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United States Nuclear Regulatory Commission
Protecting People and the Environment

Transition from Consultation to Monitoring

NRC's Increasingly Focused Review of Factors Important to FTF Performance – 13153

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Outline

- Background
- Previous Reviews
- Review Approach
  - Review DOE Models
  - Develop Independent Model
  - Conduct Independent Research
- Review Results
- Conclusions

Background

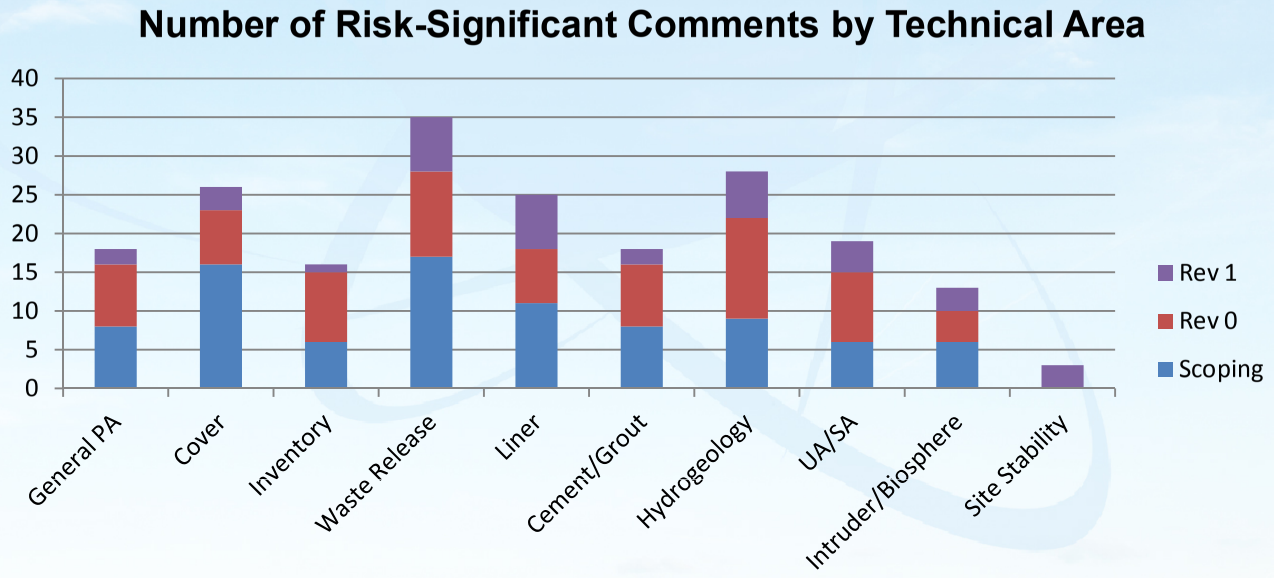
- National Defense Authorization Act for Fiscal Year 2005 (NDAA)
- Authorizes DOE to determine certain wastes associated with spent fuel reprocessing are not high-level
- DOE must consult with NRC in making such a determination
- Typically, DOE provides NRC with a waste determination and performance assessment (PA) to facilitate consultation
- NDAA also requires NRC to monitor DOE disposal actions to assess compliance with the performance objectives in 10 CFR Part 61, Subpart C

Background (cont.)

- DOE consulted with NRC on the F-Area Tank Farm Facility (FTF) at Savannah River Site (SRS)
- 51 Tanks at SRS (22 tanks in FTF)
- Scoping Phase--DOE, NRC, EPA, and SC DHEC participated in nine meetings between February 2007 and February 2008
- June 2008—DOE submitted the Rev. 0 PA
- March 2010—DOE submitted the Rev. 1 PA
- September 2010—DOE submitted a draft waste determination for FTF
- March 2012—DOE issued a final waste determination and NRC began monitoring FTF

