Overview of Depleted Uranium Screening Analysis

Presented to Interested Stakeholders

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Enclosure 3

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Agenda

9:00a	Registration	
9:30a	Opening Comments Participant Introductions	C. McKenney
10:00a	Purpose and Scope of Screening Analysis	D. Esh
11:00a	Break	
11:15a	Overview of Conceptual Model Simulation Settings Scenarios	D. Esh
12:15p	LUNCH	
1:30p	Model Implementation – Source Term	C. Grossman
3:30p	Model Implementation – Radon and Geosphere Transport	D. Esh
5:45p	Summary	C. McKenney

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Background

Background: Part 61 Analyses

- The framework for the analysis of disposal of radioactive waste on land was developed in the 1980's to support Part 61:
  - NUREG-0782, Draft EIS
  - NUREG-0945, Final EIS
  - NUREG/CR-4370, Update to Impacts Analysis

- Recognized the importance of ***protecting public health and safety over the long-term*** and placed emphasis on performance after operations cease.

- The methodology focused on ***establishing generic criteria*** for LLW disposal rather than a specific site.

Background: Part 61 Analyses

- Considered a ***comparative analysis between a reference facility and alternatives*** to select preferred performance objectives and technical requirements.
  - Waste Form and Processing
  - Site Selection
  - Site Design and Operation
  - Institutional Controls

- The performance objectives, technical, and other requirements developed through the analysis form the basis for the requirements in Part 61.

- Analyses did not consider large quantities of depleted uranium.

Background: DU Characteristics

- Prevalent forms of DU:
  - Uranium hexafluoride (UF6)
  - Uranium oxide (UO2, U3O8, or UO3)
- DU oxide contains about 85% uranium by mass.
- DU essentially initially depleted in daughter products, unlike ore or mill tailings.
- Daughter products of uranium can have widely varying mobility in the environment.

