and photos to facilitate an understanding of these site characteristics.

5.2.3. Facility Description

This section should briefly describe the specific location and type of disposal facility, type(s) of waste and waste forms disposed, and any pertinent facility features relevant to monitoring the release of constituents to the surrounding environment. Present the information in sufficient detail to support the monitoring strategy. Include maps, schematics, photos and tables to facilitate an understanding of facility characteristics.

Objective

The objective of this guide is to ensure that the monitoring program is appropriately designed and administered to support the analysis and evaluations conducted in the PA and CA and the conditions under which the disposal facility may operate.

Discussion

This guide provides a general description of the document contents, including key assumptions and conclusions from the PA, CA, and CP and how the MonP supports those assumptions and conclusions. In addition, if research and development (R&D) or field studies are being performed, describe how the MonP supports those efforts.

This guide evaluates the location of the facility and identifies the significant characteristics that may influence assumptions and conclusions of the PA, CA, and CP or the operations of the facility. The location of the site is important in developing an overall strategy for monitoring the facility to protect the public and environment. Facilities located in a humid environment may require additional instrumentation for precipitation, infiltration, vadose, and aquifer water dispersion. Sites located in an arid environment may require more air and radon monitoring. The general location of the site identifies the overall monitoring strategy for the disposal facility.

This guide also discusses relevant facility features that will contribute to establishing a strategy for monitoring the migration of radionuclides. Monitoring strategies is an important step in ensuring the safety of the public and environment in a cost-effective manner. Understanding the features of the disposal facility and the influence on facility performance is critical.

Example:

> *To ensure the monitoring at the LLW disposal facility is cost effective and effective in determining early detection of unexpected events, it does not include vadose zone monitoring because a determination was made that, due to the thinness of the vadose zone, it does not have a major role in the long-term performance of the disposal facility (Figure 5-1).*

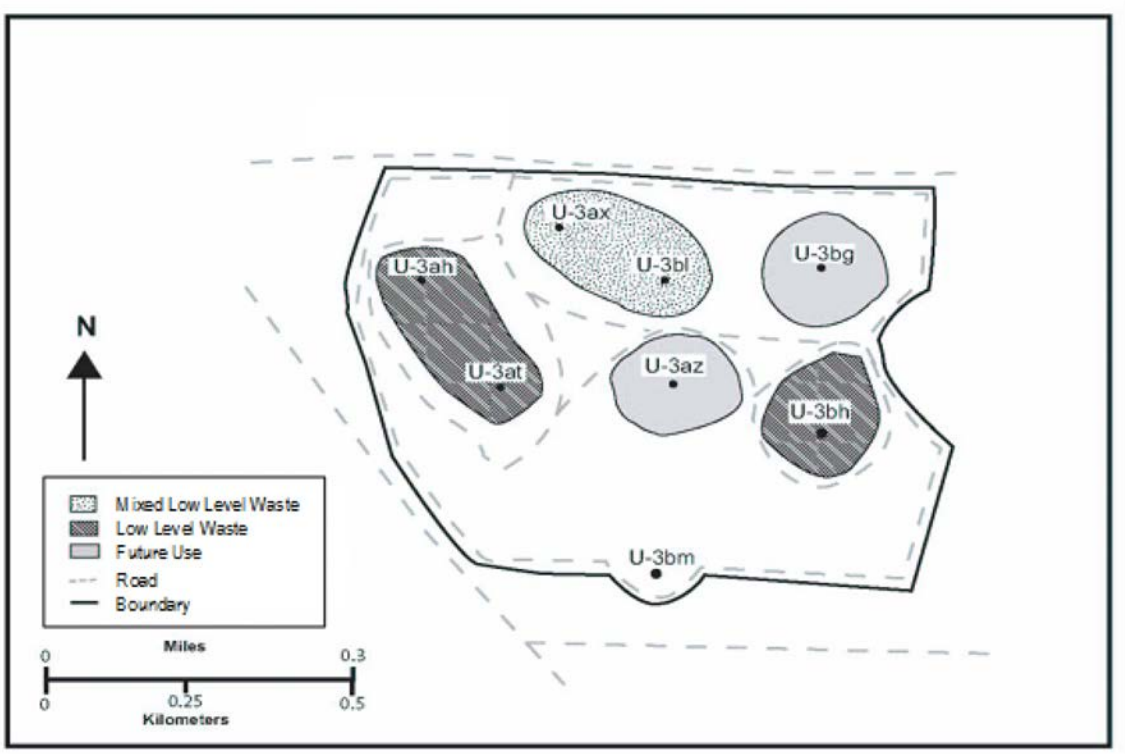


Figure 5-1. Example of Facility Description Schematic

5.2.4. Basis for Monitoring

This section should explain the regulatory framework for the monitoring program. Distinguish between performance monitoring and compliance monitoring requirements.

5.2.4.1 PA/CA Results

This section should identify key assumptions and results of the PA, CA, and other Disposal Authorization Statement (DAS) technical documents with an emphasis on factors that influence monitoring plans. Any exposure pathways considered important and requiring monitoring should be described.

5.2.4.2 Other Regulatory Drivers

This section should summarize specific requirements for monitoring from other regulatory entities (e.g., RCRA).

Objective

The objective of this guide is to explain the regulatory framework for the monitoring program. Distinguish between performance and compliance monitoring drivers and identify PA/CA assumptions and results that form the basis of the monitoring program.

Discussion

A monitoring program has two different objectives:

1. To ensure compliance with regulatory requirements; and
2. To build confidence that the facility is performing as described in the associated PA and CA.

The first objective (compliance monitoring) is to provide regular assurances that any releases from a disposal facility beyond the facility boundary, which includes a buffer zone (typically 100 meters), are not causing regulatory standards to be exceeded (e.g., MCLs in groundwater at a point of public exposure). The second objective (performance monitoring) is to build confidence that key natural and engineered barriers in the disposal facility are performing as expected and to reinforce assumptions in the PA. The key difference between performance and compliance monitoring is the interpretation of the results (Table 5-1). In compliance monitoring, a result above a standard is a direct indication of a regulatory concern. In performance monitoring, a result out of range is an indication of a parameter that is not consistent with an assumption in the PA or CA (i.e., not a compliance issue, but something that may require additional activities to confirm).

Table 5-1. Examples of the Two General Types of Monitoring

Type of Monitoring	Threshold	Timing	Examples
Performance	Action levels that are set based on PA/CA model results; trending of data	Evaluates trends for potential future exceedance based on modeling; subject to interpretation	Monitoring of waste matrix, structures, covers, vadose zone, stream, biological, subsidence
Compliance	Exceedance of MCLs or other state/Federal standards	Evaluates current state of compliance with standards	Monitoring of outfalls, air stations, monitoring wells

This guide also identifies the key assumptions and results of the PA, CA, and CP where monitoring is appropriate and applies the graded approach to exposure pathway monitoring that contribute to ensuring performance objectives will be met. In general, monitoring to confirm

performance expectations in the PA will serve as the principal area of focus, particularly in the operations phase and the initial years following facility closure in order to build confidence in the PA and update assumptions as necessary. Exposure pathways considered important and requiring monitoring should be noted.

Example of linking PA/CA assumptions/analyses to the media to be monitored:

> *Atmospheric, all-pathways, inadvertent intruder, and groundwater pathways were all included in the PA and CA. For monitoring, the atmospheric and groundwater pathways are of most interest.*
>
> *In the latest PA, only two of the forty-seven pathways analyzed were identified as being of possible consequence for the transport of radionuclides from disposed waste into the environment: 1) leaching of the waste forms resulting in contamination of local groundwater, and 2) gaseous diffusion into the atmosphere above the disposal units. The pathway involving leaching of the waste forms resulting in contamination of local groundwater was considered a relevant exposure pathway for the transport of radionuclides from disposed waste to members of the general public. Therefore, this plan monitors groundwater and its precursors (vadose zone water and sump water). The atmospheric pathway was considered less of a concern due to distance from the public and diffusion.*

5.2.5. **Monitoring Approach**

This section should summarize the approach that will be used to demonstrate how monitoring will be accomplished. Include an overview of the steps involved in the program, and references to other monitoring programs that are being used in an integrated manner.

For each section below, provide a brief discussion/justification of the assumptions and approach to select the media to be monitored, sampling locations, analytes and parameters, and frequency, respectively. The basis should be linked to results and findings from the PA/CA and specific regulatory requirements, as applicable.

5.2.5.1 Media to be Monitored

This section should describe the media to be sampled and basis for selection for compliance and performance monitoring, respectively.

5.2.5.2 Locations of Sampling

This section should identify the specific field locations and any facility/operational features that will be sampled for compliance or performance monitoring. Provide tables summarizing general

locations, maps and cross-sections offering visual representation, and schematics to provide a comprehensive understanding of the monitoring locations (Figure 5-2).

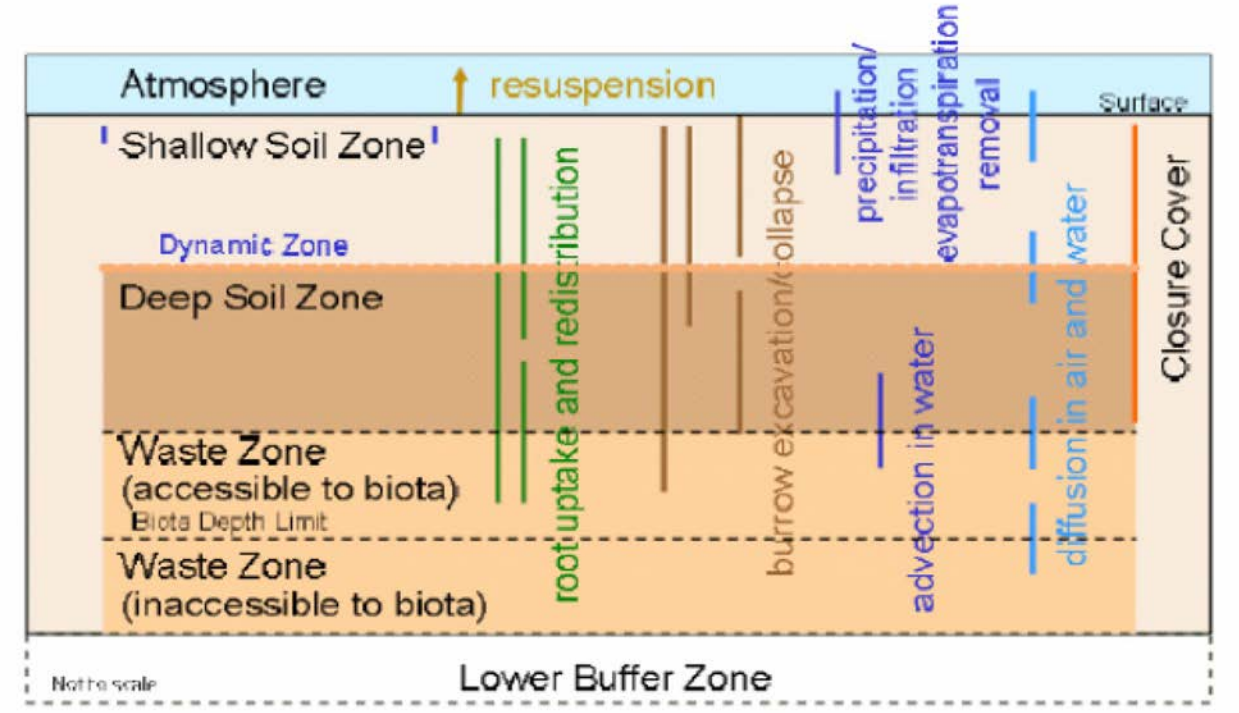


Figure 5-2. Site Characteristics

5.2.5.3 Parameters Measured

This section should describe the radionuclides, chemicals, and/or field parameters that will be monitored for compliance and performance monitoring, respectively.

5.2.5.4 Frequency of Monitoring

This section should discuss the planned sampling frequency for each location monitored either in tabular form or in the text (e.g., bulleted list).

5.2.5.5 Sampling and Analysis Methods

This section should describe the applicable sampling and analytical methodologies related to the monitoring being performed and provide reference to a formal sampling and analysis plan and QA requirements and documentation.

5.2.5.6 Tabular Summary

This section should include a tabular summary (Table 5-2) of the applicable monitoring program details, including but not limited to:

- Pathway or Relevant Feature (e.g., vault, trench cover);
- Media;
- Monitoring location;
- Radionuclide/chemical or physical parameter;
- Sampling frequency;
- Sampling methods;
- Analytical methods; and
- Minimum Detectable Activity/Method Detection Limit.

Table 5-2. Example Monitoring Summary

Pathway / Relevant Feature	Media/ Inspection	Monitoring Location	Radionuclide/ Other Substance	Sampling Frequency	Sampling Method	Analytical Method	Minimum Detectable Activity/Method Detection Limit
Groundwater pathway	Vadose zone water	Beneath and adjacent to trench disposal units	Tritium; Other radionuclides as appropriate	Twice per year for tritium	Vacuum extraction from porous cup samplers; latest procedure	Scintillation counting	Variable; as designated by the onsite laboratory
	Sump water	Vault sumps & sump	Gross alpha Nonvolatile beta Tritium	Prior to pumping when threshold liquid levels are exceeded	Pump; latest procedure	Scintillation counting	Variable; as designated by the onsite laboratory
	Groundwater	Water table wells located along edge of LLW disposal facility.	Gross alpha Nonvolatile beta Tritium	Annual[1]	Pump; Ch.15, *Environmental Compliance Procedure*.	As designated (add reference)	Variable; as designated (add reference)
Vault Concrete/ Trench Cover Monitoring	Vault features and trench covers	Visible portions of vault units; subsidence inspections of vaults and trench covers.	N/A	Periodic; per latest procedure	Vaults: visual inspections and survey measurements; Trench covers: visual inspections and comparisons with criteria specified in latest procedure.	N/A	N/A

1. Not all of the wells are sampled annually; sampling is dependent on program/permit requirements (under which these wells are sampled) and whether the wells are able to be sampled (i.e., have water or are dry).

Objective

The objective of this guide is to summarize the approach that will be used to demonstrate how compliance and performance monitoring requirements will be met.

Discussion

The approach should include a broad overview of the steps involved in the program and references to other monitoring programs that are being used to meet a facility's monitoring requirements. This section should also be used to specify the monitoring approach for a facility that has multiple disposal technologies. The ability to segregate monitoring activities for the different disposal technologies will aid in determining which technology is primarily contributing to monitoring data and can provide useful information in determining appropriate corrective actions, if required.

Example of a monitoring approach that has multiple disposal configurations:

> *Separate action levels are provided in this Monitoring Plan for each disposal unit grouping. This grouping is the same as the groupings used in the latest PA and includes:*
>
> - *East ST = "future disposal areas" east of ST7; 8 units*
> - *Center ST = ST 1 through ST7; 7 units*
> - *West ST = ST8 plus five "future disposal areas"; 6 units*
> - *CIG Trenches = 2 units*
> - *ET = 2 units*
>
> *Calculated action levels also take into account results from the plume overlap modeling in the PA.*
>
> *The action levels for tritium were calculated using the inventory limit for each disposal unit grouping and the peak activity concentration to the groundwater from the PA modeling. This methodology is based on that used in previous PA Monitoring Plans but takes into account the modeling results from the latest PA. As in past Monitoring Plans, an added conservatism is applied by setting the Action Level at 25 percent of the calculated value.*
>
> *Existing programs within the DOE site provide environmental monitoring for the LLW Disposal Facility. These existing programs have been reviewed and are referenced as appropriate.*

This guide also identifies and justifies the different media to be monitored to support the performance objectives, ensuring they will be met. Establishing a good, effective monitoring program is imperative to ensure early detection of radionuclide migration to the point of compliance and to performance objectives. As data is gathered over time, predictions of radionuclide migration through the vadose zone to the aquifer can be made.

This guide also presents the location and specific identification of various media sampling locations around the disposal facility (Figure 5-3).

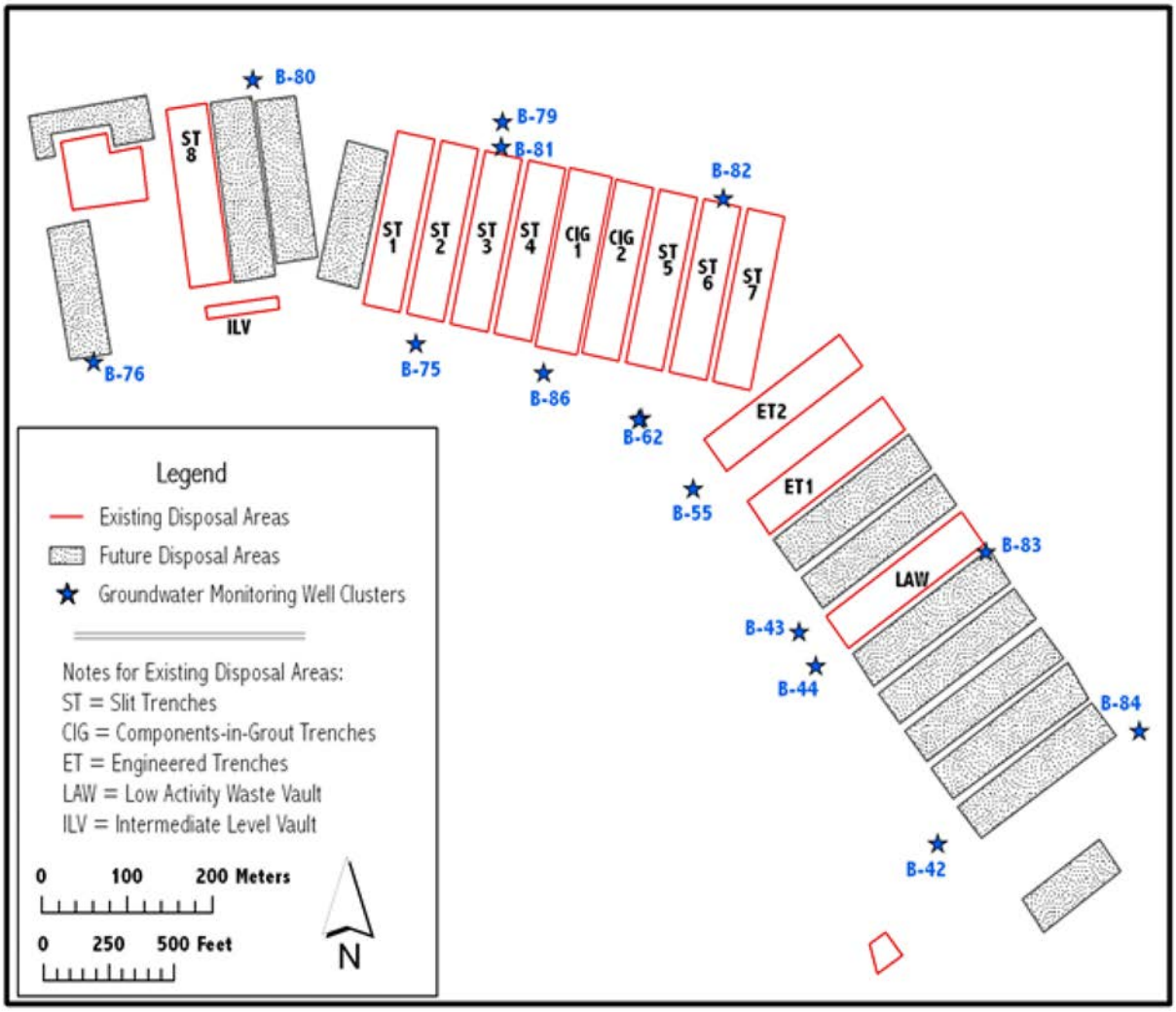


Figure 5-3. Example of Ground Water Modeling Location Schematic

This guide also specifies the minimum parameters that should be monitored. Monitoring these parameters can alert operators of changing conditions that could be caused by problems

associated with the disposal of LLW. Effluent monitoring is used for compliance [e.g., National Pollutant Discharge Elimination System (NPDES), U.S. Environmental Protection Agency (EPA), National Emissions Standards for Hazardous Air Pollutants (NESHAP)] and can identify problems requiring mitigation or corrective action. It is also used to detect hydrologic failure of engineered disposal systems, such as concrete vaults. Operational monitoring to detect migration of radionuclides is intended to ensure that applicable standards and permit requirements are met and assess potential radiation exposures or doses to members of the public. It also compares assumptions made in the PA/CA. Subsidence monitoring can provide an early indication of potential failure in long-term stability and should be included in the MonP.

