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EBS Crosscuts and Integration in the FY18 Workscope

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SNL

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Overview of Activities, 1/2

EBS R&D

- LANL
  - EBS Interfaces (integrates with Argillite)
- LBNL
  - THMC modeling of EBS/host interactions
  - Reduced-order THMC process models for GDSA
- PNNL (new with FY18 addt'l funding)
  - Micro-electrochemical testing capability
  - Integrate with ANL and LLNL and other corrosion research
- SNL
  - Multi-phase flow in the EBS, buffer re-saturation
  - Benchmarking
  - Waste package failure
  - Illitization (integrates with Crystalline)
  - Criticality (integrates with Crystalline)

Overview of Activities, 2/2

EBS International

- LANL
  - FEBEX sample characterization
- LBNL
  - FEBEX-DP and HotBent , modeling and characteritization
- PNNL
  - Spent fuel degradation (DISCO)
- SNL
  - FEBEX, EBS Task Force

Integration with GDSA/PA and/or the Safety Case, 1/3

EBS R&D

- LANL
  - EBS Interfaces (integrates with Argillite) (SAL=3)
- LBNL
  - THMC modeling of EBS/host interactions (SAL=4)
  - Reduced-order THMC process models for GDSA (SAL = 4)
- PNNL
  - Micro-electrochemical testing capability
  - Integrate with ANL and LLNL and other corrosion research

4.2 Post-closure Safety Assessment

a. FEPs analysis/screening
b. Scenario construction/screening
c. PA model/software validation
d. Barrier/safety function analyses and subsystem analyses
e. PA Model Analyses/Results
f. Uncertainty characterization and analysis
g. Sensitivity analyses

3.3.1 Waste & Engineered Barriers Technical Basis

a. Inventory characterization
b. WF/WP technical basis
c. Buffer/backfill technical basis
d. Shafts/seals technical basis
e. UQ (aleatory, epistemic)

Integration with GDSA/PA and/or the Safety Case, 2/3

EBS R&D (cont.)

- SNL
  - Multi-phase flow in the EBS, buffer re-saturation (SAL = 5)
  - Benchmarking (SAL = 3)
  - Waste package failure (SAL = 4 or 5)
  - Illitization (integrates with Crystalline) (SAL = 3)
  - Criticality (integrates with Crystalline)

3.3.1 Waste & Engineered Barriers Technical Basis

a. Inventory characterization
b. WF/WP technical basis
c. Buffer/backfill technical basis
d. Shafts/seals technical basis
e. UQ (aleatory, epistemic)

3.2 Pre-closure Basis

a. Repository design & layout
b. Waste package design
c. Construction requirements & schedule
d. Operations & surface facility
e. Waste acceptance criteria
f. Impact of pre-closure activities on post-closure

4.2 Post-closure Safety Assessment

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Integration with GDSA/PA and/or the Safety Case, 3/3

EBS International

- LANL
  - FEBEX sample characterization
- LBNL
  - FEBEX-DP and HotBent , modeling and characteritization
- PNNL
  - Spent fuel degradation (DISCO)
- SNL
  - FEBEX, EBS Task Force

4.3 Confidence Enhancement

a. R&D prioritization
b. Natural/anthropogenic analogues
c. URL & large-scale demonstrations
d. Monitoring and performance confirmation
e. International collaboration & peer review
f. Verification, validation, transparency
g. Qualitative and robustness arguments

4.2 Post-closure Safety Assessment

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3.3.1 Waste & Engineered Barriers Technical Basis

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Relationship to 2012 UFD Roadmap and R&D Priority Ratings

