Guidance for Conducting Technical Analyses for 10 CFR Part 61

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301-415-0140

Interagency Performance and Risk Assessment Community of Practice

May 20, 2015

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Objective

- Discuss the proposed revisions to the Commission's low-level radioactive waste disposal regulations and proposed guidance
- Encourage the submittal of comments on the proposed guidance
- Answer questions and receive comments on guidance from the public

Agenda

- Overview of rulemaking
- Summary of proposed rule
- Summary of proposed guidance

Agenda - continued

- Considerations for general analyses
- Performance assessment
- Inadvertent intruder assessment
- Site stability analyses
- Protective assurance period
- Performance period analyses
- Defense-in-depth analyses
- Waste acceptance
- Performance confirmation

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OVERVIEW OF RULEMAKING

Why is NRC proposing changes to 10 CFR Part 61?

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- Recognize unanalyzed waste streams in original 10 CFR Part 61
- Implement Commission policy in a public process
- Make provisions generally applicable
- Address lessons learned and recommendations

Who will rulemaking affect?

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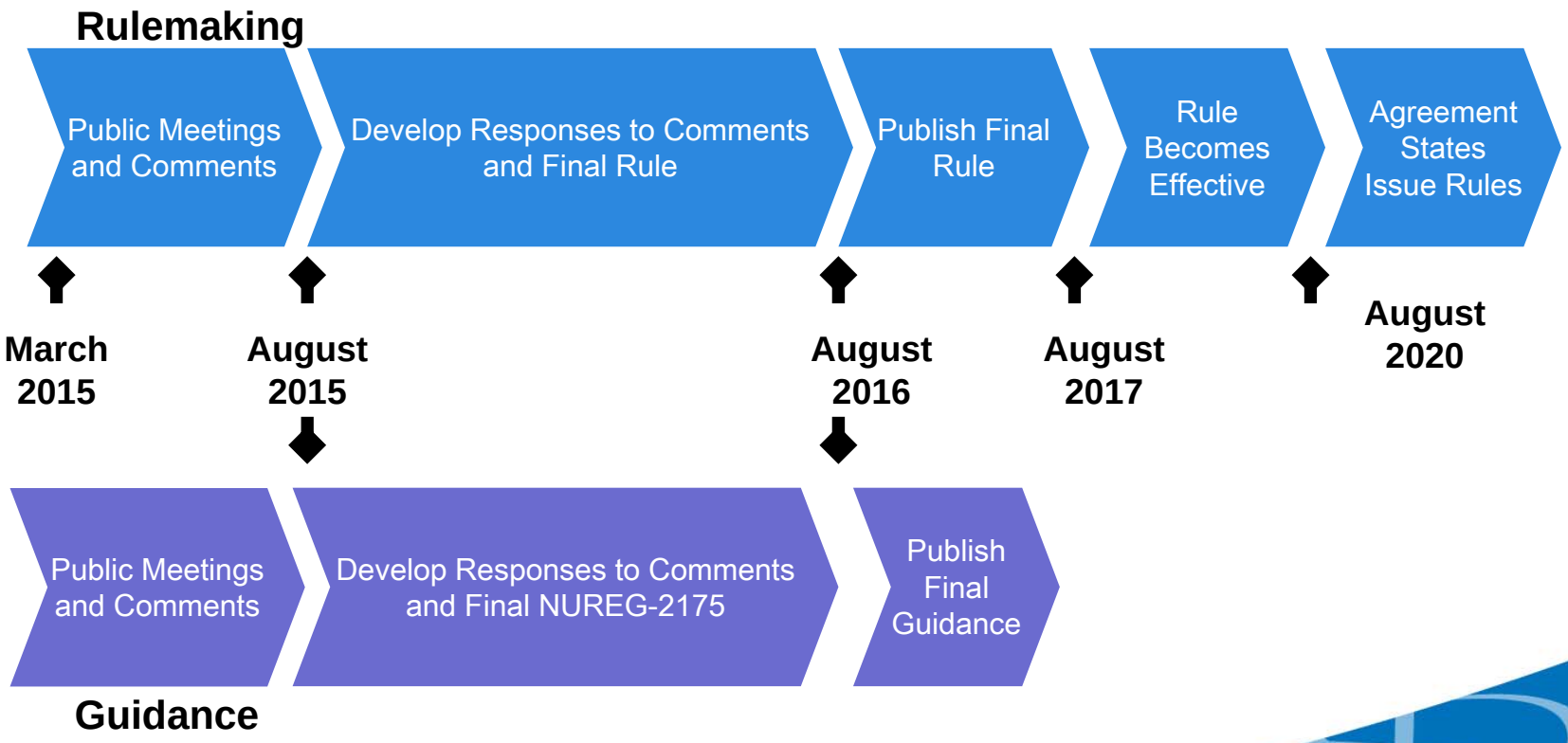
Facility	Waste	Compact Restrictions
Richland, WA	A, B, C	11 Western states in 2 LLW Compacts only
Clive, UT	A only	None, all US generators OK (Compacts must approve)
Barnwell, SC	A, B, C	SC, NJ, CT only (Atlantic Compact)
Andrews Cty, Texas	A, B, C	Texas and VT (Texas Compact), Others with Compact approval

What is the timeline for rulemaking?



Note: Dates are approximate

Public Interactions

- March 20, Phoenix, AZ
- April 28, Rockville, MD
- May 12, Austin, TX
- May 20, This Webinar
- June 2, Columbia, SC
- June 9, Richland, WA
- June 10, Salt Lake City, UT

How to Comment on Proposed Rule:

- Accepting comments 120 days from date of publication (through July 24, 2015)
- Include Docket ID NRC-2011-0012 in the subject line of your comments

- **Federal rulemaking website:** Go to http://www.regulations.gov and search for documents filed under Docket ID NRC-2011-0012
- **Mail comments to:** Secretary, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, ATTN: Rulemakings and Adjudications Staff
- **E-mail comments to:** Rulemaking.Comments@nrc.gov. If you do not receive a reply e-mail confirming that we have received your comments, contact us directly at 301-415-1677
- **Hand-deliver comments to:** 11555 Rockville Pike, Rockville, Maryland 20852, between 7:30 am and 4:15 pm Federal workdays. (Telephone 301-415-1677)
- **Fax comments to:** Secretary, U.S. Nuclear Regulatory Commission at 301-415-1101

How to Comment on Proposed Guidance:

- Accepting comments 120 days from date of publication (through July 24, 2015)
- Please include Docket ID NRC-2015-0003 in the subject line of your comments

- **Federal rulemaking web site:** Go to http://www.regulations.gov and search for documents filed under Docket ID NRC-2015-0003. Click on the comment icon and complete the web form
- **Mail comments to:** Cindy Bladey, Chief, Rules, Announcements, and Directives Branch (RADB), Office of Administration, Mail Stop: 3WFN-06-A44M, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001

How to Find Additional Information:

- Proposed rule and guidance
  - www.regulations.gov
    - Rule - Docket ID: NRC-2011-0012
    - Guidance - Docket ID: NRC-2015-0003
- Related information
  - http://www.nrc.gov/about-nrc/regulatory/rulemaking/potential-rulemaking/uw-streams.html

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QUESTIONS ON RULEMAKING PROCESS?

