Risk-Informing Low-Level Waste Regulation in the U.S.

How do we better focus regulatory attention on design and operational issues commensurate with their importance to health and safety?

World Nuclear University Alumni Assembly
Oak Ridge National Lab
April 3, 2014

Leah (Spradley) Parks

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Topics

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

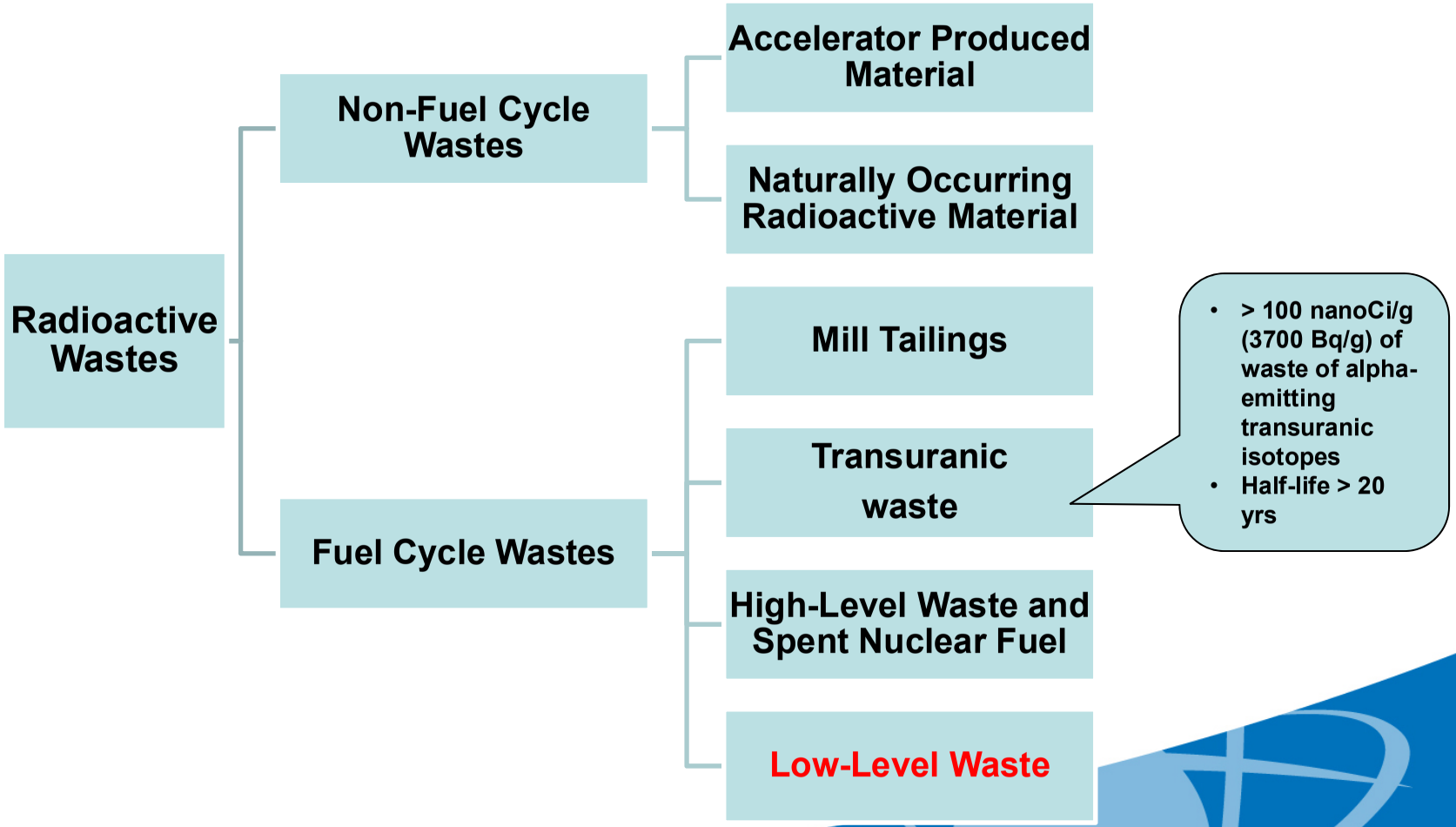
1. Definitions of Radioactive Waste

2. Background on Existing Regulation:
   - Licensing Requirements for Land Disposal of Radioactive Waste, Title 10, Chapter I of the Code of Federal Regulations, Part 61