						waste packages				Highly dependent on EBS design concept		
		2.1.04.00	1.04. BUFFER / BACKFILL									
Containment, Limited Release Engineered Barriers	Backfill/Buffer	2.1.04.01	Evolution and Degradation of Backfill/buffer	- Alteration - Thermal expansion / Degradation - Swelling/Compaction - Erosion/Dissolution - Evolution of backfill flow pathways [see also Evolution of Flow Pathways in EBS in 2.1.08.06, Mechanical Impact in 2.1.07.04, Thermal-Mechanical Effects in 2.1.11.08, Chemical Interaction in 2.1.09.06]	Partial - Design Specific	Specific R&D would require establishment of design and selection of material. Generic R&D could be conducted on backfill/buffer materials independent of design.	High	High	High	May be of high importance for performance in certain environments and disposal concepts that utilize backfill/buffer as a engineered barrier - governs "source term" release upon failure of waste packages for certain designs in certain environments. High importance for design/construction - could effect disposal system design that utilize backfill/buffer as an engineered barrier, how it is constructed, and emplacement of waste and backfill/buffer (i.e., size of waste packages and spacing). High importance for overall confidence - secondary isolation barrier and long-term barrier performance	Fundamental Gaps in Method, Fundamental Data Needs	Other countries have performed considerable investigations into different backfill and buffer materials (bentonite and cementitious materials). Additional R&D needed to better understand processes associated with backfill/buffer for these materials. Little/no information available regarding new/novel buffers/backfill materials
		2.1.05.00	1.05. SEALS									
Containment, Limited Release Engineered Barriers	Seals	2.1.05.01	Degradation of Seals	- Alteration / Degradation / Cracking - Erosion / Dissolution / precipitation - Asphalt seals: degradation as a function of temperature and degassing [see also Mechanical Impact in 2.1.07.08, Thermal-Mechanical Effects in 2.1.11.09, Chemical Interaction in 2.1.09.08]	Partial - Site Specific, Design Specific	Also media specific. Specific R&D would require establishment of seal design and selection of material - compatible with site/media. Generic R&D could be conducted on seal materials independent of design and site/media.	High	High	High	May be of high importance for performance in certain environments that rely on seals as a key part of the engineered barrier system - Could provide preferential pathways for release. Seal degradation could influence local chemistry Medium importance for design/construction: Since the seals are a key part of the waste isolation system, their importance to design and /construction/ operations is important. However, the design/construction/operation of the overall facility does not depend on the seals themselves. High importance for overall confidence - potential isolation barrier.	Fundamental Gaps in Method, Fundamental Data Needs	Various countries, including USA and international repository programs, have conducted investigations on the stability and degradation of concretes and other sealing materials. WIPP has a certified seal design and the Swedish and Finnish programs are well advanced in granite environments. A collaborative research program has been developed by DOE-EM Office of Waste Processing named the "Cementitious Barriers Partnership". The UFD EBS program will focus mainly on the development of thermodynamic database to be used in the prediction of solubilities of cementitous phases and a computational tool to perform these calculations. It will also evaluate model concepts of cement corrosion and degradation processes. Modeling of solid solution phenomena is key to the accurate representation of cement barrier degradation.
		2.1.06.00	1.06. OTHER EBS MATERIALS									
Containment, Limited Release Engineered Barriers	Other Engineered Features	2.1.06.01	Degradation of Liner / Rock Reinforcement Materials in EBS	- Alteration / Degradation / Cracking - Corrosion - Erosion / Dissolution / Spalling - Dual purpose of liner acting as "structural" feature plus as a barrier component (e.g., getter or isolation purposes). [see also Mechanical Impact in 2.1.07.08, Thermal-Mechanical Effects in 2.1.11.09, Chemical Interaction in 2.1.09.07]	Partial - Site Specific, Design Specific	Also media specific. Specific R&D would require establishment of sub-surface design and selection of materials - compatible with site/media. Generic R&D could be conducted on materials independent of design and site/media.	Medium	High	Medium	Expected to be of medium at most direct importance to long-term performance. May be of secondary importance by affecting other engineered materials Could be of high importance to repository design and construction. Estimated at medium importance for overall confidence - tunnel stability during operations Degradation within this disposal domain could translate in eventual fast percolation paths in the neighboring bounds of the disposal gallery. However, anticipated 'healing' processes could mitigate the resulting effects deleterious to barrier performance.	Improved Representation	Other countries have investigated a variety of disposal system designs, including other engineered barriers system materials Improved understanding of other EBS material degradation and impacts on other EBS processes (i.e., chemistry) are needed. For example, degradation modes at the cement / rock and cemen / metal barrier interfaces.
		2.1.07.00	1.07. MECHANICAL PROCESSES									
Containment, Limited Release Engineered Barriers	Engineered Barriers	2.1.07.01	Rockfall	- Dynamic loading (block size and velocity) [see also Mechanical Effects on Host Rock in 2.2.07.01]	No	Site Specific, Design Specific Anticipate that site screening and site selection would prefer geologic conditions that would maximize drift/tunnel stability and minimize the potential for rockfall. However, this cannot be assessed with generic R&D.						