Example of Parameters Measured:

- *Results of the PA and CA were used to provide insight into which radionuclides are expected to be the most important in meeting performance objectives. Specific constituents of interest are determined by evaluating the following specific criteria: 1) if the radionuclide is a significant contributor to dose; 2) if previous monitoring results show consistent trends of necessary concentration; or 3) if the radionuclide has a specific maximum contaminant limit (MCL) or other compliance limit.*

- *Constituents of interest for the air pathway are H-3 and C-14. In the subsurface, these radionuclides are also most likely to be early indicators of contaminant movement in the groundwater pathway due to their solubility of reliability. Others that are most likely to contribute to potential doses are Cl-36, I-129, and Tc-99. Previous vadose zone monitoring found increasing trends for total uranium; hence, the uranium isotopes (U-233/234, U-235/236, and U-238) are of interest and are being monitored.*

- *H-3 (Tc-99 and I-129) are among the first radionuclides released to groundwater. Therefore, the monitoring program will focus on analyzing water samples for H-3 and nonvolatile beta activity. Gross alpha determinations will also be made to detect any unforeseen releases of uranium or transuranic elements. A summary table identifies the radionuclides/other substances to be monitored per this Monitoring Plan.*

This guide also establishes reasonable monitoring frequencies to provide the necessary data to support compliance with regulations and performance of the facility. Frequencies should be described to the extent practicable. It is also useful to note the potential for sampling frequency to change in response to information, e.g., an unexpected result can trigger more frequent monitoring or no changes for a long period of time may be a reason to reduce monitoring frequency.

This guide also establishes the appropriate sampling method based upon the media being sampled and to revise the methodology, as appropriate, when better technologies exist. Sampling methodologies will vary depending upon the constituent being sampled in a particular media and can cover a wide range of instrumentation and methods. Sites should stay informed on commercially available sampling instruments and acceptable industry and regulatory methods.

This guide also identifies the specific analytical method used to evaluate collected samples and to revise those methods as necessary. Analytical methods will vary depending upon the constituent being sampled in a particular media and can cover a wide range of instrumentation and methods. Sites should stay informed on commercially available sampling instruments and acceptable industry and regulatory methods.

5.2.6. Data Evaluation, Management, and Reporting

This section should describe the method and frequency of monitoring data evaluation, and how data are managed and reported. This section should also specify sources of data (existing monitoring programs) for the evaluation and address procedure/policies governing interpretation of monitoring data.

5.2.6.1 Data Evaluation

This section should explain in separate subsections, how compliance and performance monitoring data are to be evaluated (e.g., trending analyses, comparison to performance thresholds, or actions levels). Compliance limits (e.g., groundwater concentrations based on state and local regulations) against which compliance monitoring data are compared should be clearly stated. Discuss the basis for established monitoring thresholds or action levels, and as appropriate, describe the expected variability (spatial and temporal) in the data in order to provide perspective for their interpretation.

For performance monitoring, describe the range of expected behavior/trend or the criteria that would signal a deviation from expected behavior/trend (e.g., vadose zone concentrations, visual inspections of vaults and covers, moisture profiles, changes in pH). It is important to establish appropriate expectations for the type of monitoring results that may be obtained and how they should be interpreted.

5.2.6.2 Frequency of Data Evaluation

This section should specify the planned frequency of data evaluation and review. Data collected pursuant to the PA/CA MonP should be evaluated no less than annually for compliance with the Standard.

5.2.6.3 Management and Reporting of Data

This section should describe the management procedure and reporting processes for monitoring data. Describe the data management system used to retain, archive and retrieve monitoring data. The PA/CA MonP should identify the frequency and method(s) of reporting the monitoring data.

The PA/CA MonP results should be reported no less than annually in the disposal facility annual summary report (ASR Chapter 9). In addition, this section should identify reporting requirements for other Federal, state and local programs (e.g., CERCLA, RCRA) which impose regulatory standards and limits on the disposal facility. Monitoring results that are outside of the expected range or exceed compliance thresholds should be described and specifically addressed in the ASR.

Objective

The objective of this guide is to evaluate the monitoring data for possible trends that could adversely affect the assumed performance of the facility in the PA or compliance with regulatory requirements.

Discussion

Performance monitoring results are often evaluated through trend analysis and comparison with performance monitoring thresholds, often expressed as action levels. Spatial and temporal trends need to be considered rather than placing too much emphasis on individual results by location or time. These data are subject to interpretation since they are compared with modeling results and assumptions.

The MonP should clearly state and explain the origin of the action levels used in the data evaluation. As part of this section, it may also be appropriate to discuss expected variability (spatial and temporal) in the data in order to provide perspective. Ranges of values for expected behavior should be provided.

In some cases, monitoring data are not compared against action levels but are qualitatively evaluated to identify changes in trends (e.g., visual inspections of vaults and covers, moisture profiles). Where possible, the MonP should either specify the range of expected behavior (or trend) or the criteria that would signal unexpected behavior or trends.

Example criteria of visual inspections:

- Cracks or settling imperfections of 2.5 to 15 cm (1 to 6 in) deep on the cover will be documented and scheduled for repair on an annual basis. No action will be taken for cracks or settling imperfections of less than 2.5 cm (1 in). Larger disruptions of the cover (animal diggings or erosion) will be immediately evaluated, repaired, and documented.

- The results of PA/ CA monitoring activities and evaluations should be documented in a facility's ASR (Chapter 9) and used to update its monitoring program, provide comparisons between monitoring results and PA and/or CA projections, and discuss its adequacy. However, many disposal facilities also rely on existing monitoring programs for some of their monitoring needs and that data may be managed and reported by other site organizations. In such circumstances the plan should clearly specify which data came from other examinations and how to address the procedure/policies given the collection of this data.
- Compliance limits (e.g., groundwater concentrations based on state and local regulations) against which compliance monitoring data are compared should be clearly stated as illustrated in Table 5-3.

Table 5-3. Aquifer Maximum Contaminant Levels (Action Levels) by Radionuclide

Radionuclide	MCL[19] (Action Level)
Gross α	15 pCi/L
Gross β[a]	50[a] pCi/L
C-14	2,000 pCi/L
Cl-36	700 pCi/L
H-3	20,000 pCi/L
I-129	1 pCi/L
Tc-99	900 pCi/L
U-233/234	See total uranium
U-235/236	See total uranium
U-238	See total uranium
Total uranium	30 µg/L
• Gross β does not have an MCL but there is a designated aquifer screening limit. • MCL maximum contaminant level.	

This guide also ensures a plan has been established and approved that evaluates monitoring data on an annual or more frequent schedule. Monitoring data should be reviewed (at a minimum) annually against standards [e.g., action levels, maximum contaminant level (MCLs)] specified in

[19] This is only an example, and it needs to be understood that groundwater quality standards are set by state and local regulations. Not all states or localities use MCLs for their drinking water standards and may be more or less stringent.

the MonP and compared with assumptions and results in the PA. However, other regulatory (e.g., permit) drivers may require more frequent review of data.

This guide also describes the management of environmental data from monitoring activities and documenting those results in an ASR. The results of PA and CA monitoring activities and evaluations are typically documented in a facility's annual review report. Often this annual report is used to document monitoring results and updates to their monitoring program, provide comparisons between monitoring results and PA and/or CA projections, and discuss the adequacy of their PA/CA monitoring programs. However, many disposal facilities also rely on existing monitoring programs for some of their monitoring needs. Therefore, their data may be managed and reported by other site organizations. This section of the MonP is used to document where and how monitoring data are managed and reported.

Example of Management and Reporting of Data:

- All monitoring data are archived in the data management system. The data management system is an Oracle™-based relational database management system developed for the comprehensive management and processing of environmental data. This database management system has been licensed and tailored to support both small and large environmental projects at the site. It will ensure consistency and promote advanced planning while providing a central repository for all unclassified environmental data.
- Evaluation of all monitoring data is conducted once per year, at minimum, and conclusions of those evaluations are incorporated into one or all of the applicable annual data reports including the NESHAP report; the Annual Groundwater Monitoring Report, and the Annual Waste Management Monitoring Report.

5.2.7. Recommendations Based on Data Evaluation

This section should describe any reviews and actions that will be taken based on the data evaluation results.

5.2.7.1 Review of PA/CA Monitoring Plan and Related Documents

This section should describe the document and program reviews that will be performed based on data evaluation results. Review the PA/CA MonP annually, at a minimum, and appropriately update to ensure it adequately represents and is consistent with the analysis and evaluations conducted to maintain the PA/CA and the current conditions under which the disposal facility operates.

5.2.7.2 Corrective Actions

This section should describe the corrective actions that will be taken if monitoring data exceed a compliance standard or reflect deviations from expected conditions in the case of performance monitoring. Address each type of relevant release (e.g., liquid, particulate, gaseous) and the method in which actions will be documented. Describe a graded approach for corrective actions dependent on whether the monitoring result exceeds regulatory criteria or the relative magnitude of monitoring data exceeding the action levels or expected behavior/trend for performance monitoring. This section should state the appropriate actions according to site permits and state/Federal regulations for compliance with performance objectives and/or functional requirements as detailed in the facility PA, CA, other DAS technical basis documents and any other programs (e.g., CERCLA, RCRA, state and local) which impose regulatory standards and limits on the disposal facility.

Objective

The objective of this guide is to review the site's MonP and to update the plan as appropriate to ensure it is consistent with the key assumptions of the PA & CA.

Discussion

Monitoring reviews include assessments of the MonP in addition to related documents (e.g., CP, PA/CA) to determine if the documents, programs, and procedures discussed in those documents need to be updated according to results from the monitoring program.

This guide also describes the actions necessary to correct any exceedance or potential exceedance of Federal, state, or DOE requirements. This section addresses the corrective actions that will be taken if data collected exceeds a standard or are unexpected (e.g., data that exceed a MCL or an action level or data that are unanticipated according to trend analyses). The plan should address each type of relevant release (e.g., liquid, particulate, gaseous) and the method in which actions taken will be documented. The LFRG site representative should be notified immediately if a performance objective/measure is exceeded.

The extent of corrective actions should place more emphasis on responding to trends rather than individual measurements at a given location and time. Types of actions include:

- Evaluation and documentation of existing data (e.g., reviewing disposal records of a specific area);
- Confirmatory sampling to verify data (e.g., may lead to increased sampling frequency);
- Additional sampling (e.g., sampling for other radionuclides or constituents; subsurface drilling and sampling);

- Modifications to the monitoring program (e.g., addition of new technologies to address a concern);
- Modifications to the PA/CA; and
- Modifications to the disposal facility (e.g., engineering controls, administrative controls).

For compliance monitoring, the PA/CA MonP should state appropriate actions according to site permits and state/Federal regulations.

An example of this graded approach is provided in Figure 5-4.

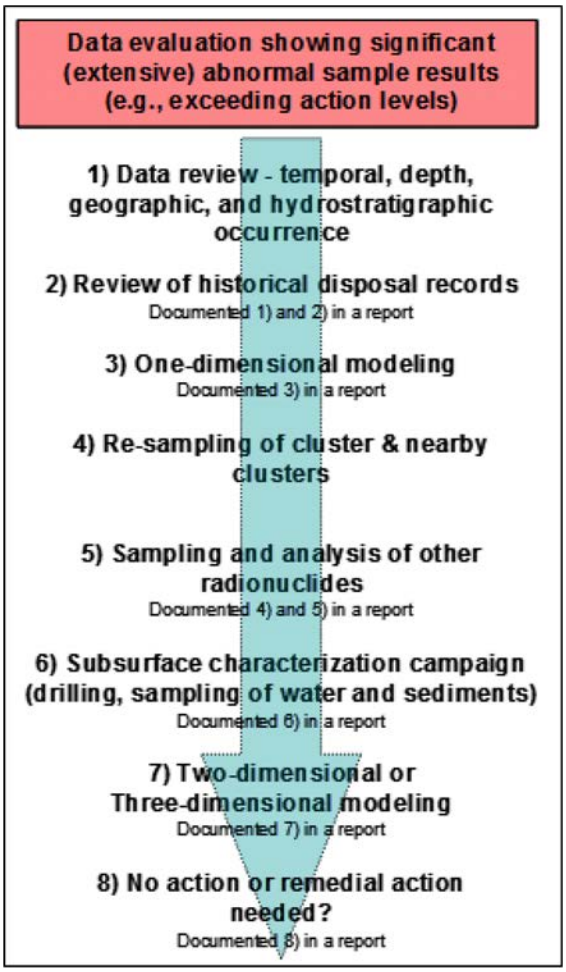


Figure 5-4. Graded Approach in Response to Unexpected Performance Monitoring Data

5.2.8. References

This section should provide the complete citations for references cited in the MonP.

5.2.9. Appendices

This section should include appendices to the MonP as necessary to provide technical details supporting the data and analyses presented in the MonP.

5.3. Compliance Demonstration

Compliance with the requirement in DOE O 435.1, to implement a MonP, can be demonstrated by a site developing and implementing a MonP procedure developed to support the PA and CA, reviewed by the LFRG, and approved by DOE to ensure that DOE 435.1 performance objectives continue to be met.

Copies of this information [at a minimum, the procedures that implement these requirements and each special analysis (SA) that is approved] should be included in the applicable facility Radioactive Waste Management Basis (RWMB).

5.4. References

DOE Order 435.1, *Radioactive Waste Management*

DOE Manual 435.1-1, *Radioactive Waste Management Manual*

DOE Guide 435.1-1, 1 Admin Chg 2, *Implementation Guide for Use with DOE M 435.1-1*, July 09, 1999

5.5. PA/CA Monitoring Plan Review Criteria

The Table 5-4 may be used to evaluate whether the document contents are complete and thorough and the document is technically adequate and defensible. Review criteria may be changed according to the scope and facility being reviewed. However, the LFRG Co-Chairs must approve the review criteria being used in the LFRG Review Plan for a specific facility.

Note: Numbers in parentheses refer to the section number in the chapter.

Table 5-4. PA/CA Monitoring Plan Review Criteria

ID	Review Criteria	Criteria Met (Yes/No/ Comment)	Comments
MO-1	Describes the purpose and scope of the MonP and clarifies its relationship to technical documents {e.g., PA, CA, closure plan (CP), PA/CA maintenance plan (MP)], and/or regulatory requirements. [Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)/RCRA]. (5.2.1 Introduction)		
MO-2	Describes the general location of the facility and pertinent aspects of the environmental setting that influence the monitoring strategy. Specific elements should include: • Important physiographic features (e.g., description of general geology [volcanic, sedimentary, other] and large scale structural features such as major faults); • Important climate considerations (e.g., precipitation, evapotranspiration rates); • Important geology/hydrogeology considerations (e.g., vadose zone characteristics, perched water, aquitards, and aquifers); and • Maps, schematics, and photos to facilitate an understanding of these site characteristics. (5.2.2 DOE Site Description)		
MO-3	Describes the specific location and type of disposal facility, type(s) of waste and waste forms disposed, and any pertinent facility features relevant to monitoring the release of constituents to the surrounding environment. (5.2.3 Facility Description)		

ID	Review Criteria	Criteria Met (Yes/No/ Comment)	Comments
MO-4	Explain the regulatory framework for the monitoring program. Distinguish between performance monitoring and compliance monitoring requirements. (5.2.4 Basis for Monitoring)		
MO-5	This section should identify key assumptions and results of the PA, CA, and other Disposal Authorization Statement (DAS) technical documents with an emphasis on factors that influence monitoring plans. Any exposure pathways considered important and requiring monitoring should be described. (5.2.4.1 PA/CA Results)		
MO-6	Summarize specific requirements for monitoring from other regulatory entities (e.g., RCRA) (5.2.4.2 Other Regulatory Drivers)		
MO-7	Summarize the approach that will be used to demonstrate how monitoring will be accomplished. Include an overview of the steps involved in the program, and references to other monitoring programs that are being used in an integrated manner. (5.2.5 Monitoring Approach)		
MO-8	Describe the media to be sampled and basis for selection for compliance and performance monitoring, respectively. (5.2.5.1 Media to be Monitored)		
MO-9	Identify the specific field locations and any facility/operational features that will be sampled for compliance or performance monitoring. Provide tables summarizing general locations, maps and cross-sections offering visual representation, and schematics to provide a comprehensive understanding of the monitoring locations. (5.2.5.2 Locations of Sampling)		

ID	Review Criteria	Criteria Met (Yes/No/ Comment)	Comments
MO-10	Describe the radionuclides, chemicals, and/or field parameters that will be monitored for compliance and performance monitoring, respectively. (5.2.5.3 Parameters Measured)		
MO-11	Discuss the planned sampling frequency for each location monitored either in tabular form or in the text (e.g., bulleted list). (5.2.5.4 Frequency of Monitoring)		
MO-12	Describe the applicable sampling and analytical methodologies related to the monitoring being performed and provide reference to a formal sampling and analysis plan and QA requirements and documentation. (5.2.5.5 Sampling and Analysis Methods)		
MO-13	Include a tabular summary of the applicable monitoring program details, including but not limited to: • Pathway or Relevant Feature (e.g., vault, trench cover); • Media; • Monitoring location; • Radionuclide/chemical or physical parameter; • Sampling frequency; • Sampling methods; • Analytical methods; and • Minimum Detectable Activity/Method Detection Limit. (5.2.5.6 Tabular Summary)		
MO-14	Describe the method and frequency of monitoring data evaluation, and how data are managed and reported. Specify sources of data (existing monitoring programs) for the evaluation and address procedure/policies governing interpretation of monitoring data. (5.2.6 Data Evaluation, Management, and Reporting)		

ID	Review Criteria	Criteria Met (Yes/No/ Comment)	Comments
MO-15	Explain in separate subsections, how compliance and performance monitoring data are to be evaluated (e.g., trending analyses, comparison to performance thresholds, or actions levels). Compliance limits (e.g., groundwater concentrations based on state and local regulations) against which compliance monitoring data are compared should be clearly stated. Discuss the basis for established monitoring thresholds or action levels, and as appropriate, describe the expected variability (spatial and temporal) in the data in order to provide perspective for their interpretation. For performance monitoring, describe the range of expected behavior/trend or the criteria that would signal a deviation from expected behavior/trend (e.g., vadose zone concentrations, visual inspections of vaults and covers, moisture profiles, changes in pH). (5.2.6.1 Data Evaluation)		
MO-16	Specify the planned frequency of data evaluation and review. Data collected pursuant to the PA/CA MonP should be evaluated no less than annually for compliance with this Standard. (5.2.6.2 Frequency of Data Evaluation)		
MO-17	Describe the management procedure and reporting processes for monitoring data. Describe the data management system used to retain, archive and retrieve monitoring data. The PA/CA MonP should identify the frequency and method(s) of reporting the monitoring data. The PA/CA MonP results should be reported no less than annually in the disposal facility ASR for compliance with this Standard. In addition, this section should identify reporting requirements for other CERCLA, RCRA, State and Federal programs which impose regulatory standards and limits on the disposal facility.		

ID	Review Criteria	Criteria Met (Yes/No/ Comment)	Comments
	Monitoring results that are outside of the expected range or exceed compliance thresholds should be described and specifically addressed in the ASR. (5.2.6.3 Management and Reporting of Data)		
MO-18	Describe any reviews and actions that will be taken based on the data evaluation results. (5.2.7 Recommendations Based on Data Evaluation)		
MO-19	Describe the document and program reviews that will be performed based on data evaluation results. Review the PA/CA MonP annually, at a minimum, and appropriately update to ensure it adequately represents and is consistent with the analysis and evaluations conducted to maintain the PA/CA and the current conditions under which the disposal facility operates. (5.2.7.1 Review of PA/CA Monitoring Plan and Related Documents)		
MO-20	Describe the corrective actions that will be taken if monitoring data exceed a compliance standard or reflect deviations from expected conditions in the case of performance monitoring. Address each type of relevant release (e.g., liquid, particulate, gaseous) and the method in which actions will be documented. Describe a graded approach for corrective actions dependent on whether the monitoring result exceeds regulatory criteria or the relative magnitude of monitoring data exceeding the action levels or expected behavior/trend for performance monitoring. This section should state the appropriate actions according to site permits and state/Federal regulations for compliance with performance objectives and/or functional requirements as detailed in the facility PA, CA, other DAS technical basis documents and other CERCLA, RCRA,		

ID	Review Criteria	Criteria Met (Yes/No/ Comment)	Comments
	State and Federal programs which impose regulatory standards and limits on the disposal facility. (5.2.7.2 Corrective Actions)		
MO-21	Provide the complete citations for references cited in the MonP. (5.2.8 References)		
MO-22	Include appendices to the MonP as necessary to provide technical details supporting the data and analyses presented in the MonP. (5.2.9 Appendices)		

CHAPTER 6. WASTE ACCEPTANCE CRITERIA GUIDE

6.1. Introduction

Goal

The goal of this guidance is to support the U.S. Department of Energy's (DOE's) initiatives to improve and maintain the highest quality radioactive waste management standards and activities throughout the DOE complex.

The primary audience of this guide is the Federal Project Director and other DOE/contractor employees involved in the disposal of low-level waste (LLW) and tank closure.

Objective

This guide provides the objectives, additional rationale, examples, and measures of performance with the various criteria needed to develop a Waste Acceptance Criteria (WAC) to ensure the performance assessment (PA) limits and the performance objectives/measures will be met.

