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FCR&D FY 2017 Planning Package Review

Used Fuel Disposition R&D Campaign DOE-Managed HLW and SNF Research 1.02.08

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Outline

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Context

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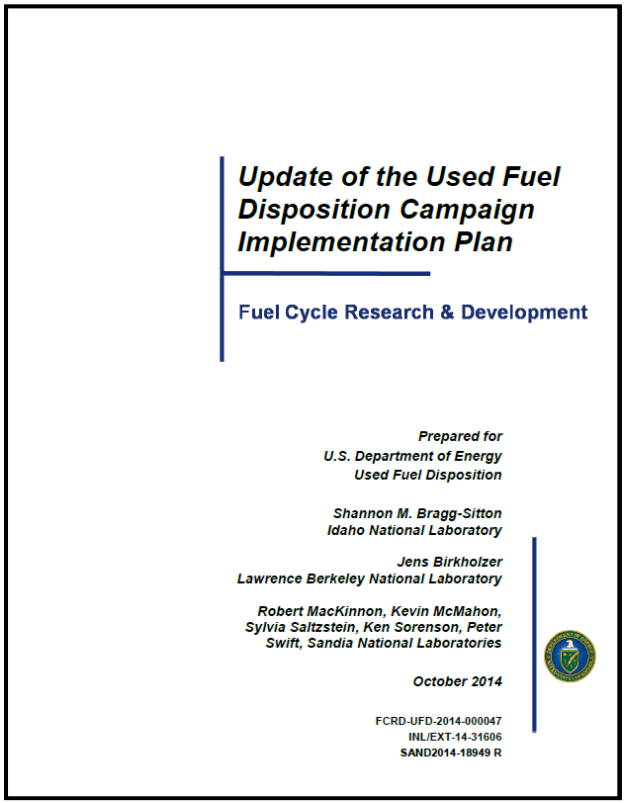
UFD R&D Campaign Mission

The MISSION of the Used Fuel Disposition Campaign is to identify alternatives and conduct scientific research and technology development to enable storage, transportation and disposal of used nuclear fuel and wastes generated by existing and future nuclear fuel cycles.

Update of the Used Fuel Disposition Campaign Implementation Plan

FCRD-UFD-2014-000047, October 2014



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Used Fuel Disposition Campaign (UFDC) Storage and Transportation R&D Objectives

1. **Support the development of the technical bases to demonstrate used fuel integrity for extended storage periods**
2. **Support the development of the technical bases for fuel retrievability and transportation after long term storage**
3. **Support the development of the technical bases for transportation of high burnup fuel**

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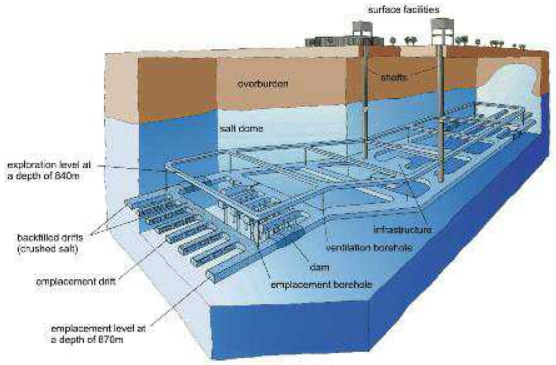
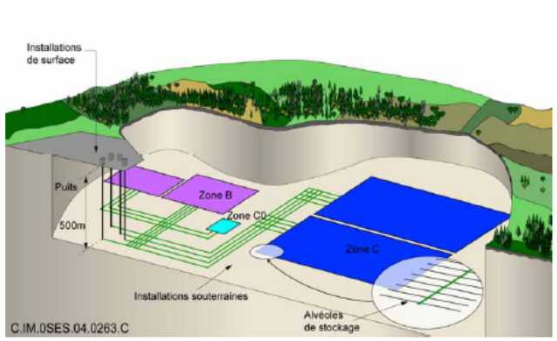
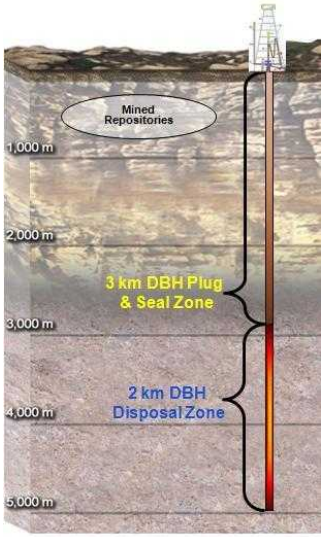
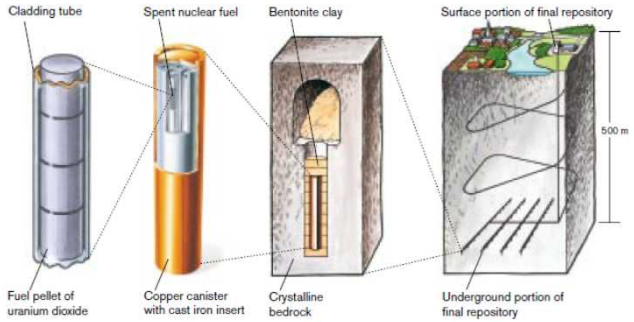
DOE's R&D Focus for UNF and HLW Disposal

- **Provide a sound technical basis for multiple viable disposal options in the US**
- **Increase confidence in the robustness of generic disposal concepts**
- **Develop the science and engineering tools needed to support disposal concept implementation**









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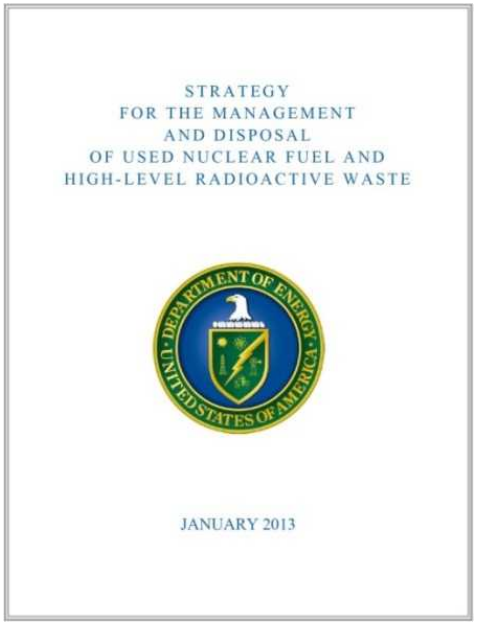
Long-Term UFD R&D Campaign Objectives

- Support the implementation of a full-scale NRC-licensed confirmatory storage demonstration facility, in collaboration with industry
- Develop the technical basis necessary to support eventual transportation of used nuclear fuel, including high-burnup fuel
- Support the DOE's development of an Integrated Waste Management System that leads to implementation of integrated storage, transportation, and disposal concepts

