Criteria for NRC's Review of Performance Assessment and Risk Insights

Presented to:

Nuclear Waste Technical Review Board

(Las Vegas, Nevada; September 20, 2004)

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Outline

1) Safety Approach

2) Principles of Risk Informed Approach

3) Risk Insights

Safety Approach

- Safety Analyses
- Safety Plans and Procedures
- Continued Safety Oversight

Safety Analyses

- Perform safety assessments (e.g., develop design basis events; screen features, events and processes)
- Evaluate radiological exposure (including ground-water protection and human intrusion)
- Update safety assessments
- Subject to NRC review

Safety Plans and Procedures

- Train, test, certify, and requalify personnel
- Emergency plans for potential releases
- Waste retrieval
- Performance Confirmation

Continued Oversight of Safety

- Continued repository oversight – 63.51(a)(3)
  - land use controls
  - permanent markers
  - records and archives
- Repository monitoring (post-permanent closure) – 63.51(a)(2)

Objectives of Risk Informed Approach

- Identification of important parameters, models, and assumptions
- Identification of important uncertainties
- Focus review on technical support in key areas of performance assessment

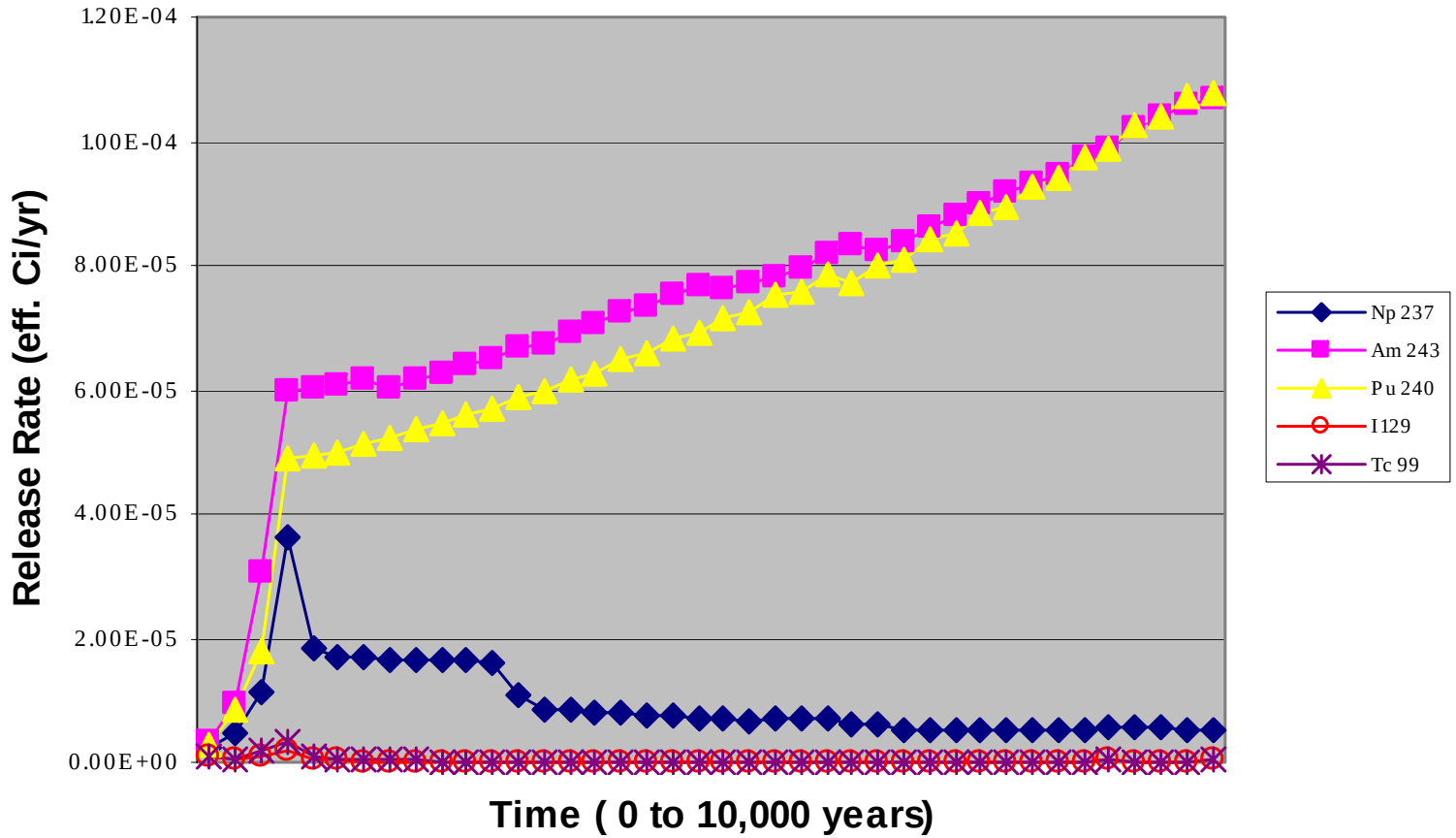
Understanding Repository Performance (Post Closure)