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OVERVIEW OF CHANGES TO 10 CFR PART 61

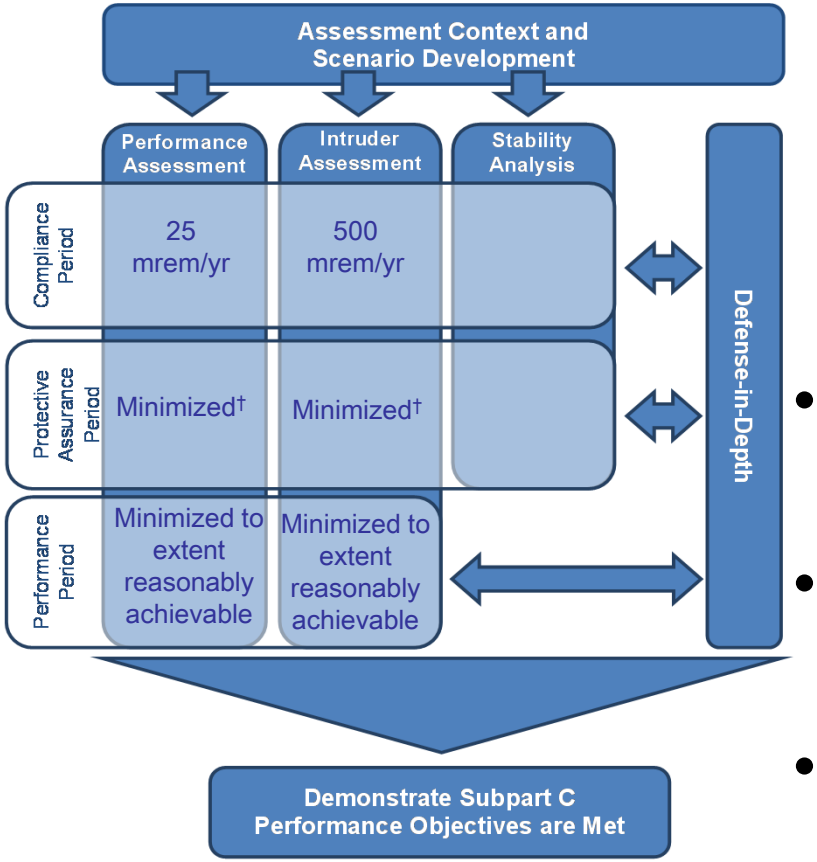
What is in the Proposed Rule?

The NRC is proposing to amend its regulations that govern low-level radioactive waste (LLRW) disposal facilities to require:

- New and revised site-specific technical analyses to demonstrate that the performance objectives are met
- To permit the development of site-specific criteria for LLRW acceptance based on the results of these analyses
- To facilitate implementation and to better align the requirements with current health and safety standards
- To ensure licensing decisions are based on defense-in-depth protections

This proposed rule would affect LLRW disposal licensees or license applicants that are regulated by the NRC or the Agreement States

Proposed Modifications to Rule



† w/ goal of 500 mrem/yr or a level reasonably achievable based on technological and economic considerations

- Performance objectives (POs) 3 tiers
  - Compliance: 1,000 yrs. post-closure
  - Protective Assurance: 1,000-10,000 yrs.
  - Performance: 10,000 yrs.+
- Requirements of technical analyses
- Explicit demonstration of defense-in-depth
- Waste acceptance requirements

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QUESTIONS ON PROPOSED RULE?

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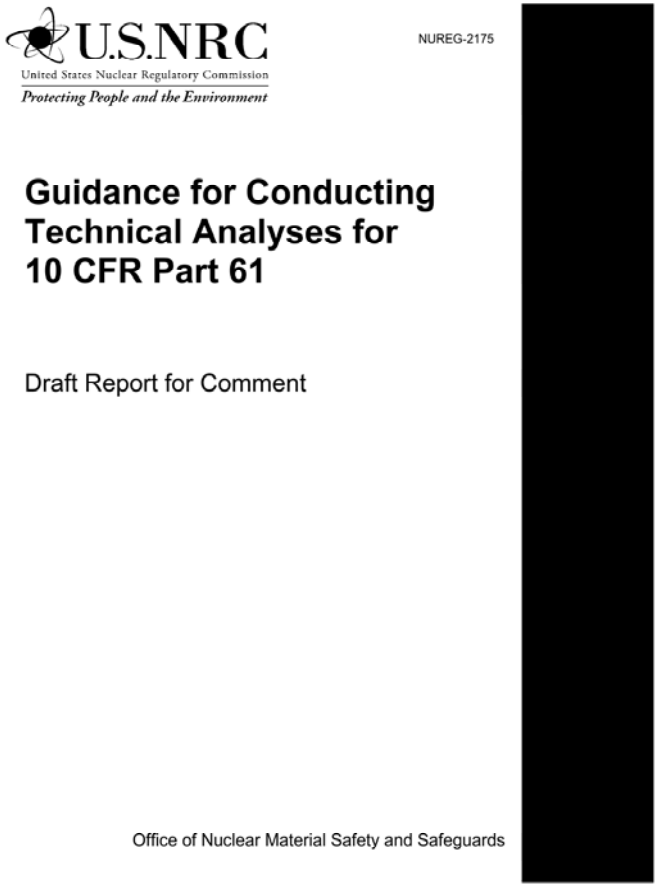
OVERVIEW OF PROPOSED GUIDANCE (NUREG-2175)

Purpose

- Provides guidance on conducting technical analyses to demonstrate compliance with the performance objectives in 10 CFR Part 61:
  - Performance assessment (PA)
  - Inadvertent Intruder assessment (IIA)
  - Assessment of stability of disposal site
  - Protective assurance period analyses
  - Performance period analyses
  - Defense-in-depth analyses
- Provides guidance for waste acceptance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NUREG-2175

Guidance for Conducting Technical Analyses for 10 CFR Part 61

Draft Report for Comment

Office of Nuclear Material Safety and Safeguards

Contents

Additional Content

- Emphasis on risk-informed approaches, flexibility
- Relationship to other NRC guidance
- Examples, tables, figures
- Appendices (e.g. hazard maps, features, events, and processes [FEPs])

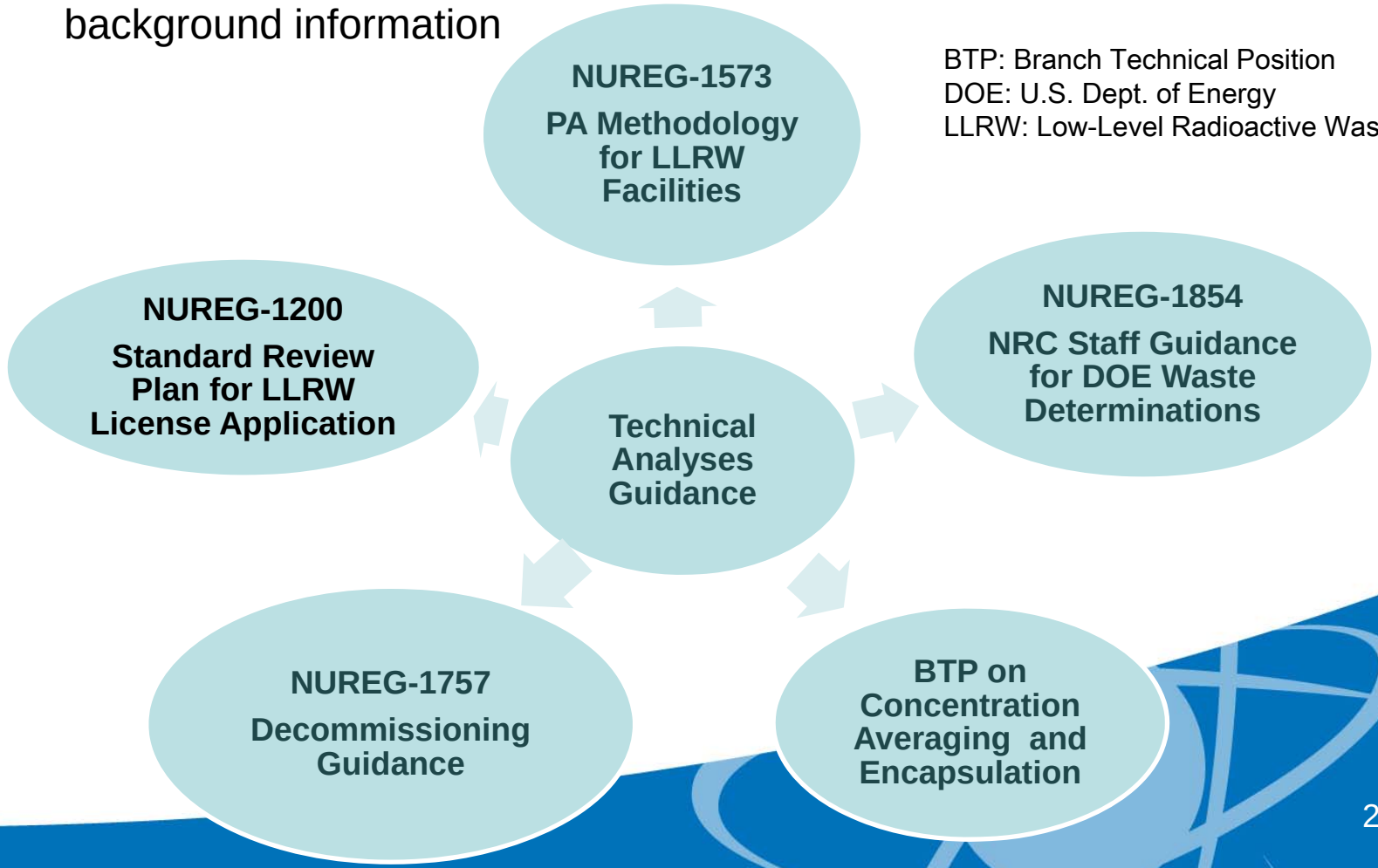
How to Find Guidance:

- Regulations.gov
  - www.regulations.gov
  - Docket ID: NRC-2015-0003
- NRC's ADAMS
  - www.nrc.gov/reading-rm/adams.html
  - Accession No. ML14357A072
- NRC's LLRW disposal webpage
  - http://www.nrc.gov/about-nrc/regulatory/rulemaking/potential-rulemaking/uw-streams.html

Overview

- Supplements existing guidance
  - Provides crosswalk to other NRC guidance documents for background information

BTP: Branch Technical Position
DOE: U.S. Dept. of Energy
LLRW: Low-Level Radioactive Waste



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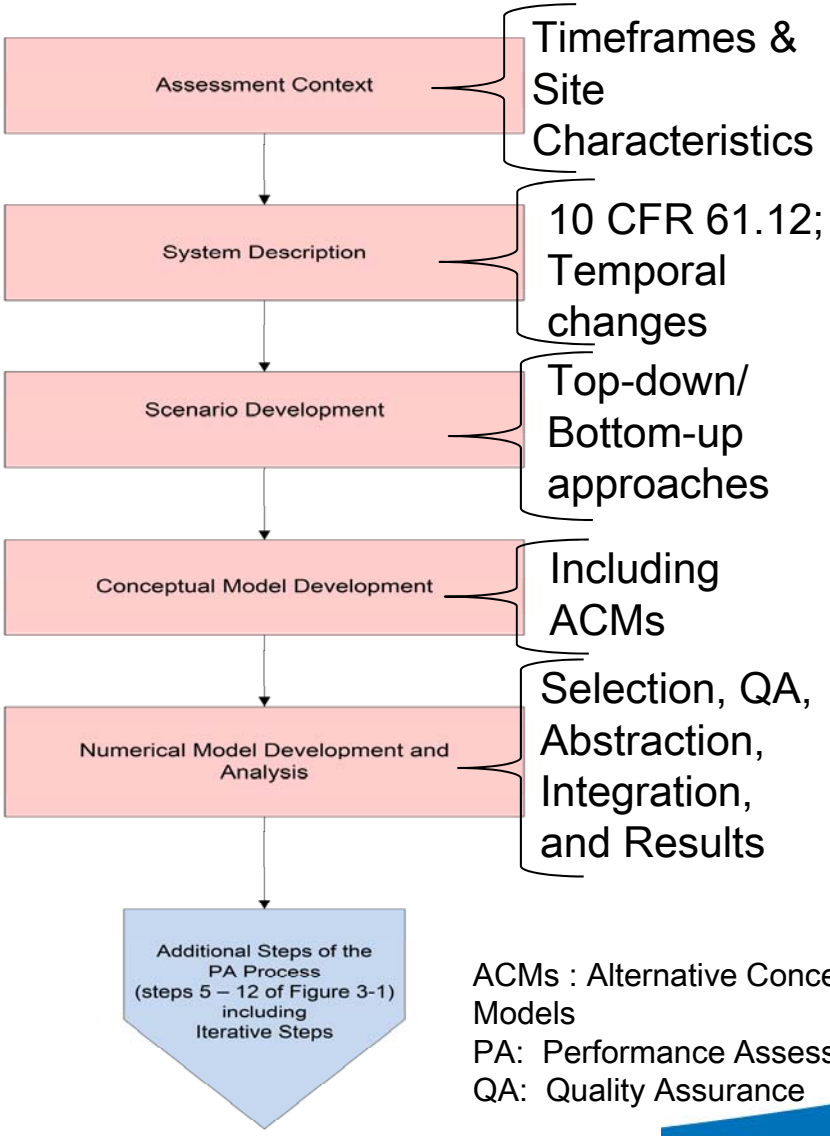
CONSIDERATIONS FOR GENERAL TECHNICAL ANALYSES

Scope



ACMs : Alternative Conceptual Models
PA: Performance Assessment
QA: Quality Assurance

Figure 2-1 **Initial Steps of the Performance Assessment Methodology**

- Guidance for preparing/reviewing any of the technical analyses
- Describes assessment process
- Acceptable dosimetry methodologies
  - Corresponding organ dose weighting and dose conversion factors

Review Considerations

- Graded approach
- Reasonable assurance
- Data Adequacy
- Uncertainty
  - Scenario
  - Model
  - Parameter
- Model support

General Analyses Considerations

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<u>Seeking feedback on</u>:

- Adequacy of guidance to develop technical analyses that meet 61.13 requirements
- Clarity of assessment process
- Guidance on scenario development

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PERFORMANCE ASSESSMENT

Performance Assessment

- PA is not a new topic – renaming of technical analyses
- Proposed modifications modernize the technical analyses requirements
- New requirements in 61.13(a):
  - Scope (features, events, and processes)
  - Uncertainty and variability
  - Model support

IMPLICIT

↓

EXPLICIT

- Requirement to update the PA at closure
- Modified siting characteristics consistent with disposal of long-lived waste

Approach

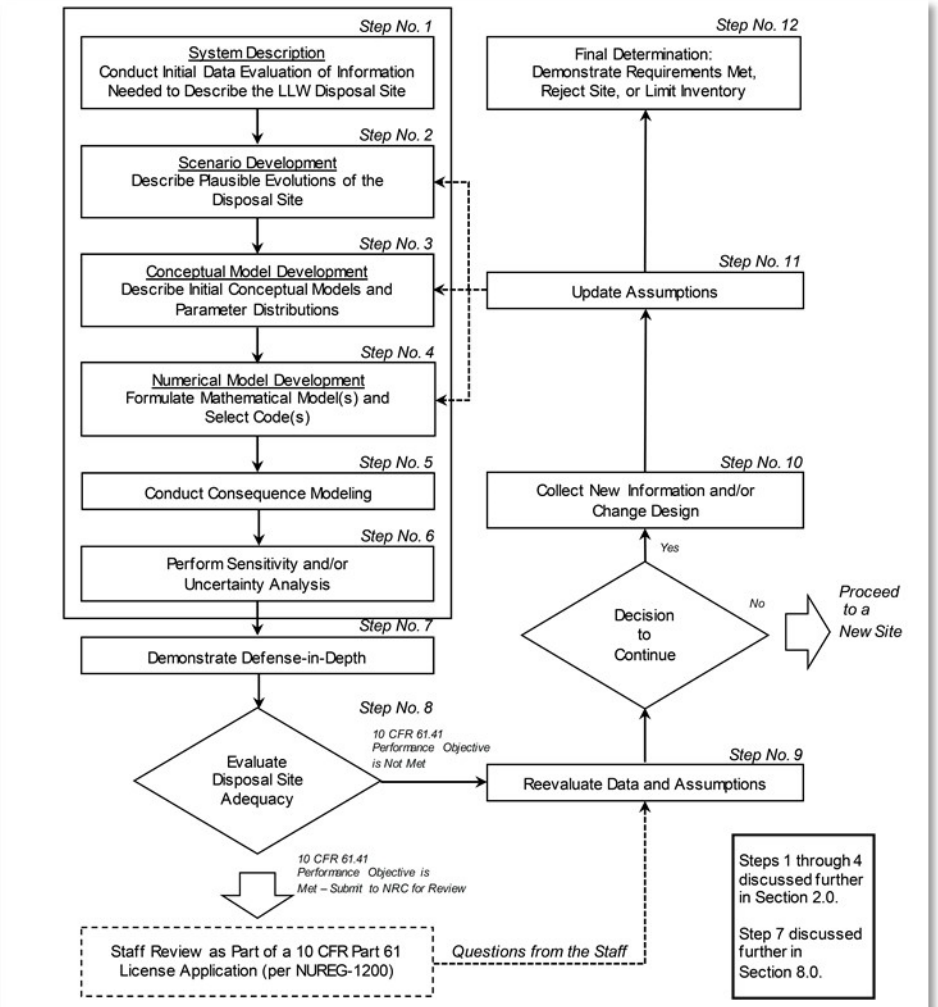

Figure 3-1 Example of a Performance Assessment Process

- Supplements NUREG-1573
- Emphasis on long-lived radionuclides
- Discusses
  - Source term
  - Transport
  - Biosphere