All LLW, including mixed [Resource Conservation and Recovery Act (RCRA)] and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) disposal facilities should have an established WAC specifying the requirements for all waste being managed (or disposed) in the facility. WACs should be based upon the facility design and associated capabilities such as volume, handling weight, allowable contents and radiological limits (derived from the PA and other regulatory or safety requirements). Furthermore, any assumptions, limitations and/or conclusions identified in the DAS, supporting technical basis documentation [i.e., PA/ Composite Analyses (CA)], or Documented Safety Analysis (DSA) should be incorporated into the approved WAC, (e.g., activity concentration and inventory limits, waste classes or categories and acceptable waste forms and container requirements). In addition, the WAC should include requirements, as applicable, from U.S. Environmental Protection Agency (EPA), Nuclear Regulatory Commission (NRC), U.S. Department of Transportation (DOT), state and Federal programs that impose regulatory standards and limits on the disposal facility.

Guides do not impose requirements but may quote requirements if the sources are adequately cited. This guidance follows the format of an objective statement, discussion, examples, a statement of one way to measure compliance, and supplemental references. Following this Guidance provides a consistent approach for compliance with the requirements of DOE Order (O) 435.1, *Radioactive Waste Management*. If the Guide has not been followed, then an explanation/justification as to why a different approach is acceptable should be provided.

The LFRG, functioning as the DOE regulatory authority, is the independent organization responsible for performing oversight of LLW disposal and tank closure in accordance with DOE O 435.1 [DOE Manual (M) 435.1-1, *Radioactive Waste Management Manual*, Chapter I, 2.E(1)(a)]. Therefore, the LFRG members utilize this Standard as guidance in performing oversight functions and judging compliance with the requirements of DOE O 435.1. (See LFRG Execution Plan for details of LFRG roles, responsibilities and processes).

6.2. Annotated Outline for Waste Acceptance Criteria

6.2.1. Introduction

This section should provide a brief "background" discussion of the disposal facility for which the WAC apply, and the technical basis upon which the criteria are based.

Objective

The objective of this guide is to provide a description of the facility and the technical basis (e.g., PA, DSA, RCRA, and CERCLA) upon which waste may be accepted into the facility.

Discussion

The WAC should provide the guidance, terms, and conditions under which the DOE will accept radioactive waste (including classified waste) for disposal in a radioactive waste disposal facility. A graded approach, commensurate with the hazards associated with the waste being disposed or the complexity of handling requirements, should be followed when preparing the facility's WAC. In addition, if agreements with state or Federal regulators have been made, a discussion of this relationship should be included in this section.

Additional sections that are recommended to be included in the WAC are a responsibilities and approval process sections. Examples include:

- *Responsibilities:*
    - *DOE Environmental Management Operations Manager – approves waste generators, approves any deviation from requirements, suspension of waste generators certification, if necessary;*
    - *Low-Level Waste Activity Lead – responsible for waste management operations; and*
    - *Radioactive Waste Acceptance Program Manager – responsible for interfacing with generators regarding RWAP program criteria and procedures, scheduling evaluations, maintaining quality records and initiating formal recommendations to the DOE AM regarding status of*

waste generator programs, suspension of waste generators certification, if necessary, and approval of corrective action plans.

Approval Process section should include:

- *Generator document requirements:*
  - *QA Program Plan;*
  - *Waste profiles;*
  - *Certification personnel list; and*
  - *Document and personnel changes notification.*
- *Facility evaluations:*
  - *Audits;*
  - *Surveillances;*
  - *Waste profiles; and*
  - *Sampling.*
- *Approval; and*
- *Suspending approval.*

6.2.2. **Radiological Limits**

This section should identify the radioactivity, concentration and inventory limits, waste classes or categories that may be managed at the facility. Identify any acceptable limits for a waste package's external surface dose rate for contact and remote-handled packages, acceptable contamination levels, and heat generation.

6.2.2.1 Inventory Concentration Limits Summary

This section should ensure the WAC defines radiological limits for the disposal facilities based on the PA. In addition, other source documents such as the DSA, EPA, RCRA or DOT limits should be included as part of the basis for radiological limits. When these source documents limits overlap the PA limits, the most restrictive limit will be used in the WAC. Any limitations on non-radiological content should also be specified.

6.2.2.2 Prohibited Radionuclides Summary

This section should identify the radionuclide, waste form, material or containers prohibited from acceptance at the receiving facility, including the basis for any prohibition.

Objective

The objective of this g is to specifically identify radionuclides and their concentration limits derived from the PA and other documents and to identify specific radionuclides that are prohibited from being disposed at the facility.

Discussion

WAC limits are derived from the PA to ensure the facility is being protective of the public and environment. To ensure these limits are met, waste should be properly characterized to ensure inventory concentrations of radionuclides being presented for disposal will meet the PA limits. Characterization is normally performed through process knowledge or sampling and analysis. Process knowledge relies upon the generator knowledge of the process (radiological and chemical) from where the waste is produced. Documentation should be submitted that attest to waste characterization. Sampling and analysis requires some type of testing to identify the radionuclides and chemicals present in a representative sample of the waste. Documentation may include: representative sample of waste inventory, appropriate analytical procedures that are used and sufficient quality control established to allow proper measurement and documentation of data quality.

WACs may provide a table of acceptable radionuclides along with the upper concentration limit so that generators can easily determine if the waste will be acceptable at the disposal facility. If the concentration is above these "action levels" (Table 6-1), the waste may require more rigorous characterization and approvals or may be prohibited from being disposed.

Examples:

1. *Radionuclide activity concentrations exceeding 1 percent of the action level; and*
2. *TRU radionuclides with concentrations that exceed 1 nCi/g.*

Table 6-1. Radionuclide Action Levels for Waste Characterization and Reporting

Nuclide	Action Level
H3	6.2 E+11 Bq/m-3
C14	5.4E+15 Bq/m-3
Pu238	1.8E+12 Bq/m-3

6.2.3. Waste Form Criteria

This section should identify the following:

- Acceptable waste forms. The PA should be used as one of the bases for acceptable waste forms;
- Restrictions or prohibitions of waste, materials, or containers that may adversely affect waste handlers or compromise facility or waste container performance;
- Requirements associated with acceptance of MLLW and classified waste/material containers, if the facility accepts these wastes;
- Requirements for waste streams needing special attention for receipt, handling, storage treatment, or disposal (e.g., sealed sources), including any additional restrictions or limitations on the waste or specifications for handling the waste containers;
- Site-specific classification or categorization system(s) that require waste stabilization, or additional management steps, for wastes containing certain concentrations of specific radionuclides;
- Requirements associated with acceptance of bulk waste, including any additional restricted materials or limitations on materials; any specific technical requirements the bulk waste should meet for compatibility with treatment, storage, or disposal operations; and the conditions or specifications for handling bulk waste containers that will be returned; and
- Acceptable limits for free liquid content on a per package basis.

Objective

The objective of this guide is to identify specific waste form requirements that can be accepted at the facility as well as waste forms that are prohibited.

Discussion

The following is a potential listing of the various waste form criteria:

1. Transuranic nuclides with half-lives greater than 20 years should not exceed 100 nCi/g.
2. Hazardous waste should not be accepted for disposal.
3. Free liquids should not exceed 1 percent of the volume of the waste when the waste is in a disposal container.
4. Fine particulate waste should be immobilized.
5. Waste gases should be packaged at a pressure that does not exceed 1.5 atmospheres absolute at 20 degrees Centigrade.
6. Where practical, waste should be treated to reduce volume and provide a more stable waste form.
7. Waste containing pathogens, infectious wastes, or other etiologic agents should not be accepted.
8. Waste containing PCBs that meet the requirements for disposal in a solid waste or permitted hazardous waste landfill as specified in the Code of Federal Regulations (CFR) 40 CFR Part 761, *Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce*, *and Use Prohibitions* and Nevada State Environmental Commission (NAC) 444.9452, *Adoption by Reference of Certain Federal Regulations* should be accepted.
9. Waste containing un-reacted explosives should not be accepted.
10. Pyrophoric materials contained in waste should be treated, prepared, and packaged to be nonflammable.

6.2.4. **Waste Package Criteria**

This section should:

- Specify acceptable combinations of waste forms, containers, and packages providing structural stability or inadvertent intrusion protection throughout the life cycle of the waste; the PA should be used as one of the bases for acceptable package criteria; and
- Establish acceptable facility package and conveyance system contamination levels.

6.2.4.1 Package Tracking

This section should identify applicable package labeling and marking requirements including any necessary information about bar coding or other tracking systems used at the facility receiving the waste and the application of the system by generators and operators identifying final disposal location at the disposal facility.

6.2.4.2 Package Durability and Stability

This section should specify waste packages and closures that are designed to ensure the package will withstand the effects of changing temperatures, weather, pressures, and/or vibrations under normal handling and shipping conditions and not breach or lose the package contents. Identify acceptable void space limits consistent with requirements associated with potential subsidence at the disposal facility.

6.2.4.3 Bulk Waste Packaging

This section should identify the guide for bulk non-containerized waste.

Objective

The objective of this guide is to package waste to ensure the safety of workers and protect the public and environment throughout the life cycle of the waste container.

Discussion

Waste packages should meet the requirements identified in DOE Orders, Title 10 CFR, Title 40 CFR and Title 49 CFR requirements, as applicable, such as design, nuclear safety, radiation levels, activity limits, nuclear heating and multiple hazards. The following are some typical waste package criteria examples:

1. *Nuclear criticality safety – the quantity of fissile material in a waste package should be limited so that an infinite array of such packages will be subcritical if the array were to be flooded with water to any credible degree.*

2. *Package activity limitations – are based on Plutonium-239 equivalent-grams. The PE-g limit for all waste packages is 300 PE-g total, except for DOT Type B containers.*

3. *Closure – waste package closures should be designed to ensure they will withstand the effects of changing temperatures, weather, pressures, and/or vibrations under normal handling and shipping conditions and not breach or lose the package contents.*

4. *Strength – disposal package should be capable of supporting uniformly distributed load of 16,477 kg/m2.*

5. *Handling – waste packages exceeding 1mSv/hr. dose rate at 30 centimeters should be considered for remote handling.*

6. *Contamination levels – external contamination levels for waste packages and transport vehicles should meet the release limits specified in title 10 CFR Part 835, Appendix D.*

7. *Marking and labeling – each waste package should be marked and labeled according to Appendix C and should be intact and readable when the shipment arrives at the disposal site.*

8. *Bar coding – each waste package should receive a bar code that meets the specifications in Appendix C that is used to track the package to the final disposal location.*

9. *Waste containers and shipping configuration*

    a. *Waste containers, at a minimum, will be industrial package (IP-1) meeting the requirements of 49 CFR 173.411 and 173.1414.*

    b. *Waste transported as bulk waste with no packaging should be identified on the waste profile with a complete description of the items and the means to which the waste will meet regulatory requirements. These will be approved on a case-by-case basis.*

6.2.5. Waste Transfer and Transportation Requirements

This section should:

- Identify the waste transfer requirements (generator facility to the treatment, storage, or disposal facility) and documentation/record requirements;
- Specify acceptable transportation routes to minimize radiological/chemical risk information on accident rates, time in transit, population density, construction activities, and time of day should be considered when determining radiological risk;
- Specify, if necessary, shipping arrangements, including any electronic traffic data bases or scheduling systems being used;
- Identify any package protection requirements to provide physical protection to the packages to prevent breaching or ensure wastes certification status is preserved; and
- Identify any specific DOE Order (e.g., DOE 460.1C, *Packaging and Transportation Safety*, DOE O 460.2A, *Departmental Materials Transportation and Packaging Management*, and DOE O 461.1C, *Packaging and Transportation for Offsite Shipment of Materials of National Security Interest,* & DOE O 461.2, O*nsite Packaging and Transfer of Materials of National Security Interest*) and/or DOT requirements.

Objective

The objective of this guide is to ensure waste packages are properly approved for transfer from facility to facility through approved transportation routes and in compliance with DOE and Federal regulations.

Discussion

The transfer and transport of waste packages is an important step in the life cycle of the waste. Shipping entities should properly characterize and package the waste to ensure containment is not compromised throughout the transportation process. Proper marking, labeling, coding, and documentation is the foundation of the receiving facility knowing what waste is being presented for disposal and how to properly handle and dispose of the waste to protect the workers. The following are some typical WAC requirements examples:

1. *Shipment scheduling and limitations – mixed LLW and classified shipment frequency are specifically scheduled with the operations manager to accommodate additional processing needs. A schedule of receiving routine waste from generators will be published at the beginning of the fiscal year based upon waste projections from the generators.*

2. *Shipping Arrangement – generators should receive approval from the disposal facility that the waste is acceptable for disposal prior to shipment. The generator should then obtain a shipment date approval from the disposal facility. Waste generators should comply with the following:*

    a. *Security seals attached to the conveyance prior to departure;*

    b. *A "Drivers Questionnaire" should be completed by the transport driver; and*

    c. *Pre-notification information should be entered into HAZTRAK database.*

3. *Consignment of Shipments – specific receiving facility name and address.*

4. *Receiving hours – hours that waste may be delivered are from 0700 to 1400 hours, Monday through Thursday, except holidays.*

5. *Shipping documentation.*

    a. *Accountable or special nuclear material shipments – generators should complete "Nuclear Material Transaction Report" DOE/NRC Form 741*

and a site "Accountable Nuclear Materials Authorization to Ship Waste" form.

b. DOE regulated shipments – generators should complete shipping papers with shipper's certification as required by 49 CFR including "Uniform Hazardous Waste Manifest, classified Matter Hazardous Material Shipping Document" or "Bill of Lading."

6. Shipment certification statement – should be signed by authorized personnel only.

7. Transportation – waste should be shipped in accordance with DOE, DOT, EPA, State and local hazardous waste requirements. Shipments are made by "exclusive-use vehicles" or "dedicated service" only. Motor carriers identified on the DOE Motor Carrier Evaluation Program are automatically approved for use. Shippers must always exercise due diligence when selecting a motor carrier; Motor Carrier Evaluation Program (MCEP) data is not real-time and a motor carrier's credentials (i.e., dated documents) may have lapsed since the last MCEP data run.

6.2.6. Evaluation and Acceptance

This section should:

- Identify the waste evaluation requirements for the receiving facility, including confirmation that both technical and administrative requirements of the WAC have been met;
- Specify the process to be followed for the disposition of non-conforming wastes; and
- Specify the process for evaluating proposed and discovered changes to the WAC for compliance with the requirements in the approved RWMB(s).

6.2.6.1 WAC Deviations

This section should specify the process for WAC deviations and include:

- The nature of the WAC deviation;
- The rationale for the deviation; and
- Demonstration that the deviation does not violate the DAS, supporting technical basis documentation (i.e., PA/CA), DSA, or requirements, as applicable, from EPA, NRC, DOT, state and Federal programs.

Objective

The objective of this guide is to ensure a process for receipt inspection of the waste is established and properly documented including any non-compliant inspections.

Discussion

Waste receipts at the disposal facility is the last line of defense to ensure the facility is being protective of the worker, public and environment. Waste receiving inspections ensure the waste is not only meeting the WAC but that the facility will be in alignment with the assumptions and conclusions identified in the PA. Chapter 8, "Change Control Process" identifies the process to be used for proposed or discovered changes to the WAC. These changes will be evaluated against the assumptions and conclusions of the PA and compared to the RWMB to evaluate any additional changes. QA records should be kept attesting to the fact that the waste receipts meet the administrative and technical requirements identified in previous sections of this chapter. The following are some typical WAC requirement examples:

1. *Waste receipt and records – facility operators are responsible for inspecting waste shipments to the WAC requirements upon arrival and maintaining shipment records. Operator will take receipt of the waste or classified matter after it has been unloaded, inspected, verified, and accepted by facility personnel.*

2. *Disposition of noncompliant conditions – facility operators are responsible for identifying and documenting noncompliance issues discovered when conducting waste receipt and disposal activities. Noncompliance shipments may be returned to the generator facility or require resolution from the generator. Generators should be responsible for dispositioning rejected wastes and coordinating transportation and manifesting back to the generator's site or alternate facility.*

3. *Waste refusal – shipments that do not comply with the WAC will not be accepted for disposal. Reasons for refusal include, but are not limited to, failure to have:*

    a. *Conforming package activity limits;*

    b. *Sufficient funding transferred to the disposal facility to cover the cost of handling and disposal;*

    c. *A DOE/NRC Form 741 on file prior to shipments arrival;*

    d. *A signed certification statement accompanying the shipment;*

e. Successful verification performed on the waste containers in accordance with the WAC and applicable procedures; and

f. Written approval from Material Control and Accountability for shipment of accountable materials.

6.2.7. Waste Documentation and Records Management

This section should identify the documentation/quality records, including waste characterization data and supporting information that should be provided by the waste generator.

Objective

The objective of this guide is to ensure all the proper documentation has been completed by the waste generator prior to waste shipment.

Discussion

Activities affecting the quality of waste certification program should be prescribed and performed in accordance with written instructions, procedures, or drawings and available to those performing the work. A document control system should be established to ensure that these documents are prepared, reviewed, approved, controlled and revised. Generator documents include procedures or records involving the generation, packaging, inspection, characterization and certification of the waste. In addition, documentation required for the transportation of waste should be in compliance with the applicable Federal, state and local requirements (e.g., 49 CFR).

6.2.8. References

This section should include a complete list of citations for materials referenced in the WAC.

6.2.9. Appendices

This section should include appendices to the WAC as necessary to provide technical details supporting the data and analyses presented in the WAC.

6.3. Compliance Demonstration

Compliance with this guide can be demonstrated by a site WAC developed to support the PAs and CAs, reviewed by the LFRG, approved by DOE and implemented in the field to ensure that DOE O 435.1 performance objectives continue to be met. A WAC should be prepared by the contractor and approved by DOE that:

- Makes the WAC consistent with DOE O 435.1;

- Reflects review and approval in accordance with DOE and contractor requirements;
- Meets the Review Criteria for this Chapter; and
- Reflects the Guidance provided for this Chapter.

Copies of this information (at a minimum, the procedures that implement these requirements) should be included in the applicable facility RWMB(s).

6.4. References

DOE Order 435.1, Chg 1, *Radioactive Waste Management*, July 09, 1999

DOE Order 458.1, *Radiation Protection of the Public and Environment*, February 11, 2011

DOE Order 460.1C, *Packaging and Transportation Safety*, May 14, 2010

DOE Order 460.2A, *Departmental Materials Transportation and Packaging Management*, December 22, 2004

DOE Order 461.1C, *Packaging and Transportation for Offsite Shipment of Materials of National Security Interest,* July 20, 2016

DOE Order 461.2, *Onsite Packaging and Transfer of Materials of National Security Interest*, November 1, 2010

DOE Manual 435.1-1, *Radioactive Waste Management Manual*, July 9, 1999

DOE Guide 435.1-1, 1 Admin Chg 2, *Implementation Guide for Use with DOE M 435.1-1*, July 09, 1999

Low-Level Waste Disposal Facility Federal Review Group Manual, Revision 3, 2008

6.5. Waste Acceptance Criteria Review Criteria

The Table 6-2 may be used to evaluate whether the document contents are complete and thorough and the document is technically adequate and defensible. Review criteria may be changed according to the scope and facility being reviewed. However, the LFRG Co-Chairs must approve the review criteria being used in the LFRG Review Plan for a specific facility.

Note: Numbers in parentheses refer to the section number in the chapter.