Background:
DU Characteristics

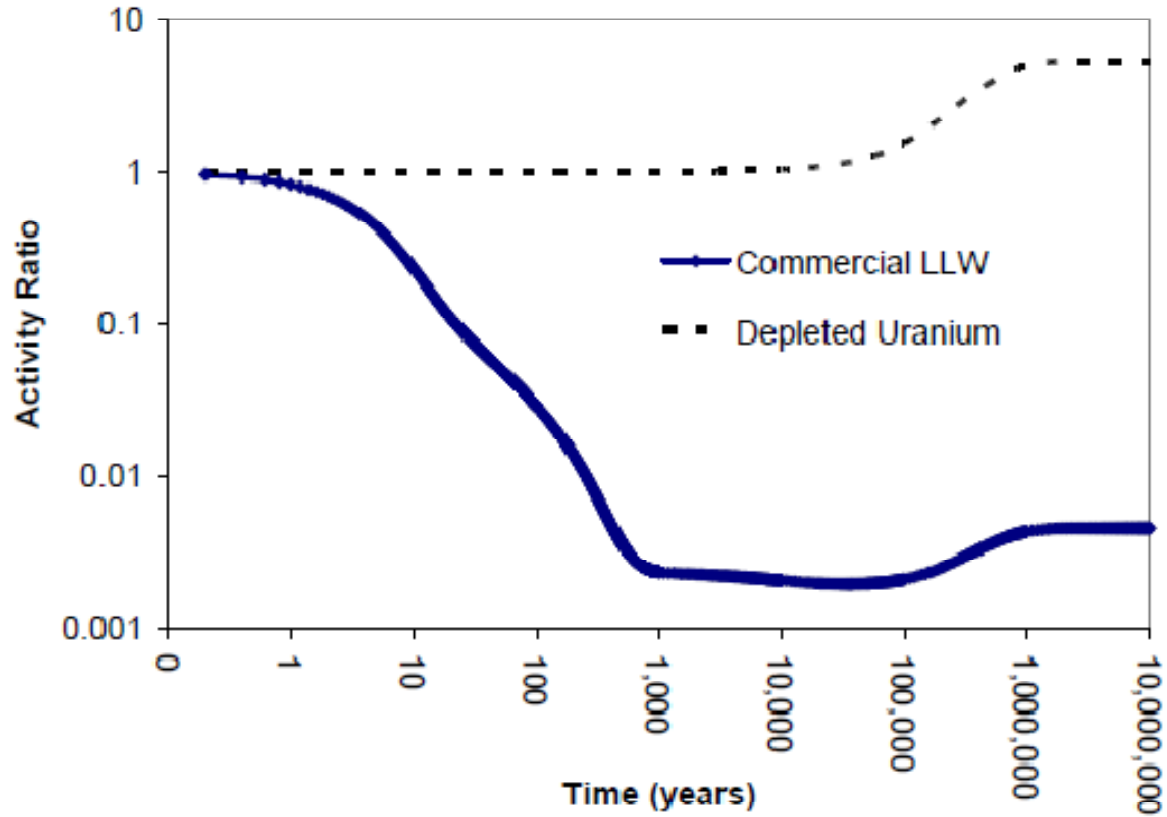

Figure 1 Activity Ratios of DU and a Commercial LLW Facility. The activity ratios are defined as the initial activity to the activity at various points in time.

Background: Commission Orders

- Commission affirmed depleted uranium was a low-level radioactive waste in the LES proceedings.
  - CLI-05-05

- Commission also directed NRC staff to consider whether the quantities of depleted uranium from enrichment facilities warrant amending its waste classification in Part 61.
  - CLI-05-20

Background: Commission Papers – SECY-08-0147

- NRC staff completed a technical analysis to understand the impacts of near-surface disposal of large quantities of DU such as those expected from commercial uranium enrichment.
- Analysis addressed whether amendments to 61.55(a) are necessary to assure disposal meets the performance objectives.
- Analysis concluded that near-surface disposal may be appropriate, but not under all site conditions.

Background: Commission Papers – SECY-08-0147

- Based on the results, staff identified four options to facilitate safe disposal:
  - Issue a Generic Communication
  - Require a site-specific analysis
  - Develop DU waste classification
  - Re-examine waste classification framework

- Staff recommended conducting rulemaking to specify need for a site-specific analysis prior to disposal of large quantities of DU

Background: Commission Papers – SRM-SECY-08-0147

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- The Commission instructed the staff to :
  - Specify a ***requirement for a site-specific analysis*** for the disposal of large quantities of depleted uranium
  - Develop ***guidance*** document outlining parameters and assumptions used in conducting a site-specific analysis
  - Conduct a ***workshop*** to discuss issues associated with disposal of DU
  - Longer-term, staff should propose resources for a comprehensive revision to ***risk-inform waste classification framework.***

Background: Purpose of Analysis

- To respond to Commission direction to consider whether quantities of DU warrants amending waste classification tables in Part 61.

- ***Screening model*** to evaluate risk and uncertainty of near-surface disposal of DU

- To understand the ***impacts of key variables*** on the risk:
  - Exposure Scenarios
  - Pathways
  - Period of Performance
  - Disposal Configurations
  - Waste Forms
  - Site Conditions

Background: Screening Analysis Approach

- A primary consideration was whether the Part 61 performance objectives could be met by a generic site:
  - Protection of general public from releases of radioactivity;
  - Protection of individuals from inadvertent intrusion;
  - Assumed generic sites achieved stability requirements.

- Consistent with methodology used for the development of Part 61.

- Some variables were evaluated outside of ranges that may have been used in the development of Part 61.

Background: Screening Analysis Approach

- Calculations were performed probabilistically to represent the impact of variability and uncertainty.
- Approach identified constraints for safe disposal.
- However, conclusions are not absolute because of the wide range of variables considered.

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Overview of Conceptual Model

Conceptual Model Overview – Part 61 Analysis

- After the period of active institutional control, receptors were assumed to engage in residential, agricultural, or other activities on or in the vicinity of the disposal site.
- A receptor engaging in activities on the site was regarded as an inadvertent intruder.
- Receptors engaging in activities outside of the site was regarded as a member of the public.