Support the Administration's 2013 *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste*



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Three-Year UFD Campaign Objectives (2017-2019)

Storage and Transportation R&D

- Support the high burn-up fuel full-scale storage demonstration project
- Develop understanding of how temperature and pressure affect cladding integrity in high-burnup UNF
  - Predictive modeling
  - Experimentation
- Develop understanding of how corrosion and stress corrosion cracking affect performance of stainless steel dry storage canisters
  - Material and environmental data; predictive modeling
- Characterize external loadings on UNF during normal conditions of transport

Disposal R&D

- Field a deep borehole test
  - Initiate drilling in 2016, complete testing in 2019
- Complete evaluation of the direct disposal of dual-purpose canisters
- Develop experimental and modeling basis for understanding long-term performance of disposal systems in argillaceous rock, salt, crystalline rock, and deep boreholes
  - Leverage international disposal R&D
- Develop reference cases for generic disposal concepts

DOE HLW and SNF R&D

- Initiate a repository program for disposal of defense HLW and some DOE-managed SNF

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Carryover, Assumptions, Prerequisites, Linkages, and Dependencies

Carryover

- UFD R&D FY12 carryover beginning FY13: ~$5.5 M
- UFD R&D FY13 carryover beginning FY14: ~$4.4 M
- UFD R&D FY14 carryover beginning FY15: ~$5.9 M
- UFD R&D FY15 carryover beginning FY16: ~$5.1 M
- UFD R&D FY16 PICS NE data from May 2016
  - Variance $2.0 M
  - Identified carryover $1.9 M

Assumptions and Prerequisites

- Planning target for FY17 is $39.7M, not including DOE-managed HLW and SNF R&D
  - The planning target includes significant non-lab NE-53 commitments (e.g., industry contracts)
- Budget and scope for INL facility adaptation ($4.5M) and railcar work ($6M) moved to Integrated Waste Management System (IWMS) per DOE guidance
- DOE-managed HLW and SNF R&D will be included in IWMS planning

Linkages and Dependencies

- Integration with NFST, Material Recovery and Waste Form, Fuel Cycle Options, MPACT
- Uncertainty remains regarding location of the deep borehole field test

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NEUP Activities relevant to the UFD R&D Campaign

- **UFD R&D is affiliated with 15 active NEUP research projects (not including FY16 awards)**
  - 7 projects in Storage R&D
  - 1 project in Transportation R&D
  - 3 projects in Disposal R&D
  - 4 Integrated Research Projects in Storage R&D
- **All NEUP UFD R&D projects were invited to the UFD R&D Campaign annual meeting in June 2016**
  - Principal investigators from 5 projects attended and presented their work
  - Interactions were positive, and continued NEUP participation will be encouraged in coming years
    - Note that not all UFD-relevant NEUP projects map one-to-one to ongoing UFD R&D activities

Overview of FY17 Planning

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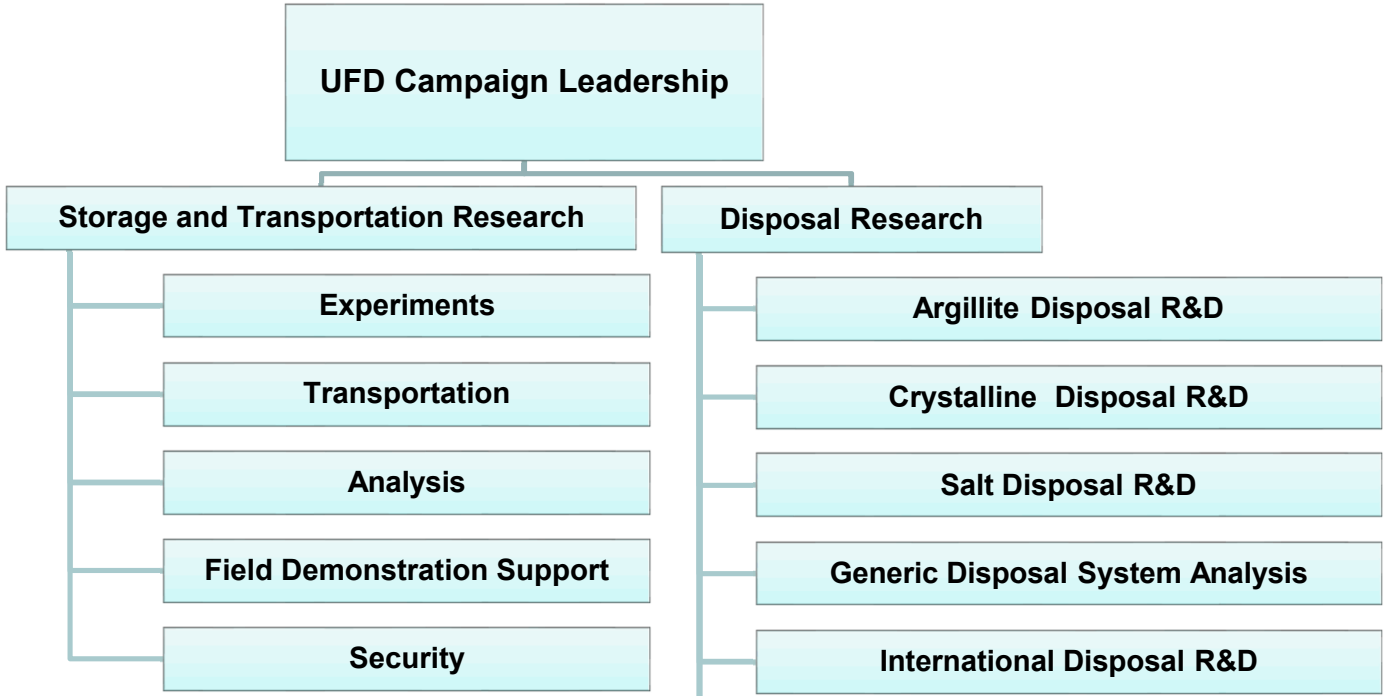
UFD R&D Campaign Structure 1.02.08.01 through 1.02.08.03



High-burnup Confirmatory Data Project (industry-led, managed directly by DOE in 1.02.08.04)

Deep Borehole Field Test (procurement managed directly by DOE in 1.02.08.03)