Relationship to 2012 UFD Roadmap and R&D Priority Ratings

1.2.03.01 - Seismic Activity Impacts EBS and/or EBS Components -	4.94
2.1.09.13 - Radionuclide Speciation and Solubility in EBS - In Waste Form - In Waste Package - In Backfill - In Tunnel -	4.86
2.1.03.02 - General Corrosion of Waste Packages -	4.34
2.1.03.03 - Stress Corrosion Cracking (SCC) of Waste Packages -	4.34
2.1.03.04 - Localized Corrosion of Waste Packages -	4.34
2.1.03.05 - Hydride Cracking of Waste Packages -	4.34
2.1.02.01 - SNF (Commercial, DOE) Degradation - Alteration / Phase Separation - Dissolution / Leaching - Radionuclide Release -	4.01
2.2.07.01 - Mechanical Effects on Host Rock - Salt	3.83
2.2.07.01 - Mechanical Effects on Host Rock - Clay/Shale	3.83
2.2.02.01 - Stratigraphy and Properties of Host Rock - Granite/Crystalline	3.74
2.2.02.01 - Stratigraphy and Properties of Host Rock - Deep Boreholes	3.74
2.2.02.01 - Stratigraphy and Properties of Host Rock - Salt	3.74
2.2.02.01 - Stratigraphy and Properties of Host Rock - Clay/Shale	3.74

Used Fuel Disposition Campaign Disposal Research and Development Roadmap
FCRD-USED-2011-000065 Rev. 1

Relationship to 2012 UFD Roadmap and R&D Priority Ratings

UFD FEP ID No., Title, and Media	Overall Priority Score
2.2.11.04 - Thermal Effects on Chemistry and Microbial Activity in Geosphere - Deep Boreholes	3.55
2.2.11.04 - Thermal Effects on Chemistry and Microbial Activity in Geosphere - Clay/Shale	3.55
2.1.04.01 - Evolution and Degradation of Backfill/buffer -	3.50
2.1.05.01 - Degradation of Seals -	3.50
2.2.11.06 - Thermal-Mechanical Effects on Geosphere - Deep Boreholes	3.40
2.2.11.06 - Thermal-Mechanical Effects on Geosphere - Clay/Shale	3.40
2.2.11.07 - Thermal-Chemical Alteration of Geosphere - Deep Boreholes	3.40
2.2.11.07 - Thermal-Chemical Alteration of Geosphere - Clay/Shale	3.40
2.1.07.03 - Mechanical Effects of Backfill -	3.29
2.2.09.59 - Colloidal Transport in Host Rock - Granite/Crystalline	3.29
2.2.09.59 - Colloidal Transport in Host Rock - Clay/Shale	3.29

Relationship to 2012 UFD Roadmap and R&D Priority Ratings

2.1.09.51 - Advection of Dissolved Radionuclides in EBS - In Waste Form - In Waste Package - In Backfill - In Tunnel -	3.06
2.1.09.52 - Diffusion of Dissolved Radionuclides in EBS - In Waste Form - In Waste Package - In Backfill - In Tunnel -	3.06
2.1.09.53 - Sorption of Dissolved Radionuclides in EBS - In Waste Form - In Waste Package - In Backfill - In Tunnel -	3.06
2.1.07.04 - Mechanical Impact on Backfill -	2.94
2.2.08.07 - Mineralogic Dehydration - Granite/Crystalline	2.82
2.2.08.07 - Mineralogic Dehydration - Deep Boreholes	2.82
2.2.08.07 - Mineralogic Dehydration - Clay/Shale	2.82
2.1.08.04 - Flow Through Seals -	2.80
2.1.09.07 - Chemical Interaction of Water with Liner / Rock Reinforcement and Cementitious Materials in EBS - In Backfill - In Tunnels -	2.80
2.1.07.05 - Mechanical Impact on Waste Packages -	2.76
2.1.08.03 - Flow in Backfill -	2.76
2.1.09.02 - Chemical Characteristics of Water in Waste Packages -	2.76
2.1.07.02 - - Drift Collapse - Drift deformation (EDZ) -	2.70
2.1.09.01 - Chemistry of Water Flowing into the Repository -	2.64
2.1.06.01 - Degradation of Liner / Rock Reinforcement Materials in EBS -	2.62
2.1.09.09 - Chemical Effects at EBS Component Interfaces -	2.61
2.1.11.01 - Heat Generation in EBS -	2.59

Future R&D & Integration Timeframe

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Questions?

Back-Up Slides