3. Revisions to 10 CFR Part 61

Definitions of Radioactive Wastes

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment



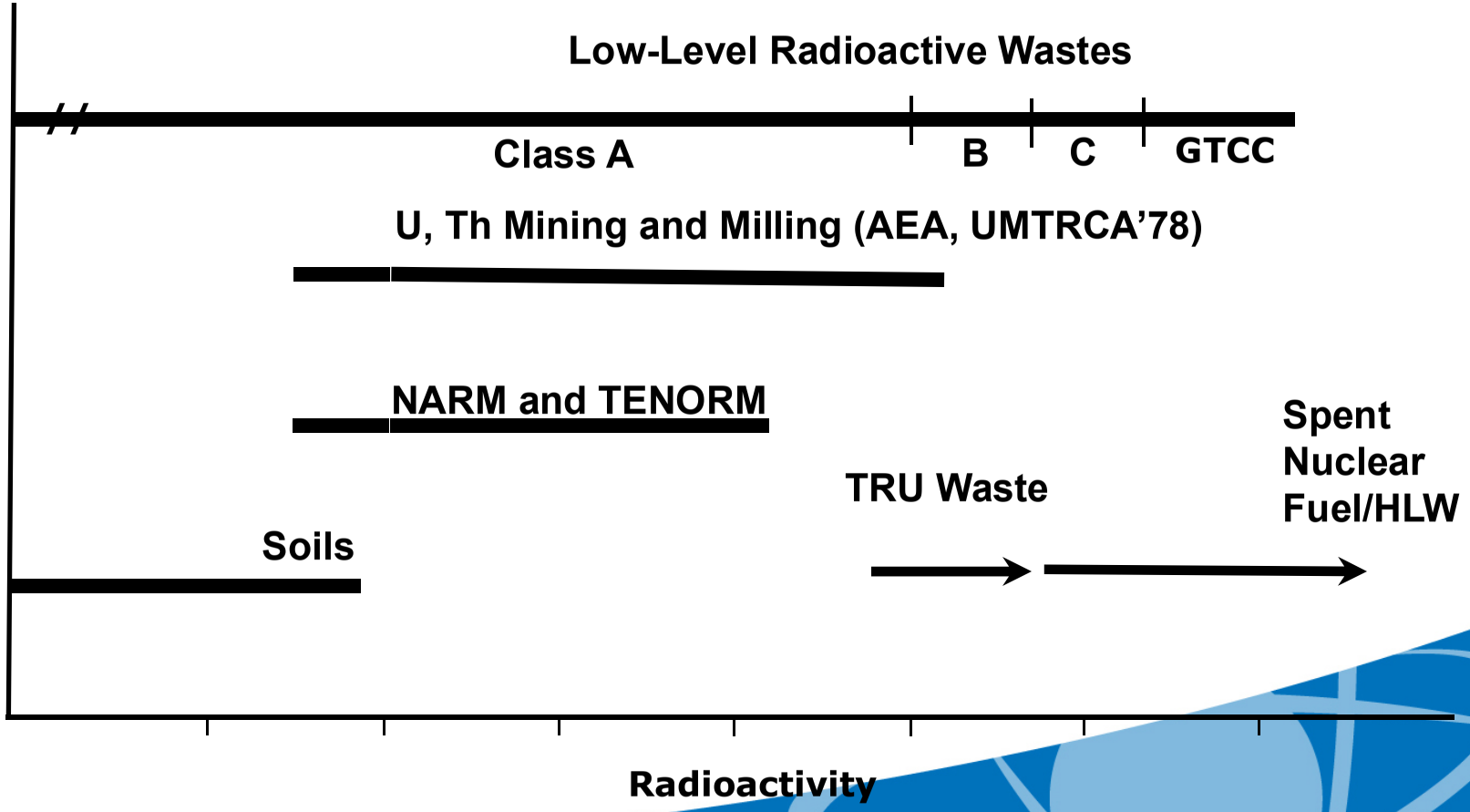
Low Level Radioactive Waste

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- LLW is generated:
  - During the operation of nuclear reactors, fuel manufacturing and enrichment facilties;
    - contaminated clothing, wiping rags, mops, filters
    - reactor water treatment residues
  - By users of radioactive materials (hospitals, industry, universities, etc.), and
    - equipments and tools, luminous dials
    - medical tubes, swabs, injection needles, syringes, and
    - laboratory animal carcasses and tissues.
  - From cleanup and decommissioning of sites no longer in operation.
    - Concrete, soil, equipment