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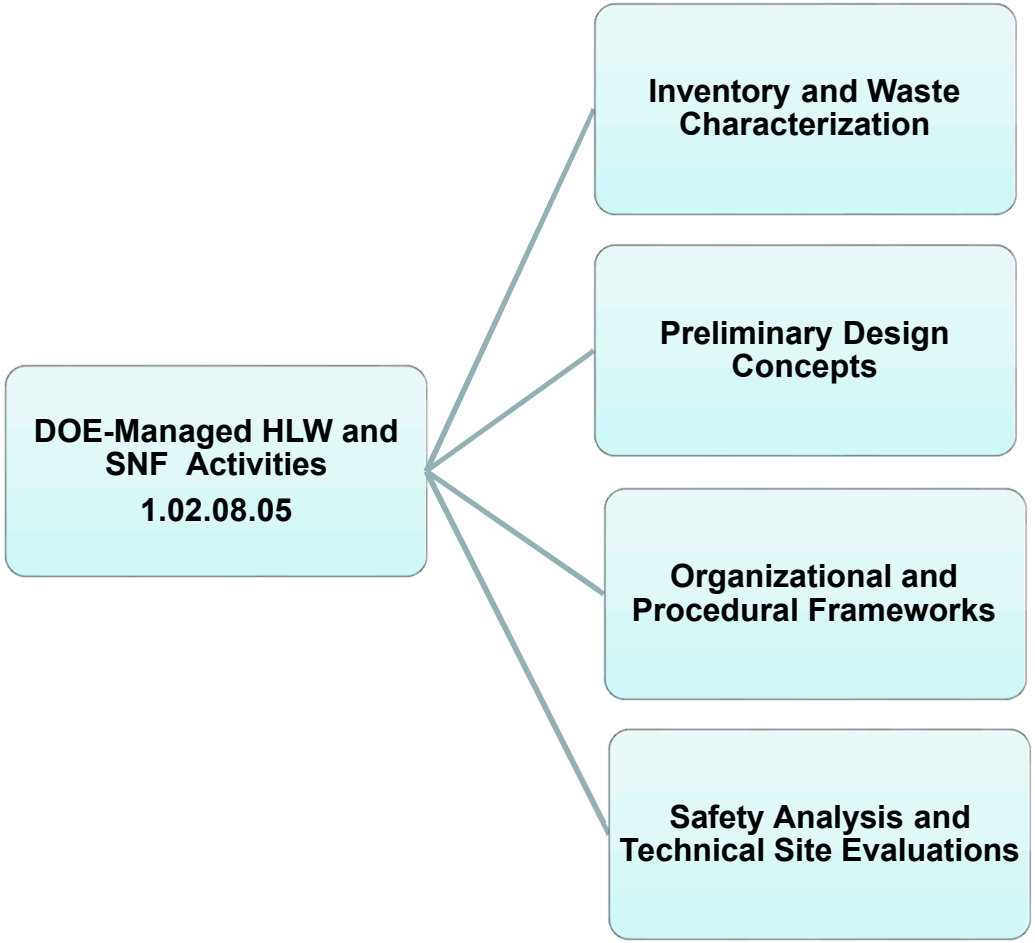
DOE-Managed HLW and SNF Research (1.02.08.05)



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Comparing the President's FY17 Budget Request with the House and Senate Bills

	FY 2015	FY 2016	FY 2017						
	Current	Enacted	Request	House Subcommittee (4/13/16)	Delta		SAC (4/14/16)	Delta	
Used Nuclear Fuel Disposition	70,224	85,000							
UNFD R&D	[47,724]	[62,500]	74,338	61,128	(13,210)	D/		(74,338)	d/
Integrated Waste Management System	[22,500]	[22,500]	76,300	0	(76,300)	E/	61,050	(15,250)	
Unallocated	0	0	0	8,000	8,000		89,290	89,290	
Fuel Cycle R&D	**191,242**	**203,800**	**249,938**	**177,228**	**(72,710)**		**219,730**	**(30,208)**	

All amounts are "Pre-tax": historically, approx. 20% of the NE R&D budget has gone to University programs and 10% to other HQ programs

HOUSE NOTES

D/ $6M for rail cars, $12M for high burnup fuel

E/ Hard Zero

SENATE NOTES

d/ includes 14.25M for long term storage R&D (?)

050 - Defense Function Funding within Request

Dollars in Thousands

	FY 2015	FY 2016	FY 2017						
	Current	Enacted	Request	House Subcommittee (4/13/16)	Delta		SAC (4/14/16)	Delta	
050 Funding									
Fuel Cycle R&D - UNFD - IWMS	4,500	-	15,260	**0**	**(15,260)**		**0**	**(15,260)**	

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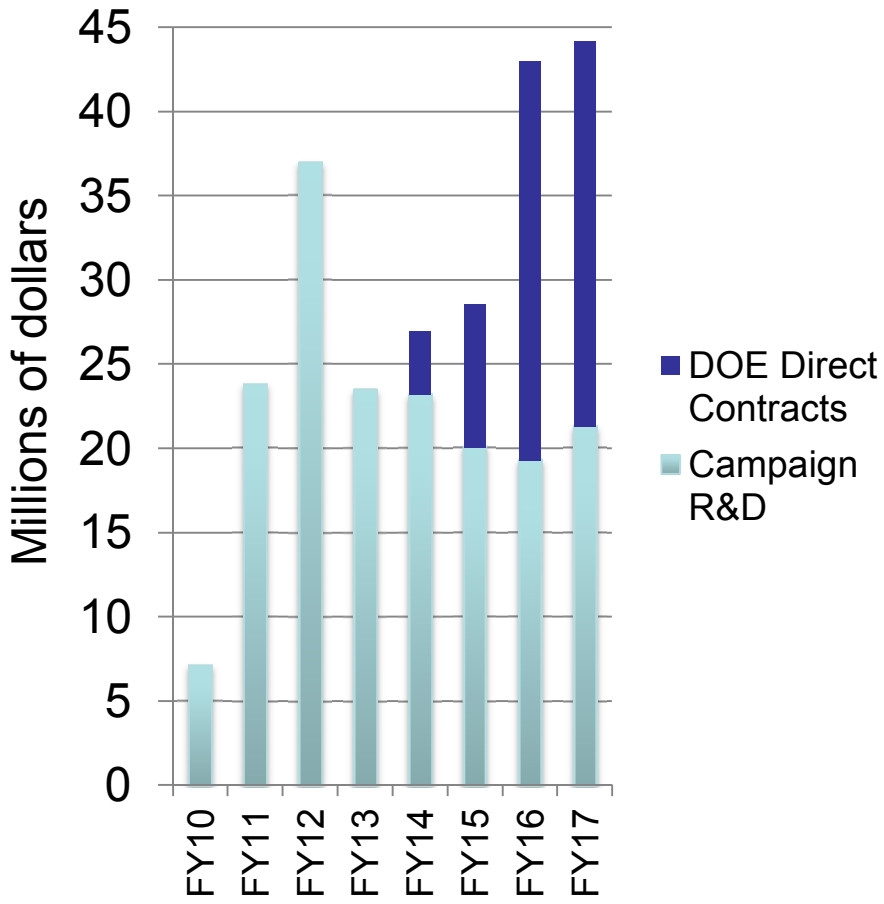
UFD R&D Funding 2010-2017