Performance Assessment

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<u>Seeking feedback on</u>:

- Adequacy of guidance to demonstrate requirements at 10 CFR 61.13(a)
- Clarity of guidance
- Guidance vs. regulation

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INADVERTENT INTRUSION

Inadvertent Intrusion

- Intrusion possible, though unlikely
- Assist regulatory decision-making given disposal is in near-surface
- Separate PO because controls required, but cannot be solely relied upon

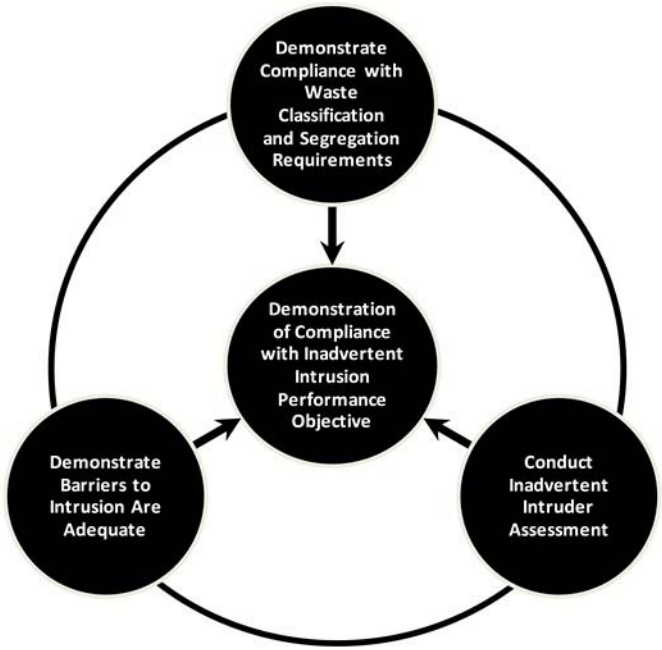

Figure 4-1 Technical Analyses Required to Demonstrate Compliance with the 10 CFR Part 61 Performance Objective for the Protection of Individuals from Inadvertent Intrusion

Inadvertent Intruder Assessment

- Inadvertent intruder assessment (IIA) is a new analysis
- New requirements in 61.13(b):
  - Scope
  - Intruder barriers
  - Uncertainty and variability
- Performance objective in 61.42
- Requirement to update IIA at closure

Inadvertent Intruder Assessment Overview

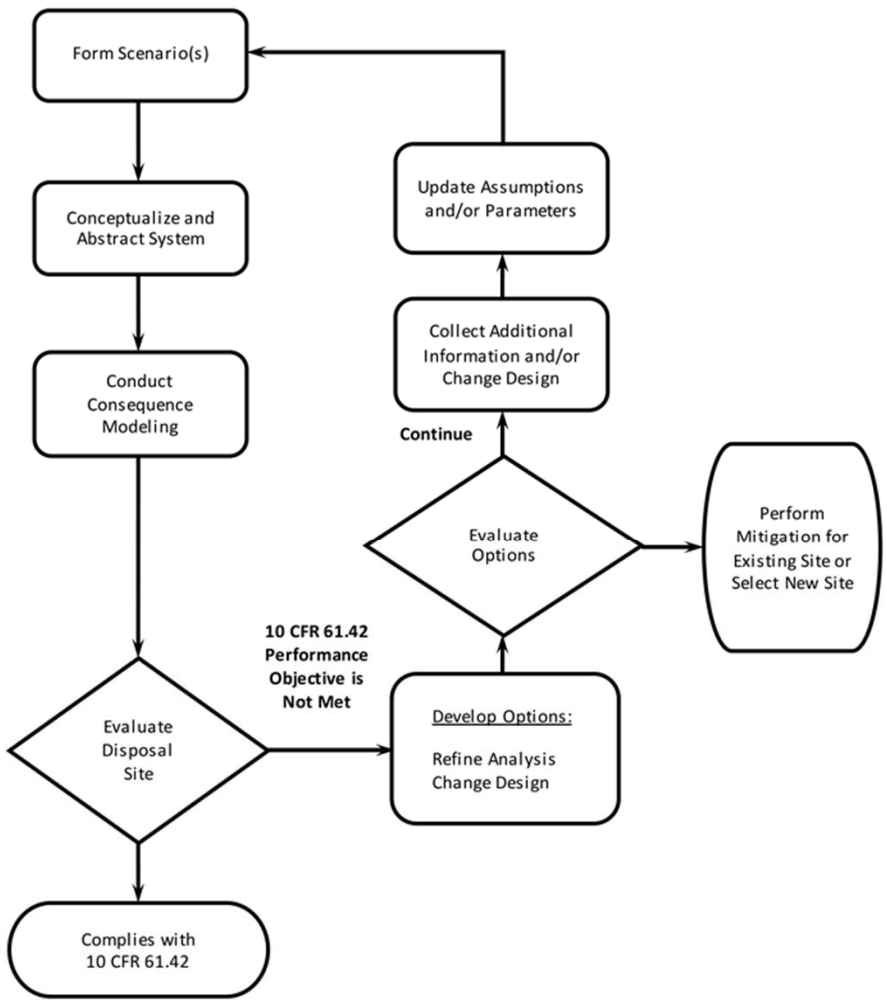

Figure 4-2 Example of an Inadvertent Intruder Assessment Process Required Per 10 CFR 61.42

- Stylized calculation
- Receptor scenarios are key component to consider uncertainties
- Annual dose limit of 500 mrem for compliance periods

Intruder Receptor Scenarios

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Table 4-1 Comparison and Description of Intruder Receptor Scenario Terms Used in this Guidance

Types of Scenarios		Evaluation Purpose	Description
Plausible	Generic	All can be used to demonstrate compliance with the inadvertent intruder performance objective.	The scenarios used to inform the waste classification criteria at 10 CFR 61.55 that are consistent with normal activities including agriculture, dwelling construction, resource exploration or exploitation.
	Site-Specific		A scenario developed, using site information, either from scratch or by modifying a generic scenario that is consistent with activities in and around the disposal site at the time of closure.
	Reasonably Foreseeable		Reasonably foreseeable scenarios are based on normal activities or other pursuits that are consistent with activities in and around the disposal site at the time of closure. Normal activities include agriculture, dwelling construction, resource exploration or exploitation (e.g., well drilling). The NRC staff continues to believe the generic receptor scenarios associated with normal activities are typically plausible assuming the loss of institutional controls and the loss or significant degradation of the capabilities of intruder barriers. The NRC staff also continues to view the generic receptor scenarios as reasonably bounding over long timeframes, given the uncertainty in estimating future human activities over long time periods. However, licensees can also rely on site-specific scenarios that are consistent with activities in and around the site at the time of closure to limit speculation about future human activity.
	Less Likely but Plausible	Not analyzed for compliance, but may be used to risk-inform the decision.	Intruder activities that are plausible, assuming the loss of institutional controls, based on the capabilities of intruder barriers, site characteristics, and historical uses, but are **not** reasonably foreseeable considering normal activities or other pursuits that are different than activities in and around the site at the time of closure. These scenarios are usually site-specific.
Implausible		No analysis required.	Assuming the loss of institutional controls, intruder activities that could not occur because of persistent physical limitations of the site.