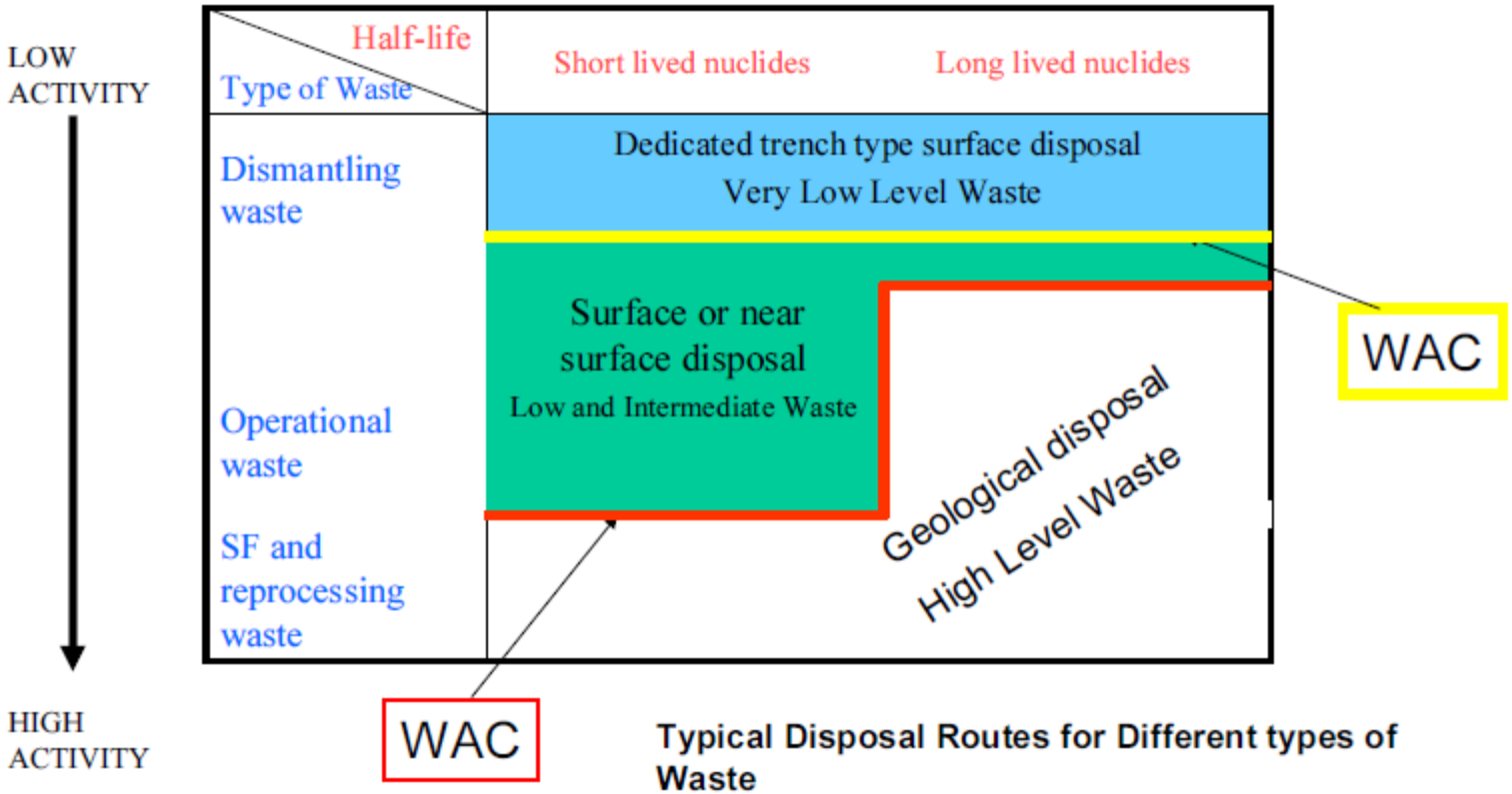
The Spectrum of Radioactive Wastes

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment



French Definitions of Radioactive Wastes

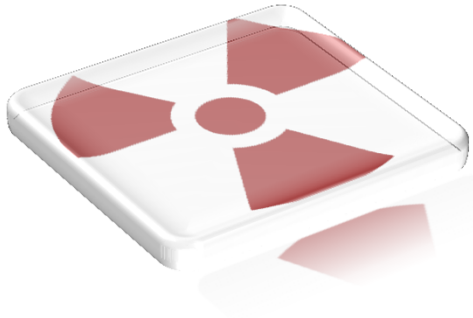
U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment



Typical Disposal Routes for Different types of Waste

2009 ANDRA Presentation to WNU SI Technical Tour

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment



PART 61 BACKGROUND

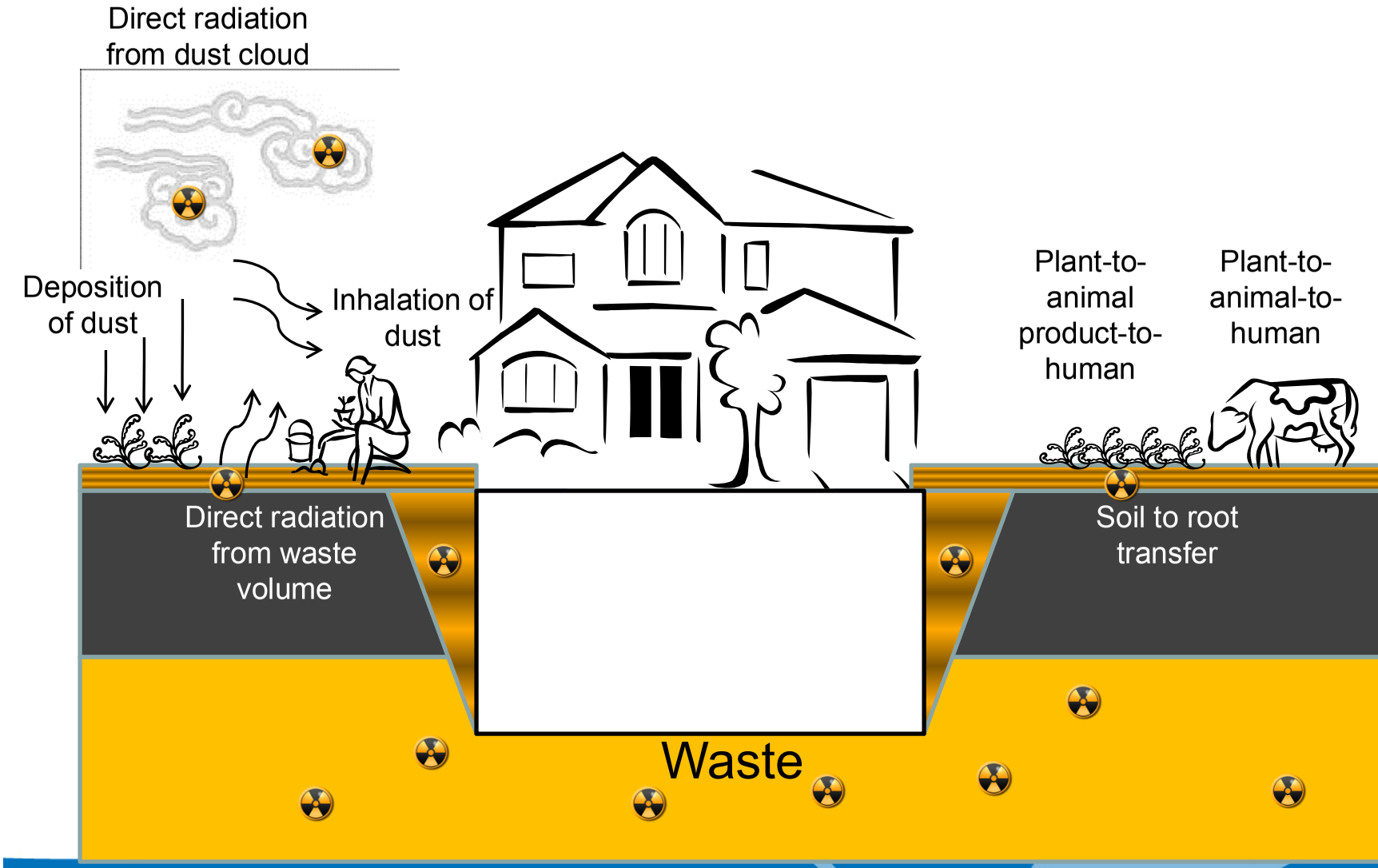
10 CFR Part 61

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Requirements for land disposal of LLW
- Performance objectives assure safe disposal
  1. Protection of general public
     - (25 mrem/y [0.25 mSv/y] TEDE standard)
  2. Protection of inadvertent intruders
     - No dose standard in current rule
  3. Protection of individuals during operations
     - (10 CFR Part 20 limits)
  4. Stability after site closure
- Demonstrate performance via technical analyses and waste classification

Intruder Agriculture

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment



Waste Classification

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Intended to ensure on a non-site specific basis that the requirements are met.
- At the time, NRC envisioned a large number disposal facilities. Therefore, a **generic system** to apply to all sites was developed (e.g. the waste classification tables).

Mechanics of Waste Classification

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

1) Decide protection limits.
2) Derive scenarios for exposure.
3) Perform inverse calculations (exposure pathway analyses) – what concentrations of materials result in my protection limits over what period of time?
4) Apply other factors to modify derived concentrations.

Protection Limits and Time of Compliance

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Variety of intruder dose limits were considered.
- Waste classification tables were based on a 500 mrem (5mSv) (whole-body) exposure to the intruder.
- Development initially considered a 10,000 year “period of performance” or “time of compliance”
- Part 61 does not set an intruder dose limit or specify a period of performance in the rule text