Previous Reviews

Number of Comments During Various Reviews			
Reviews:	**Scoping**	**Rev 0 PA**	**Rev 1 PA**
Risk-significant Comments	NA	76	38
Clarifying Comments	NA	14	46
Total Number of Comments	87	90	94



Review Approach

- Multiple Review Approaches Used by NRC Staff
- Review of DOE Models
  - Created additional intermediate outputs
  - Interrogated results
  - Re-packaged results (e.g., summarized barrier performance)
- Development of Independent Models
  - Uses probabilistic approaches to conduct sensitivity and uncertainty analysis
  - Provides independent check of DOE modeling results
  - Facilitates evaluation of alternative (or “what if”) scenarios

Review Approach (cont.)

- Independent Research
  - NRC-sponsored research at the Center for Nuclear Waste Regulatory Analyses (CNWRA) began in 2006.
  - CNWRA studied the hydraulic and chemical performance of cementitious materials and other technical areas (e.g., natural system sorption, and engineered closure cap performance and degradation).
  - NRC hopes to work with DOE to study leaching behavior of key radionuclides from actual FTF high-level waste samples in the future.

Review Approach

Review DOE Models: Barrier Analysis Example 1

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Contributions of Various FTF Barriers to Reducing Risk for Three Key Radionuclides (Tc-99, Pu-239, and Np-237)					
		Tc-99	Pu-239	Np-237	Notes
1	Total Barrier Performance Needed (Function of Inventory)	6 (Type I)	9 (Type IV, Tank 18)	6 (Type I)	Factor reduction in concentration needed to meet the 61.41 dose standard. The tank/type producing the highest dose for each key radionuclide is provided in parentheses.
Engineered System					
2a	Solubility Control	0	2	1 to 2	Final solubility
2b		(9 to 11)	(9 to 11)	(5 to 6)	Initial solubility
3	Basemat Attenuation (Sorption)	<1	2	2	Very important for Pu and Np. Can compensate for solubility.
4	Near-Field Diffusion or Dispersion	2	1	1	Additional reduction in concentration due to upward diffusion into tank grout, large cell size, or dispersion.
Natural System					
5	Aquifer Dilution	1	1	1	Based on simple aquifer mixing model; comparison of concentrations between vadose zone, source and saturated zones. Pu sorption can compensate for other barrier underperformance.
6	Sorption	<<1	1	<<1	
7	Additional Dispersion to POC	1-2	1	1	
8	Total Barrier Performance	5	8	6 to 7	Sum of rows 2a, 3-7.
9	Calculated Safety Margin	-1	-1	0 to 1	Difference Between Row 8 and Row 1.