- Normal activities or other reasonably foreseeable pursuits consistent with expected activities in and around the site at the time of closure
- Flexibility for generic or site-specific intruder receptor scenarios

Inadvertent Intruder Assessment

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<u>Seeking feedback on</u>:

- Adequacy of guidance to demonstrate requirements in 10 CFR 61.13(b)
- Clarity of guidance
- Guidance vs. regulation

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SITE STABILITY ANALYSES

Site Stability

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- Early challenges arose from site stability issues – mostly water
- Examine active natural processes
- Reasonable assurance that there will not be a need for ongoing active maintenance
- Stability of the disposal site for compliance and protective assurance periods

Site Stability Analyses

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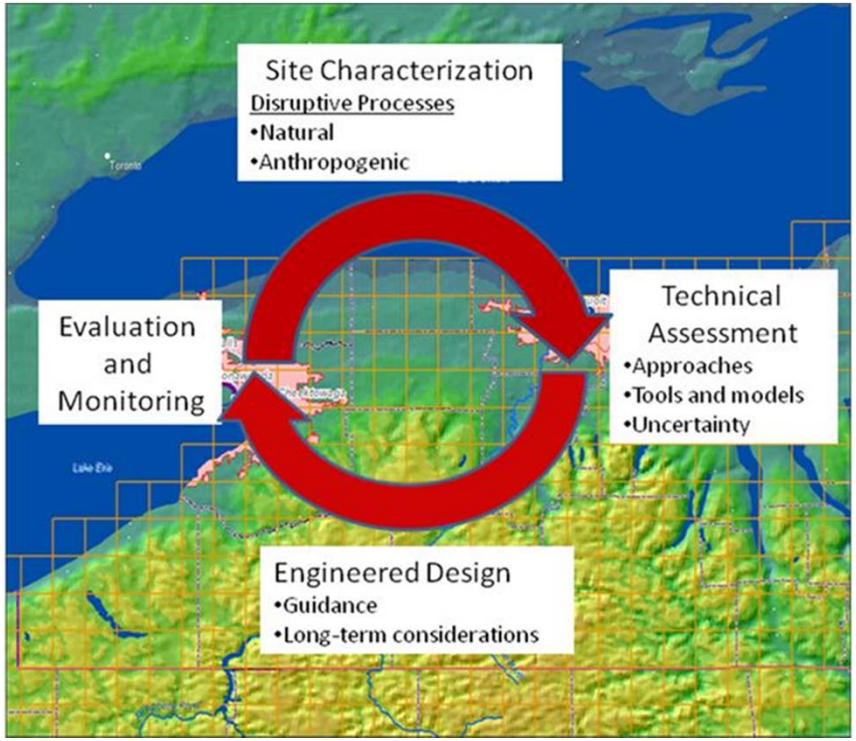
- Site stability
  - Waste
  - Disposal site
  - Surrounding environment
- Guidance focuses on:
  - Disruptive processes
  - Technical assessment
  - Engineered barriers
- Generally, demonstrated in context of meeting 10 CFR 61.41 and 61.42



Disruptive Processes

- Reasonably foreseeable (~10%+ likelihood over time period)
- Consistent with waste
- Processes
  - Natural
  - Anthropogenic – intruder
  - Subsidence/settlement

Technical Assessment

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- Site description
- Screen
  - Radiological risk
  - Process and event
- Define scope
- Characterize information
- Perform assessment
- Integrate
- Iterate, as necessary
- Model support

a. Design-Based:

i. Define the design objectives.
ii. Develop or select the design.
iii. Document and provide the basis for assumptions.
iv. Characterize or parameterize the design.
v. Assess the expected performance of the design.
vi. Provide support for the design.
vii. Iterate, if necessary.

b. Model-Based:

i. Define the model objectives.
ii. Develop or select the conceptual model.
iii. Document and provide the basis for assumptions.
iv. Develop the numerical model.
v. Parameterize the model.
vi. Calibrate the model.
vii. Verify the model.
viii. Characterize uncertainty.
ix. Provide model support.
x. Iterate, if necessary.

Engineered Barriers

Steps:

- Describe barriers
- Provide technical basis
- Describe uncertainty
- Demonstrate suitability of numerical models
- Perform sensitivity analyses
- Provide model support
- Provide quality assurance/quality control

Site Stability Analyses

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<u>Seeking feedback on</u>:

- Adequacy of guidance to demonstrate requirements at 61.13(d) are met
- Clarity of guidance
- Guidance vs. regulation

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PROTECTIVE ASSURANCE PERIOD ANALYSES

Protective Assurance Period

- Second tier of the analyses timeframe (1,000-10,000 years)
- Required for all types of low-level waste
- Proposed as an optimization type process, rather than comparison to a dose limit
- Goal → minimize doses
- Annual dose below 500 mrem or level reasonably achievable
  - Technical considerations
  - Economic considerations

Protective Assurance Period

- Simplest approach: extend the PA and IIA
- Approach in guidance:

High risk = High effort
Low risk = Low effort

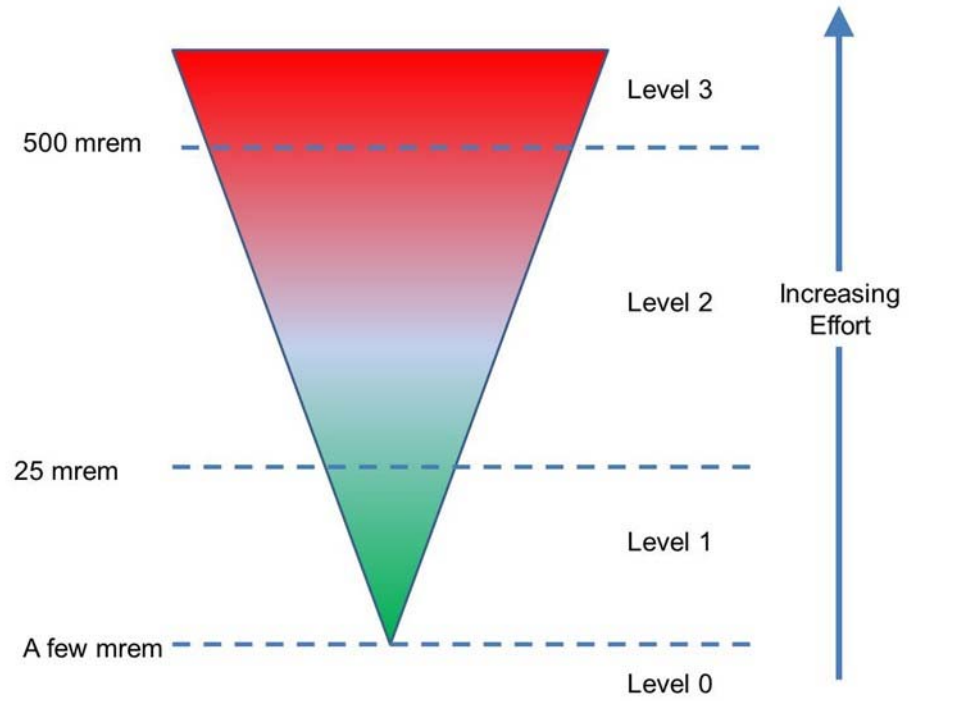

Figure 6-1 Analyses Framework for the Minimization Process for the Protective Assurance Period Analyses Applied to 10 CFR 61.41(b)

Protective Assurance Analyses

<u>Seeking feedback on</u>:

- Adequacy of guidance to demonstrate 10 CFR 61.41(b), 61.42(b), and 61.44(b) are met
- Clarity of guidance
- Guidance vs. regulation

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PERFORMANCE PERIOD ANALYSES

Performance Period

- Applicable to times after 10,000 years
- Applies only if sufficient waste is present (Table A)
- Concentrations based on disposal site average using sum of fractions approach
- Minimize impacts to the extent reasonably achievable
- Requirements for analyses in 61.13(e)
  - Assess how the disposal site limits long-term impacts
  - Identify design features and site characteristics

Performance Period

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Table A - Average Concentrations of Long-lived Radionuclides Requiring Performance Period Analyses

Radionuclide	Concentration (Ci/m^3)[1]
C-14	0.8
C-14 in activated metal	8
Ni-59 in activated metal	22
Nb-94 in activated metal	0.02
Tc-99	0.3
I-129	0.008
Long-lived alpha-emitting nuclides[2, 3]	10
Pu-241[3]	350
Cm-242[3]	2,000

[1] Values derived from § 61.55 Class A limits.
[2] Includes alpha-emitting transuranic nuclides as well as other long-lived alpha-emitting nuclides.
[3] Units are nanocuries per gram.