- Site and waste characteristics influence timing and peak of projected doses

Table 1 (Long-lived radionuclides)

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Radionuclide	Concentration curies per cubic meter except as noted
C-14	8
C-14 in activated metal	80
Ni-59 in activated metal	220
Nb-94 in activated metal	0.2
Tc-99	3
I-129	0.08
Alpha emitting transuranic nuclides with half-life greater than 5 years	[1]100
Pu-241	[1]3,500
Cm-242	[1]20,000

[1]Units for these radionuclides are nanocuries per gram

- Concentration < 10% Class A
- 10% < Concentration < 100% Class C

Table 2 (Short-lived radionuclides)

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Radionuclide	Concentration, curies per cubic meter			
	A Col. 1	**B** Col. 2	**C** Col. 3	**GTCC**
Total of all nuclides with < 5 yr half-life	700	(1)	(1)	
H-3	40	(1)	(1)	
Co-60	700	(1)	(1)	
Ni-63	3.5	70	700	
Ni-63 in activated metal	35	700	7000	
Sr-90	0.04	150	7000	
Cs-137	1	44	4600	

(1) There are no limits established for these radionuclides in Class B or C wastes. Practical considerations such as the effects of external radiation and internal heat generation on transportation, handling, and disposal will limit the concentrations for these wastes. These wastes shall be Class B unless the concentrations of other nuclides in Table 2 determine the waste to the Class C independent of these nuclides.

Table 1 and Table 2

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- If radioactive waste does not contain any nuclides listed in either Table 1 or 2, it is Class A.

- If waste contains a mixture of radionuclides listed in Table 1 and Table 2:
  - if concentration does not exceed 10% of the Table 1 value, use Table 2.
  - If the concentration is between 10%-100% of the Table 1 value, the waste is Class C, provided the concentration of nuclides listed in Table 2 does not exceed the value shown in Column 3 of Table 2.