Review Approach

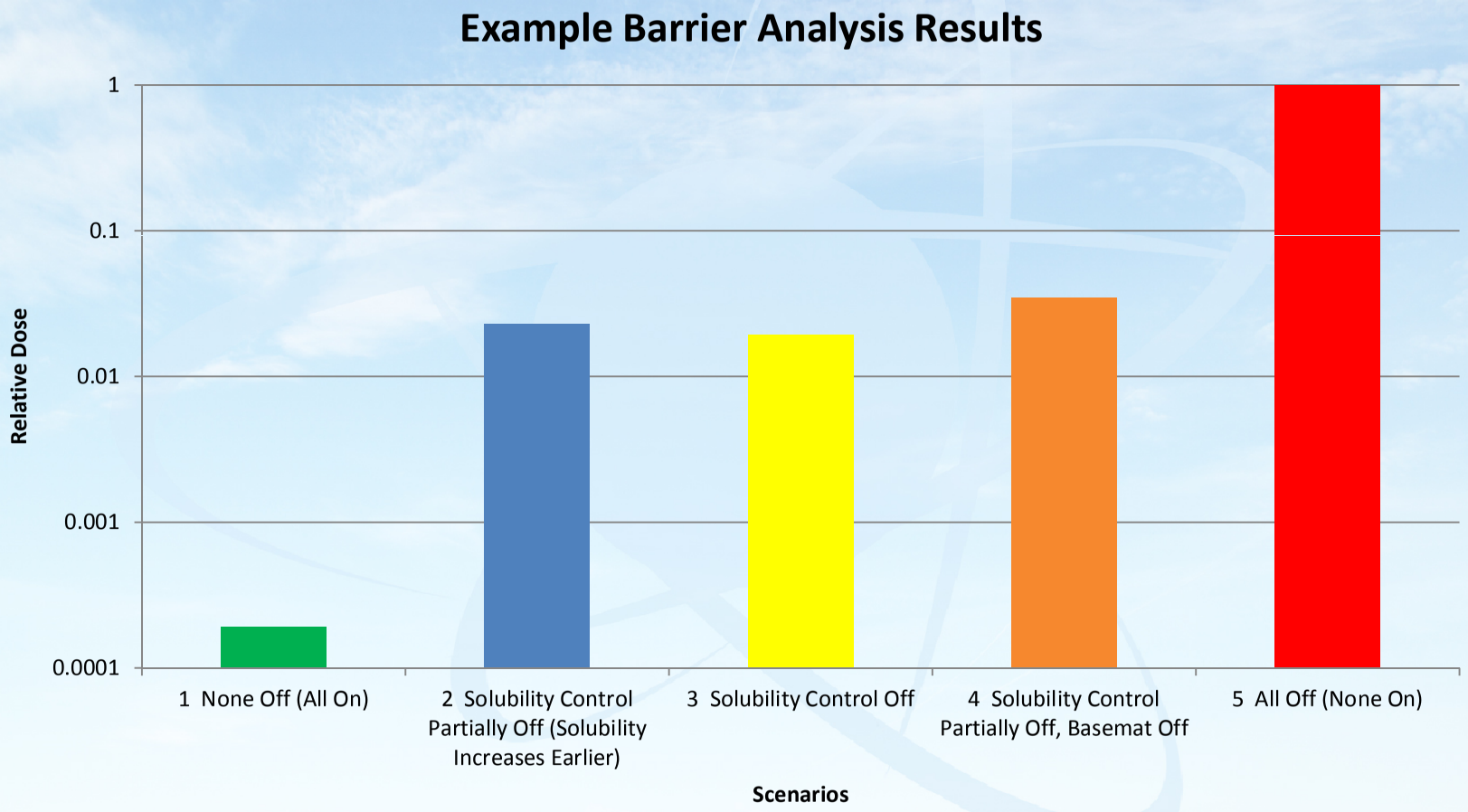
Review DOE Models: Barrier Analysis Example 2

Barrier Effectiveness Levels			
Barriers	States (Worst to Best)		
Solubility Control	Low Solubility Control (Very High Solubility Limit)	Moderate Solubility Control (Moderate Solubility Limit)	High Solubility Control (Low Solubility Limit)
Basemat Sorption	None (No sorption or by-Pass)	Moderate to High Sorption (High K_d)	
Natural System Sorption	Low Sorption (Low K_d)	Moderate Sorption	High Sorption (High K_d)

Barrier Analysis Cases			
	Solubility Control	Basemat Sorption	Natural System Sorption
Case 1 None Off (All On)	High	Moderate to High	High
Case 2 Solubility Partially Off **Solubility Increases Earlier	Moderate	Moderate to High	Moderate
Case 3 Solubility Control Off	Low	Moderate to High	Moderate
Case 4 Solubility Control Partially Off, Basemat Off (By-Pass)	Moderate	None	Moderate
Case 5 All Off (None On)	Low	None	Low