Performance Period Approach

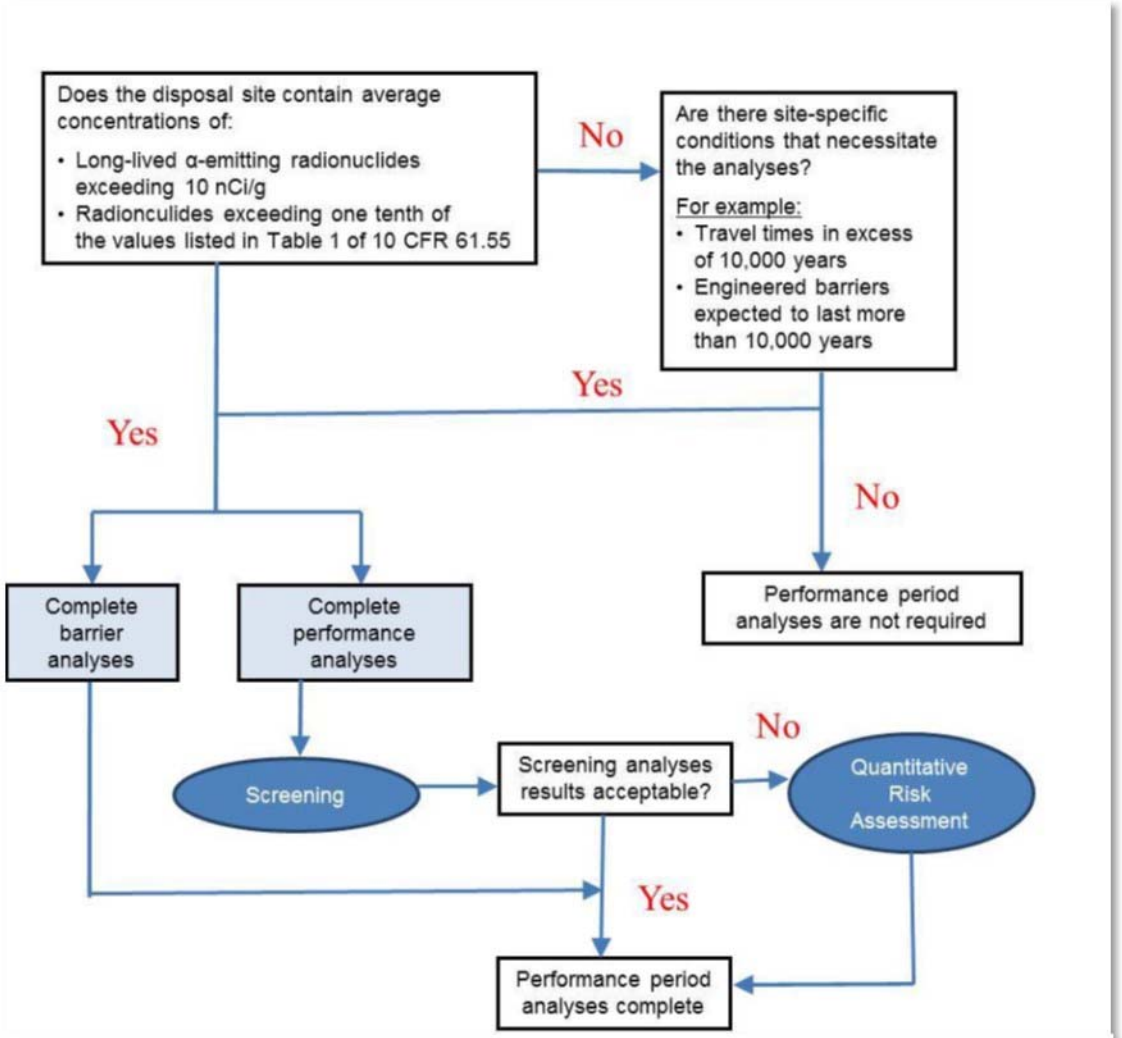

Figure 7-1 Recommended Approach to Conducting Performance Period Analysis

Performance Period Analyses

<u>Seeking feedback on</u>:

- Adequacy of the approach to the performance period analyses
- Averaging approach to concentrations
- Adequacy and clarity of guidance
- Guidance vs. regulation

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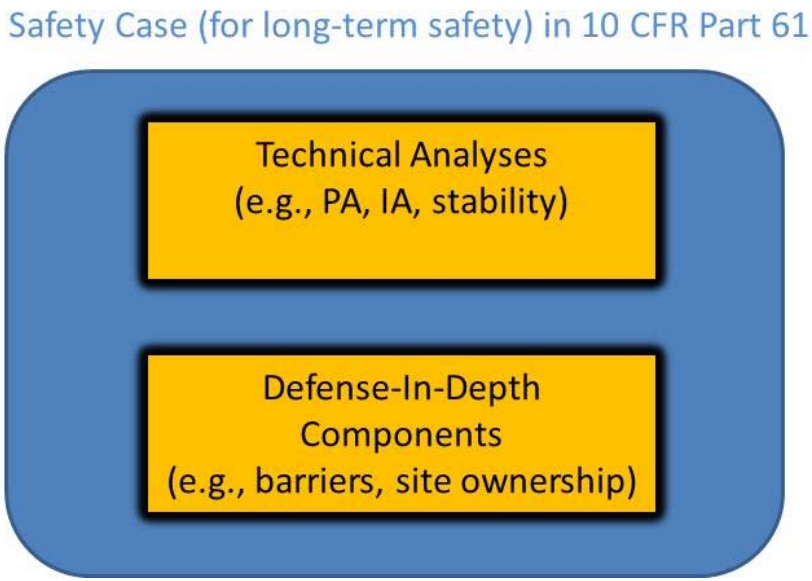
DEFENSE-IN-DEPTH ANALYSES

Safety Case



- Proposed rule includes discussion of safety case
- Explains how the combination of defense-in-depth (DiD) and PA (i.e., safety case) should be used to support the licensing decision

Defense-in-Depth

Defense-in-Depth:
The use of multiple, independent, and redundant layers of defense so that no single layer, no matter how robust, is exclusively relied upon for safety.

- Multiple layers
- Independent layers
- Redundant layers
- Safety margin
- Risk informed

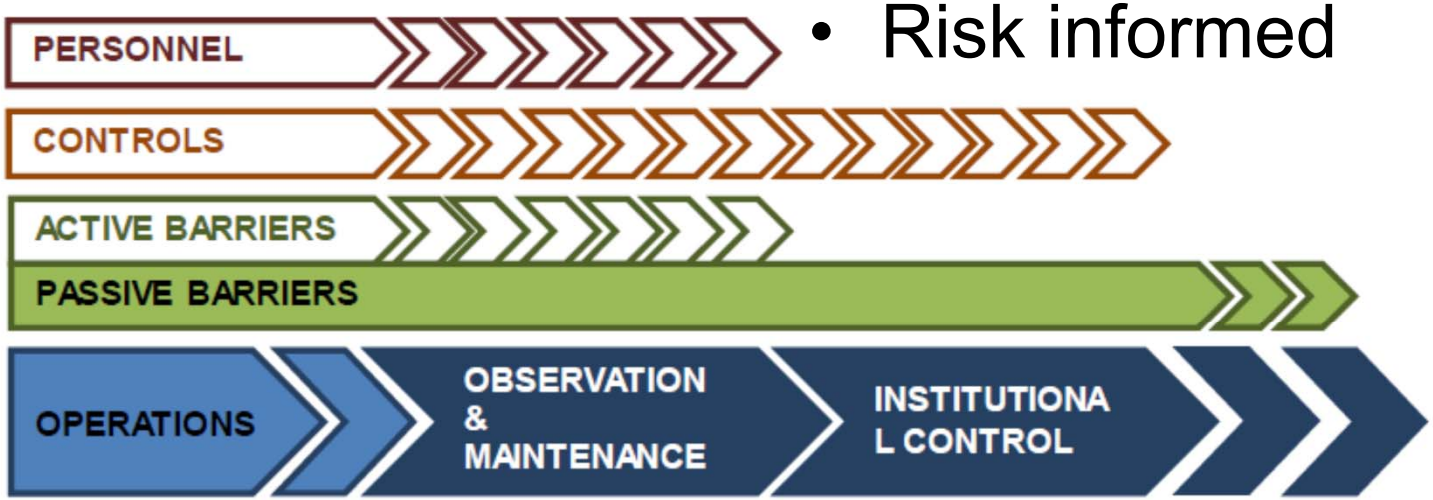


Figure 8-2 **Land Disposal Facility Lifecycle and Timeframes for Defense-in-Depth Layers** (Duration of lifecycle timeframes are not to scale. Dark blue timeframes are considered the post-closure period.)