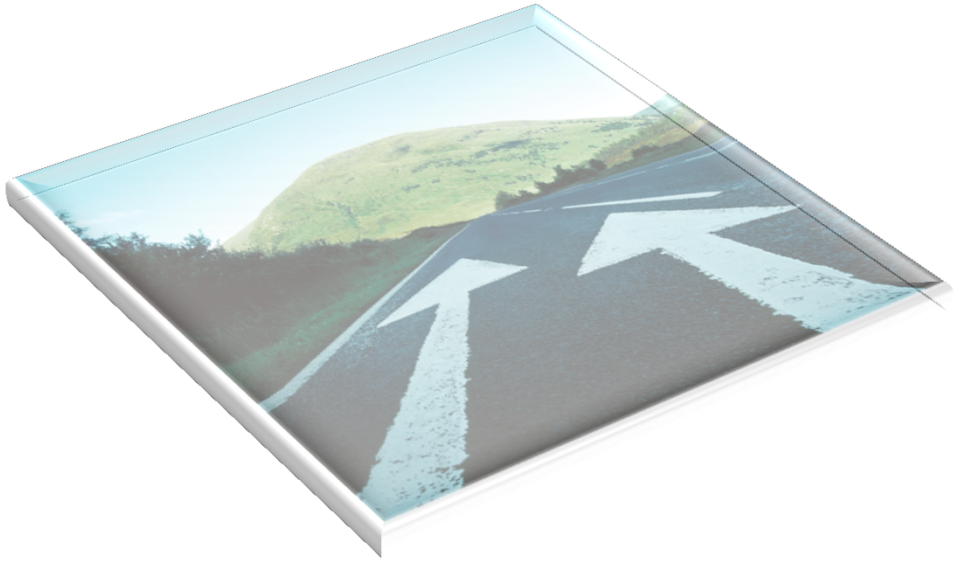
Regulatory Approach

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

	Radionuclide Concentration	Waste Form	Examples	Intruder Protection*	Waste Segregation
Class A	low concentrations	minimum waste form requirements No stabilization requirements	Contaminated protective clothing, paper, trash	no measures to protect intruder Waste decays to acceptable levels to intruder after 100 yr	unstable Class A waste must be segregated from Class B and C wastes
Class B	higher concentrations activity generally 10 – 40 times greater than Class A	minimum waste form requirements 300-yr stabilization requirement	resins and filters from nuclear power plants, wastes encapsulated or stabilized in concrete	requires stabilization of waste form to protect intruder Waste decays to acceptable levels to intruder after 100 yr, provided that waste form is recognizable	need not be segregated from Class C wastes
Class C	Highest concentrations activity generally 10-100 times greater than Class B	minimum waste form requirements 300-yr stabilization requirement	nuclear power plant reactor components, sealed sources, high-activity industrial waste	requires stabilization of waste form and deeper disposal (or barriers) to protect intruder Waste decays to acceptable levels to intruder after 500 yr	need not be segregated from Class B wastes

* The 10 CFR Part 61 regulation assumes a 100-yr caretaker period

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment



REVISIONS TO PART 61

Recent Developments

- Waste classification limits based on 1980's understanding of low-level waste streams[1]
- Recent waste streams not envisioned during development of Part 61 (Depleted Uranium)
- Disposal may be appropriate, but not under all conditions[2]

[1] NUREG-0945, NUREG-0782
[2] SECY-08-0147, SECY-10-0043

Initial Commission Direction 2008[1]

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Require **site-specific analyses (e.g., performance assessment)** to demonstrate compliance with the performance objectives
- Specify technical requirements of the analyses
- Develop accompanying guidance