- FY09: UFD R&D Planning meeting at ANL June 2009
- FY11: Storage and Transportation R&D added
- FY12: Temporary funding increase
- FY13: Formation of NFST
- FY14-FY16: increasing importance of industry contracts for large-scale R&D projects
  - High-Burnup Data Project
  - Deep Borehole Field Test
- FY17 (proposed)
  - includes $4.5M for DOE HLW/SNF

Approximate total funding for UFD R&D
(including DOE-managed HLW and SNF R&D in FY16 and FY17)



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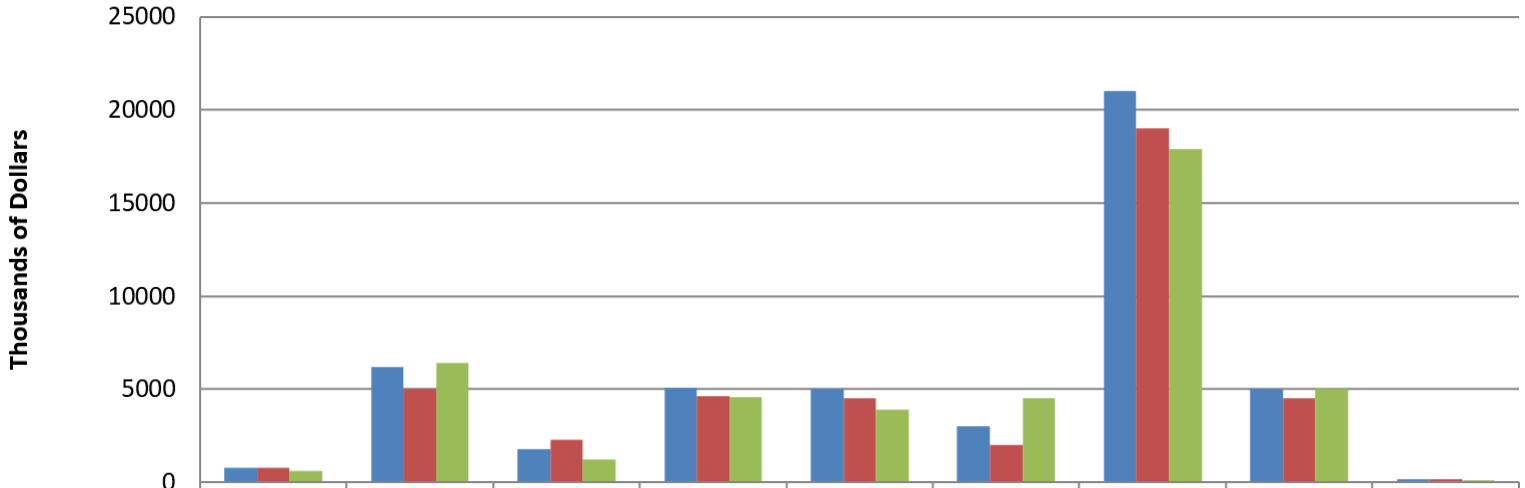
FY17 Planning Targets

- **NE-5 Planning guidance for FY17**
  - Total for UFD R&D including industry contracts is $39.7M
  - Total for DOE-Managed HLW/SNF R&D is $4.5M
- **Guidance at the work package level will come from control account managers**

FY16 versus FY17 Planning Targets



	Campaign Management	Storage and Transport w/o Cask Demo Support	Storage and Transport Cask Demo Support	Disposal Research w/o Deep Borehole	Deep Borehole Research	DOE-managed HLW and SNF Research	DOE Deep Borehole Direct	Industry Storage Cask Data	DOE Fees for International Collaboration
FY16 Baseline	800	6200	1800	5035	5000	3000	21000	5000	190
FY16 Replan	800	5000	2300	4620	4500	2000	19000	4500	190
FY17 Targets	600	6432	1200	4555	3912	4500	17878	5000	123

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Proposed FY17 UFD R&D Campaign Control Account Structure

Focus Area	Control Accounts	Proposed FY17 Funding
Campaign Management and Integration	**Management and Integration**	**600k**
Storage and Transportation Research (ST)		**7632k**
	Experiments [1]	3425k
	Transportation	2825k
	Analysis	150k
	Field Demonstration Support [1]	1200k
	Security	32k
Disposal Research (DR)		**8590k**
	Argillite Disposal R&D	1200k
	Crystalline Rock Disposal R&D	1230k
	Salt Disposal R&D	1010k
	Generic Disposal System Analysis	575k
	International Research Coordination [2]	488k
	Dual Purpose Canister Disposal R&D	175k
	Deep Borehole Field Test	3912k

[1] Proposed Campaign Total for FY17 $16.8 M

13 Control Accounts

[1] $1.2M in Field Demo Support includes $1M from Experiments. Experiments total is $4.425M with $1M showing in Field Demo Support
[2] $16.8M total includes 123k set aside to pay international membership fees associated with Disposal Research

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Summary of Proposed FY17 UFD Control Accounts at $39.7 M Target

CONTROL ACCOUNT	ANL	INL	LANL	LBNL	LLNL	ORNL	PNNL	SNL	SRNL	DOE	FY 17 Total	FY 16 Re-Plan	Change from FY16 Re-Plan
Campaign Management & Integration	0	0	0	0	0	0	0	600	0		600	800	-200
ST Experiments	500	0	0	0	0	2500	650	700	75		4425	3400	1025
ST Transportation	0	0	0	0	0	50	700	2000	75		2825	800	2025
ST Analysis	0	0	0	0	0	50	100	0	0		150	775	-625
ST Field Demonstration Support	0	50	0	0	0	50	50	0	50		200	2300	-2100
ST Security	0	0	0	0	0	0	0	32	0		32	25	7
DR Argillite Disposal R&D	45	0	250	490	85	0	0	330	0		1200	1285	-85
DR Crystalline Disposal R&D	45	0	310	160	215	0	0	500	0		1230	1315	-85
DR Salt Disposal R&D	0	0	285	161	0	0	0	564	0		1010	1100	-90
DR Generic Disposal System Analysis	0	0	0	0	0	0	0	575	0		575	560	15
DR International Research Coordination	0	0	0	350	0	0	0	15	0	123	488	520	-32
DR Dual Purpose Canister R&D	0	0	0	0	0	175	0	0	0		175	220	-45
DR Deep Borehole Field Test	0	119	632	474	0	222	160	2305	0		3912	4500	-588
DR Deep Borehole Field Test Site Mgmt & Drilling Svcs (DOE)										17000	17000	18000	-1000
DR Deep Borehole Field Test Engineering Services Contract (DOE)										878	878	1000	-122
DOE/EPRI Storage Demonstration										5000	5000	4500	500
Management & Integration	0	0	0	0	0	0	0	600	0		600	800	-200
Storage and Transportation	500	50	0	0	0	2650	1500	2732	200		7632	7300	332
Disposal Research	90	119	1477	1635	300	397	160	4289	0		8590	9310	-720
Total	590	169	1477	1635	300	3047	1660	7621	200	23001	39700	41100	-1400