Table 6-2. Waste Acceptance Criteria Review Criteria

ID	Review Criteria	Criteria Met (Yes/No/)	Comments
W-1	Provide a brief background discussion of the disposal facility for which the WAC apply, and the technical basis upon which the criteria are based. (6.2.1 Introduction)		
W-2	Identify the radioactivity, concentration and inventory limits, waste classes or categories that may be managed at the facility. Identify any acceptable limits for a waste package's external surface dose rate for contact and remote-handled packages, acceptable contamination levels, and heat generation. (6.2.2 Radiological Limits)		
W-3	Define radiological limits for the disposal facilities based on the PA. In addition, other source documents such as the DSA, EPA, RCRA or DOT limits should be included as part of the basis for radiological limits. Use the most restrictive limit in the WAC when other source documents limits overlap the PA limits. Any limitations on non-radiological content should also be specified. (6.2.2.1 Inventory Concentration Limits Summary)		
W-4	Identify the radionuclide, waste form, material or containers prohibited from acceptance at the receiving facility, including the basis for any prohibition. (6.2.2.2 Prohibited Radionuclides Summary)		
W-5	Identify the following: • Acceptable waste forms. The PA should be used as one of the bases for acceptable waste forms; • Restrictions or prohibitions of waste, materials, or containers that may adversely affect waste handlers or compromise facility or waste container performance;		

ID	Review Criteria	Criteria Met (Yes/No/)	Comments
	• Requirements associated with acceptance of MLLW and classified waste/material containers, if the facility accepts these wastes; • Requirements for waste streams needing special attention for receipt, handling, storage treatment, or disposal (e.g., sealed sources), including any additional restrictions or limitations on the waste or specifications for handling the waste containers; • Site-specific classification or categorization system(s) that require waste stabilization, or additional management steps, for wastes containing certain concentrations of specific radionuclides; • Requirements associated with acceptance of bulk waste, including any additional restricted materials or limitations on materials; any specific technical requirements the bulk waste should meet for compatibility with treatment, storage, or disposal operations; and the conditions or specifications for handling bulk waste containers that will be returned; and • Acceptable limits for free liquid content on a per package basis. (6.2.3 Waste Form Criteria)		
W-6	This section should: • Specify acceptable combinations of waste forms, containers, and packages providing structural stability or inadvertent intrusion protection throughout the life cycle of the waste. The PA should be used as one of the bases for acceptable package criteria; and • Establish acceptable facility package and conveyance system contamination levels. (6.2.4 Waste Package Criteria)		

ID	Review Criteria	Criteria Met (Yes/No/)	Comments
W-7	Identify applicable package labeling and marking requirements including any necessary information about bar coding or other tracking systems used at the facility receiving the waste and the application of the system by generators and operators identifying final disposal location at the disposal facility. (6.2.4.1 Package Tracking)		
W-8	Specify waste packages and closures that are designed to ensure the package will withstand the effects of changing temperatures, weather, pressures, and/or vibrations under normal handling and shipping conditions and not breach or lose the package contents. Identify acceptable void space limits consistent with requirements associated with potential subsidence at the disposal facility. (6.2.4.2 Package Durability and Stability)		
W-9	Identify the guidance for bulk non-containerized waste. (6.2.4.3 Bulk Waste Packaging)		

ID	Review Criteria	Criteria Met (Yes/No/)	Comments
W-10	This section should: • Identify the waste transfer requirements (generator facility to the treatment, storage, or disposal facility) and documentation/record requirements; • Specify acceptable transportation routes to minimize radiological/chemical risk. Information on accident rates, time in transit, population density, construction activities, and time of day should be considered when determining radiological risk; • Specify, if necessary, shipping arrangements, including any electronic traffic data bases or scheduling systems being used; • Identify any package protection requirements to provide physical protection to the packages to prevent breaching or ensure wastes certification status is preserved; and • Identify any specific DOE Order (e.g., DOE O 460.1C, O 460.2A, and O 461.1B & O 461.2) and/or DOT requirements. (6.2.5 Waste Transfer and Transportation Requirements)		
W-11	This section should: • Identify the waste evaluation requirements for the receiving facility, including confirmation that both technical and administrative requirements of the WAC have been met; • Specify the process to be followed for the disposition of non-conforming wastes; and • Specify the process for evaluating proposed and discovered changes to the WAC for compliance with requirements in the approved RWMB(s). (6.2.6 Evaluation and Acceptance)		

ID	Review Criteria	Criteria Met (Yes/No/)	Comments
W-12	Specify the process for WAC deviations and include: • The nature of the WAC deviation; • The rationale for the deviation; and • Demonstration that the deviation does not violate the DAS, supporting technical basis documentation (i.e., PA/CA), DSA, or requirements, as applicable, from EPA, NRC, DOT, state and Federal programs. (6.2.6.1 WAC Deviations)		
W-13	Identify the documentation/quality records, including waste characterization data and supporting information that should be provided by the waste generator. (6.2.7 Waste Documentation and Records Management)		
W-14	Include a complete list of citations for materials referenced in the WAC. (6.2.8 References)		
W-15	Include appendices to the WAC as necessary to provide technical details supporting the data and analyses. (6.2.9 Appendices)		

CHAPTER 7. PA/CA MAINTENACE PLAN GUIDE

7.1. Introduction

Goal

The goal of this guide is to support U.S. Department of Energy's (DOE's) initiatives to improve and maintain the highest quality radioactive waste management standards and activities throughout the DOE complex.

The primary audience of this guide is the Federal Project Director and other DOE/contractor employees involved in the disposal of low-level waste (LLW) and tank closure.

Objective

The objective of this guide is to provide additional rationale, examples, and measures of performance for developing a maintenance plan (MP) which supports performance assessments (PAs), composite analysis (CAs) and other technical document revisions. Maintenance consists of four essential activities: compliance and performance monitoring; research and development; planned reviews and analysis; and revisions to the PA/CA.

Guides do not impose requirements but may quote requirements if the sources are adequately cited. This guidance follows the format of an objective statement, discussion, examples, a statement of one way to measure compliance, and supplemental references. Following this guidance provides a consistent approach for compliance with the requirements of DOE Order (O) 435.1, *Radioactive Waste Management*. If the Guide has not been followed, then an explanation/justification as to why a different approach is acceptable should be provided.

The Low-Level Waste Disposal Facility Federal Review Group (LFRG), functioning as the DOE regulatory authority, is the independent organization responsible for performing oversight of LLW disposal and tank closure in accordance with DOE O 435.1 [DOE Manual (M) 435.1-1, *Radioactive Waste Management Manual*, Chapter I, 2.E(1)(a)]. Therefore, the LFRG members utilize this guidance in performing oversight functions and judging compliance with the requirements of DOE O 435.1. (See LFRG Execution Plan for details of LFRG roles, responsibilities and processes)

7.2. Annotated Outline for PA/CA Maintenance Plan

7.2.1. Introduction

This section should describe the purpose and scope of the PA/CA maintenance program and provide an overview of the approach, including site-established priorities. The PA/CA MP should contain:

- Planned maintenance activities and schedules;
- Planned changes to the PA/CA Monitoring Program;
- Research and development activities;
- Planned reviews and analysis;
- Status of DAS conditions and/or limitations;
- Status of LFRG key and secondary issues and plans for resolution; and
- A schedule of PA, CA or other technical basis documents planned revisions and the status of the revisions.

The PA/CA MP should summarize the relationship of the PA/CA MP with other relevant documents associated with the disposal facility. The PA/CA MP should be reviewed annually by the site and updated as needed to address priorities based upon new information or proposed changes, the status of any disposal authorization statement (DAS) conditions/limitations and LFRG issues.

Objective

The objective of this guide is to establish the scope of the PA/CA MP; provide a summary of its relationship with other technical documents including annual review requirement.

Discussion

The PA/CA MP is an essential element of the maintenance process as it serves to identify required activities and the schedules for completing them. The PA/CA MP should be reviewed and approved by the site DOE and reviewed by the LFRG. It should be updated annually to address any new information, proposed changes, and the status of any DAS conditions/limitations and LFRG issues.

7.2.2. Key Assumptions

This section should summarize key assumptions regarding major aspects of the disposal facility, including design, operations, waste form/inventory, and closure, essential to performance

expectations and maintenance of PA/CA/CP until the facility is released from DOE control. It should identify major assumptions such as land use(s), point of assessment (POA), and any interacting end-state facility/waste site configurations and inventories [including decontamination and decommissioning (D&D), Resource Conservation and Recovery Act (RCRA), and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) actions] not directly related to the disposal facility and the linkage to planned or required maintenance activities.

Objective

The objective of this guide is to ensure the key PA/CA assumptions are identified in the MP.

Discussion

The PA/CA documents identify key assumptions that the modeling results and conclusions are based upon and then compare those results to the performance objectives/measures identified in DOE O 435.1. Other technical [e.g., CP, Waste Acceptance Criteria (WAC)] documents are developed using these PA/CA key assumptions and conclusions. If changes occur that affect key assumptions, the PA/CA MP should be revised to capture the activities that should be completed (e.g., MonP revision) to ensure continued protection of the public and environment.

Examples of key assumptions:

- Institutional control will be maintained for 100 years;
- Minimum of 4-feet of native soil will be placed over the waste;
- At least 25-feet should be maintained from the bottom of the waste to the aquifer;
- No more than 25 Ci of Tritium may be disposed in the facility; and
- Only onsite LLW will be accepted for disposal.

7.2.3. Monitoring

This section should provide an overview of the monitoring program and describe any planned changes to the PA/CA MonP, special monitoring studies, or monitoring-related oversight activities (e.g., site-wide groundwater model consistency committee reviews).

Planned changes to the PA/CA MonP should be presented to the LFRG for review and approval prior to implementation of the planned changes. A detailed description of the planned change, the purpose of the change, and linkage to PA/CA performance objective and DAS conditions or limitations should be provided.

Objective

The objective of this guide is to identify any changes that need to be made to the MonP or special monitoring studies required to support the PA/CA or operations of the disposal facility.

Discussion

Monitoring is an essential part of ensuring the facility is performing as outlined in the PA and in ensuring compliance with performance objectives/measures or other Federal/state regulations. Identifying and planning special monitoring studies to support the PA/CA is critical in maintaining these documents. In addition, reviewing and updating the MonP on an annual basis is essential in the maintenance process to demonstrate regulatory standards have not been exceeded and to verify modeling assumptions and analyses with empirical data and information.

This guide also ensures that the LFRG has reviewed and approved any planned changes to the MonP prior to implementation. The MonP is closely linked to the PA/CA and any planned changes should be reviewed by the LFRG to ensure monitoring activities are supporting the performance or compliance of the facility. The plan change should be described in detail, the purpose of the change compared to the current condition, and how this change will support either the PA/CA results and conclusions or a DAS condition or limitation.

7.2.4. Research and Development

This section should describe any ongoing or planned research and development (R&D) activities required to manage and/or reduce the uncertainty associated with the PA/CA/CP. Each activity should be linked to a specific need related to the PA/CA, change control, or resolution of LFRG conditions or review issues.

Objective

The objective of this guide is to ensure R&D activities essential in maintaining the PA/CA are identified in the MP.

Discussion

R&D addresses information needs (typically prioritized based on sensitivity and uncertainty analyses) in order to increase confidence levels in PA/CA results/conclusions. Monitoring results, DAS conditions/limitations, or change control process evaluation results could identify conditions that will require R&D activities. R&D work should have clearly stated goals to support defensible assessments while maintaining an appropriate, but not excessive, conservative basis.

7.2.5. Planned Review and Analysis

This section should describe all planned and/or ongoing reviews including:

- The Disposal Facility Annual Summary Report (ASR) (Chapter 9);
- Review of PA, CA, and other DAS technical basis documents;
- Review of UDQE/special analysis (SA); and
- Review of radioactive waste management basis (RWMB).

The review may be performed by DOE and other regulatory authorities [U.S. Environmental Protection Agency (EPA)/State/ Nuclear Regulatory Commission (NRC)].

7.2.5.1 Status of DAS Conditions/Limits

This section should identify any conditions/limits identified in the DAS; including a proposed schedule for resolution/compliance for each. A description of other conditions imposed by the Program Secretarial Officers (PSO) that require the PA/CA MP to track should also be included. A schedule should be developed for resolution of DAS Conditions/Limits (e.g., revision of the MonP within 1 year of issuance of the DAS).

7.2.5.2 LFRG Key and Secondary Issues

This section should identify the DAS conditions/limits most commonly linked to key or secondary issues identified in the LFRG Review Report for the PA/CA or other DAS technical basis documents. Additionally, this section should specify expectations regarding the actions necessary to resolve any outstanding LFRG review secondary issues.

The objective of this guide is to ensure all planned and ongoing reviews are identified in the MP.

Discussion

Planned reviews and analysis provide a structured approach for evaluating new information or proposed changes and confirm the continued adequacy of the PA/CA and the conditions/limits in the DAS. In addition, any DAS conditions, limitations and issues that are identified by the LFRG are tracked until resolved through the MP. Examples of periodic reviews and analyses are:

- Unreviewed disposal questions evaluations;
- SAs;
- LFRG PA & CA reviews; and

- Annual Summary reviews.

This guide also ensures DAS conditions/limitations are identified in the MP and tracked until resolved. Conditions/limitations are identified in the DAS and placed on the facility as a result of the LFRG review and recommendations to the Deputy Assistant Secretary.

Condition examples include:

- *A facility being required to evaluate a key assumption (K_d value of Tc-99) in more detail through R&D or field studies within a year of DAS issuance;*
- *Update the MonP within one year of DAS issuance; and*
- *Track and resolve all LFRG secondary issues in the MP.*

Example of a limitation: disposal of tritium should be limited to 12 Ci.

This guide also ensures that all key and secondary issues are properly tracked and resolved. Key and secondary issues are a result of the LFRG review of the PA/CA and technical documents. Issues that are not resolved at the time of the review should be identified in the LFRG Issue Data Base (see LFRG Execution Plan) and the sites MP and tracked until properly resolved. Table 7-1 is an example of how to display and track the resolution status of secondary Issues.

Table 7-1. Example: Secondary Issues Status Table

No.	Issue	Resolution	Response
7.1.1	**Sensitivity and Uncertainty Analyses (SA)**		
	The sensitivity and uncertainty analysis (SA) in the performance assessment is incomplete and does not increase confidence in the overall results of the PA. The SA should focus on the most sensitive parts of the PA, release and transport of non-sorbing radionuclides from the slit and engineered trenches.	Additional work on sensitivity and uncertainty analysis is required at a level that increases confidence in the robustness of the waste concentration limits and sum of fractions. This could be accomplished through deterministic or probabilistic SA. The use of probabilistic methods is preferred and would allow for global versus local SA. However, effective use of probabilistic SA will require resolution of concerns with the current GoldSim model and is expected to take some time. In the near term adequate confidence in the SA may be gained through focusing the SA on the components of the disposal system most likely to compromise compliance with performance objectives; the non-sorbing radionuclides disposed in the slit and engineered trenches. A more thorough discussion of existing deterministic analyses relevant to non-sorbing radionuclide disposal in slit and engineered trenches with some additional analyses is needed.	Information provided through factual accuracy includes new analysis that bracket model results for operationally controlled aspects of waste disposal operations (percentages of non-crushable waste and the presence or absence of cellulose degradation products for the slit and engineered trenches. Additional clarification was provided on infiltration conditions and how these conditions vary during modeling simulations corresponding to operational and institutional control periods and for alterative assumptions of closure cover performance. Sum-of-fraction limits were calculated for the non-sorbing radionuclides using forecast closure inventories for a representative disposal unit. These sum of fractions remain well below the base case and strengthen the argument that the base case is acceptably conservative. Collectively, the additional material increased confidence in the PA results to a sufficient level to reduce the sensitivity and uncertainty of the key issue to a secondary issue. As a secondary issue, multiple aspects of sensitivity and uncertainty analysis

No.	Issue	Resolution	Response
			will continue to be evaluated through maintenance studies as described in item 2.1.2 of the Maintenance Plan.
7.1.2	**Justification of Data for Non-Sorbing Radionuclides (Criterion 3.1.9.2)**		
	The current PA analysis assumes slight sorption of Tc-99 in the subsurface following release from slit and engineered trenches. Given this assumption, derived disposal limits for non-sorbing and slightly sorbing radionuclides and sum of fractions calculations indicate that groundwater protection limits are met. That is, the sum of fractions value is less than unity. The assumption of slight sorption of Tc-99 in the subsurface is not fully justified with existing data. Most studies of radionuclide transport assume a K_d of 0 for Tc-99 and thus the SRS needs to demonstrate convincingly an acceptable basis for a Tc-99 K_d of > 0. If Tc-99 is non-sorbing (K_d = 0 mL/g), estimates of groundwater contamination levels will increase because the contribution of Tc-99 will be added to that of other non-sorbing radionuclides, primarily H-3 and C-14. This outcome will cause some reduction of disposal limits for these radionuclides and an increase in the sum of fractions estimate for currently filled trenches or other trenches to be filled using currently derived disposal limits. It is possible that the sum of fractions value may exceed unity, thereby causing	Additional information will be provided regarding site specific justification for the assumed value of 0.1 ml/g for the Tc K_d. The information will address a review of literature values and site-specific experiments that have been conducted to estimate the Tc K_d as well as a discussion of site specific soil properties that are important to determination of Tc mobility (e.g., iron content, clay content). If the information is sufficient to justify the use of 0.1 ml/g as the K_d for Tc, then the issue can be considered fully resolved. If the site-specific information is not sufficient to justify the use of 0.1 ml/g as the K_d for Tc, then additional groundwater pathway simulations for the slit and engineered trenches will be needed. If necessary, the additional groundwater pathway analyses for Tc-99 released from slit and engineered trenches will need to assume a K_d of 0 ml/g or some value less than 0.1 ml/g as agreed with the review team. Subsequent changes to cumulative peak contamination levels for non-sorbing radionuclides, disposal	The Lab provided supplemental Tc-99 sorption data for the PA analysis in a technical report which was briefly discussed and referenced in the Background chapter of the PA. This key issue was subsequently reduced to a secondary issue. Site-specific laboratory batch K_d analyses will be completed to determine whether Tc-99 is either slightly or truly non-sorbing in the subsurface and PA results and conclusions will be revised accordingly.

No.	Issue	Resolution	Response
	unacceptable burial ground performance either for currently filled trenches or future trenches. The current analysis does not allow a determination of the potential for this outcome.	limits, and sum of fractions calculations can then be determined. If the additional analyses indicate that sums of fractions do not exceed unity for currently filled disposal units, no additional actions are necessary for these units and this issue can be reduced to a secondary issue for future units. If the analyses indicate a sum of fractions greater than unity, then additional actions should be taken to achieve compliance with DOE Order 435.1. If the issue reduces to a secondary issue, then site-specific laboratory batch K_d analyses should be completed to determine whether Tc-99 is either slightly or truly non-sorbing in the subsurface. Depending on the outcome of the data produced, currently derived Tc-99 and other non-sorbing radionuclide disposal limits may be revised. Subsequent sum of fractions estimates should be calculated accordingly.	

Note: The Sum of Fraction rule for mixtures of radionuclides is used to determine the amount of each radionuclide that can be disposed based on its limit derived from the PA. It is calculated by dividing each nuclides concentration by the appropriate limit and adding each of the resulting values. If the sum is less than 1.0, then the limit has not been exceeded

7.2.6. Planned Maintenance Activities and Schedules

This section should provide a listing of planned maintenance activities and their proposed schedule (funding estimates/expectations) for each of the four essential maintenance components (compliance and performance monitoring, R&D activities, periodic reviews and analyses, and revision of the PA/CA).

Objective

The objective of this guide is to ensure that planned activities and associate schedules are identified in the MP.

Discussion

The MP supports the DAS and issues identified by the LFRG during review of the PA/CA and technical documents. Should funding not be available at the levels indicated in the MP, the plan scope should be reanalyzed to ensure essential activities are sustained. Projected out-year cost in the MP does not commit DOE to fund these activities but simply represents possible future cost to complete an activity. Table 7-2 is an example of a MP activities cost and schedule. In addition, the table should be backed up with justifications that identify the activity to resolve any issues.

Table 7-2. Example of Maintenance Plan Schedule of Activities

Analysis Activity	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	Total
Evaluate impact of numerical dispersion on PA limits.	80	75	0	0	0	0	0	0	0	0	155
Update the Closure Plan.	30	30	0	0	0	0	0	30	30	30	150
Evaluate potential cementitious degradation mechanisms.	10	0	0	0	0	0	0	0	0	0	10
Evaluate alternative disposal of high tritium and other production waste.	0	0	200	0	0	0	0	0	0	0	200
Measure hydraulic properties to validate PA assumptions.	5	0	0	0	0	0	0	0	0	0	5
Re-evaluate operational covers.	100	0	0	0	0	0	0	0	0	0	100

Analysis Activity	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	Total
Develop initial three-dimensional Vadose zone model.	100	0	0	0	0	0	0	0	0	0	100
Construct and monitor geochemical lysimeters for site specific K_ds.	160	50	50	50	50	50	50	50	50	50	610
Conduct annual PA monitoring validation.	25	25	25	25	25	25	25	25	25	25	250
Install and expand vadose zone monitoring system.	33	33	0	0	0	0	0	0	0	0	66
PA Total	**543**	**213**	**425**	**225**	**225**	**225**	**225**	**255**	**255**	**225**	**2816**
Perform CA annual review.	60	60	60	60	60	60	60	60	60	600	675
Perform Special Analyses to maintain CA baseline.	0	100	100	100	100	100	100	100	100	900	900
Maintain CA models and database.	20	20	20	20	20	20	20	20	20	200	0
CA Total	**80**	**180**	**180**	**180**	**180**	**180**	**180**	**180**	**180**	**180**	**1700**
GRAND TOTAL: PA + CA	**623**	**393**	**605**	**405**	**405**	**405**	**405**	**405**	**405**	**405**	**4456**

Note: Dollar values do not reflect actual budget request but are estimates for planning purposes only.