Conceptual Model Overview – Part 61 Analysis

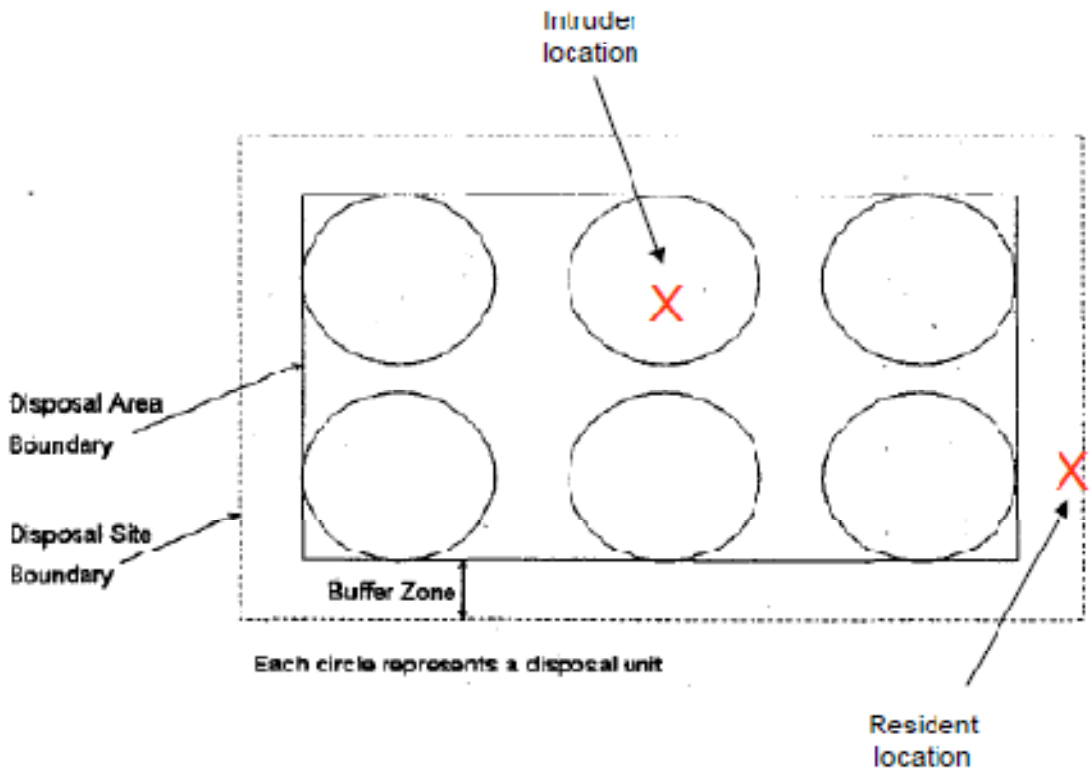

Figure 2 Geometric Relationship of the Disposal Units, Disposal Area, and Buffer Zone of a Disposal Site. Adapted from the Final Environmental Impact Statement for Part 61 (NRC, 1982).

Conceptual Model Overview – Part 61 Analysis (Intruder)

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- Scenarios:
  - Intruder-drilling
  - Intruder-construction
  - Intruder-agriculture

- Pathways:
  - Inhalation of contaminated soil and air
  - Direct radiation
  - Ingestion of contaminated water and food grown in soil

- Intruder-agriculture and 500-mrem dose threshold were used to develop waste classification tables in Part 61.