Summary of FY17 L2 Milestones

- **Storage and Transportation Research**
  - Experiments
    - Documentation of analysis of data collection of Lower Temp Ring Compression Tests (ANL, 8/30/17)
    - Documentation of analysis of non-destructive tests on sister pins (ORNL, 9/15/2017)
    - Stress corrosion cracking final report (SNL, 8/30/2017)
  - Transportation
    - Initial test report for full-scale rail cask Normal Conditions of Transport tests (SNL, 9/30/2017)
  - Analysis
    - Thermal analysis report for one dry cask design (PNNL, 7/28/2017)
- **Disposal Research**
  - Argillite Disposal R&D
    - Evaluation of Used Nuclear Fuel Disposition in Clay-bearing Rocks (SNL, 9/15/2017)
  - Crystalline Disposal R&D
    - Evaluation of Used Nuclear Fuel Disposition in Crystalline Rocks (SNL, 9/22/2017)

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Summary of FY17 L2 Milestones (cont.)

- **Disposal Research (cont.)**
  - Salt Disposal R&D
    - Proceedings from the 7th US/German Workshop on Salt Mechanics and Repository Design, (August 31, 2017, SNL).
  - Generic Disposal System Analysis
    - Generic Disposal System Model Development and Reference Case Applications (SNL, 09/22/2016)
  - International Research Coordination
    - International Collaboration Activities in Different Geologic Disposal Environments (LBNL, 9/28/2017)
  - Deep Borehole Field Test
    - DBFT Conceptual Design Report (incorporates design reviews, priority analyses, and borehole construction alternatives) (SNL, 08/31/2017)
    - Deep Borehole Disposal Safety Analysis (DOE, 09/08/2017)
    - Integrated Geoscience Data and Evaluation of Geologic Conditions for DBFT Site (SNL 09/15/2017)
    - Laboratory and Borehole Testing Strategy (SNL, 09/29/2017)

14 Proposed Level 2 Milestones in UFD R&D Campaign for FY17

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FY17 Control Account Planning Package Detail

UFD Management & Integration

OBJECTIVES:

- Provide program management, integration, and technical support for the Used Fuel Disposition Campaign. Provide technical coordination for UFDC R&D efforts at participating laboratories under the FCR&D Program.
- Interact with the Nuclear Energy Advisory Committee, the Nuclear Waste Technical Review Board, and other internal and external review and advisory groups as needed. Support DOE NE University Programs as needed.

SCOPE:

- NTD labor
- Admin and technical staff support labor
- Project controls support labor
- Travel
- CAM Labor to support campaign-level planning & management

LAB SPLITS:

ANL	INL	LANL	LBNL	LLNL	ORNL	PNNL	SNL	SRNL	Total
0	0	0	0	0	0	0	600	0	600

LEVEL 2 MILESTONES: none

CHANGE FROM FY16: Decreased by $200k

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UFD Storage and Transportation Research
Experiments

OBJECTIVES:

Conduct separate effects tests and small-scale tests that have been identified in the Used Nuclear Extended Storage and Transportation Research and Development Review and Plan (FCRD-UFD-2014-000050). Develop data necessary to further understand fundamental materials degradation issues associated with components (including the fuel) of long-term storage systems (including the baseline sister pin testing) and subsequent transportation of used nuclear fuel. This data also serves an important benchmarking function for the validation and verification of predictive models.

SCOPE:

Support measurement of data to determine the Ductile-Brittle Transition Temperature (DBTT) for various high burnup cladding materials lower temperatures (e.g., 350º C); conduct in-cell bend tests on lower burnup sections of high burnup spent fuel and conduct cumulative effects testing in NCT fatigue cycles; Conduct non-destructive tests on sister pins; conduct SCC investigations on full-scale (diameter) mockup in collaboration with industry and support ASME committee work on SCC, conduct thermo-hydraulic testing of a full-scale BWR surrogate assembly at pressures and temperatures relevant to existing licensed dry storage canister designs.

LAB SPLITS:

ANL	INL	LANL	LBNL	LLNL	ORNL	PNNL	SNL	SRNL	Total
500	0	0	0	0	2500	650	700	75	4425

LEVEL 2 MILESTONES:

- Documentation of data collection of Lower Temp RCT tests (ANL, 8/30/2017)
- Documentation of non-destructive tests on sister pins. (ORNL, 9/15/2017)
- Stress corrosion cracking final report. (SNL, 9/30/2017)

CHANGE FROM FY16: Increase of $925k

UFD Storage and Transportation Research
Transportation

OBJECTIVES:

Assess the retrievability of used fuel after long term storage and evaluate the ability to transport high-burnup fuel.

1. Extend the truck and rail Normal Conditions of Transport loading investigations to planning for a full-scale rail test plan.
2. Integrate results of high burnup rod testing at ORNL, assembly modeling at PNNL, and assembly testing at SNL to strengthen the technical justification for eventual UNF transport.

SCOPE:

- Continue Normal Conditions of Transport (NCT) analysis efforts, focused on conducting a full-scale rail test. Activities include working with ENSA to instrument and conduct heavy-haul truck, coastal shipment, ocean shipment, rail shipment and test track tests at TTCI to obtain a library of rail shock and vibration loading data.

LAB SPLITS:

ANL	INL	LANL	LBNL	LLNL	ORNL	PNNL	SNL	SRNL	Total
0	0	0	0	0	50	700	2000	75	2825

LEVEL 2 MILESTONES:

M2: Initial test report for full-scale rail cask Normal Conditions of Transport tests (SNL, 9/30/2017)

CHANGE FROM FY16: Increase of $1925K

UFD Storage and Transportation Research
Analysis

OBJECTIVES:

Conduct analyses, integrate experimental data, and develop the technical basis for extended long term storage and subsequent transportation of nuclear used fuel. Provide thermal and mechanical computations for operational conditions related to long term storage and subsequent transportation of used nuclear fuel. In addition, develop separate phenomenological models to predict behavior of specific high priority gap technical issues (e.g., stress corrosion cracking) that can be integrated into existing larger platform models. The experimental data obtained will provide an important benchmarking basis for justifying the predictive value of the models and analyses.