Example Justifications:

Evaluate Impact of Numerical Dispersion on PA Limits

a. Description: Numerical dispersion is an artifact of all numerical modeling. It arises from trying to reduce numerical oscillations resulting from solving contaminant transport equations. This effect appears as an overshoot and undershoot near the concentration front, thus 'smearing' contamination across the interface between adjacent cells. Numerical dispersion in the PA models needs to be investigated to determine the extent of this phenomenon and to take appropriate compensatory measures, if they are needed. The impact of numerical and mechanical dispersion in PORFLOW on peak solute concentrations was examined in PORFLOW QA testing and verification for a one-dimensional

saturated soil column. This study showed that fine mesh resolution is needed to capture the peak solute concentration in PORFLOW if no mechanical dispersion is present. SRNL will address numerical dispersion in two and three dimensions in this study.

b. Milestone: Final report

c. Due Date: FY17

d. Responsibility: NL

e. Estimated Cost: FY16 $80K

Update E Area Low-Level Waste Facility (ELLWF) Closure Plan:

a. Description: LLW management is regulated under DOE Order 435.1. DOE-HQ signed revision 1 of the DAS on 7/15/2008 authorizing continued operation. The DAS conditions of approval include a requirement to revise the CP as necessary to address any deviations from the closure concept analyzed in the PA. The CP was revised in 2014 to align with the closure concept evaluated in the 20013 revision of the PA and subsequent Special Analysis of Operational Stormwater Runoff Covers (SA-20013-00397). Going forward, the CP will be reviewed annually to determine if actions taken during the previous year or any new information results in the need to change the closure concept. In FY15, site will have a conceptual closure cap design prepared, including a conceptual layout (i.e., Plot Plan) and profile. The conceptual design will incorporate an HDPE liner into the closure cap profile. In FY14 site-specific HELP modeling will be conducted incorporating both the new conceptual layout of the cap and the revised cap profile that includes the new HDPE layer. This work is needed as input to the next PA revision planned for FY19.

b. Milestone: Revised plan in FY17. Annually Maintain CP in accordance with DOE O 435.1

c. Due Date: Annually

d. Responsibility: NL

e. Estimated Cost: FY16 $30K

7.2.7. Revisions to DAS Documents

This section should describe any planned or ongoing revisions of the DAS, PA, CA, PA/CA MonP, WAC, UDQE, Unreviewed Composite Analysis Question Evaluation (UCAQE), CP, or RWMB. The annual review and assessment of the PA/CA MP should be scheduled in coordination with the ASR so than any revisions to the DAS technical basis documents and the results of those revisions are reported in the ASR.

Objective

The objective of this guide is to ensure the revisions to the DAS, technical documents, and RWMB are coordinated with the issuance of the ASR.

Discussion

The ASRs (Chapter 9) are completed after the end of the fiscal year and assess the need for changes to the DAS, technical documents, and RWMB. The primary purpose of the ASR is to identify all the changes that have occurred, are ongoing, or are planned to occur at the disposal facility to HQ and the LFRG. The proposed revisions to the DAS, technical documents, and the RWMB are used for planning purposes to identify the need for HQ/LFRG reviews.

Examples of proposed revisions to the DAS, PA, CA are changes in:

- *Waste forms or containers;*
- *Radionuclide inventories;*
- *Facility design and operations;*
- *Closure concepts;*
- *Conceptual model;*
- *K_d value to a key radionuclide that significantly affects dose;*
- *The location of the site boundary in land use plans; and*
- *DAS conditions (secondary issues verified complete).*

7.2.8. References

This section should identify references cited in the PA/CA MP.

7.2.9. Appendices

This section should include appendices as necessary to provide details supporting the PA/CA MP.

7.3. Compliance Demonstration

Compliance with the requirement in DOE O 435.1 to conduct PA and CA Maintenance can be demonstrated by a site MP developed to support the PA and CA, reviewed by the LFRG and approved by DOE management to ensure that DOE O 435.1 performance objectives continue to be met.

Copies of this information (at a minimum, the procedures that implement these requirements) should be included in the applicable facility RWMB(s).

7.4. References

DOE Order 435.1, Chg 1, *Radioactive Waste Management*, July 09, 1999

DOE Order 458.1, *Radiation Protection of the Public and Environment*, February 11, 2011

DOE Manual 435.1.1, *Radioactive Waste Management Manual*, July 09, 1999

DOE Guide 435.1-1 Admin Chg 2, *Implementation Guide for Use with DOE M 435.1-1, July 09, 1999*

Low-Level Waste Disposal Facility Federal Review Group Manual, Revision 3, 2008

7.5. Maintenance Plan Review Criteria

The Table 7-3 may be used to evaluate whether the document contents are complete and thorough and the document is technically adequate and defensible. Review criteria may be changed according to the scope and facility being reviewed. However, the LFRG Co-Chairs must approve the review criteria being used in the LFRG Review Plan for a specific facility.

Note: Numbers in parentheses refer to the section number in the chapter.

Table 7-3. Maintenance Plan Review Criteria

ID	Review Criteria	Criteria Met (Yes/No/ Comment)	Comments
MA-1	Describe the purpose and scope of the PA/CA maintenance program and provide an overview of the approach, including the site-established priorities for maintenance activities for the PA/CA, MonP, and CP. Summarize the relationship of the PA/CA MP with other relevant documents associated with the disposal facility. The PA/CA MP should be reviewed annually by the site and updated as needed to address priorities based upon new information or proposed changes, the status of any disposal authorization statement (DAS) conditions/limitations and LFRG issues. (7.2.1 Introduction)		
MA-2	Describe key assumptions regarding major aspects of the disposal facility including design, operations, waste form/inventory, and closure, essential to the performance expectations and maintenance of the PA/CA and CP until the facility is released from DOE control. It should identify major assumptions such as land use(s), point of assessment (POA), and any interacting end-state facility/waste site configurations and inventories [including decontamination and decommissioning (D&D), Resource Conservation and Recovery Act (RCRA), and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) actions] not directly related to the disposal facility. (7.2.2 Key Assumptions)		
MA-3	Provide an overview of the monitoring program and describe any planned changes to the PA/CA MonP, special monitoring studies, or monitoring-related oversight activities (e.g., site-wide groundwater model consistency committee reviews). (7.2.3 Monitoring)		

ID	Review Criteria	Criteria Met (Yes/No/ Comment)	Comments
MA-4	Describe any ongoing or planned research and development (R&D) activities associated with managing and/or reducing the uncertainty associated with the PA/CA/CP. Each activity should be linked to a specific need related to the PA/CA, change control, or resolution of LFRG conditions or review issues. (7.2.4 Research and Development)		
MA-5	Describe all planned and/or ongoing reviews including the disposal facility annual summary report (ASR) (Chapter 9); review of PA, CA, and other DAS technical basis documents, UDQE/SA as well as reviews of radioactive waste management basis (RWMB), or by DOE and other regulatory authorities [U.S. Environmental Protection Agency (EPA)/state/ Nuclear Regulatory Commission (NRC)]. (7.2.5 Planned Review and Analysis)		
MA-6	Identify any conditions/limits identified in the DAS; including a proposed schedule for resolution/compliance for each. A description of other conditions imposed by the PSO that require the PA/CA MP to track should be included. A schedule should be developed for resolution of DAS Conditions/Limits (e.g., revision of the MonP within 1 year of issuance of the DAS). (7.2.5.1 Status of DAS Conditions/Limits)		
MA-7	Identify the DAS conditions/limits most commonly linked to key or secondary issues identified in the LFRG Review Report for the PA/CA or other DAS technical basis documents. Additionally, this section should specify expectations regarding the actions necessary to resolve any outstanding LFRG review secondary issues. (7.2.5.2 LFRG Key and Secondary Issues)		

ID	Review Criteria	Criteria Met (Yes/No/ Comment)	Comments
MA-8	Provide a listing of planned maintenance activities and their proposed schedule (funding estimates/expectations) for each of the four essential maintenance components (compliance and performance monitoring, R&D activities, periodic reviews and analyses, and revision of the PA/CA). (7.2.6 Planned Maintenance Activities and Schedules)		
MA-9	Describe any planned or ongoing revisions of the DAS, PA, CA, PA/CA MonP, WAC, UDQE, Unreviewed Composite Analysis Question Evaluation (UCAQE), CP, or RWMB. The annual review and assessment of the PA/CA MP should be scheduled in coordination with the ASR so than any revisions to the DAS technical basis documents and the results of those revisions are reported in the ASR. (7.2.7 Revisions to DAS Documents)		
MA-10	Identify references cited in the PA/CA MP. (7.2.8 References)		
MA-11	Include appendices as necessary to provide details supporting the PA/CA MP. (7.2.9 Appendices)		

CHAPTER 8. CHANGE CONTROL PROCESS GUIDE

8.1. Introduction

Goal

The goal of this guide is to support the Department of Energy's (DOE's) initiatives to improve and maintain the highest quality radioactive waste management standards and activities throughout the DOE complex.

The primary audience of this guide is the Federal Project Director and other DOE/contractor employees involved in the disposal of low-level waste (LLW) and tank closure.

Objective

The objective of this guide is to provide additional rationale, examples, and measures of performance to addresses the change control process for (performance assessments) PAs, composite analyses (CAs), and technical basis document revisions.

Guides do not impose requirements but may quote requirements if the sources are adequately cited. This guidance follows the format of an objective statement, discussion, examples, a statement of one way to measure compliance, and supplemental references. Following this guidance provides a consistent approach for compliance with the requirements of DOE Order (O) 435.1, *Radioactive Waste Management*. If the Guide has not been followed, then an explanation/justification as to why a different approach is acceptable should be provided.

The LFRG, functioning as the DOE regulatory authority, is the independent organization responsible for performing oversight of LLW disposal and tank closure in accordance with DOE O 435.1 [DOE Manual (M) 435.1-1, *Radioactive Waste Management Manual*, Chapter I, 2.E(1)(a)]. Therefore, the Low-Level Waste Disposal Facility Federal Review Group (LFRG) members utilize this guidance in performing oversight functions and judging compliance with the requirements of DOE O 435.1. (See LFRG Execution Plan for details of LFRG roles, responsibilities and processes).

8.2. Annotated Outline for Change Control Process Procedure

8.2.1. Introduction

This section should describe the sites overall process to ensure the information, assumptions and results delineated in the PA/CA remain valid when new information resulting from research and development, proposed changes in operational activities, or discoveries of information that was not previously analyzed in the PA/CA are discovered. Each site will have its own unique screening and evaluation criteria based up the PA/CA.

As stated above, this guide follows the format of an objective statement, discussion, examples, statement of one way to measure compliance, and supplemental references. Following this guide will ensure compliance with the requirements in DOE O 435.1 to provide a change control process procedure for PAs and CAs. This guide describes and provides an annotated outline for a change control process as an example of one way to meet the DOE O 435.1 requirement. This change control process is modeled after the Unreviewed Safety Question (USQ) process used in DOE safety requirements in the Code of Federal Regulations (CFR), 10 CFR 830.203, and thus the terms Unreviewed Disposal Question Evaluation (UDQE), Unreviewed Composite Analysis Question Evaluation (UCAQE), and Special Analysis (SA) are provided as an example of how to meet the requirements. If the guide is not followed, then an explanation/ justification as to why a different approach is acceptable should be provided.

DOE should oversee the development and implementation of a change control process as described in this Standard. In the example provided, DOE should ensure evaluations of proposed changes or new information take place [Unreviewed Disposal Question Evaluation (UDQE)/ Unreviewed Composite Analysis Question Evaluation (UCAQE)]. DOE should also ensure that the PAs, CAs and special analyses (SAs) are approved by the DOE Field Element Manager. In addition, the DOE LFRG site member should ensure all evaluations (UDQEs/UCAQEs), PA, CA, and SAs are included in the ASR and the site radioactive waste management basis (RWMB). Procedures should be established that delineate the specific responsibilities and authorities of each entity in the DOE and contractor offices.

Objective

The objective of this guide is to ensure that the assumptions, results, and conclusions of the approved PA, and CA (including any SA), remain valid and that the changes are within the bounds of the disposal authorization statement (DAS) requirements, conditions, or limitations and intended to ensure that proposed activities, discoveries, or new information in LLW/transuranic radioactive waste (TRU)/ Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) disposal practices are reviewed at the appropriate level and frequency.

Discussion

The UDQE/UCAQE has been established to mimic the Unreviewed Safety Question (USQ) process (10 CFR 830.203, *Nuclear Safety Management*). The USQ program applies to reviews of proposed activities/new information against the safety basis such as the Documented Safety Analysis (DSA) Report, while the UDQE/UCAQE applies to reviews of proposed activities, discoveries or new information to ensure that at a minimum, the PA and CA have properly evaluated and enveloped the proposed change or new information. See Attachment 8-5, USQ/UDQE/SA Integrated Process Flowchart.

This chapter provides a change control process for PAs and CAs when proposed activities/changes and new information/discoveries outside the envelope of conditions analyzed in the PA/CA are proposed. The change control process is documented through the preparation of an UDQE, UCAQE, or a SA procedure and approved at the appropriate DOE and contractor level. The UDQE/UCAQE/SA process should be part of a facility's RWMB and DAS.

Sites should develop procedures that detail clear lines of DOE and contractor responsibilities and authorities; and provide direction on performing screening, detailed evaluations, and SA, when required. These are key to ensuring the disposal facility will continue to meet the performance objectives delineated in DOE O 435.1.

In order to ensure compliance with this guide, a SA may be initiated for, but not limited to, the following matters:

- During the annual PA/CA review, the DOE field office or contractor identifies a concern or potential problem that needs to be evaluated. Resolution of the concern may require the acquisition of data through monitoring, testing, or research, or the use of existing data in a SA;
- The PA/CA technical expert may determine the need for SA due to errors found in the prior analyses or to improve a prior analysis (e.g., reduce conservatism);
- Ongoing monitoring, testing, and research may yield results that warrant evaluation to determine their significance to the conclusions in the PA/CA;
- Disposal of radionuclides not analyzed in the PA/CA;
- Disposal of waste streams not analyzed in the PA/CA;
- Changes in waste forms that could impact release rates for critical radionuclides;
- Waste exceeds the total inventory analyzed for PA/CA significant radionuclides;
- Changes in the facility design or operation from those described or evaluated in the PA/CA;
- A desire to take credit for a feature or mechanism that was not considered in the PA/CA; and
- Changes to the CP that have not been analyzed for impact to the PA/CA.

In order to properly implement the change control process at a disposal site, a formal organizational structure should be established.

An example of an acceptable organizational structure is as follows: A PA/CA Review Committee (PARC) is established in the contractor organization that is responsible for operating the disposal facility. The PARC is normally responsible for review and approval of UDQE/UCAQE screenings and evaluations. This committee also reviews PA, CA, and SA. The PARC should be chaired by the organization responsible for the LLW/TRU/CERCLA disposal

facility operations, but has membership consisting of DOE O 435.1, engineering, PA/CA technical, subject matter experts. The DOE LFRG site representative should stay abreast of all developments brought before the PARC and may be a non-voting member. Screenings and UDQE's are approved by the PARC and disposal facility manager. The DOE Field Element Manager (FEM) or his/her designee should develop procedures for DOE field office review and approval of SAs that are submitted by the contractor.

8.2.2. UDQE/UCAQE

8.2.2.1 Screening

This section should describe the PA/CA screening process and criteria being used to determine whether a PA/CA evaluation is needed on the proposed activity, discovery or new information. The following process should be used in performing a PA or CA Screening:

- Define the proposed activity, change or new information outside the envelope of conditions analyzed in the PA/CA or DAS documents;
- Review the activity, or new information against the screening criteria;
- Document the potential impacts to the facility operations, processes or disposal limits approved in the DAS or technical basis documents;
- Document the need for further evaluation; and
- Obtain the appropriate contractor review and approval levels (DOE approval is not required).

Objective

The objective of this section is to ensure that sites have developed procedures that describe the screening process to be used when evaluating proposed activity, discovery or new information.

Discussion

Attachment 8-1, *Unreviewed Disposal Question Screening Criteria*, and Attachment 8-3, *Unreviewed Composite Analysis Question Screening Criteria*, provides examples of the questions a site may use in implementing a screening process. Each site will be different and should develop criteria appropriate for their facility.

If the UDQ screening results for the proposed activity, discovery, or new information is positive (positive means that the screening cannot determine if the proposed activity, discovery, or new information is within the analysis boundaries of the PA or CA), the PARC should approve the screening, when at a minimum, a PA/CA evaluation is needed. The Design Authority Engineer may determine that a SA is required and the evaluation step can be skipped allowing the SA to be performed without the evaluation, but only after consultation with the PARC (e.g., DOE O

435.1 experts, Facility Engineering Manager, and the PA/CA technical experts). The PARC should approve the Design Authority Engineers' determination that a SA is required prior to starting the SA.

8.2.2.2 Evaluation

This section should describe the PA/CA evaluation process and criteria being used to determine whether the proposed activity, discovery or new information is within the bounds of the current PA/CA assumptions or conclusions and if further technical evaluation is necessary through the development of a SA. The following process should be used when performing a PA or CA evaluation:

- Define the proposed activity, change or new information outside the envelope of conditions analyzed in the PA/CA or DAS documents;
- Review the activity, or new information against the evaluation criteria;
- Document the potential impacts to the facility operations, processes or disposal limits approved in the PA/CA and obtain the appropriate contractor review and approvals;
- Document the need for further evaluation through the development of a SA, as appropriate; and
- Proposed activities may be implemented if the proposed activity passes the evaluation criteria.

Objective

The objective of this requirement is to ensure that sites have developed procedures that describe the evaluation process to be used when evaluating proposed activity, discovery or new information.

Discussion

Attachment 8-2, *Unreviewed Disposal Question Evaluation*, and Attachment 8-4, *Unreviewed Composite Analysis Question Evaluation*, provides an example of the questions a site may use in implementing an evaluation process. Each site will be different and should develop criteria appropriate for their facility.

Prior to approval to proceed with any proposed activity or incorporate new information, a PA/CA evaluation is needed to determine if the proposed activity, discovery, or new information is within the bounds of the current PA/CA/DAS. If the proposed activity is within the bounds of the PA/CA/DAS, the PA/CA evaluation is documented, the proposed activity may be approved, and the issued closed. If the proposed activity is outside the bounds of the current PA/CA/DAS

or is indeterminate, a SA should be developed. Each site should develop their own evaluation criteria with its own unique set of evaluation criteria based on its PA/CA.

Process example:

- *The UDQ Evaluation Originator (EO) will check the appropriate box(es) of Attachment 8-4 and then support the conclusion in the space provided, including references. A continuation sheet(s) may be attached if the space provided is not adequate.*

- *If the EO answered each question "NO", this indicates a SA is not necessary. In this case, the PA/CA evaluation is the authorizing document, after a peer review and PARC approval. A "YES" answer to any question on the PA/CA evaluation indicates that a SA should be prepared. The evaluation form should be signed and forwarded to the peer reviewer. If the peer reviewer concurs with the EO, the peer reviewer indicates concurrence and forwards the PA/CA evaluation to the EO for review and approval by the PARC. Whenever the peer reviewer disagrees with the finding(s) of the EO, the peer reviewer returns the PA/CA evaluation with comments to the EO for resolution.*

- *If a decrease in any specific PA radionuclide limit results from the proposed activity, discovery, or new information, a SA should be performed to quantify the revised limits. An increase in the PA limit caused by the new information will require a SA only if the increase in PA limit is to be implemented. If it is unknown whether or not the proposed activity, discovery, or new information will decrease PA limits, then a SA should be performed. If the PARC has unresolved comments or questions, the package is returned to the EO for resolution.*

- *If the proposed activity, discovery or new information does not require a SA, the PARC so indicates and forwards the form back to the EO. The proposed activity is approved for implementation or discovery/new information is accepted.*

- *If a SA is determined to be necessary (any question in Attachment 8-4 is answered "YES" for the proposed activity, discovery, or new information), the PARC forwards a request to the EO for either cancellation; modification such that it no longer would involve a SA; or preparation of a SA and DOE Approval Request.*

8.3. Special Analysis (SA)

The primary role of the SA should be to evaluate through modeling or other technical evaluation methods the impact of a proposed activity, discovery, or new information to the input and assumptions or results in the PA/CA, or to supplement or amend the analyses performed in the original PA/CA. A SA should be approved by DOE before any proposed activities can be implemented.

In order to ensure compliance with the requirements, the SA should be presented to the PARC for review and approval and then submitted to the local DOE for approval. As seen in the Requirements, a proposed activity requiring a SA should not be implemented until the DOE approves the SA. In addition, the DOE LFRG representative should monitor the implementation of this guide and ensure a summary of the SA is provided in the annual summary report (ASR) presented to the LFRG for review and DOE Headquarters (HQ) approval at the end of the fiscal year.

If the SA is not approved, appropriate responses include:

- Do not implement proposed activity;
- Modify the proposed activity, conduct further analysis, collect additional data; and
- Revise the SA and resubmit to DOE for approval.

The annotated outline should be utilized by sites to develop an effective SA unless the DOE disposal facility staff request and receive approval from the LFRG Co-Chairs for the use of an alternative outline. CERCLA disposal facilities should also use this outline.

8.3.1. Special Analysis Annotated Outline

8.3.1.1 Executive Summary

This section should include a brief summary of why the SA is being conducted, the results of the analysis and conclusions and/or recommendations.