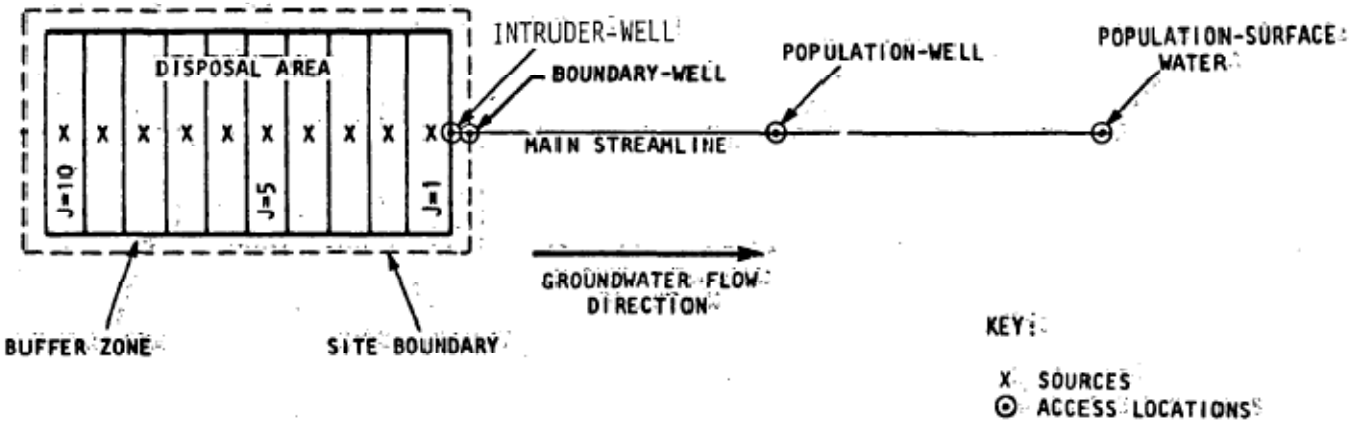
- NUREG/CR-4370 explicitly addressed effects of radon gas generation.

Conceptual Model Overview – Part 61 Analysis (Resident)

- Scenarios:
  - Boundary well
  - Population well
  - Surface water

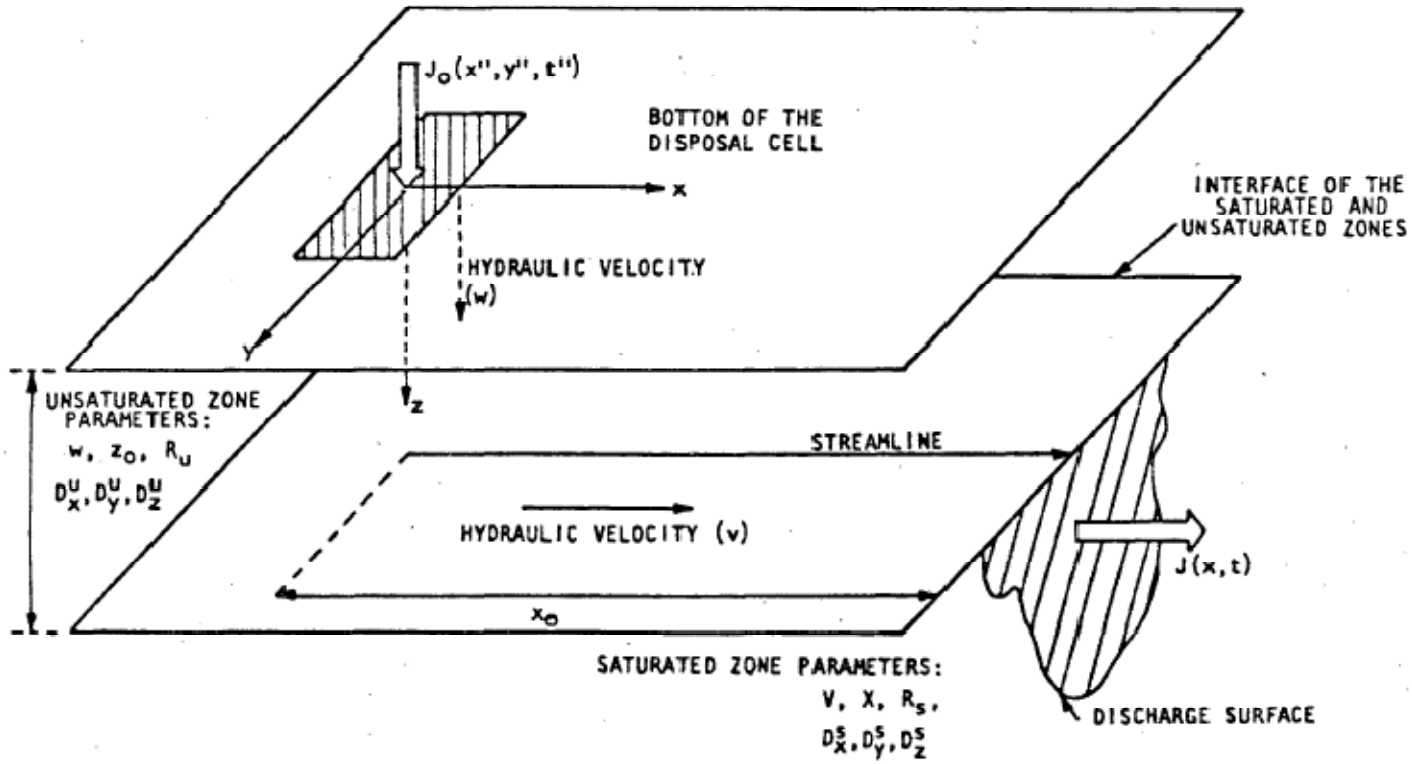
- Pathways:
  - Inhalation of contaminated soil and air
  - Direct radiation
  - Ingestion of contaminated water and food grown in soil