SCOPE:

- Conduct thermal analyses for NAC and TN-40 storage systems

LAB SPLITS:

ANL	INL	LANL	LBNL	LLNL	ORNL	PNNL	SNL	SRNL	Total
0	0	0	0	0	50	100	0	0	150

LEVEL 2 MILESTONES:

- Thermal analysis report on dry cask storage systems (PNNL, 7/28/2017)

CHANGE FROM FY16: Decrease of $1200k

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UFD Storage and Transportation Research
Field Demonstration Support

OBJECTIVES:

Support the successful implementation of the DOE/EPRI High Burnup Spent Fuel Data Project and associated R&D to support the project. The lab support is focused on technical interactions with the DOE and DOE contractor team, assessing the balance between advancing the science of storage with licensing risk, support Sister Pin Test Plan development of baseline experiments, evaluation of sensor and monitoring technologies to support data collection for the demonstration project, and interfacing on a regular basis with the NRC on the technical aspects of the project.

SCOPE:

Scope includes identification and sequencing of required near-term testing, facility capabilities and necessary up-grades, planning for loading the demo cask, in-service inspection, and integration of near-term testing with confirmatory in-situ monitoring and inspection. This work will include collaboration with industry on obtaining and analyzing in-situ environmental data associated with used fuel SS canister corrosion and stress corrosion cracking, including ultrasonic testing.

LAB SPLITS:

ANL	INL	LANL	LBNL	LLNL	ORNL	PNNL	SNL	SRNL	Total
0	50	0	0	0	50	50	0	50	200

LEVEL 2 MILESTONES: none

CHANGE FROM FY16: Decrease of $1900k

UFD Storage and Transportation Research
Security

OBJECTIVES:

Assess the impact of the spent fuel security during transportation, as well as how material attractiveness issues affect physical protection strategies and requirements. Coordinate with the MPACT campaign and NFST on security issues associated with storage.

SCOPE:

Collaborate with DOE and NRC subject matter experts regarding security of extended storage and subsequent transportation of UNF. Continue to assess the impact of NRC rule-making with regards to security implications for commercial spent fuel storage and transportation.

LAB SPLITS:

ANL	INL	LANL	LBNL	LLNL	ORNL	PNNL	SNL	SRNL	Total
0	0	0	0	0	0	0	32	0	32

LEVEL 2 MILESTONES: none

CHANGE FROM FY16: Decrease of $118k

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UFD Disposal Research
Argillite Disposal R&D

OBJECTIVES:

Work activities in this control account address the long-term thermal, hydrological, chemical, and physical behavior of used nuclear fuel in the near- and far-field of argillite disposal concepts.

SCOPE:

- Evaluate Thermal/Hydrological/Mechanical/Chemical (THMC) processes in the near- and far-field, including backfilled engineered and natural barrier systems (EBS/NBS) materials relevant to argillite disposal environment for used nuclear fuel.
- Development of thermodynamic databases (ambient and elevated temperatures) for EBS/NBS materials and their implementation in various modeling efforts such as chemical equilibria, sorption, and reactive transport.
- Conduct experimental work on waste package material degradation and interaction with clay to inform EBS/NBS chemical and transport models.
- Support close integration of R&D activities with GDSA for development of PA modeling for disposal in argillite.
- Coordinate the scope, activities, and results for use across the UFD and integrate such efforts with those in other UFD DR and ST work activities.
- International collaboration: SKB Task Force (EBS), FEBEX-DP, CI (Mont Terri)

LAB SPLITS:

	ANL	INL	LANL	LBNL	LLNL	ORNL	PNNL	SNL	SRNL	Total
Argillite	45	0	250	140	85	0	0	260	0	780
International	0	0	0	350	0	0	0	70	0	420
Total	**45**	**0**	**250**	**490**	**85**	**0**	**0**	**330**	**0**	**1200**

LEVEL 2 MILESTONE:

Evaluation of Used Nuclear Fuel Disposition in Clay-Bearing Rocks (SNL, 9/15/2017)

CHANGE FROM FY16: Decrease of $200K

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UFD Disposal Research
Crystalline Disposal R&D

OBJECTIVES:

Work activities in this control account address the long-term thermal, hydrological, chemical and physical behavior of used fuel in the near and far field of crystalline rock disposal concepts.

SCOPE:

- Model fluid flow and transport in fractured crystalline rocks to demonstrate the potential application of a discrete fracture network model to actual field testing data obtained from international collaborations
- Evaluate THMC behaviors in clay-based backfill and buffer materials and develop THMC modeling capabilities to assess engineered barrier system (EBS) responses to different temperatures and pressures; evaluate impacts of the interaction between EBS and crystalline host rock.
- Conduct experimental investigation of radionuclide interactions with natural and engineered materials in a crystalline disposal environment, and develop process models, informed by observations, that can be readily incorporated into field-scale radionuclide transport models.
- Support the development of a total system performance assessment model for a generic crystalline repository and ensure close integration with other work packages.
- International collaboration: DECOVALEX, KAERI, BRIE

LAB SPLITS:

	ANL	INL	LANL	LBNL	LLNL	ORNL	PNNL	SNL	SRNL	Total
R&D	45	0	160	160	105	0	0	270	0	740
International	0	0	150	0	110	0	0	230		490
TOTAL	**45**	**0**	**310**	**160**	**215**	**0**	**0**	**500**	**0**	**1230**

LEVEL 2 MILESTONE:

Evaluation of Used Nuclear Fuel Disposition in Crystalline Rocks (SNL, 9/22/2017)

CHANGE FROM FY16: Decrease of $265k

UFD Disposal Research
Salt Disposal R&D

OBJECTIVES:

2017 salt disposal R&D focuses on mechanical properties of salt, mechanisms of radionuclide transport in salt, and modeling of coupling of thermal, mechanical, hydrological, and chemical processes.

SCOPE:

- Experimental investigations of chemistry issues for heated salt and high-level waste
- Experimental investigations of the transport properties of salt and salt mixed with clay.
- Experimental investigations of the mechanical properties of salt
- Benchmark testing of thermal, mechanical, hydrological, and chemical coupled process models
- International collaboration: US/German salt host-rock repository collaborations in research, design and operations (200k)

LAB SPLITS:

	ANL	INL	LANL	LBNL	LLNL	ORNL	PNNL	SNL	SRNL	Total
R&D	0	0	285	100	0	0	0	364	0	810
International	0	0	0	0	0	0	0	200	0	200
TOTAL	**0**	**0**	**285**	**161**	**0**	**0**	**0**	**564**	**0**	**1010**

LEVEL 2 MILESTONES: Proceedings from the 7th US/German Workshop on Salt Mechanics and Repository Design, *(*August 31, 2017, SNL).