- Risk Insight
  - inventory (potential risk)
  - identification of barriers important to waste isolation
  - uncertainties

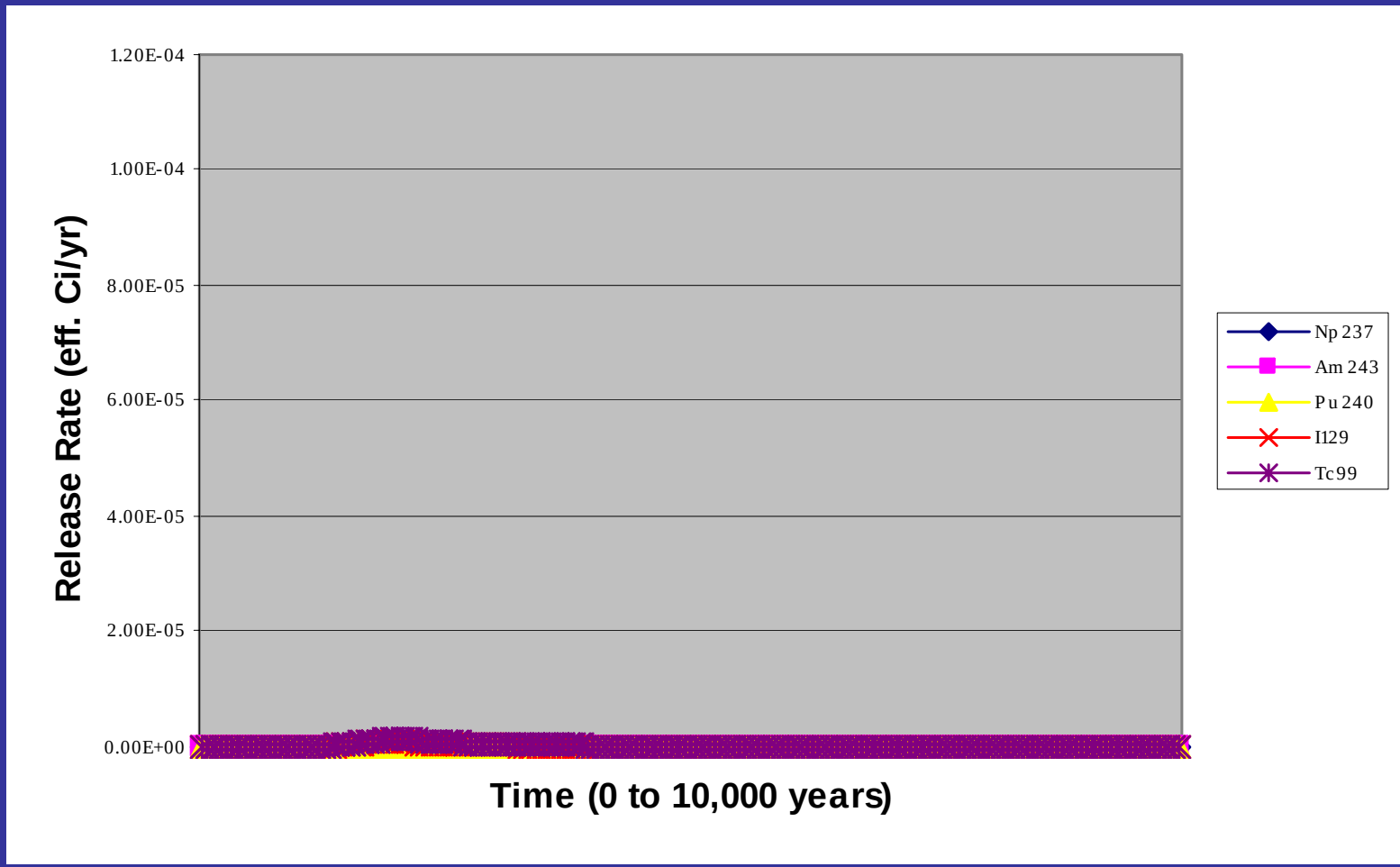
Radionuclide Inventory

Nuclide	Half-Life (yrs)	Percent of Inventory at 1,000 yrs (by activity)	Percent of Inventory at 1,000 yrs (by activity - weighted by DCF)
Am 241	430	54%	56%
Pu 240	6,500	25%	25%
Pu 239	24,000	18%	18%
Am 243	7,400	1.2%	1.2%
Tc 99	210,000	0.7%	0.0003%
U 234	240,000	0.1%	0.01%
C 14	5,700	0.07%	0.00005%
Np 237	2,100,000	0.06%	0.08%
Cs 135	2,300,000	0.03%	0.00007%
U 238	4,500,000,000	0.02%	0.001%
I 129	16,000,000	0.002%	0.0002%
Th 230	77,000	0.001%	0.0002%

Estimated Release from Waste Package (weighted by DCF)



Estimated Release from Geologic Setting (weighted by DCF)



Effectiveness of Waste Isolation

- **Limit on releases based on comparison with the individual protection limit (15 mrem/year)**
  - annual release rate from 1 waste package less than 10,000 (LLL); or 1,000 (LL); or 100 (L) times below the standard

- **Limit on delay of release or transport to compliance location**
  - delay time greater than 10,000 (DDD); or 1,000 (DD); or 100 (D) years

Effectiveness of Repository Waste Isolation Functions

[D = delay time; L = lowering of release rate;
increased letters denotes increased effectiveness]

Safety Functions	Important Features	Radionuclides in the Ground-Water Pathway											
		Am 241	Pu 240	Pu 239	Am 243	Tc 99	U 234	C 14	Np 237	Cs 135	U 238	I 129	Th 230
Onset of Release	Waste Package	DDD	DDD	DDD	DDD	DDD	DDD	DDD	DDD	DDD	DDD	DDD	DDD