8.3.1.2 Introduction

This section should provide a summary of the disposal facility background, including location, operations, processes and Waste Acceptance Criteria (WAC) in sufficient detail to provide context for the preparation of the SA and the potential impacts of the proposed activity, discovery or new information to disposal facility operations, processes, or disposal limits.

8.3.1.3 Analysis of Performance

This section should include detailed information of the analysis that was performed. The SA should provide an analysis, in sufficient detail, of the potential impacts of the proposed activity, discovery or new information to disposal facility operations, processes, or disposal limits that differ from the current PA/CA. At a minimum, the analysis should include a consideration of potential impacts or changes to the following items:

- Mathematical and conceptual models including numeric codes and software quality assurance (QA);
- Exposure pathway analysis;
- Dose assessments;
- Source terms and release(s) mechanisms;
- Material properties;
- CP changes;
- Uncertainty and sensitivity analysis; and
- Inadvertent intruder analysis.

8.3.1.4 Results and Interpretation of Special Analyses

This section should include a presentation and interpretation of the results of the analysis of performance for the facility conducted pursuant to the SA. These results should include any changes or required modification relative to the current PA and/or CA and performance objectives.

8.3.1.5 Conclusions

This section should present the conclusions of the SA. This section should also include any recommendations or immediate actions that need to be taken. The recommendations should include whether or not the SA should be approved and the proposed action implemented/new information accepted, or if a modification to the PA or CA is required prior to implementation/acceptance any changes. In addition, this section should include any changes required to DAS documents including but not limited to MonPs, PA/CA MP or WAC.

8.3.1.6 References

This section should provide references to any applicable documents that support the SA.

8.3.1.7 Appendices

This section should provide the detailed information, e.g., calculations, dose tables, radionuclide contributions, referenced in the body of the SA that is necessary to adequately support the SA.

Objective

The objective of this guide is to establish a standardized format and content to be used when developing a SA.

Discussion

SAs are used as a cost-effective method to evaluate proposed activity, discovery or new information to a disposal facility without revising the entire PA/CA. SA can result in WAC changes allowing either more or less activity of radionuclides; changes in facility design (e.g., thicker/thinner operational covers) or to improve the facility performance or to be more protective of the public and environment. Sites should use caution when a number of SA have been performed on the facility to ensure a system is in place to distinguish between the various facility changes. A site should decide at some point to revise the PA/CA to ensure there is a clear understanding of the assumptions and conclusions of these documents and that there is a reasonable expectation that the DOE O 435.1 performance objectives/measures will be met.

8.4. LFRG Notifications

- In developing a UDQE/UCAQE/SA, the LFRG should be notified upon the occurrence of one of the following events: Any violation or potential violation of the performance objectives;
- If the new PA forecasted dose is above 50 percent of any performance objective. (e.g., projected all pathway dose is above 12.5 mrem);
- Any fundamental change in the PA conceptual model;
- Any fundamental change in the disposal methodology (e.g., changing from vault to trench disposal);
- The new CA dose is greater than the administrative dose limit of 30 mrem; and
- Disposal of a waste type (hazardous, mixed, transuranic or high level waste) that the facility is not authorized to dispose.

The LFRG may request additional information or explanation of the change, or may require a more detailed review by an LFRG review team.

Objective

The objective of this guide is to establish requirements when the LFRG site representative should notify the LFRG.

Discussion

The LFRG is responsible for the oversight of radioactive waste disposal sites from the context of the DAS and associated technical basis documents including those associated activities in the RWMB document. Communication between LFRG site representatives and the LFRG at-large is very important in DOE's self-regulatory process. This process is delineated in the LFRG Execution Plan.

8.5. Compliance Demonstration

Compliance with the requirement in DOE O 435.1 to implement a change control process can be demonstrated by a site developing and implementing a change control process procedure developed to support the DAS, PA and CA, reviewed by the LFRG, and approved by DOE management to ensure that DOE O 435.1 performance objectives continue to be met.

Copies of this information (at a minimum, the procedures that implement these requirements) should be included in the applicable facility RWMB(s).

8.6. Attachments

Attachment 8-1, Example of Unreviewed Disposal Question Screening (UDQS) Criteria

Attachment 8-2, Example of Unreviewed Disposal Question Evaluation (UDQE)

Attachment 8-3, Example of Unreviewed Composite Analysis Question Screening (UCAQS) Criteria

Attachment 8-4, Example of Unreviewed Composite Analysis Question Evaluation (UCAQE)

Attachment 8-5, USQ/UDQE/SA Integrated Process Flowchart

8.7. References

10 CFR 830.203, *Nuclear Safety Management, Unreviewed Safety Question Process*

DOE O 458.1, *Radiation Protection of the Public and the Environment*

DOE O 435.1, *Radioactive Waste Management*

DOE Manual 435.1-1, *Radioactive Waste Management Manual*, July 09, 1999

DOE G 435.1-1 Admin Chg 2, *Implementation Guide for Use with DOE M 435.1-1*, July 09, 1999

Low-Level Waste Disposal Facilities Federal Review Group Manual, Revision 3, 2008

Savannah River Site Procedure, SW-ENG-0601, *Unreviewed Disposal Question*

8.8. Change Control Process Review Criteria

The Table 8-1 may be used to evaluate whether the document contents are complete and thorough and the document is technically adequate and defensible. Review criteria may be changed according to the scope and facility being reviewed. However, the LFRG Co-Chairs must approve the review criteria being used in the LFRG Review Plan for a specific facility.

Numbers in parentheses refer to the section number in the chapter.

Figure 8-1. Change Control Process Review Criteria

ID	Review Criteria	Criteria Met (Yes/No/ Comment)	Comments
CC-1	Describe the sites overall process to ensure the information, assumptions and results delineated in the PA/CA remain valid when new information resulting from research and development, proposed changes in operational activities, or discoveries of information that was not previously analyzed in the PA/CA are discovered. Each site will have its own unique screening and evaluation criteria based up the PA/CA. (8.2.1 Introduction)		
CC-2	DOE should oversee the development and implementation of a change control process as described in this guide. In the example provided, DOE should ensure evaluations of proposed changes or new information take place [Unreviewed Disposal Question Evaluation (UDQE)/ Unreviewed Composite Analysis Question Evaluation (UCAQE)] and the PAs, CAs and SAs. In addition, the DOE LFRG site member should ensure all UDQE/UCAQE are included in the ASR and the site radioactive waste management basis (RWMB).		

ID	Review Criteria	Criteria Met (Yes/No/ Comment)	Comments
	Procedures should be established that delineate the specific responsibilities and authorities of each entity in the DOE and contractor offices. (8.2.1 Introduction)		
CC-3	Describe the PA/CA screening process and criteria being used to determine whether a PA/CA evaluation is needed on the proposed activity, discovery or new information. (8.2.2.1 Screening)		
CC-4	Describe the PA/CA evaluation process and criteria being used to determine whether the proposed activity, discovery or new information is within the bounds of the current PA/CA assumptions or conclusions and if further technical evaluation is necessary through the development of a SA. (8.2.2.2 Evaluation)		
CC-5	In developing a UDQE/UCAQE/SA, the LFRG should be notified upon occurrence of one of the following events. The LFRG may request additional information or explanation of the change, or may require a more detailed review by an LFRG review team. • Any violation or potential violation of the performance objectives; • If the new PA forecasted dose is above 50 percent of any performance objective. (e.g., projected all pathway dose is above 12.5 mrem); • Any fundamental change in the PA conceptual model; • Any fundamental change in the disposal methodology (e.g., changing from vault to trench disposal); • The new CA dose is greater than the administrative dose limit of 30 mrem; and • Disposal of a waste type (hazardous, mixed, transuranic or high level waste)		

ID	Review Criteria	Criteria Met (Yes/No/ Comment)	Comments
	that the facility is not authorized to dispose. (8.4 LFRG Notifications)		

The Table 8-2 should be used to ensure the document contents are complete and thorough and the document is technically adequate and defensible.

Table 8-2. Special Analysis Review Criteria

ID	Review Criteria	Criteria Met (Yes/No/ Comment)	Comments
SA-1	Include a brief summary of why the SA is being conducted, the results of the analysis and conclusions and/or recommendations. (8.3.1.1 Executive Summary A)		
SA-2	Provide a summary of the disposal facility background, including location, operations, processes and Waste Acceptance Criteria (WAC) in sufficient detail to provide context for the preparation of the SA and the potential impacts of the proposed activity, discovery or new information to disposal facility operations, processes, or disposal limits. (8.3.1.2 Introduction B)		
SA-3	Include detailed information of the analysis that was performed. The SA should provide an analysis, in sufficient detail, of the potential impacts of the proposed activity, discovery or new information to disposal facility operations, processes, or disposal limits that differ from the current PA/CA. (8.3.1.3 Analysis of Performance)		
SA-4	Include a presentation and interpretation of the results of the analysis of performance for the facility conducted pursuant to the SA. These results should include any changes or required modification relative to		

ID	Review Criteria	Criteria Met (Yes/No/ Comment)	Comments
	the current PA and/or CA and performance objectives. (8.4.1.4 Results and Interpretation of Special Analysis)		
SA-5	Present the conclusions of the SA. This section should also include any recommendations or immediate actions that need to be taken. The recommendations should include whether or not the SA should be approved and the proposed action implemented/new information accepted, or if a modification to the PA or CA is required prior to implementation/acceptance any changes. In addition, this section should include any changes required to DAS documents including but not limited to MonPs, PA/CA MP or WAC. (8.3.1.5 Conclusions)		
SA-6	Provide references to any applicable documents that support the SA. (8.3.1.6 References)		
SA-7	Provide the detailed information, e.g., calculations, dose tables, radionuclide contributions, referenced in the body of the SA that is necessary to adequately support the SA. (8.3.1.7 Appendices)		

Attachment 8.1. Example of Unreviewed Disposal Question Screening Criteria

Proposed activity, discovery, or new information:

_____

_____

_____

REVIEW the following questions against the proposed activity, discovery, or new information:

1. Does the proposed activity, discovery, or new information involve a change to the disposal facility from what has been previously described or analyzed in the most recent DAS conditions or limitations, Performance Assessment, approved Special Analyses, or approved UDQE?

   Yes ❑ No ❑ N/A ❑

2. Does the proposed activity, discovery, or new information involve a change to the disposal process or procedures from what has been previously described or analyzed in the most recent Performance Assessment, approved Special Analyses, or approved UDQE?

   Yes ❑ No ❑ N/A ❑

3. Does the proposed activity, discovery, or new information involve a change to the radionuclide disposal limits from what has been previously described or analyzed in the most recent Performance Assessment, approved Special Analyses, or approved UDQE?

   Yes ❑ No ❑ N/A ❑

4. Does the proposed activity, discovery, or new information involve a change to the Waste Acceptance Criteria from what has been previously described or analyzed in the most recent Performance Assessment, approved Special Analyses, or approved UDQE?

   Yes ❑ No ❑ N/A ❑

5. Does the proposed activity, discovery, or new information involve a change to what has been previously described or analyzed in the Performance Assessment, approved Special Analyses Inputs and Assumptions (I&A)?

   Yes ❑ No ❑ N/A ❑

6. Does the proposed activity, discovery, or new information involve a change to the facility closure design or criteria from what has been previously described or analyzed in the most recent Performance Assessment, approved Special Analyses, approved UDQE, or associated Closure Plan?

Yes ❑ No ❑ N/A ❑

7. Does the proposed activity, discovery, or new information involve a test or experiment not described or analyzed in the most recent Performance Assessment, approved Special Analyses, approved UDQE, or associated Closure Plan?

Yes ❑ No ❑ N/A ❑

8. Does the proposed activity, discovery, or new information involve any analytical errors, omissions, or deficiencies in the most recent Performance Assessment, approved Special Analyses, approved UDQE, or associated Closure Plan?

Yes ❑ No ❑ N/A ❑

If all questions above are answered, "No" or "N/A", then implement proposed activity. If any of the questions above are answered "Yes", then forward this screening form to the PA technical expert for development of an UDQE or Special Analysis.

Provide Explanation / Justification for all answers.

_____

_____

_____

Is a UDQE or Special Analysis needed? Yes ❑ No ❑

Originator Signature	Name	Date
Reviewer Signature	Name	Date

Attachment 8.2. Example of Unreviewed Disposal Question Evaluation

UDQE No: _____ Page No. _____

1. Unreviewed Disposal Question Evaluation

   a. Is the proposed activity, discovery, or new information outside the bounds of the approved PA (e.g., does the proposed activity, discovery, or new information involve a change to the basic disposal concept as described in the PA, such as critical inputs/assumptions or an increase in inventory analyzed in the PA)?

   Yes ❑ No ❑ N/A ❑

   b. Would the proposed activity, if implemented, or does the new information or discovery result in the PA performance objectives being exceeded?

   Yes ❑ No ❑ N/A ❑

   c. Would the radionuclide disposal limits in the approved PA need to be changed to implement the proposed activity?

   Yes ❑ No ❑ N/A ❑

   d. Does the new information result in a change in the radionuclide disposal limits in the approved PA?

   Yes ❑ No ❑ N/A ❑

   e. Would the proposed activity, if implemented, result in a change to the DAS conditions or limitations or does the new information or discovery result in a change to the DAS conditions or limitations?

   Yes ❑ No ❑ N/A ❑

2. Is a SA needed? Yes ❑ No ❑

Unreviewed Disposal Question Evaluation Originator

Comments: _____

_____

_____

_____ _____ _____

Signature Name Date

Unreviewed Disposal Question Evaluation Peer Reviewer

Comments: _____

_____

_____

_____ _____ _____

Signature Name Date

3. Does the proposed activity, discovery, or new information necessitate a change to the PA in accordance with this procedure?

Yes ❑ No ❑

If a SA is needed, indicate the follow-up action by checking one of the following boxes and return to EO.

❑ Cancel proposed activity.

❑ Modify proposed activity to attempt to eliminate SA.

❑ Initiate request for Special Analysis & DOE approval of the proposed activity.

Facility Operations Manager

_____ _____ _____

Signature Name Date

Attachment 8.3. Example of Unreviewed Composite Analysis Question Screening Criteria

Proposed Activity/Discovery/New information: _____

_____

_____

REVIEW the following questions against the proposed activity, discovery, or new information:

1. Does the proposed activity, discovery, or new information involve a change to a disposal facility performance assessment?

   Yes ❑ No ❑ N/A ❑

2. Does the proposed activity, discovery, or new information involve a change to an existing or new environmental restoration site?

   Yes ❑ No ❑ N/A ❑

3. Does the proposed activity, discovery, or new information involve a change to the site use plan or end state document that may impact the locations of potential public exposure considered in the CA?

   Yes ❑ No ❑ N/A ❑

4. Does the proposed activity, discovery, or new information involve a change to a new or existing D&D activity?

   Yes ❑ No ❑ N/A ❑

5. Does the proposed activity, discovery, or new information involve the construction of a new radioactive facility or a change in radiological emissions/migration from an existing facility?

   Yes ❑ No ❑ N/A ❑

6. Does the proposed activity, discovery, or new information involve a change in the operation of a facility regarding new radionuclide isotopes and/or increased activity levels for known existing isotopes or involve the end state configuration and radionuclide inventory of facilities/waste sites that are major CA dose contributors?

   Yes ❑ No ❑ N/A ❑

7. Does the proposed activity, discovery, or new information involve a change to what has been previously described or analyzed in the CA Inputs and Assumptions (I&A) database?

   Yes ❑ No ❑ N/A ❑

8. Does the proposed activity, discovery, or new information involve any analytical errors, omissions, changes in descriptions, or deficiencies in the most recent Composite Analysis or approved Special Analyses?

Yes ❑ No ❑ N/A ❑

9. Does the proposed activity, discovery, or new information involve information associated with the CA model input and assumptions such as PA flux to the water table or stream flow rates?

Yes ❑ No ❑ N/A ❑

10. Does the proposed activity, discovery, or new information involve a change due to completion of work outlined in the PA/CA Maintenance Plan?

Yes ❑ No ❑ N/A ❑

11. Does the proposed activity, discovery, or new information involve a change related to CA Monitoring?

Yes ❑ No ❑ N/A ❑

12. Does the proposed activity, discovery, or new information involve a change to a DAS condition or limitation?

Yes ❑ No ❑ N/A ❑

If any of the questions above answered "Yes", then forward this form to the CA technical expert for development of an UCAQE or Special Analysis.

Provide Explanation / Justification for all answers:

_____

_____

_____

_____

Is a UCAQE or Special Analysis needed? Yes ❑ No ❑

_____	_____	_____
Originator Signature	Name	Date
_____	_____	_____
Reviewer Signature	Name	Date

Attachment 8.4. Example of Unreviewed Composite Analysis Question Evaluation

1. Unreviewed Composite Analysis Question Evaluation

   a. Is the proposed activity, discovery, or new information outside the bounds of the approved CA (e.g., does the proposed activity, discovery, or new information involve a change to the basic concepts described in the CA such as critical inputs/assumptions or an increase in source inventory analyzed in the CA)?

   Yes ❑ No ❑

   b. Would the proposed activity, discovery, or new information result in the CA performance objective or administrative limit being exceeded?

   Yes ❑ No ❑

   c. Would the radionuclide source assumptions in the approved CA need to be changed?

   Yes ❑ No ❑

   d. Would the proposed activity, discovery, or new information result in a change to a DAS condition or limitation?

   Yes ❑ No ❑

Unreviewed Composite Analysis Question Evaluation Originator

2. Is a SA needed? Yes ❑ No ❑

_____	_____	_____
Signature	Name	Date

Unreviewed Composite Analysis Question Evaluation Peer Reviewer

3. Is a SA needed? Yes ❑ No ❑

Comments: _____

_____

_____

_____	_____	_____
Signature	Name	Date

Responsible Manager

4. Is a SA needed? Yes ❑ No ❑
   (If "No", return to UCAQE originator).

5. Does the activity/discovery/new information necessitate a change to the CA in accordance with this procedure? Yes ❑ No ❑

Comments: _____

_____

_____

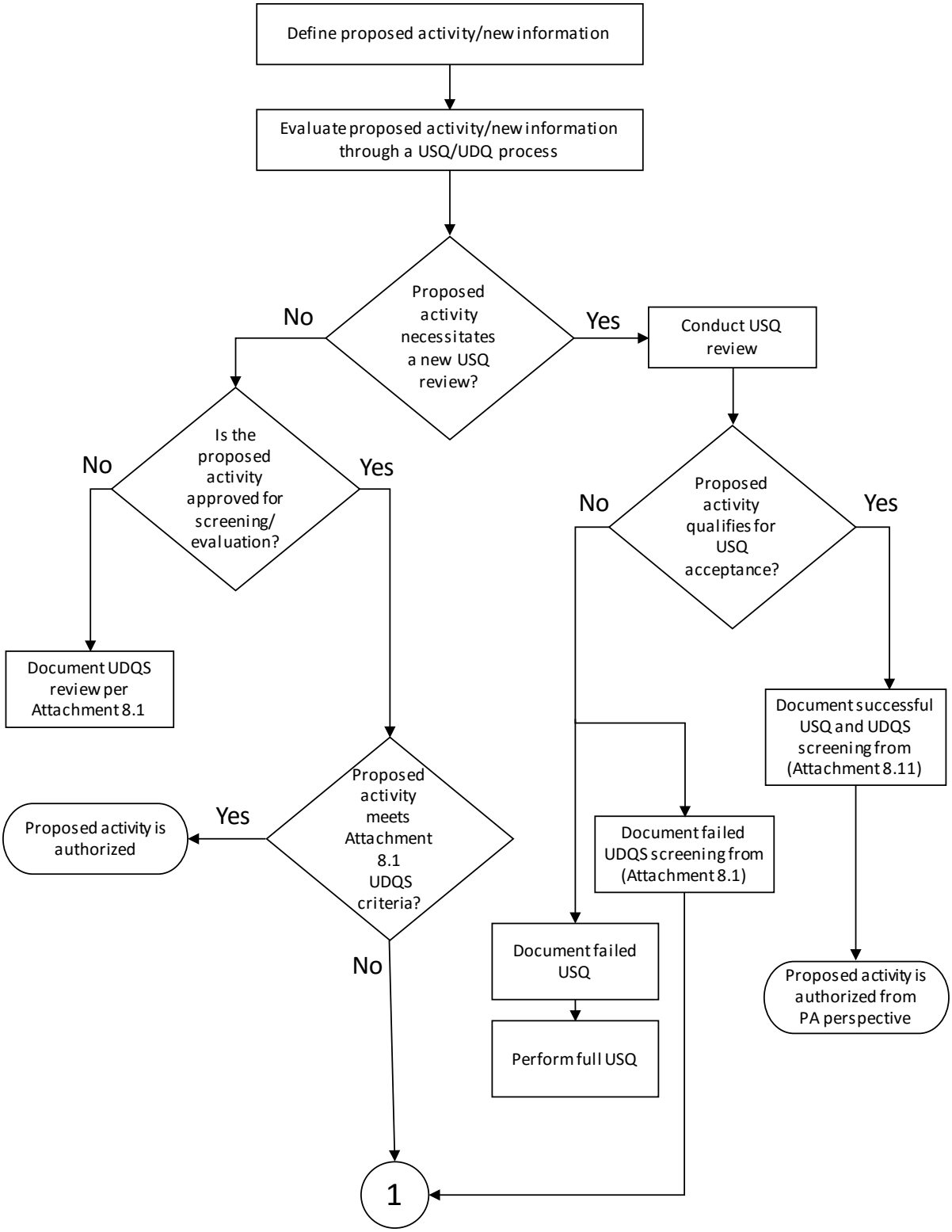
If a SA is needed, indicate the follow-up action by checking one of the following and return to the EO.