Defense-in-Depth Analyses

- Identify DiD protections
- Describe safety functions
- Demonstrate safety margin
  - Varies over lifecycle and risks
  - Relative to POs
  - Uncertainty (e.g., less likely, but plausible scenarios)
- Recommended approach: rely on results of other analyses

Defense-in-Depth Analyses

<u>Seeking feedback on:</u>

- Adequacy of guidance for demonstrating DiD
- Clarity of guidance
- Guidance vs. regulation

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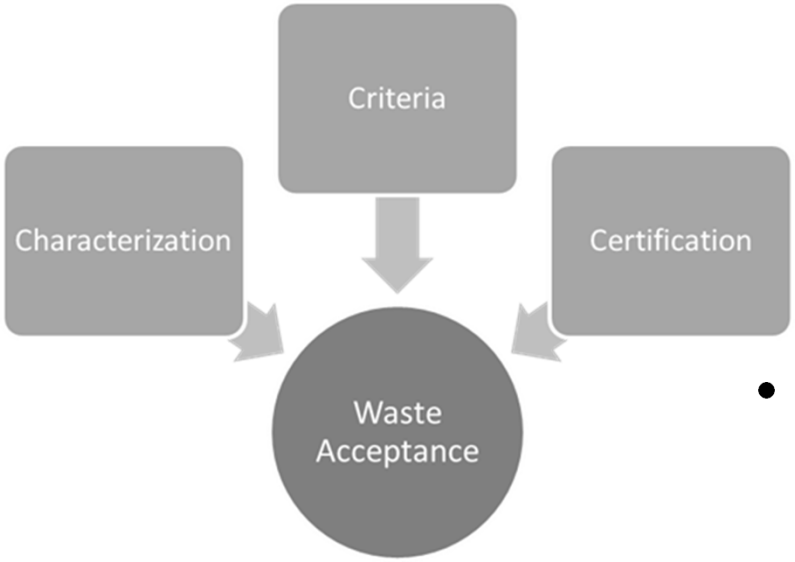
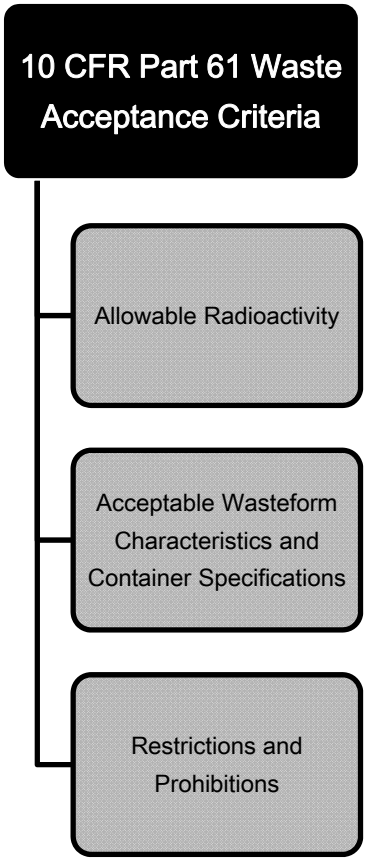
WASTE ACCEPTANCE

Waste Acceptance



- New requirements for developing waste acceptance criteria (WAC) using either:
  - 61.55 waste classification system, or
  - Site-specific WAC
- New 61.58 focuses on three areas:
  - WAC
  - Waste characterization
  - Waste certification

Criteria



- Criteria established from:
  - Waste classification tables
  - Results of technical analyses
- Demonstrate POs
  - Focus on significant radionuclides and wasteform characteristics and container specifications
  - Combination of concentration and inventory limits

Waste Classification

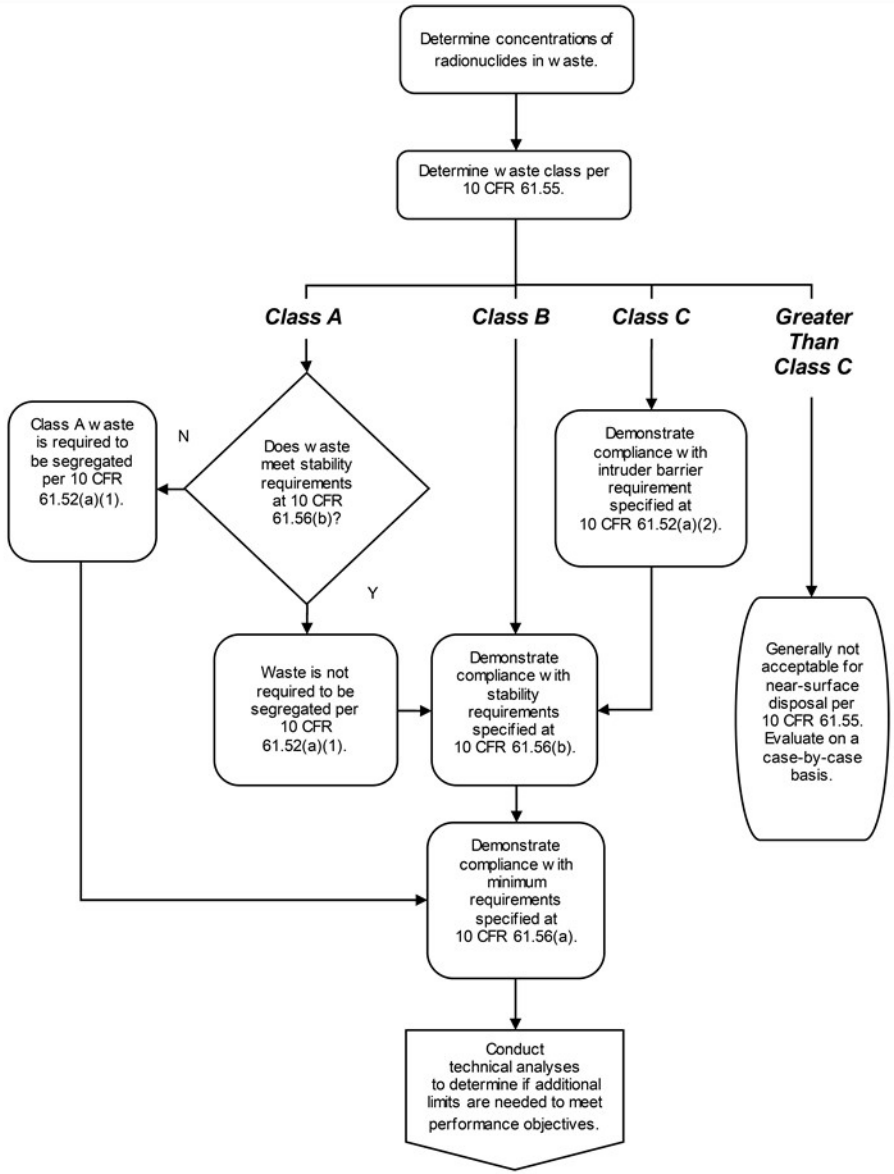


Figure 9-4 Waste Classification and Segregation for Waste Classes

1

Characterization

- Acceptable methods
  - Direct measurement
  - Indirect methods
    - Materials accountability
    - Characterization by source
    - Scaling factors
- Existing NRC guidance (i.e., BTPs)
- Inventory, wasteforms, and containers
- Graded approach
- Acceptable uncertainty

Certification Program

Describes:

- Responsibilities
- Procedures
- Documentation
- Audits
- Maintenance
- Waste profiles
  - Prior to disposal
  - Summarize waste form and characterization data
- Quality assurance/quality control
- Certification maintenance procedures

Waste Acceptance

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<u>Seeking feedback on:</u>

- Adequacy of guidance to demonstrate waste acceptance requirements are met
- Clarity of guidance
- Guidance vs. regulation

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PERFORMANCE CONFIRMATION

Performance Confirmation

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Table 10-1 Regulatory Requirements Supportive of Performance Confirmation

Section	Requirement
10 CFR 61.7(c)(3)	Post-closure monitoring and maintenance
10 CFR 61.12(g)	A description of the disposal site closure plan, including those features that facilitate closure and eliminate the need for maintenance
10 CFR 61.28	Contents of application for closure
10 CFR 61.52	Land disposal facility operation and disposal site closure
10 CFR 61.53(c)	Environmental monitoring during construction and operation
10 CFR 61.53(d)	Environmental monitoring, post operational surveillance

- Not required, but supported by regulation
- Elements:
  - Verification site conditions, barriers, DiD within limits assumed
  - Monitoring of disposal site performance
  - Verification of safety case
  - During operations and institutional control period

