DOE Order 435.1
Disposal Authorization and Tank Closure Technical Standard

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P&RA Community of Practice Technical Exchange
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Documentation Required for a LLW Disposal Facility

An Integrated & Iterative Regulatory Framework

**Performance Assessment (PA)**
- Specifies radionuclide disposal limits
- Specifies conditions on design, construction, operations, monitoring, maintenance, and closure

**Composite Analysis (CA)**
End state, public dose projection of the cumulative interaction of all radioactive sources anticipated to remain at the site and interact with the LLW disposal facilities

**PA & CA Review and Approval**
- LFRG Review and Approval and DOE-HQ Approval
- Ensure technical quality of assessments and compliance with performance requirements.

**Disposal Authorization Statement (DAS)**
- LFRG and DOE-HQ review of PA/CA Maintenance, Closure, and Monitoring Plans
- Specifies radionuclide disposal limits
- Specifies conditions on design, construction, operations, monitoring, maintenance, and closure

**Closure Plan**

**PA/CA Maintenance Plan**

**Monitoring Plan**

**Annual Reviews**
- Change Control
- Waste Acceptance Criteria
- Tank Closure Documentation

www.energy.gov/EM
Technical Standard

• Disposal Authorization Statement (DAS) and Tank Closure Documentation Technical Standard provides consolidated guidance for implementation of DOE Order (O) 435.1, *Radioactive Waste Management*.

• Includes required documents for DAS issuance and tank closure; the approval and issuance process; and maintenance, reporting and review requirements.
Technical Standard Scope

Applicable to the development, review and approval of documents that support:

1. Issuance and revision of a DAS for disposal of:
   - LLW (including MLLW)
   - TRU disposed onsite at DOE facilities other than the WIPP and
   - Radioactive CERCLA waste at CERCLA disposal facilities

2. Issuance and revision of Tier 1 and 2 Tank Closure Documentation
Evolution of Documents

DOE Manual 435.1-1
Requirements

DOE Guide 435.1-1

Guides
- PA/CA
- Closure
- Maintenance
- LFRG Manual
& PMP

Technical Standard
History

- Guides were developed to assist sites in implementing the requirements for a Disposal Authorization Statement (DAS).
- Well written and generally accepted, but were outside the DOE Directive System and did not cover all necessary documentation.
- LFRG Co-Chairs recommended formalizing and updating the guides and adding new content requirements in a Technical Standard.
- Teams were set up with federal and contractor personnel to develop the different chapters, multiple review cycles.
- Structure and purpose evolved (requirements, guidance, tanks).
Technical Standard Contents

• Chapter 1 – Introduction and Purpose (LFRG Processes)
• Chapter 2 – Performance Assessment Guide
• Chapter 3 – Composite Analysis Guide
• Chapter 4 – Closure Plan Guide
• Chapter 5 – PA/CA Monitoring Plan Guide
• Chapter 6 – Waste Acceptance Criteria Guide
• Chapter 7 – PA/CA Maintenance Plan Guide
• Chapter 8 – Change Control Process Guide
• Chapter 9 – Disposal Facility Annual Summary Report Guide

RED: Previously in Guides
BLUE: New Guidance
Chapter 1

• Integrated Protection System
  – Safety Case and Defense-in-Depth Concepts
• Links to recommendations from the International Atomic Energy Agency, International Commission on Radiological Protection, and National Council on Radiation Protection and Measurements
• Expectations for preliminary and operating DAS and Tank Closure Documentation
• LFRG responsibilities and review processes
• Approach goes to extraordinary lengths to consider potential consequences in the far future
• PAs and CAs are one part of a robust defense-in-depth approach for safety
• Multiple levels of added safety factors (e.g., dose constraints, conservative bias, inadvertent intrusion)
Chapters 2 - 9

- Annotated outline for documents
- Content expectations and examples
- Guidance to support development of documentation
- Review criteria
• Approaches and understanding have significantly improved since 1999
• Brief overview of some topics that received additional attention in the Technical Standard:
  • General Philosophy (role of PA during lifecycle, use for understanding and supporting decisions, part of safety case)
  • Scenarios, Total System Perspective, Safety Functions, FEPS
  • Time of Compliance/Assessment
  • Sensitivity & Uncertainty Analysis
  • Interpretation of Results
  • Inadvertent Intrusion
  • Exposure Assumptions
“Scenarios” is used broadly to represent the system and collection of cases (potential futures) that are considered in an assessment

- Sources
- Exposure Pathways
- Land Use/Receptors
- Conceptual Models
- Failure Assumptions
- “What-if”
Approach for development of scenarios

**Conceptual Model Focus** - Start with initial description of the system and its evolution and refine as needed in areas critical to the decision.

**Systems Approach** - Consider behavior of individual features in the context of overall system performance rather than independently (refinement of details is made within context of importance for system performance).