Release Rate From Engineered Barriers	Waste Form					LL		LLL		LL	L	L	LL
	Solubility Limits										LLL		L
	Solubility Limits; Limited Water		L	L	L		L		L		LLL		LL
Transport In Geosphere	Transport in Fractures	DDD	DD	DD	DD	D	D	D	D	DDD	D	D	DD
	Transport in Porous Media	DDD	DDD	DDD	DDD	D	DDD	D	DDD	DDD	DDD	D	DDD

Saturated Zone Variation

- Alluvium
  - retardation factors can vary orders of magnitude for certain radionuclides
  - length of flow path

- Fractured Tuff
  - significance of matrix diffusion depends on sorption properties of matrix and extent of fracturing

Variation in Waste Isolation of Saturated Zone

Radionuclides	Attributes of Waste Isolation for Saturated Zone							
	Alluvium Distance		Alluvium Retardation		Alluvium Distance & Retardation		Alluvium Distance & Retardation (no matrix diff.)	
	Low	High	Low	High	Low	High	Low	High
Americium 241	DDD	DDD	DDD	DDD	DDD	DDD	DDD	DDD
Plutonium 240	DDD	DDD	DDD	DDD	DDD	DDD	DDD	DDD
Plutonium 239	DDD	DDD	DDD	DDD	DDD	DDD	DDD	DDD
Americium 243	DDD	DDD	DDD	DDD	DDD	DDD	DDD	DDD
Technetium 99	D	D	D	D	D	D	D	D
Uranium 234	DD	DD	D	DDD	DD	DDD	D	DDD
Carbon 14	D	D	D	D	D	D	D	D
Neptunium 237	DD	DD	D	DDD	DD	DDD	D	DDD
Cesium 135	DDD	DDD	DDD	DDD	DDD	DDD	DDD	DDD
Uranium 238	DD	DD	D	DDD	DD	DDD	D	DDD
Iodine 129	D	D	D	D	D	D	D	D
Thorium 230	DDD	DDD	DD	DDD	DD	DDD	D	DDD

Summary

- Risk insights based on comprehensive understanding of the repository system that:
  - identifies important parameters, models, and assumptions
  - considers uncertainties
  - provides an “informed” and focused approach for NRC’s review