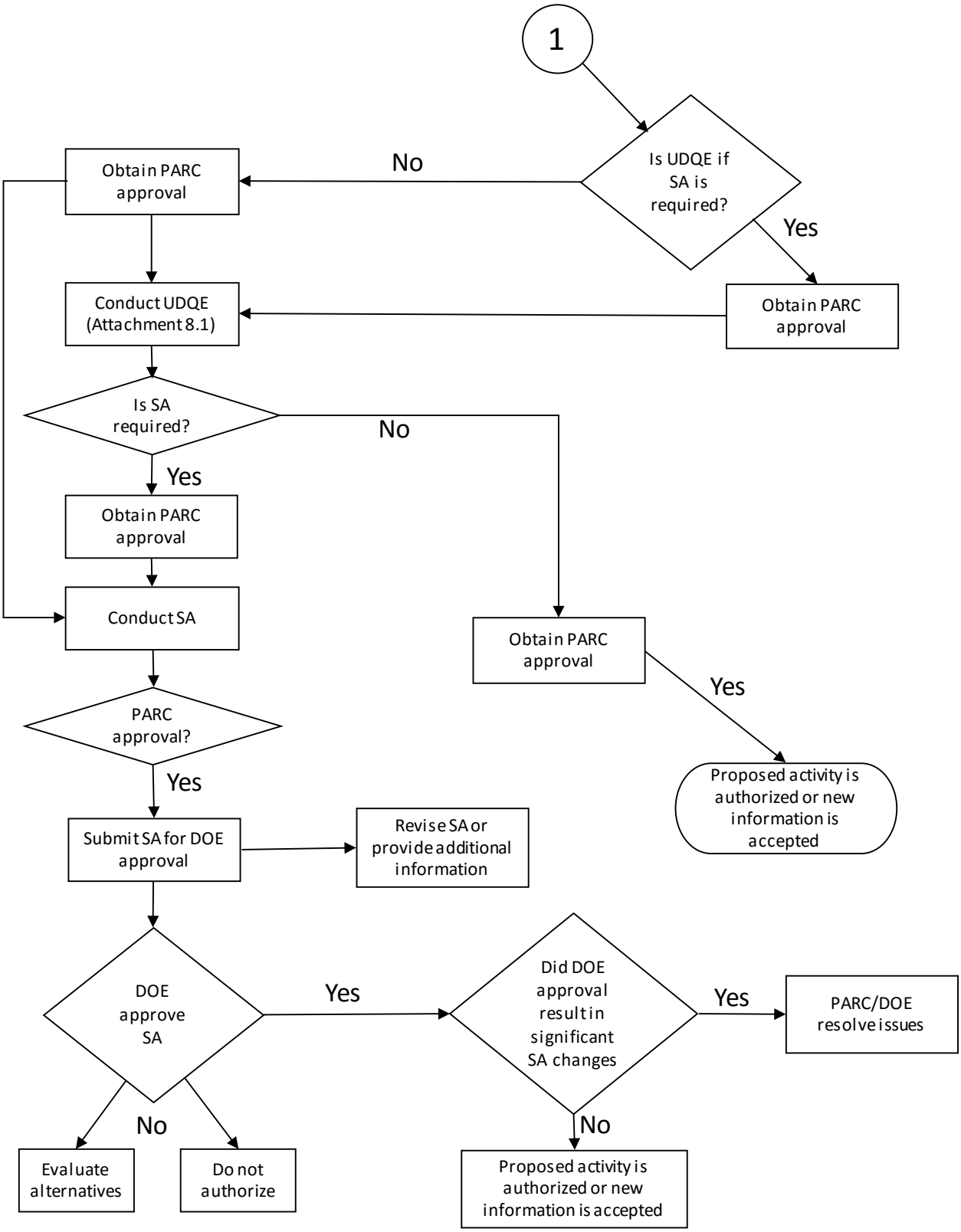
❑ Initiate discussions concerning the identified proposed activity, discovery, or new information with the responsible organization for possible alternatives.

❑ Initiate request for Special Analysis.

_____	_____	_____
Signature	Name	Date

Attachment 8.5. USQ/UDQE/SA Integrated Process Flowchart




1
Is UDQE if SA is required?
No
Yes
Obtain PARC approval
Conduct UDQE (Attachment 8.1)
Obtain PARC approval
Is SA required?
No
Yes
Obtain PARC approval
Conduct SA
Obtain PARC approval
Yes
PARC approval?
Proposed activity is authorized or new information is accepted
Yes
Submit SA for DOE approval
Revise SA or provide additional information
DOE approve SA
Yes
Did DOE approval result in significant SA changes
Yes
PARC/DOE resolve issues
No
No
Evaluate alternatives
Do not authorize
Proposed activity is authorized or new information is accepted

CHAPTER 9. DISPOSAL FACILITY ANNUAL SUMMARY REPORT GUIDE

9.1. Introduction

Goal

The goal of this guidance is to support U.S. Department of Energy's (DOE's) initiatives to improve and maintain the highest quality radioactive waste management standards and activities throughout the DOE complex.

The primary audience of this guide is the Federal Project Director and other DOE/contractor employees involved in the disposal of low-level waste (LLW) and tank closure.

Objective

This guide provides the objectives, additional rationale, examples, and measures of performance that addresses the annual summary report (ASR). The ASR compares the annual operations of the facility to the disposal authorization statement (DAS) including the assumptions and conclusions of the performance assessment (PA), composite analysis (CA) and technical basis documents.

Guides do not impose requirements but may quote requirements if the sources are adequately cited. This guidance follows the format of an objective statement, discussion, examples, a statement of one way to measure compliance, and supplemental references. Following this Guidance provides a consistent approach for compliance with the requirements of DOE Order (O) 435.1, *Radioactive Waste Management*. If the Guide has not been followed, then an explanation/justification as to why a different approach is acceptable should be provided.

The LFRG, functioning as the DOE regulatory authority, is the independent organization responsible for performing oversight of LLW disposal and tank closure in accordance with DOE O 435.1 [DOE Manual (M) 435.1-1, *Radioactive Waste Management Manual,* Chapter I, 2.E(1)(a)]. Therefore, the Low-Level Waste Disposal Facility Federal Review Group (LFRG) members utilize this Standard as guidance in performing oversight functions and judging compliance with the requirements of DOE O 435.1. (See LFRG Execution Plan for details of LFRG roles, responsibilities and processes).

9.2. Annotated Outline for Annual Summary Report

The ASR should focus on the changes of the current year's performance and operations relative to the approved PA, CA and technical basis documents. It should also summarize the facility history and background information, and explain an unanticipated situation experienced in the current year.

The tables used in the annotated outline should define the mandatory elements of the ASR and provide a format for reporting the required information. The detailed report supporting the required information should be referenced. Additional text supporting the table information or providing an evaluation of the table data should be added to the ASR.

9.2.1. Executive Summary

This section should provide an overview of the documents and data used to make the certification of the continued adequacy of the PA, CA, DAS, other DAS technical basis documents, and the radioactive waste management basis (RWMB) to meet the DOE O 435.1 performance objectives/measures. If these documents need revision a corrective action plan should be developed and implemented.

Objective

The objective of this guide is to summarize the important operation data and determine the impact, if any, to the DAS, technical basis documents and the RWMB.

Discussion

A determination of the continued adequacy of the PA, CA, and DAS should be made on an annual basis. The continued adequacy of the PA and CA, with respect to the assumptions, conclusions and recommendations (future work), and the reasonable expectation for meeting the performance objectives/measures should be documented in the ASR. A determination is that the PA, CA, and DAS are still valid or need to be revised. In addition, an annual disposal operations summary documenting the continued compliance with the DOE O 435.1 and the RWMB should be included in the ASR. The RWMB should be reviewed and re-approved at least every two years or when the radioactive waste management controls [revision to PA, CA, Waste Acceptance Criteria (WAC), etc.] established in the RWMB, or the conditions or circumstances for which they were established, have significantly changed. The RWMB should be revised as necessary to reflect accurately any significant changes in the basis of operations and any revisions of documents comprising the RWMB.

The ASR provides a structured approach for demonstrating there is a reasonable expectation that the performance objectives/measures identified in the Order requirements will be met. Specifically, the ASR is used to:

- Identify any newly discovered or planned changes in assumed conditions or proposed activities (e.g., new waste stream) or a change in disposal operations;

- Evaluate the cumulative effects of all changes, including changes evaluated in the change control processes[20], in relation to the DAS, PA/CA assumptions, conclusions and RWMB;
- Identify any planned analyses (e.g., SA, research and development) or results from completed analyses, to address any questions/uncertainties raised by these changes;
- Describe the facility's annual operations as related to waste receipts, current and future inventories, monitoring results and trends, land use changes and results of any independent or internal audits, self-assessments or other evaluations;
- Provide a status update for: any DAS conditions/limitations, key or secondary issues resulting from LFRG review of the facility's PA/CA and supporting technical basis documents; and
- Certify the continued adequacy of the DAS, PA, CA and RWMB.

ASR provides a mechanism for routine assessment of the PA/CA derived controls on waste disposal so that potential problems are identified and managed in a timely manner. This mechanism should use the "Change Control Process" in Chapter 8 to assess changes or new information. That is, the assumptions and analyses in the PA/CA are used to establish a performance envelope and are translated into administrative and engineering controls in designs, procedures (e.g., WAC). The Change Control Process [described as UDQE/UCAQEs and special analyses (SAs) in Chapter 8 provide a mechanism for evaluating conditions not originally included in the PA/CA to determine if they impact the assumptions or conclusions. The ASR is used to document that this integrated protection and oversight system is in place and working well to ensure operations have been conducted within the performance envelop of the DAS for the disposal facility. This information will be used to update the research and development planning and implementation process in the "PA/CA Maintenance Plan" (MP) in Chapter 7.

The RWMB is the authorization by the site field element manager (FEM) for a facility to begin operations. The RWMB includes the DAS and all the technical basis documents (e.g., PA, CA, WAC, etc.) operational procedures [e.g., As Low As Reasonably Achievable (ALARA)], safety analysis, etc. to ensure facility operations will be protective of the worker, public and environment. Proposed changes to the RWMB should be evaluated and approved prior to implementation.

The UDQE and/or the UCAQE (Chapter 8) is one way to fulfill the change control process requirement in DOE O 435.1 for radioactive waste disposal, as well as other processes such as nonconforming reports, WAC deviation, corrective action reports, etc.

[20] See Chapter 8 for guidance for the UDQE and UCAQE processes as examples of one way to meet this requirement.

The ASR is used to document the periodic and/or episodic review/revision of the RWMB. The review of the RWMB is important to ensure the "authorization" to operate the facility from the site FEM is still valid.

The ASR assessment period corresponds to the government fiscal year (October 1 – September 30) and should be submitted to the Deputy Assistant Secretary for Waste and Material Management (DASWMM) and the Director Regulatory Intergovernmental and Stakeholder Engagement (DRISE) by the FEM or designee by the last working day of March of the subsequent fiscal year. The sites may be granted an extension to this date with the LFRG Co-Chairs approval. The FEM or designee should transmit the ASR via cover memorandum stating that either the disposal facility's DAS, PA, CA, technical basis documents (CP, WAC, etc.) and RWMB remain valid or that a revision is necessary. The memo should also state what corrective actions are in place, if necessary, to ensure there is a reasonable expectation that the disposal facility will continue to meet performance objectives of DOE O 435.1 requirements.

The DASWMM and DRISE will forward the ASR to the LFRG for review and comment ensuring the site is complying with DOE O 435.1 requirements. The LFRG should provide the DASWMM and DRISE with their review recommendations for consideration. (See LFRG Execution Plan)

9.2.2. Changes Potentially Affecting the PA, CA, DAS OR RWMB

This section should include all Change Control Process evaluations (called UDQE/UCAQE in Chapter 8) or other change control processes (e.g., non-conformances, corrective action) used to evaluate proposed actions, changes and new information to determine if these activities are within the boundaries analyzed in the approved PA and CA. Their potential effect on the continued adequacy of the DAS, PA, CA and RWMB should be provided. Specific information for each identified change should be described in Table 9-1 below.

Table 9-1. Potential Changes Affecting the PA, CA, DAS or RWMB

Disposal Facility/Unit	UDQE/UCAQE or Change control process identification number	Change, Discovery, Proposed Action, New Information description	Evaluation Results	Special Analysis number (if applicable)	PA, CA, DAS or RWMB Impacts

Objective

The objective of this guide is to identify all potential or actual changes, discoveries, proposed actions and new information identified during the operation of the facility and what impact, if any, it has on the PA, CA, DAS or RWMB.

Discussion

This section should identify all the Change Control Process Evaluations (UDQE's, and UCAQE's, as described in Chapter 8) and SAs that were performed during the year along with a status report. These processes evaluate proposed actions, changes and new information to determine if these activities are within the boundaries analyzed in the approved PA and CA, and their potential effect on the continued adequacy of the DAS, PA, CA and RWMB. A copy of the SA's, and Change Control Process evaluations (UDQEs, and UCAQEs), should be submitted along with the ASR if required to properly describe the change.

Specific information for each identified change should describe the baseline assumption/condition from which the divergence was identified. A description of the results and significance of the divergence with respect to the degree of expected impact to the DAS, PA and CA conclusions should be included. An SA may be prepared if additional evaluations are required to determine the impact to the PA or CA. The SA is a revision to PA/CA and may be used to establish or inform decisions related to establishing, new disposal limits or change how the facility is operated for example. Discuss any PA/CA modifications or revisions believed necessary to address any inconsistencies or to compensate for any increased uncertainty. Each of these changes should be compared to the LFRG review thresholds that are identified in Chapter 8

Any actual or potential exceedance of a PA performance objectives or CA dose constraint should be reported and discussed with the LFRG as soon as possible.

The following are examples of items that are normally discussed in this section:

- *Report any divergences from expected or planned conditions that have been discovered in site characteristics or facility-related attributes potentially significant to facility performance;*

- *Identify divergences from expected or planned conditions that have been or will be voluntarily made to facility design/construction/operations/closure plans or other activities significant to facility performance, e.g., changes in procedures and systems intended to prevent disposal of inappropriate waste;*

- *Include descriptions of any research and development results relevant to the PA/CA analysis models and input data that are believed to affect the quality or conclusions of the PA/CA;*

- *Discuss any modifications to Land Use Planning that could affect the PA or CA, such as the location of the hypothetical future member of the public;*

- *Discuss any modifications to the inventory of residual radioactive material, current or expected for the disposal facility, that were used as a basis for the PA and/or CA;*

- *Discuss any changes required to be made to the DAS or DAS technical basis documents (e.g., PA/CA MonP, CP, PA/CA MP, WAC) and RWMB; and*

- *Discuss any SA that are planned or were completed during the year. Include the reason for the SA, results of analysis and impact on the PA, CA, DAS and RWMB etc. If the LFRG reviewed the SA, provide a brief description of the results and any issues, conditions, or limitations that resulted from the review.*

Table 9-2 provides examples of conditions/discoveries/new information that have the potential to affect the PA, CA, DAS or RWMB.

Table 9-2. Examples of Conditions/Discoveries/New Information That Have the Potential to Affect the PA, CA, DAS or RWMB

Disposal Facility/ Unit	UDQE or Change control process identification number	Change, Discovery, Proposed Action, New Information description	Evaluation Results	Special Analysis number (if applicable)	PA, CA, DAS or RWMB Impacts
#1	UDQE-1	Tc-99 K_d should be re-evaluated using the type of soil that is consistent with the soil in the vadose zone directly below the LLW disposal facility.	TBD	SA-1	Potential impacts to the all pathway dose in PA. RWMB will be revised at end of FY to include SA.
#1	UDQE-2	Installation of five new piezometers.	Increase effectiveness of monitoring migration at the facility	NA	None

Disposal Facility/ Unit	UDQE or Change control process identification number	Change, Discovery, Proposed Action, New Information description	Evaluation Results	Special Analysis number (if applicable)	PA, CA, DAS or RWMB Impacts
#1	UDQE-3	Depth of landfill unit excavated to 30 ft. versus 25 ft. in PA.	TBD	SA-2	Potential impact to PA. Changing vadose zone thickness could increase all pathway dose. RWMB will be revised at end of FY to include SA.
#1	UCAQE-1	New sources that could interact with disposal facility identified.	Two new environmental restoration sites have been identified. However, the impact is less than 0.01 mrem and is considered insignificant.	NA	None

In addition, discuss any issues that were identified to the LFRG during the year that exceeded a LFRG notification threshold identified in Chapter 8 and the results of the discussion. This information will be used to update the research and development planning and implementation process in Chapter 7, "Maintenance Plan".

9.2.3. Cumulative Effects of Changes

This section should include an evaluation and discussion of the cumulative effects of all the changes that have been identified in above in "Changes Potentially Affecting the PA, CA, DAS OR RWMB" section during the year.

Objective

The objective of this guide is to evaluate all the changes or potential changes holistically and determine the effects, if any, on the PA, CA, DAS or RWMB.

Discussion

This section should evaluate and discuss the cumulative effects of all the changes that have been identified in "Changes Potentially Affecting the PA, CA, DAS OR RWMB" during the year and determine if the PA, CA, DAS and RWMB are still valid or if a revision has been or will be made to those documents in the future. If revisions to these documents are warranted, a schedule should be provided in the ASR.

Determining the significance of the changes as it relates to revising the PA, CA, DAS and RWMB can be subjective and may require the combined expertise of contractor and Federal employees. Below is a list of potential issues or changes that may be considered individually or in combination when making the decision to revise the PA, CA, DAS, & RWMB or not.

- Changing the PA/CA model approach from deterministic to probabilistic;
- Changing the PA/CA modeling software;
- Changing the PA/CA conceptual model;
- Significant changes to the PA/CA assumptions or operations of the facility;
- A significant number of SA's have been implemented that change the acceptable limits of radionuclides in the PA and it is difficult for operations personnel to determine the latest approved limits;
- A significant number of new CA sources that interact with the disposal facility have been identified;
- A discovery that a specific radionuclide limit has been reached and can no longer be disposed of in the facility requiring a WAC revision to include a limit/condition for this radionuclide; and
- UDQE #1 & #3 identified in Table 9-2 above should be evaluated in combination because TC-99 is a mobile radionuclide that is a primary dose contributor.

9.2.4. Waste Receipts

This section should include the following information in the table format below. In addition, a discussion regarding waste receipts should be included (Table 9-3).

Table 9-3. Waste Receipts

Disposal Facility/Unit	Disposed Volumes (m3) to date	PA-Estimated Disposal Capacity (m3)	Percent Filled (%) Volume	Sum of Fractions or Total curie vs PA Curie Limit	PA/CA Impacts

Objective

The objective of this guide is to evaluate past waste receipts, waste receiving during the fiscal year against the waste volume and activity levels evaluated in the PA.

Discussion

The review of waste receipts should include:

- Actual disposed inventories (volume and total curies) through the end of the reporting period including any adjustments needed as a result of the impact of new information on past waste receipts or improvements in waste characterization;
- A status of the total curie inventory limit to the actual disposed inventory (i.e., limit vs actual);
- Any anticipated change to the final disposed curie inventories compared to the PA/CA projection;
- Any noteworthy impact on the performance objective (e.g., most limiting sum of fraction[21] for specific exposure pathway, or 50 percent of the performance objective);
- Percent fill for each disposal unit (e.g., by volume and curie inventory); and
- Determining consistency of waste forms with WAC.

[21] The Sum of Fraction rule for mixtures of radionuclides is used to determine the amount of each radionuclide that can be disposed based on its limit derived from the PA. It is calculated by dividing each nuclides concentration by the appropriate limit and adding each of the resulting values. If the sum is less than 1.0, then the limit has not been exceeded.

The review of past and future waste receipts is based on a review of documentation such as quality records (e.g., QA records, receipt records, audits/surveillances, waste projections, and controlling documents (e.g., procedures, WAC)). The review should be designed to confirm that the controls on waste receipts are consistent with the limitations derived from the PA.