Review Approach

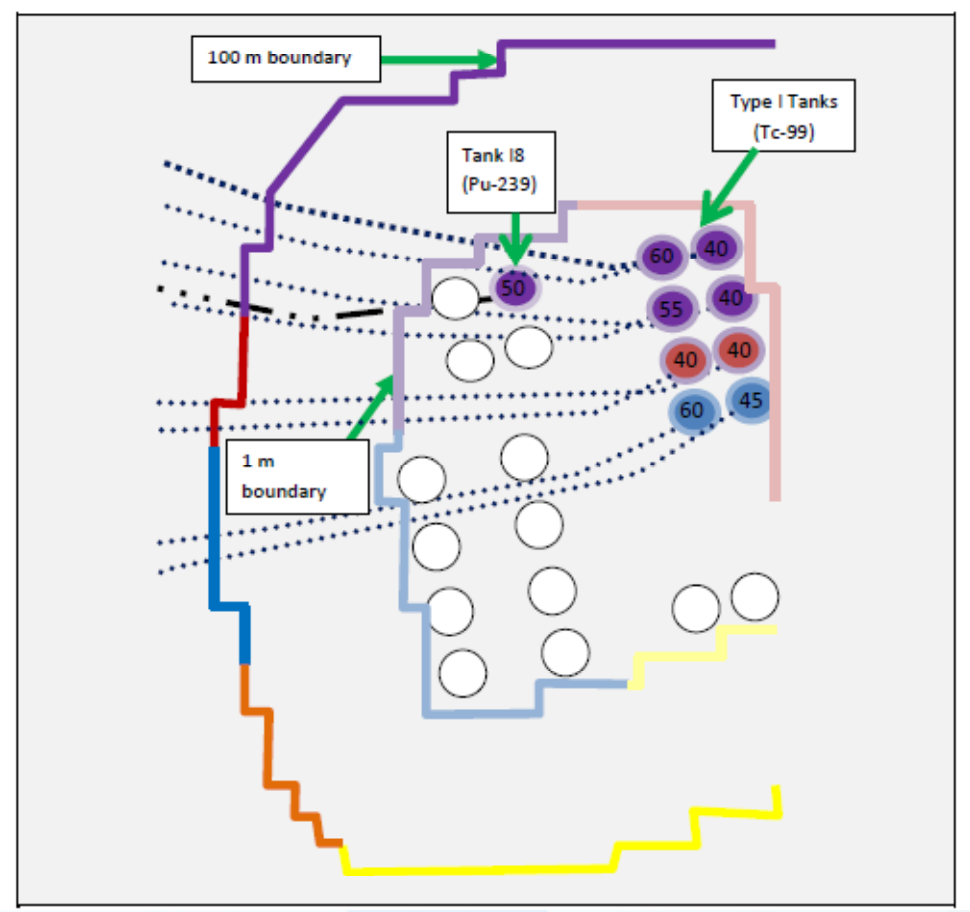
Review DOE Models: Barrier Analysis Example 2