Conceptual Model Overview – Part 61 Analysis (Resident)



GEOMETRIC RELATIONSHIPS
OF DISPOSAL AREA AND DISCHARGE LOCATIONS

Conceptual Model Overview – Part 61 Analysis –



GEOMETRY OF GROUNDWATER MIGRATION

Conceptual Model Overview – DU Analysis

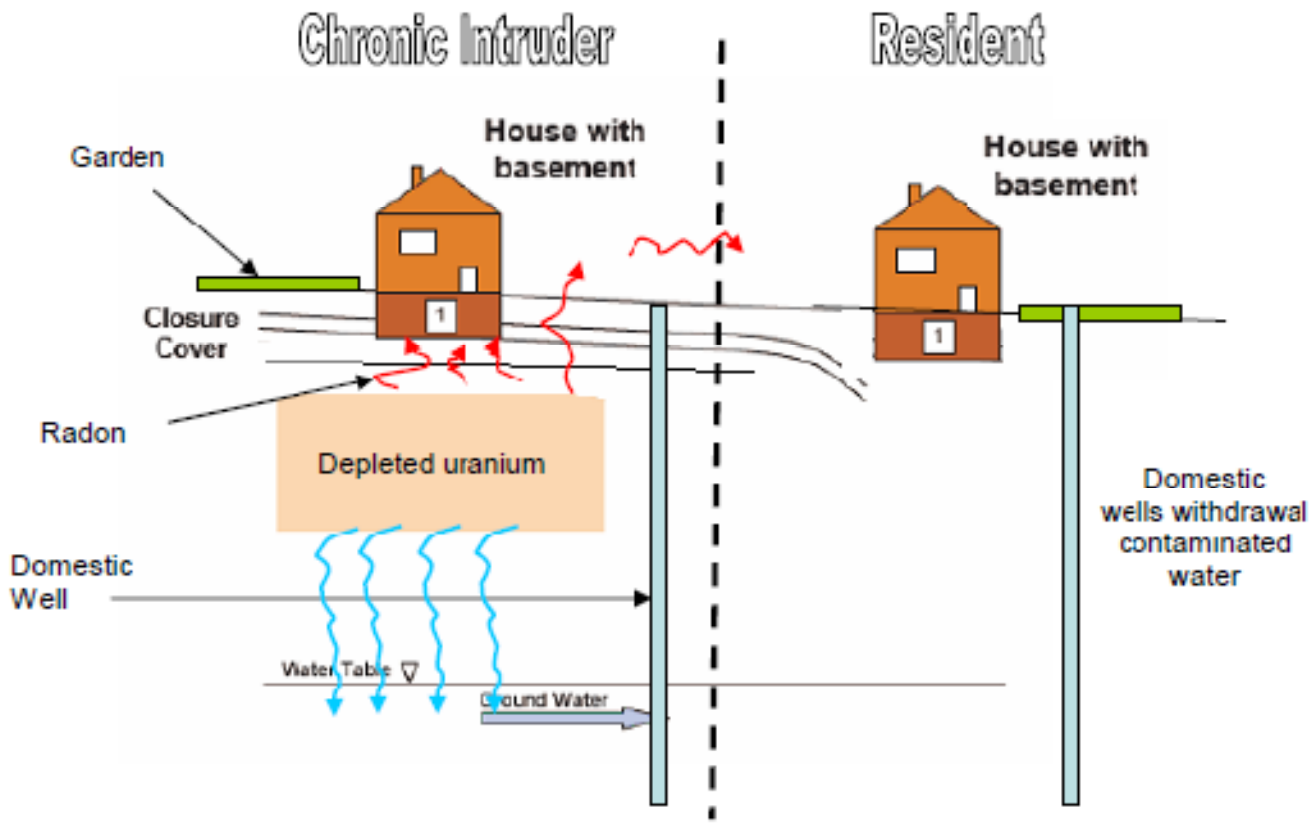


Figure 5 Conceptual Model Showing the Primary Scenarios.

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Model Implementation

Model Implementation

- Attachment to SECY-08-0147 provided summary of model implementation
- The remainder of the day we will go through the model file
- Feel free to ask questions

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Model Results

Table I Percent of Probabilistic Realizations that Meet the Performance Objectives

Scenario	Performance Period (yr)	Resident[1]			Chronic Intruder[2]
		Total dose	Drinking water	Inhalation	Total dose
Arid, 1 m disposal depth	1,000	**100**	**100**	**100**	<2
	10,000	40	**90**	**50**	0
	100,000	10	**60**	20	0
	1,000,000	<1	40	8	0
Arid, 3 m disposal depth	1,000	**100**	**100**	**100**	2
	10,000	**80**	**90**	**100**	0
	100,000	**50**	**60**	**80**	0
	1,000,000	20	40	**70**	0
Arid, 5 m disposal depth	1,000	**100**	**100**	**100**	**100**
	10,000	**80**	**90**	**100**	**100**
	100,000	**50**	**60**	**90**	**90**
	1,000,000	30	40	**90**	**70**
Humid, 5 m disposal depth	1,000	**70**	**70**	**100**	**100**
	10,000	0	0	**100**	20
	100,000	0	0	**100**	0
	1,000,000	0	0	**97**	0
Arid,[3] 5 m disposal depth, Grout	1,000	**100**	**100**	**100**	**100**
	10,000	**90**	**90**	**100**	**100**
	100,000	**70**	**70**	**100**	**90**
	1,000,000	**60**	**60**	**90**	**80**

[1] Percent of realizations that are below 25 mrem/yr total effective dose equivalent (TEDE). The resident consumes contaminated plants raised at the site, but does not consume contaminated animals. The results for the resident do not have radon diffusing into the basement, but the resident does get exposure to radon in the ambient environment while outdoors and indoors. Results are rounded to one significant figure.