Annual reviews should be designed to assess the radionuclides contained in the waste, waste volume and waste form. The reviewer should consider the need to review past waste receipts, revised inventory estimates, projected waste receipts, and total inventory. The review of waste receipts should also consider improvements to waste characterization methods that may have occurred. The PA may have used conservative estimates of significant radionuclide inventories based on gross activity. Use of improved methods that allow actual measurements of significant radionuclides may indicate that previous estimates were overly conservative and that the WAC could be revised in light of reduced uncertainty. The review should describe the disposal facility's efforts to balance curie limits vs. volume capacity of waste units to make efficient use of the disposal units' capabilities.

The waste projected to be received at the site in the future should also be considered to determine whether currently projected waste receipts are nominally the same as those anticipated at the time the PA was prepared.

Example:

> *Programmatic changes at a site could affect the wastes expected to be generated in the future.*

The site has decided, along with the EPA, to change the environmental restoration cleanup criteria for certain radionuclides. The new cleanup criteria is more stringent than the previous criteria resulting in an increase in these radionuclides in the waste stream being disposed at the onsite LLW disposal facility. The site confirms that the radionuclide concentrations and total inventories resulting from this programmatic change is within the bounds of the current PA.

The review of waste forms should be designed to confirm that the actual disposed waste forms are consistent with WAC derived from the PA.

Example:

> *The PA was based on a critical radionuclide being contained and disposed in a robust stainless steel container. However, it was discovered that the waste had been disposed in a carbon steel container that will degrade much faster than the stainless steel container. The site re-evaluates the PA assumption and determines the impacts of the new waste form. Similarly, the PA may have been based on expected waste form characteristics from a treatment process that was not yet*

operational. Once the treatment process is operational, the actual waste form characteristics should be reviewed to determine whether they are consistent with those used in the PA.

The overall result of the review of waste receipts will be a determination of whether any changes are needed to ensure the continued adequacy of the PA with respect to radionuclide limits and waste form requirements (Table 9-4). This information will be used to update the research and development planning and implementation process in the MP (Chapter 7).

Table 9-4. Example of Waste Receipts

Disposal Facility/Unit	Disposed Volumes (m3) to date	PA-Estimated Disposal Capacity (m3)	Percent Filled (%)	Sum of Fractions or PA Curie Limit	PA/CA Impacts
Rad Landfill #1	20, 848	23,000	.91	1.2	Exceeded curie limit for Tc-99. SA to evaluate started in October and will be complete December 2015
Rad Landfill #2	10,000	20,000	50	.56	None

9.2.5. Monitoring

This section should include monitoring results using the following table format. In addition, a discussion regarding monitoring results should be included. For compliance monitoring (Table 9-5), action levels that are exceeded should be documented along with any corrective actions in the ASR. For performance monitoring, results differing from expected behavior should be documented and discussed with any corrective actions (Table 9-6).

Table 9-5. Compliance Monitoring

Disposal Facility Unit	Monitoring Type	Monitoring Results & Trends	Performance Objective Measure or other Regulatory Limit	Action Level	Action Taken	PA/CA Impacts

Table 9-6. Performance Monitoring

Disposal Facility Unit	Monitoring Purpose	Monitoring Results & Trends	PA Expected Behavior	Action Taken	PA/CA Impacts

Objective

The objective of this guide is to collect monitoring data, identify possible trends and monitoring levels where some type of action may be required.

Discussion

The review of monitoring results consists of several activities including:

- Comparing facility monitoring results to expected performance and determining consistency with PA assumptions including the conceptual model;
- Comparing PA/CA monitoring results to performance objectives/measures and to any other applicable regulatory requirements (e.g., RCRA);
- Evaluating other overlapping on-site monitoring activities for significant results (e.g., site annual environmental report); and
- Determining if better methodologies or technologies are available for monitoring. This activity is meant for sites to simply be aware of new industry technologies or technologies employed at other sites that could be used at their particular site.

The review also should determine if the monitoring results supports a determination that the disposal facility remains within the Performance Objectives of DOE O 435.1 and that the facility remains in compliance with any other applicable regulatory requirements.

Data collected as part of the facility's PA/CA MonP should be reviewed to determine if the facility is functioning within the performance envelope, i.e., results indicate that parameter values are conservative in terms of projected dose. If so, the information should be noted as confirming the adequacy of the current analysis. However, if monitoring results indicate that a particular parameter used in the PA may not be as conservative as assumed and the impact would be a significant increase in projected dose or releases, additional analyses may be necessary. Conversely, if monitoring results indicate that a particular parameter used in the PA was overly conservative; these data may provide the basis for SAs to raise disposal facility radionuclide limits.

The monitoring data should also be evaluated to identify any necessary or suggested changes to the PA/CA MonP (Chapter 5). In addition to the monitoring specified in the facility's PA/CA MonP, results of other monitoring relevant to facility performance may also be reviewed. This monitoring may include non-routine monitoring, such as sampling of liquids collected from the facility or monitoring of structural integrity of a vault and environmental monitoring in the vicinity of the disposal facility. These monitoring results should be evaluated in the same manner as the facility monitoring data to determine if they indicate the need any change control process evaluations due to over- or under-estimation of a parameter value and to determine consistency with the conceptual model. This information will be used to update the research and development planning and implementation process in the MP.

The PA/CA monitoring results are designed to detect changing trends in performance to allow application of any necessary corrective action prior to exceeding the PA performance objective dose limit or CA dose constraint. Any required modifications to the monitoring program should be discussed as well as any exceedance of action levels.[22] Should an action level exceedance occur, the resulting actions taken should be discussed with the LFRG (see LFRG Execution Plan) and any corrective actions taken documented in the ASR to ensure PA performance objectives or CA dose constraint are not exceeded (Tables 9-7 and 9-8).

Table 9-7. Examples of Compliance Monitoring

Disposal Facility Unit	Monitoring Type	Monitoring Results & Trends	Performance Objective Measure or Other Regulatory Limit	Action Level	Action Taken	PA/CA Impact
#1	Tritium in Vadose zone	63.8 pCi/ml	100 pCi/ml	75 pCi/ml	None	None
#2	Sumps	2.5 mrem beta/gamma	4 mrem beta/gamma	3.0 mrem beta/gamma	None	None
#3	Groundwater	3.5 mrem beta/gamma	4 mrem beta/gamma	3.0 mrem beta/gamma	Began investigation in December should have results in February 2015	TBD

[22] An action level is an administrative limit placed on the facility monitoring activities that provides a "flag" or "caution" to the site that future investigation may be required to ensure performance objectives will not be violated

Disposal Facility Unit	Monitoring Type	Monitoring Results & Trends	Performance Objective Measure or Other Regulatory Limit	Action Level	Action Taken	PA/CA Impact
#$	Vault concrete	No cracks identified	Cracks should be less than 1/2 inch in width	¼ inch in width	None	None

Table 9-8. Example of Performance Monitoring

Disposal Facility Unit	Monitoring Purpose	Monitoring Results & Trends	PA Expected Behavior	Action Taken	PA/CA Impacts
#1	Radionuclide transport	Tritium above action level 75 pCi/ml at midpoint of vadose zone	Below 40 pCi/ml	Re-sample and investigation past tritium disposal	None

9.2.6. Research and Development

This section should include R&D, field studies, etc. and associated discussion.

Objective

The objective of this guide is to document the results of any R&D activity that may reduce uncertainty and evaluate those results against the PA/CA.

Discussion

The review of the R&D results consists of several activities including:

- Evaluating R&D results to determine impacts on PA and CA results and conclusions, and consistency with conceptual model(s);
- Determining if better methodologies or technologies are available that could enhance disposal facility performance; and
- Evaluating the results of special studies.

The review should be designed to determine if data collected during R&D activities indicate that the disposal facility is performing as postulated in the PA and CA, and to determine if the conceptual models are still applicable (i.e., still adequately represent the disposal facility) (Table 9-9). Additionally, the review should provide information needed by the FEM to update the status of research and development needs related to the disposal facility continued operation within the DAS.

Table 9-9. Research and Development Activities

Document Number	Results	PA/CA Impacts

The review of R&D results should include those available from facility specific or applicable onsite activities and may include results from activities conducted at other sites. Facility specific R&D requirements may be identified as a condition of the DAS and the progress of meeting that condition should be reported in the ASR. Once applicable R&D results have been identified, they should be reviewed with respect to facility performance and reported in the ASR.

If R&D results indicate that the facility is functioning within the performance envelope, i.e., results indicate that parameter values are conservative in terms of projected dose, then the information should be noted as confirming the adequacy of the current PA analysis. However, if research and development results indicate that a particular parameter used in the PA may not be as conservative as assumed and the impact would be a significant increase in projected dose or releases, additional analyses may be necessary. Conversely, if research and development results indicate that a particular parameter used in the PA was overly conservative; this data may provide the basis for conducting a SA to raise disposal facility radionuclide limits. New information from R&D activities should be evaluated using the UDQE/UCAQE program described in Chapter 8 of this Standard.

In some cases, instead of data, R&D results will consist of improved analytical methods (e.g., computer codes). In these cases, the review should determine whether application of these improved methods to the PA would reduce the uncertainty associated with the results of the assessment. If so, the significance of the reduced uncertainties may be discussed (e.g., WAC could be revised). In some cases, it may be appropriate to conduct a change control process evaluation to quantitatively evaluate the impact of the method on PA or CA results. This information will be used to update the research and development planning and implementation process in the MP (see Chapter 7).

This section should include R&D, field studies, etc. in the format below (Table 9-10).

Table 9-10. Example of Research and Development Activities

R&D Document Number	Results/Discussion	PA/CA Impacts
#1	Concrete vault durability/degradation projections study. Three studies have been conducted on the properties of the vault concrete and four studies on the durability/degradation of the vaults. All the information/data from these studies has been evaluated, consolidated, and synthesized. Based upon this evaluation nominal property values have been recommended, including a saturated hydraulic conductivity of 1.0E-12 cm/s and an effective diffusion coefficient of 6.4E-08 cm2/s. It has been determined that the structural degradation predictions, which were used as the basis for the 2011 PA, remain valid.	None
#2	Benchmarking probabilistic modeling for uncertainty and sensitivities. The LFRG recommended the site to revise the probabilistic models and to update the sensitivity analysis to bolster their defensibility. A comparison was made between the deterministic and probabilistic models. The probabilistic model produced mass flux and concentration curves that were sufficiently similar to the multi-dimensional deterministic models for all evaluated radionuclides and progeny. It was concluded that the probabilistic model was justified to be used for sensitivity and uncertainty analysis in conjunction with the deterministic model.	None

9.2.7. Planned or Contemplated Changes

This section should include the following planned or contemplated changes (including completion schedules) in disposal facility design, construction, operations, closure, R&D, land use or in technical basis documents (MP, CP, WAC, MonP, Change Control Process) presented in a table following the format below. In addition, an associated discussion should be provided (Table 9.11).

Table 9-11. Planned or Contemplated Changes

Planned or contemplated change	Change Basis	PA/CA Impact	Schedule

Objective

The objective of this guide is to identify any planned or contemplated changes to the facility that may change the assumptions and conclusions of the PA/CA.

Discussion

This section of the ASR is to advise HQ of planned or contemplated changes in disposal facility design or operations or in the PA/CA MP (Table 9-12).

The discussion of recommended changes should include the expected significance of the changes with respect to the PA and CA results and conclusions. If needed to illustrate the impacts of specific changes, the ASR should reference the results of the PA or CA analysis (change control process evaluation & SA). If significant changes to the results or conclusions are expected, the summary should recommend whether or not the PA and CA should be revised along with a proposed completion schedule. This section should also address recommended changes to technical basis documents (i.e. MP, CP, WAC, DAS, etc.) and research and development activities associated with the LLW disposal facility along with a proposed completion schedule. Any recommended changes to the DAS should be discussed. This information will be used to update the research and development planning and implementation process in the MP (see Chapter 7).

Table 9-12. Example of Planned or Contemplated Changes

Planned or Contemplated Change	Change Basis	PA/CA Impact	Schedule
Monitoring Plan revision	Vadose zone monitoring. The lysimeter network may be expanded to address new trench operations, replace non-functioning or non-producing lysimeters, or to investigate specific areas of interest. Potential areas of expansion in FY2016 include new lysimeters around closed sections of the radioactive landfill.	None	FY2016
Land Use Plan revision	The site is reducing the footprint from the original Land Use Plan.	Potential change to the dose for a member of the public – point of assessment	FY2016

9.2.8. Status of DAS Conditions, Key and Secondary Issues

This section should provide a status update on any DAS conditions and key or secondary issues resulting from an LFRG review of the facility's PA and CA and other technical basis documents (e.g., MonP, CP, etc.). The information should be provided in the format as shown in Table 9-13. A separate discussion of the information in the table should be included.

Table 9-13. Status of DAS Conditions, Key and Secondary Issues

Disposal Facility/Unit	Key/Secondary Issue or DAS Condition number	Issue description	Initial Resolution schedule date	Projected Resolution scheduled date	Disposition Documentation & Date Completed	PA, CA, DAS Impact

Objective

The objective of this guide is to identify, track, and resolve issues and conditions placed on facility operations.

Discussion

This section should provide a status update on any DAS conditions, key or secondary issues resulting from an LFRG review of the facility's PA and CA and other technical basis documents (e.g., MP, CP, etc.). For each condition and/or issue, the report should include:

- Classification (DAS condition, key or secondary);
- Identifying number (from the review team reports);
- Statement of the condition/issue;
- Imposed deadline or facility commitment for resolution or the date on which resolution was achieved; and
- Citation of the documentation acknowledging final resolution (Table 9-14).

The LFRG may use the ASR as documentation of successful resolution of the issue(s). When the full suite of issues for a PA, CA, or other technical basis documents has been resolved, subsequent annual summaries should only include a statement that all resolutions for all issues have been approved. This information will be used to update the research and development planning and implementation process in the MP (see Chapter 7).

Table 9-14. Example of DAS Conditions and Key and Secondary Issues

Disposal Facility/Unit	Key/Secondary Issue or Das Condition Number	Issue Description	Resolution Scheduled Date	Disposition Documentation	PA, CA, DAS Impact
#1	LFRG Review Report dated 1/1/15. Secondary Issue #7.2.5.	Documentation of conceptual models incomplete.	3/16/16	Pending	None
#1	LFRG Review Report dated 1/1/15. Secondary Issue #7.2.8.	Air pathway dose did not consider cumulative effect over multiple disposal units.	Complete	Special Analysis 10-15	Volatile radionuclide limits were reduced slightly
#1	LFRG Review Report dated 1/1/15. Secondary Issue #7.3.1.	Inconsistency between average and effective porosity and PA key assumption.	Complete	Hydraulic Property Data Package 11-15	None

Disposal Facility/Unit	Key/Secondary Issue or Das Condition Number	Issue Description	Resolution Scheduled Date	Disposition Documentation	PA, CA, DAS Impact
#1	DAS condition #1	Update the monitoring plan within 1 year of DAS issuance.	4/16/16	Pending	None

9.2.9. Certification of the Continued Adequacy of the PA, CA, DAS and RWMB

The following statement signed by the FEM or designee should be included in the ASR.

> *I certify to the best of my knowledge that information in this ASR is true, accurate and complete and that any proposed or implemented changes associated with the PA or other technical basis documents provide a reasonable expectation that the performance objectives/measures identified in DOE O 435.1 will be met.*

Objective

The objective of this guide is to provide a certification statement signed by the FEM attesting to the accuracy of the ASR.

Discussion

This section should include a statement that present conclusions drawn from the ASR that include a discussion or description of the relevant factors, if any, that may have challenged or supported the determination of PA, CA, DAS and RWMB adequacy. The ASR should contain a summary statement as to whether the information reviewed resulted in any change to the PA, CA, DAS or RWMB.

9.3. Compliance Demonstration

Compliance with the requirement in DOE O 435.1 for an ASR can be demonstrated by a site developing an ASR to support the PA and CA, reviewed by the LFRG, approved by DOE to ensure that DOE O 435.1 performance objectives continue to be met.

9.4. Attachment

Attachment 9-1, *Example Annual Summary Report Cover Letter*

9.5. References

DOE Order 435.1, Chg 1, *Radioactive Waste Management*, July 09, 1999

DOE Order 458.1, *Radiation Protection of the Public and Environment*, February 11, 2011

DOE Manual 435.1-1, *Radioactive Waste Management Manual*, July 09, 1999

DOE Guide 435.1-1, Admin Chg 2, *Implementation Guide for Use with DOE M 435.1-1*, July 09, 1999

Low-Level Waste Disposal Facility Federal Review Group Manual, Revision 3, 2008

NRC, Regulatory Guide 1.174 - *An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis, Nuclear Regulatory Commission*, Revision 1, November 2002.

9.6. Annual Summary Report (ASR) Review Criteria

The Table 9-15 may be used to evaluate whether the document contents are complete and thorough and the document is technically adequate and defensible. Review criteria may be changed according to the scope and facility being reviewed. However, the LFRG Co-Chairs must approve the review criteria being used in the LFRG Review Plan for a specific facility.

Note: Numbers in parentheses refer to the section number in the chapter.

Table 9-15. Annual Summary Report (ASR) Review Criteria

ID	Review Criteria	Criteria Met (Yes/No)	Comments
ASR-1	Provide an overview of the documents and data used to make the certification of the continued adequacy of the PA, CA, DAS, other DAS technical basis documents, and the radioactive waste management basis (RWMB) to meet the DOE O 435.1 performance objectives/measures. If these documents need revision a corrective action plan should be developed and implemented. (9.2.1 Executive Summary)		
ASR-2	All Change Control Process evaluations (called UDQE/UCAQE in Chapter 8) or other change control processes (e.g., non-conformances, corrective action) used to evaluate proposed actions, changes and new information to determine if these activities are within the boundaries analyzed in the approved PA and CA. Their potential effect on the continued adequacy of the DAS, PA, CA and RWMB should be provided. Specific information for each identified change should be described. Specific		

ID	Review Criteria	Criteria Met (Yes/No)	Comments
	information for each identified change should be described in Table 9-1 below. (9.2.2 Changes Potentially Affecting the PA, CA, DAS or RWMB)		
ASR-3	An evaluation and discussion of the cumulative effects of all the changes that have been identified in "Changes Potentially Affecting the PA, CA, DAS or RWMB" during the year. (9.2.3 Cumulative Effects of Changes)		
ASR-4	The information regarding waste receipts should be provided and discussed. In addition, a discussion regarding waste receipts should be included (Table 9.3). (9.2.4 Waste Receipts)		
ASR-5	This section should include monitoring results using the following table format. In addition, a discussion regarding monitoring results should be included. For compliance monitoring (Table 9-5), action levels that are exceeded should be documented along with any corrective actions in the ASR. For performance monitoring, results differing from expected behavior should be documented and discussed with any corrective actions. (9.2.5 Monitoring)		
ASR-6	R&D, field studies, etc. results should be provided and discussed. See Table 9-8 for information. (9.2.6 Research and Development)		
ASR-7	Planned or contemplated changes (including completion schedules) in disposal facility design, construction, operations, closure, R&D, land use or in technical basis documents (MP, CP, WAC, MonP, Change Control Process) presented in a table following the format in Table 9-11. (9.2.7 Planned or Contemplated Changes)		

ID	Review Criteria	Criteria Met (Yes/No)	Comments
ASR-8	Provide a status update on any DAS conditions and key or secondary issues resulting from an LFRG review of the facility's PA and CA and other technical basis documents (e.g., MonP, CP, etc.). See Table 9-13 for information. (9.2.8 Status of DAS Conditions, Key and Secondary Issues)		
ASR-9	The following statement signed by the FEM or designee should be included in the ASR. *I certify to the best of my knowledge that information in this ASR is true, accurate and complete and that any proposed or implemented changes associated with the PA or other technical basis documents provide a reasonable expectation that the performance objectives/measures identified in DOE O 435.1 will be met.* (9.2.9 Certifications of the Continued of the Adequacy of the PA, CA, DAS and RWMB)		

Attachment 9.1. Example Annual Summary Report Cover Letter

TO: DAS for EM-10 and 30

FROM: Field Element Site Manager

SUBJECT: Annual Summary Report for LLW Disposal Facility

Annual Summary Report for LLW Disposal Facility for FY 2016 (LLW-01) is attached for your consideration. We have reviewed and approved the report developed by the LLW contractor and agree that:

- The LLW Disposal Facility PA and associated CA assumptions and conclusions remain valid based on considerations of all changes identified or planned;
- The reasonable expectation that the LLW Disposal Facility will meet the performance objective identified in DOE O 435.1A, *Radioactive Waste Management*, remains valid;
- The DAS, based on interpretation of the data collected, monitoring results, and other information, remains valid; and
- The RWMB has been revised and approved to include the two Special Analysis detailed in the attached Annual Summary Report.

I certify to the best of my knowledge that information in this Annual Summary Report is true, accurate and complete and that any proposed or implemented changes associated with the PA or other technical basis documents provide a reasonable expectation that the performance objectives/measures identified in DOE O 435.1 will be met.

_____

Field Element Manager

Attachment 1. LLW Disposal Facility Annual Summary Report