Review Approach

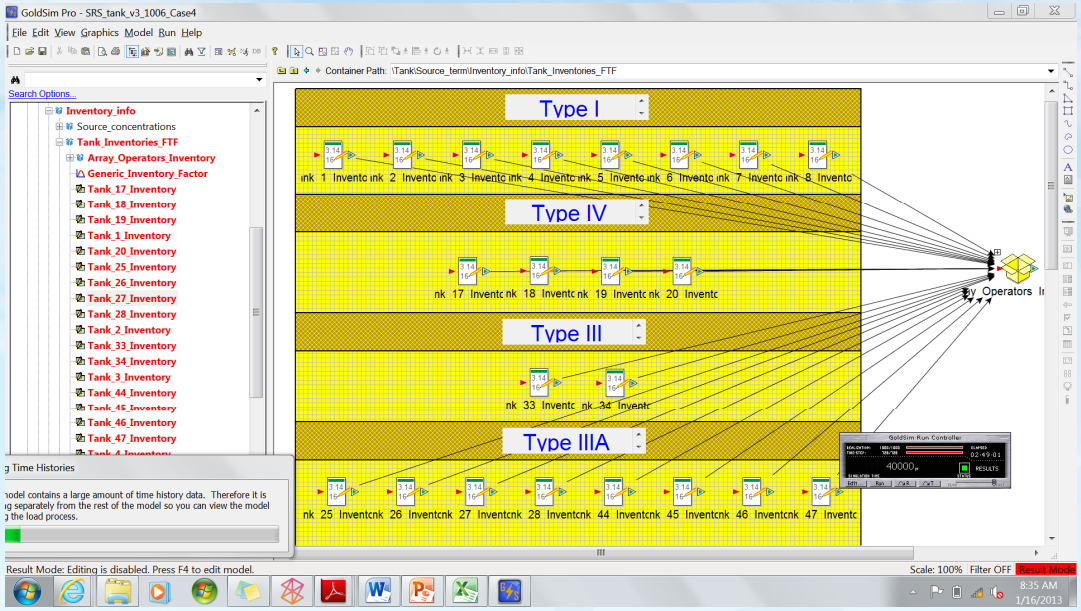
Review DOE Models: Attenuation Factors

- Attenuation factors are 15-40 from the source to the 1-m boundary and 1.3 to 3 from the 1-m to the 100-m boundary for Tc-99 (Type I tanks are relatively far from the 1-m boundary)
- Attenuation factor of 5 from the source to the 1-m boundary and 10 from the 1-m to the 100-m boundary for Pu-239 for Tank 18 (tank is close to the 1-m boundary)



Review Approach

Develop Independent Model



- Contains most up-to-date inventory information for tanks and major auxiliary components
- Contains tank/type specific modeling parameters
- Allows analysis of risk associated with wall inventory
- Manages data inputs using Access database
- Biosphere modeling using BDose developed by CNWRA

Review Approach

Conduct Independent Research

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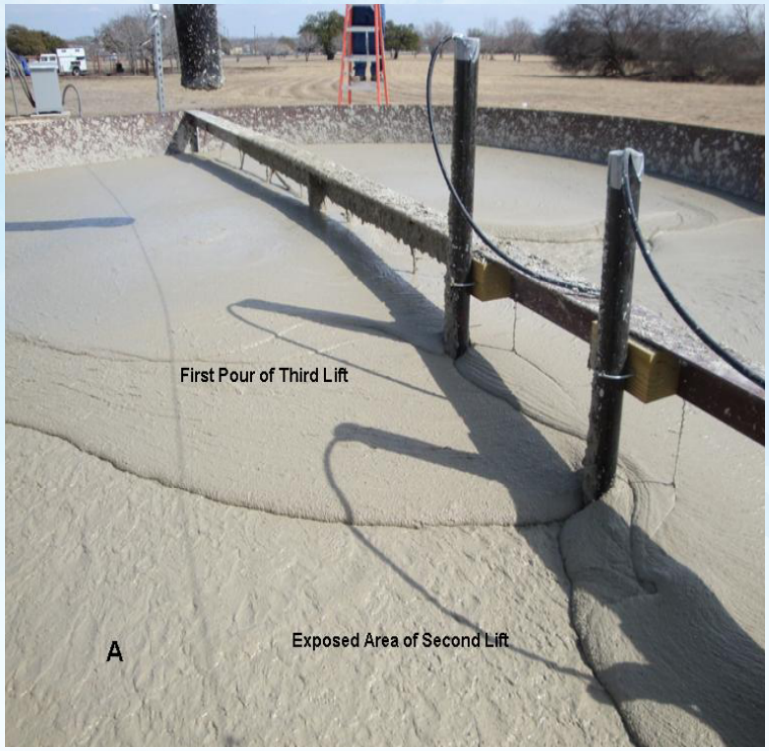
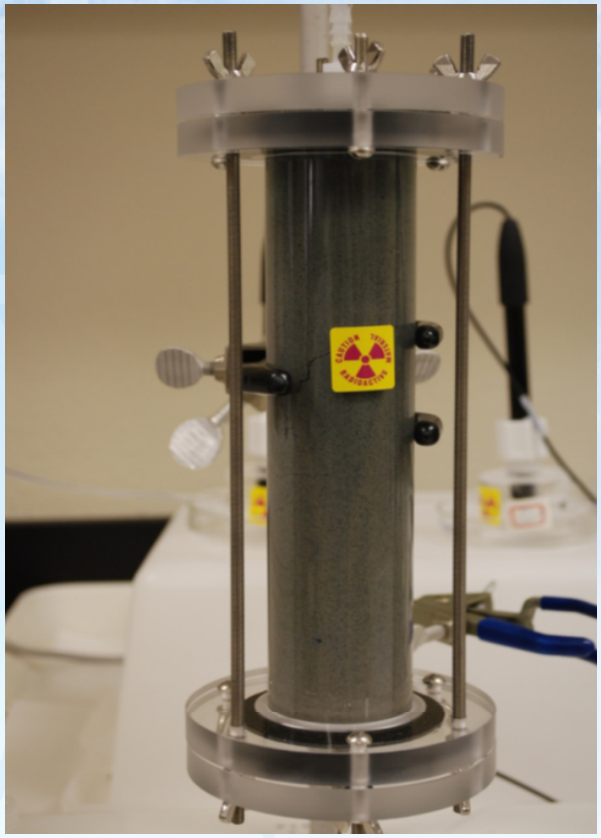
Intermediate-scale grout monolith construction and testing (used DOE SRS, proposed tank formulation)