Performance Confirmation

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<u>Seeking feedback on:</u>

- Adequacy of guidance
- Clarity of guidance
- Guidance vs. regulation

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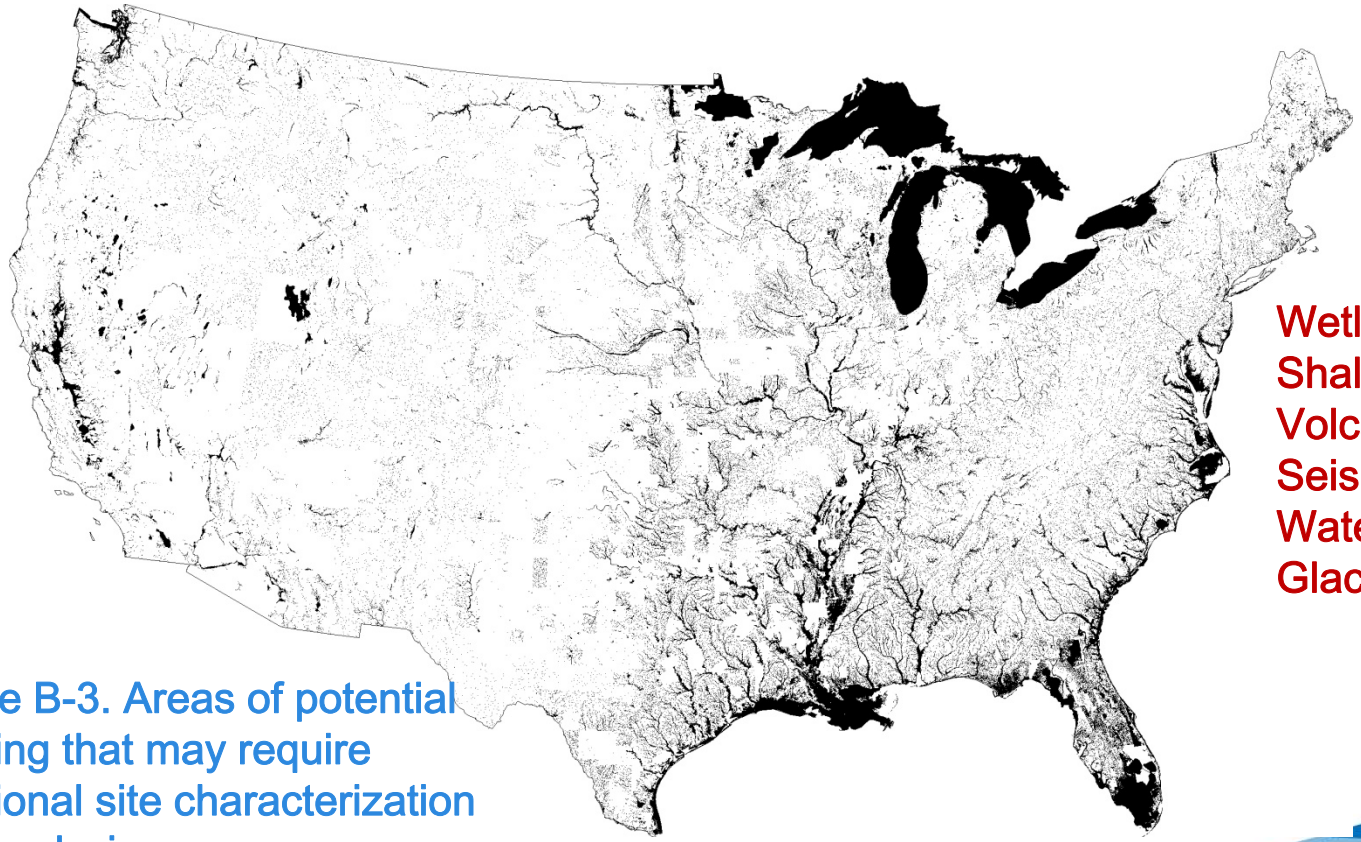
APPENDICES

Site Suitability Hazard Maps



Wetlands
Shallow Water Tables
Volcanic Activity
Seismic Activity
Water Erosion
Glaciers

Figure B-3. Areas of potential flooding that may require additional site characterization and analysis

FEPs Resources

- Generic FEPs lists for LLRW disposal – Appendix C
  - Starter list – Table C-1
    - Core list of FEPs essential for performance assessment
  - Comprehensive lists – Table C-9 and Table C-10
    - Provides example FEPs
    - Provides numerous reference lists for FEPs
    - Cites FEPs as “long-term” where they are relevant for performance period analyses
  - Could be used as starting point for project-specific FEPs lists
- Provides examples of identifying, categorizing, and screening of FEPs
  - Hanford, SRS, and Clive, Utah

Additional Approaches to Scenario Analysis

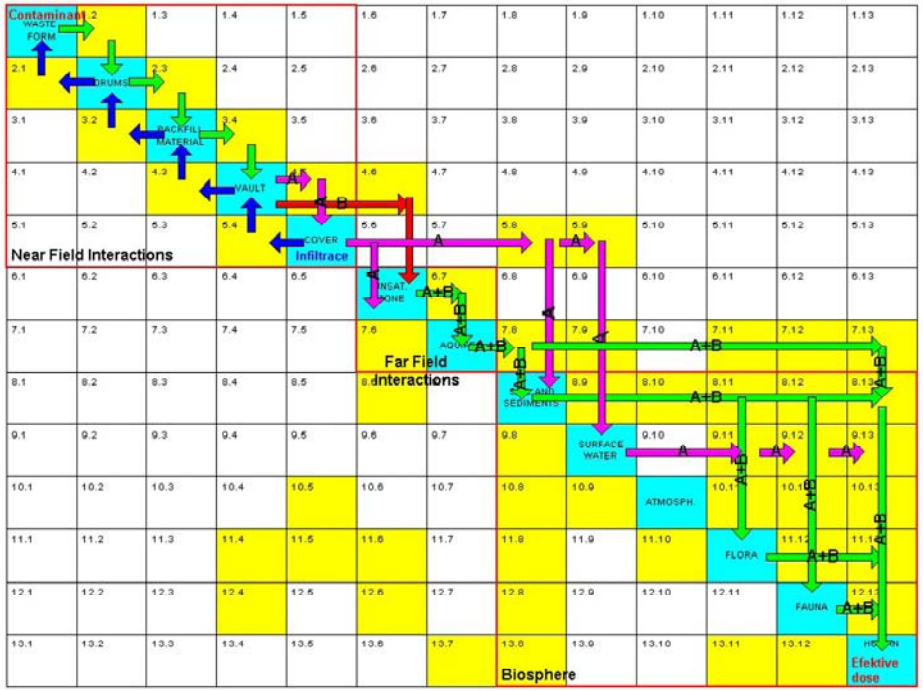
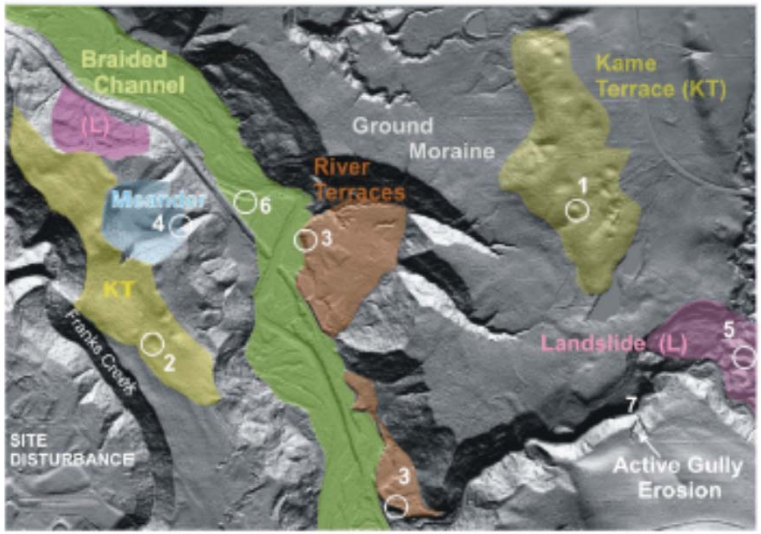


Figure D-3 Example of an interaction matrix for a central scenario including the bathtub effect (IAEA, 2004)

- Event tree analyses
- Logic diagrams
- Interaction matrices
- Influence diagrams
- Judgmental approaches

Site Stability Examples



Example of Land Element Mapping (colors) with Dating Prioritization Numbers

- Model-based approach:
  - West Valley erosion modeling
- Design-based approach:
  - Moab UT uranium mill tailings site

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Questions?

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See our Low-Level Radioactive Waste Disposal (Site-Specific Analysis Rulemaking) website:

http://www.nrc.gov/about-nrc/regulatory/rulemaking/potential-rulemaking/uw-streams.html

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