## **Used Fuel Disposition R&D Campaign**

## Overview of Defense Repository Safety Analysis R&D

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Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND2016-5328PE



- Work breakdown structure of Safety Analysis WBS
- GDSA Framework as an integration tool
- Overview of six ongoing Safety Analysis work packages

### Work Structure for the R&D Program Disposition



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# **Model Integration Linkages**



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# **Safety Analysis Work Packages**



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**Disposition** 

- WP 1 (SNL): Complete Reference Cases for each Geologic Medium (some are deferred)
- WP 2 (SNL): FEPs Analysis
- WP 3 (LANL): FEPs Analysis (aka. the Colloid Synthesis Report)
- WP 4 (SNL): Define Generic Performance/Safety Objectives (deferred pending funding)
- WP 5 (SNL): Evaluate Alternative EBS Concepts
- WP 6 (SNL): Total System Performance Assessment
- WP 7 (SNL): Document Preliminary Technical Site Evaluation Plan (deferred pending funding)
- WP 8 (LANL): Preliminary Regional Geology Evaluation

#### WP 1 (SNL): Complete Reference Cases for each Geologic Medium **Disposition**





#### (some work in FY15; hope to update for FY16)



(deferred due to funding cut)

Source: ANDRA 2005b.



(R&D conducted under DBFT WPs)



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## WP 1: Reference Cases (continued) Fractured Crystalline (Granite)





## WP 2 (SNL): FEPs Analysis

- Preliminary screening to be based on FEPs matrix approach being developed in collaboration with Germans
- FEPs screening is a function of host rock and waste characteristics:



	Characteristics,		Processes										Events							
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	Glossary / Definitions	CP	TM	TH	TC	ΤB	TT	TL	RA	LG	CL	HP	OP	NC	EF	SM	IG	HE	OE	
Waste and Engineered Features																				
(WF) Waste Form and Cladding																				
	(01) SNF and Cladding																			
	(02) Vitrified HLW																			
	(05) Other HLW																			
	(06) Metal Parts from Reprocessing																			
	(WP) Waste Package and Internals																			
s	(01) SNF																			
	(02) Vitrified HLW																			
	(05) Other HLW																			
	(06) Metal Parts																			
	(BB) Buffer/Backfill																			
	(01) Waste Package Buffer																			
	(02) Drift/Tunnel Backfill																			
	(MW) Emplacement Drifts/Rooms and																			
	Mine Workings																			
	(01) Open Excavations																			
	(02) Drift/Tunnel Support																			
	(03) Liners																			
	(SP) Seals/Plugs																			
	(01) Drift/Tunnel Seals																			
	(02) Shaft Seals																			
	(03) Borehole Plugs																			
Geosphere Features																				
(HR) Host Rock												1						Γ		
	(01) Disturbed Rock Zone (DRZ)																			
	(02) Emplacement Unit(s)																			
	(03) Other Host Rock Units																			
	OU) Other Geologic Units																			
	(01) Overlying / Adjacent Units																			
	(including Caprock, Aquifers)																			
	(02) Underlying Units																			
	Surface Features																			
	(BP) Biosphere								Ī			1								
	(01) Natural Surface and Near-Surface																			
	Environment																			
	(02) Flora and Fauna																			
	(03) Humans																			
	(04) Food and Drinking Water																			
	(05) Dwellings and Other Man-Made																			
	Surface Features/Materials																			
						Syste	em Fe	ature	s											
	(RS) Repository System																			
	(01) Assessment Basis																			
	(02) Preclosure/Operational																			
	(03) Other Global																			

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# Thermal Characteristics of HLW and SNF Affect Disposal Strategies

- Repository designs and operational concepts can be engineered to address waste-form thermal characteristics:
  - All Defense HLW is relatively cold: less than 500 W per canister
  - Most DOE-managed SNF is relatively cold: less than 1000 W per canister
  - All commercial SNF has comparatively high thermal output
  - Some naval SNF is comparable in thermal power to commercial SNF
- Initial R&D will limit EBS/repository designs to canisters of approximately less than 1000 W



## WP5 (SNL): Evaluate Alternative EBS Concepts

- Developed in collaboration with WBS 1.02.08.05.02 "Preliminary Design Concepts" (Matteo)
- For FY16, considering two primary waste types: DOE SNF (all types, but dominated by Nreactor fuel) and DOE HLW (both SRS and Hanford)
- Considering both single-canister vertical emplacement (SNF) and multi-canister horizontal emplacement (HLW), in separate areas of the repository
  - Representing thermal variability:
    - 7 different "thermal bins", distributed spatially, for DOE SNF
    - SRS glass and Hanford glass have different average thermal outputs



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#### Used Fuel Disposition WP6 (SNL): Total System Performance Assessment

- M2 milestone in Nov 2016: "Status of Progress Made Toward Safety Analysis and Technical Site Evaluations for DOE Managed HLW and SNF"
- Simulations conducted with the GDSA-PFLOTRAN Framework (heat, fluid, and mass transport)
- Granite host-rock natural barrier system is the same as in GDSA commercial SNF simulations
- Waste characteristics, packaging, degradation rates, and repository layout are specific to a defense-waste repository
- Preliminary simulations and example UA/SA for the granite defense repository reference case





#### Used Fuel WP8 (LANL): Regional Geology Evaluations Disposition

- Comparisons of granitic terrane and fracture features at Forsmark, Sweden—used as a basis for the UFD reference case—to granitic provinces in North America
- Maps of water table elevations (thickness of unsaturated zone)



Crystalline rock outcrop





#### Session 3: Safety Analysis and Organization/Procedural Frameworks

- 10:10 10:30: Overview of D-Repo Safety Analysis R&D Sevougian
- 10:30 10:50: Regional Geology Investigations Perry
- 10:50 11:20: D-Repo Repository Reference Case and Preliminary PA Simulations – **Stein**
- 11:20 11:35: Draft Program Plan: Organizational and Procedural Frameworks Swift
- 11:35 11:50: Wrap-up and Brainstorming on Future Directions All

# **Back-Up Slides**

#### Inventory and Waste Characterization

- <u>M2</u>: The On-line Waste Library (OWL): Usage and Status Report (SNL, 9/23/2016)
- <u>M4</u>: Inventory Input Report (SRNL, 7/29/2016)

#### Preliminary Design Concepts

- <u>M2</u>: Status of Progress Made Toward Preliminary Design Concepts for the Inventory in Select Media for DOE Managed HLW/SNF (SNL, 9/30/2016)
- <u>M4</u>: Decay Heat of Selected Defense Waste Materials (SRNL, 7/29/2016)

#### Organizational and Procedural Frameworks

- <u>M2</u>: Draft Program Plan for the Permanent Disposal of High-Level Radioactive Waste and Spent Nuclear Fuel from Defense and Department of Energy Research and Development Activities (SNL, 7/29/2016)
- <u>M2</u>: Generic Organizational and Procedural Framework for DOE Managed HLW and SNF Licensing (SNL, 9/16/2016)

#### Safety Analysis and Technical Site Evaluations

- <u>M2</u>: Status of Progress Made Toward Safety Analysis and Technical Site Evaluations for DOE Managed HLW and SNF (SNL, 11/3/2016, i.e., in FY17)
- <u>M4</u>: Preliminary Regional Site Evaluations for Disposal of DOE-Managed HLW and SNF (LANL, 9/16/2016)