Waste Release Experiments (used saltstone formulation)

Review Results

- NRC's review of FTF PA documentation became increasingly focused over time
- Risk insights were gained through
  - Review of DOE models
  - Independent Modeling
  - Independent research
- Risk insights obtained during the consultation phase helped focus limited NRC resources to monitor DOE disposal actions
- Monitoring factors were prioritized by risk-significance and timing

Review Results (cont.)

Monitoring Areas (MA)				
MA 1 Inventory	**MA 2 Waste Release**	**MA 3 Cementitious Material Performance**	**MA 4 Natural System Performance**	**MA 5 Closure Cap**
1.1—Final Inventory and Risk Estimates†	2.1—Solubility-Limiting Phases/Limits and Validation	3.1—Cement Vault Performance (As It Impacts Steel Liner Corrosion)‡	4.1—Natural Attenuation of Pu	5.1—Long-Term Hydraulic Performance*
1.2— Residual Waste Sampling†	2.2—Chemical Transition Times‡	3.2—Groundwater Conditioning‡	4.2—Calcareous Zone Characterization†	5.2—Long-Term Erosion Protection Design*
1.3— Residual Waste Volume†		3.3—Shrinkage and Cracking†	4-3— Environmental Monitoring†	
1.4— Ancillary Equipment Inventory*		3.4—Grout Performance†		
1.5—Waste Removal (As It Impacts ALARA)*		3.5—Basemat Performance‡		

*Lower Priority

†Medium Priority

‡High Priority Dependent or More Difficult *(The monitoring factors in orange‡ are risk-significant to DOE's PA, but the need for their implementation may be dependent on results of other monitoring factors. Because the monitoring factors in orange‡ are also expected to be more difficult to study or support, work on monitoring factors in red§ are recommended first.)*

§High Priority Recommended

Conclusions

- NRC staff has increasingly focused its reviews of DOE PA documentation for FTF
- NRC developed a plan to facilitate monitoring of DOE disposal actions at the FTF
- NRC staff strove to develop a stream-lined monitoring plan
- NRC prioritized monitoring factors in terms of risk-significance and timing

Conclusions (cont)

- Factors important to performance include the following:
  - Residual waste inventory
  - Waste release parameters
    - Chemical transition times
    - Solubility limiting phases/limits
  - Hydraulic and chemical performance of cementitious materials including
    - Extent of groundwater conditioning
    - Shrinkage and cracking
    - Basemat K_ds
  - Natural system performance
    - Soil K_ds
    - Dilution
- NRC staff will continue to work with its Federal and State partners, and the public to fulfill its monitoring responsibilities under the NDAA as tank farm closure progresses