**Safety Function Perspective** – Understanding of roles and functions of “barriers” within total system and addressing potential failure mechanisms for key barriers (FEPs lists can provide insights, audit role).
Cover – Limit infiltration, biointrusion and direct contact with waste, airborne releases

Waste Zone/Source – Limit subsidence, drainage, delay transport

Liner – Collect leachate for operations, limit water and contaminant releases

Vadose Zone – delay and disperse radionuclides that may be released

Saturated Zone – delay and disperse radionuclides that may be released
Time of Compliance

• 1,000 years after closure for quantitative compliance

• $\leq 1,000$ years – Calculated doses are used for regulatory compliance and strictly compared to quantitative constraints

• $> 1,000$ years – Evaluate model stability, timing of potential peaks and consider potential for catastrophic impacts. Support risk-informed decision-making recognizing increasingly speculative and uncertain assumptions.

• Calculations do not stop at 1,000 years and results after 1,000 years play a role in decision-making
Risk-informed, performance-based approach requires an appropriate time frame for quantitative compliance

Consistent with international recommendations and US rules addressing near-surface disposal

Meaningfulness of results considering increasingly speculative over time

Presence of long-lived contaminants is not unique to LLW (e.g., metals in hazardous waste, NORM)

Selection of a “time of compliance” is a science and policy decision, considering factors such as intergenerational equity and resource allocation
Use of Probabilistic Approaches

- Broader perspective for behavior of engineered and natural systems
- Only as accurate as inputs - need to defend distributions & probabilities
- Can be less detail in models (e.g., source release, groundwater pathway) - demonstrate that “simplified” representation is adequate
- Interpretation of results (emphasis on central tendency vs. tails)

Hanford ERDF PA Example

Idaho RH LLW Facility PA
• First emphasis – factors that push peak into 1,000 years
• Seeking factors influencing magnitude of peaks
• Magnitude of peak at any time may change - but peak may not change
• How to consider changes in multiple “peaks,” not just timing?
• Approach to formal sensitivity and uncertainty analysis continues to evolve based on experience
Interpretation of Probabilistic Results

• Peak of the mean or median dose history, whichever is higher, should generally be used to compare with the performance objectives in the context of compliance

• Other results from distributions used to:
  • Inform the decision in conjunction with the results of sensitivity analyses
  • Assess a need for reduction in uncertainty via PA and CA maintenance

• Mean of the peaks is not appropriate for the purposes of demonstrating reasonable expectation of meeting the performance objectives
IAEA, ICRP and OECD/NEA

- Consider inadvertent human intruder (IHI), not deliberate intrusion
- Striving to reduce potential for and/or consequences of intrusion
- Intrusion considered separately from normal evolution in the context of optimization
- Optimize waste acceptance, design, etc.
- Probability of 1 for IHI, one or more stylized scenarios
Inadvertent Human Intrusion Assumptions

- Assess the potential consequences in the case of an assumed temporary loss of institutional controls (hypothetical) – analyst encouraged to discuss factors influencing likelihood

- Immediately “possible” following loss of active controls (i.e., loss of memory of site, land use/deed restrictions not effective) – Engineered features can delay timing

- Stylized scenarios similar to basis for waste classification typically used to avoid speculation about future human actions
What has to happen for full intrusion scenario to occur?

Can debate likelihood of each of these independently, but often assume **all** occur with a probability of 1:

- Loss of control (implies government ceases to meet obligation)?
- Loss of memory - IHI can potentially occur at end of active control?
- IHI event will occur at the site?
- IHI within footprint of facility rather than outside footprint?
- IHI hits waste within footprint?
- Barriers are not effective (or “limited” delay before intrusion)?
- Drill will not be deterred or deflect around barrier, container or waste form (or “limited” delay before intrusion)?
- Driller/worker will not recognize that something is different/wrong?
- Driller stands in dust cloud rather than directing dust away?
- All drill cuttings are respirable?
- Resident mixes waste cuttings in home garden soil?
- Drill cuttings will behave like soil for uptake in plants?
- More highly exposed individuals (e.g., subsistence farmer)?
Credit for Barriers (Tanks)

- Delay at least 500 years for closed tank
- A closed tank is considered a robust, stable waste form (metal tank and reinforced concrete filled with grout)
- NRC assumes 500 year delay for robust, stable waste forms used for Class C waste
- Tank farm transfer lines may not be consistent with a robust stable waste form – earlier potential intrusion
  - Radionuclide inventory, potential to hit transfer line are questions
Exposure Assumptions

• Concept of Representative Person replaces average member of the critical group – *age and gender weighted average person receiving a dose that is representative of the more highly exposed individuals in the population*

• Assumed exposures at the location and time of the peak and stylized scenarios represent more highly exposed individuals (e.g., subsistence farmer)

• When site-specific information is used, mean or median exposure parameters are used for the more highly exposed individuals

• Maximally exposed individual can also be used
Summary

• DOE has issued a technical standard with guidance for development, review and approval of documentation to support a Disposal Authorization Statement or for Tank Closure

• The Technical Standard updates and formalizes what had previously been documented in guides that were not in the directives system

• Several topics not addressed in previous guides are also addressed

• Performance assessment guidance includes updated information reflecting experience since DOE Order 435.1 was issued