CHANGE FROM FY16: Decrease of $240k (when combined with FY16 control account for Salt Field Test)

U.S. DEPARTMENT OF ENERGY
Nuclear Energy

UFD Disposal Research
Generic Disposal System Analysis

OBJECTIVES:

Develop a disposal system modeling and analysis capability that supports the prioritization of Disposal Research (DR) R&D and the evaluation of disposal system performance, including uncertainty, for a range of disposal options (e.g., salt, argillite, crystalline, deep borehole). The system-level modeling capability will: integrate updated conceptual models of subsystem processes and couplings developed under this and other DR work packages; be used to evaluate DR R&D priorities; leverage existing computational capabilities (e.g., meshing, visualization, high-performance computing (HPC)) where appropriate; and be developed and distributed in an open source environment.

SCOPE:

- Upgrade models for baseline isotope behavior (e.g., phase-partitioning, decay, release)
- Integrate subsystem conceptual models, developed under other DR work packages, into the GDSA-PA system model architecture (e.g., colloid transport, non-Darcy flow, discrete fracture model, waste package degradation)
- Perform simulations of selected reference case demonstration problems and conduct sensitivity analyses to inform R&D planning.

LAB SPLITS:

ANL	INL	LANL	LBNL	LLNL	ORNL	PNNL	SNL	SRNL	Total
0	0	0	0	0	0	0	575	0	575

LEVEL 2 MILESTONE:

None

CHANGE FROM FY16: Decrease of 25k

U.S. DEPARTMENT OF ENERGY
Nuclear Energy

UFD Disposal Research
International Research Coordination

OBJECTIVES:

Coordinate, facilitate, and conduct international collaborative disposal research to benefit from international knowledge base with regards to various geologic disposal environments

SCOPE:

- Fees for international activities with UFD participation (e.g., Mont Terri Project, DECOVALEX Project, SKB Task Forces, FEBEX-DP) ($113k)
- Coordination and facilitation of UFD-supported R&D activities among participating national laboratories and comparable initiatives/programs outside the US ($225k)
- Support for World Wide Review Summary of international programs ($75k)
- Support for OECD-NEA RepMet project ($15k)
- Hosting of and participation in international bilateral collaborations and workshops (e.g., DECOVALEX, JFCS, KURT) ($75k)

LAB SPLITS:

ANL	INL	LANL	LBNL	LLNL	ORNL	PNNL	SNL	SRNL	DOE	Total
0	0	0	350	0	0	0	15	0	123	488

LEVEL 2 MILESTONE:

International Collaboration Activities in Different Geologic Disposal Environments (LBNL, 9/28/2017)

CHANGE FROM FY16: Decrease of $77k

U.S. DEPARTMENT OF ENERGY
Nuclear Energy

UFD Disposal Research
Disposal of Dual Purpose Canisters

OBJECTIVES:

Perform generic evaluations of the feasibility of geologic disposal of used nuclear fuel in dual-purpose storage and transportation canisters

SCOPE:

Update the UNF-ST&DARDS template repository at ORNL to include the templates representing the two stylized degradation cases for the additional PWR fuel canisters (approximately 1,000 canisters) for which new information is available from GC-859. This will include an update of the unified database with criticality calculation results. This update will include both dual-purpose canisters (DPCs) and storage-only canisters with similar weld-sealed construction, that contain PWR fuel. (The BWR fuel canisters from GC-859 will be updated at a future time when the best representation of axial burnup profiles is known.)

LAB SPLITS:

ANL	INL	LANL	LBNL	LLNL	ORNL	PNNL	SNL	SRNL	Total
0	0	0	0	0	175	0	0	0	175

LEVEL 2 MILESTONES: none

CHANGE FROM FY16: Decrease of 75k

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UFD Disposal Research
Deep Borehole Field Test (Roll-up Control Account)

OBJECTIVES:

- Plan and initiate a field test of the deep borehole disposal concept

SCOPE:

- Integrate and evaluate site geoscience data
- Develop site characterization and characterization borehole test plans
- Develop conceptual design and specifications for the field test borehole and for emplacement system testing
- Manage and integrate DBFT activities to support project goals and deep borehole disposal concept evaluation
- International: $100k at LBNL to support the Swedish BH work, $200k at SNL for Sheffield, and $100k at SNL for KAERI/KURT

LAB SPLITS:

	ANL	INL	LANL	LBNL	LLNL	ORNL	PNNL	SNL	SRNL	DOE	Total
DBFT	0	119	632	374	0	222	160	2005	0	0	3512
International				100				300			400
TOTAL	**0**	**119**	**632**	**474**	**0**	**222**	**160**	**2305**	**0**	**0**	**3912**

LEVEL 2 MILESTONES:

- DBFT Conceptual Design Report (incorporates design reviews, priority analyses, and borehole construction alternatives) (SNL, 08/31/2017)
- Deep Borehole Disposal Safety Analysis (DOE, 09/08/2017)
- Integrated Geoscience Data and Evaluation of Geologic Conditions for DBFT Site (SNL 09/15/2017)
- Laboratory and Borehole Testing Strategy (SNL, 09/29/2017)

CHANGE FROM FY16: Decrease of $1088k

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Nuclear Energy

UFD Disposal Research
Deep Borehole Field Test – Site Geoscience Data Evaluation Task

OBJECTIVES:

- Integrate existing geoscience data for the DBFT site with additional collected site characterization data to evaluate thermal-hydro-mechanical-chemical (THMC) conditions at depth.

SCOPE:

- Consolidate existing data for DBFT site geologic conditions into coherent/comprehensive representation
- Integrate additional collected site characterization data into the existing site data representation
- Evaluate the THMC conditions in the crystalline basement at the site in the context of the preferred conditions for a safe, successful disposal concept

LAB SPLITS:

ANL	INL	LANL	LBNL	LLNL	ORNL	PNNL	SNL	SRNL	DOE	Total
0	119	500	274	0	0	0	450	0	0	1343

LEVEL 2 MILESTONES:

- Integrated Geoscience Data and Evaluation of Geologic Conditions for DBFT Site (SNL 09/15/2017)

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UFD Disposal Research
Deep Borehole Field Test – Site Characterization Task

OBJECTIVES:

- Develop plans, supported by process modeling, for downhole testing in the characterization borehole

SCOPE:

- Develop geomechanical and hydrological numerical models of both generic and site-specific conditions to inform (a) downhole test design, and (b) process modeling to support the system performance assessment model
- Develop testing plans for borehole and laboratory tests

LAB SPLITS:

ANL	INL	LANL	LBNL	LLNL	ORNL	PNNL	SNL	SRNL	DOE	Total
0	0	132	226	0	0	0	600	0	0	958

LEVEL 2 MILESTONES:

- Laboratory and Borehole Testing Strategy (SNL, 09/29/2017)

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Nuclear Energy

UFD Disposal Research
Deep Borehole Field Test – Field Test Engineering Task

OBJECTIVES:

- Develop conceptual design and specifications for the field test borehole and for emplacement system testing