[2] Percent of realizations that are below 500 mrem/yr TEDE. When the waste depth is greater than 3 m, the waste disruption process is through well drilling, not home excavation.

[3] The performance of grout over long periods of time is very uncertain. If the initial low leachability of grouted waste can be maintained, a performance benefit can be realized.

Model Results

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The summary conclusions from the technical analysis are:

- Near-surface disposal (i.e., less than 30 m, as defined in Part 61) may be appropriate for large quantities of DU under certain conditions. However, unfavorable site conditions can result in the performance objectives not being met. Examples of unfavorable conditions include shallow disposal (< 3 m depth) and humid sites with a potable groundwater pathway.
- Because of the in-growth of radon and other daughter products, periods of performance of 1,000 years or less result in a significant truncation of estimated risk.
- Shallow disposal (< 3m deep) is likely to not be appropriate for large quantities of DU, regardless of site conditions. Shallow disposal may be possible if robust intruder barriers, excluding the possible excavation of DU, and a robust radon barrier that can effectively limit radon fluxes over the period of performance are installed, and their performance is justified. Small quantities (1 – 10 metric tons) could be disposed of at shallow depths.
- Depleted uranium can be disposed of under arid conditions and meet the Part 61 performance objectives for 1,000 to 1 million years performance periods, if the waste disposal depth is large, or robust barriers are in place to mitigate radon.
- Disposal under humid conditions with viable water pathways is probably not appropriate for large quantities of DU.