[1]SRM-SECY-08-0147

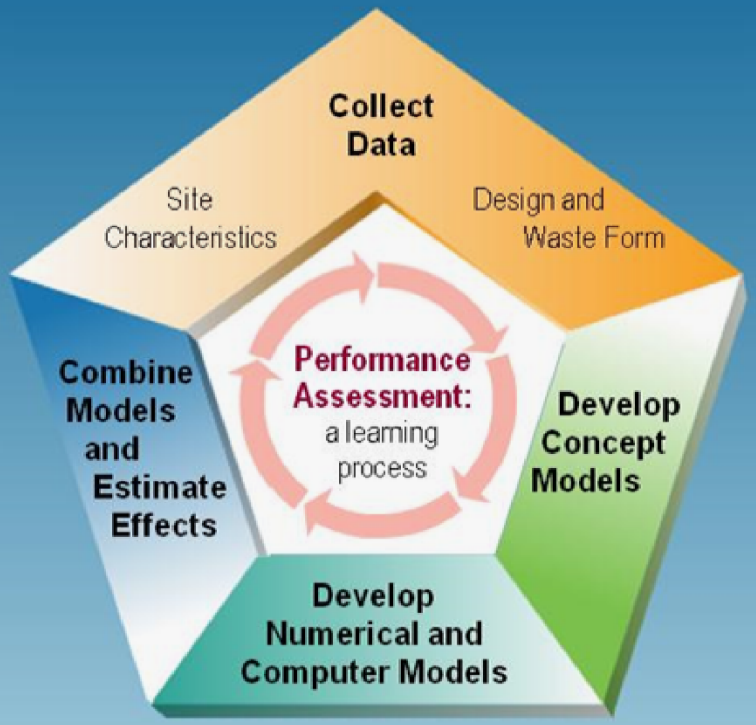
Overview of Performance Assessment

What is Performance Assessment?

- Systematic analysis of what could happen at a site

Why use it?

- Complex system
- Systematic way to evaluate data
- Internationally accepted approach



What is assessed?

- What can happen?
- How likely is it?
- What can result?

How is it conducted?

- Collect data
- Develop scientific models
- Develop computer code
- Analyze results

NRC would require a Performance Assessment to:

- Provide site and design data
- Describe barriers that isolate waste
- Evaluate features, events, and processes that affect safety
- Provide technical basis for models and inputs
- Account for variability and uncertainty
- Evaluate results from alternative models, as needed

Commission Direction 2011[1]

- Consider:
  - Flexibility to use current International Commission on Radiological Protection (ICRP) dose methodologies
  - Two-tiered period of performance:
    - Reasonably foreseeable compliance period
    - Longer period of performance that is not *a priori*
  - Flexibility to establish site-specific waste acceptance criteria or use the existing tables
  - Balance Federal-State alignment

[1] SRM-COMWDM-11-0002/COMGEA-11-002

NRC Staff Proposal to Commission 2013

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

	General Population	Inadvertent intruder	Long-Term Qualitative Analyses
Current Regulations	• Deterministic pathway analysis • Undefined time period • 0.25 mSv/y • ALARA concept	• Comply with Tables • Barriers to intrusion • Undefined period of performance • No annual dose limit	• None
Proposed Regulations	• Performance assessment • 10,000 yr • 0.25 mSv/y • ALARA concept	• Comply with Tables or site –specific acceptance criteria • Barriers to intrusion • Intruder assessment for 10,000 yr • 5 mSv annual dose limit	• Analyses for > 10,000 yr that demonstrates releases will be minimized to the extent reasonably achievable • Analyses that demonstrate how the facility has been designed to limit long-term releases

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

"Introducing significant uncertainties to the performance analyses through speculation on human activities, waste and site performance, and earth processes for millennia is unlikely to improve either our ***decision making process*** *or our* ***understanding*** *of the safety decisions regarding near surface [/ow-level waste] disposal."*

-Advisory Committee on Reactor Safeguards

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

"there has been a much less compelling case to convince that any such analysis [10,000 yr] would be meaningful given the vast uncertainties associated with changes in site parameters and in the state of society over the coming 10,000 years...It provides a **false comfort** to insist on an analysis based on guesswork and subjective speculation."

- Commissioner Magwood

Current Commission Direction[1]

- Regulatory Compliance Period
  - 1,000 yrs
  - 25 mrem/y (0.25 mSv/y) dose limit to general public
- Protective Assurance Period
  - 10,000 yrs
  - 500 mrem/y (5 mSv/y) 'analytical threshold' to public and intruder
  - As low as reasonably achievable based on technical and economic considerations
- Qualitative Analysis
  - Beyond 10,000 yrs to evaluate ability of disposal system to mitigate long-term risks associated with long-lived waste

[1] SRM-SECY-13-0075

Next Steps

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Publish proposed rule and draft guidance for public comment
- 120 day public comment period
- Deliver final rulemaking package to the Commission

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

QUESTIONS?