SCOPE:

- Complete engineering reviews of waste package and emplacement system concepts
- Perform additional priority engineering analyses focusing on important mechanisms including the sinking velocity for conceptual package designs
- Identify and evaluate alternative concepts for disposal borehole construction (including casing type, cementing, construction and emplacement fluids, and support matrices), and determine the implications for the DBFT
- Issue a conceptual design report that includes the FY15 conceptual design documentation, input from the FY15 expert panel and the engineering services support contractor, and input from the priority engineering analyses

LAB SPLITS:

ANL	INL	LANL	LBNL	LLNL	ORNL	PNNL	SNL	SRNL	DOE	Total
0	0	0	0	0	222	0	639	0	0	861

LEVEL 2 MILESTONES:

- DBFT Conceptual Design Report (incorporates design reviews, priority analyses, and borehole construction alternatives) (SNL, 08/31/2017)

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UFD Disposal Research
Deep Borehole Field Test – Project Integration and Concept Evaluation

OBJECTIVES:

- Manage and integrate DBFT activities being performed by multiple organizations to support DBFT project goals and deep borehole disposal concept evaluation.

SCOPE:

- Manage and integrate DBFT activities including: site characterization and data evaluation, modeling, technical coordination with industry contractors, legal and regulatory requirements, quality assurance, and scheduling
- Develop a system performance assessment model to support test design and concept evaluation
- Characterize DOE-managed waste forms and canisters

LAB SPLITS:

ANL	INL	LANL	LBNL	LLNL	ORNL	PNNL	SNL	SRNL	DOE	Total
0	0	0	0	0	0	150	600	0	0	750

LEVEL 2 MILESTONES:

- Deep Borehole Disposal Safety Analysis (DOE, 09/08/17)

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UFD Disposal Research
Collaborative International Research (not a separate control account)

OBJECTIVES:

Engage in collaborative disposal research with international partners. Work is funded and managed through the relevant campaign control accounts (e.g., Argillite, Crystalline, Salt Disposal R&D and Deep Borehole Disposal), and uses cooperative agreements established and maintained through the International Research Coordination control account.

SCOPE:

- Argillite: Thermal/hydrologic/mechanical modeling of behavior of clay, collaborative modeling of EBS behavior (DECOVALEX, Mont Terri and Horonobe), (420k in Argillite Disposal R&D)
- Crystalline: Modeling of the evolution of clay buffer materials in crystalline media (Sweden "BRIE" test, FEBEX-DP), Colloid transport tests and modeling in fractured crystalline rock (CFM test at Grimsel, Switzerland); DECOVALEX modeling studies; Studies related to SKB Task Forces; Testing at KAERI Underground Research Tunnel (KURT). (490k in Crystalline Disposal R&D)
- Salt: International collaborations with Germany including salt core testing and thermo-mechanical model benchmark testing (200k in Salt Disposal R&D)
- Deep Borehole: LBNL to support the Swedish BH work, $200k at SNL for Sheffield and $100k at SNL for KAERI/KURT (400k in Deep Borehole Field Test)

LAB SPLITS:

	ANL	INL	LANL	LBNL	LLNL	ORNL	PNNL	SNL	SRNL	Total
Argillite	0	0	0	350	0	0	0	70	0	420
Crystalline	0	0	150	0	110	0	0	230	0	490
Salt	0	0	0	0	0	0	0	200	0	200
Deep Borehole	0	0	0	100	0	0	0	300	0	400
TOTAL	**0**	**0**	**150**	**450**	**110**	**0**	**0**	**800**	**0**	**1510**

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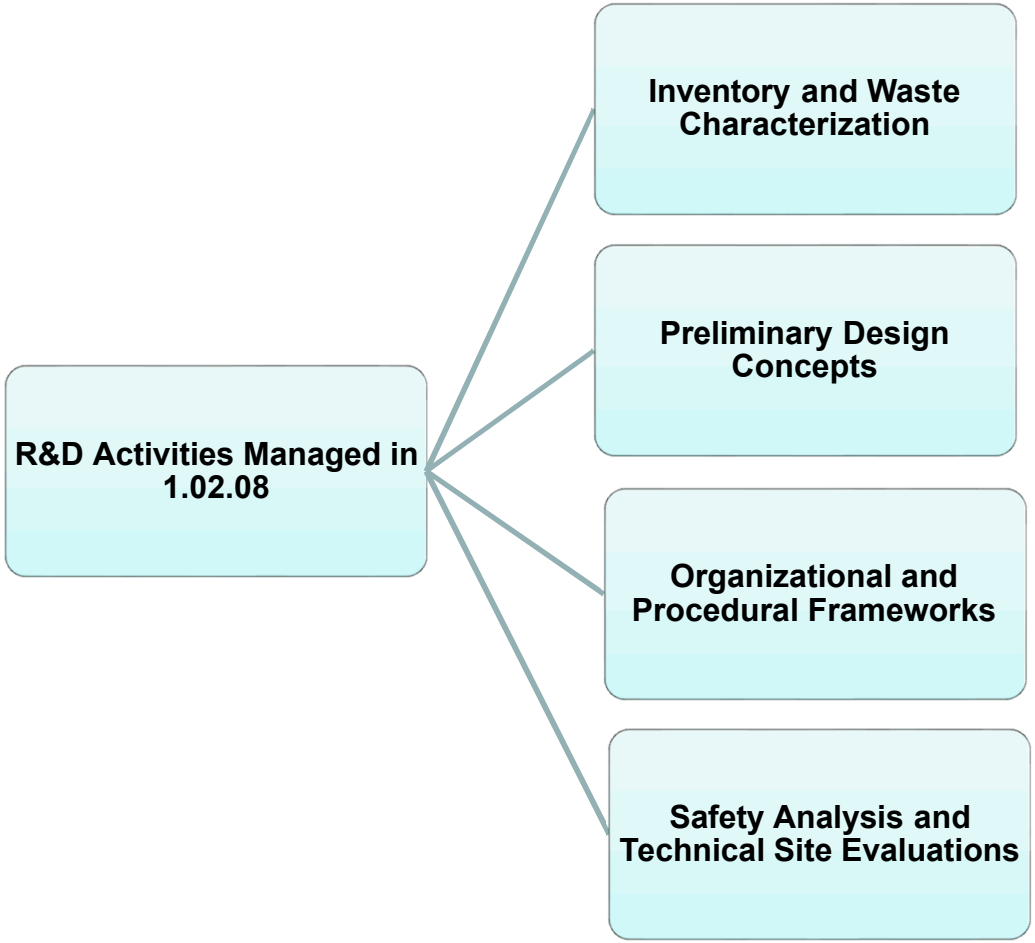
DOE-Managed HLW and SNF Research



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DOE Managed HLW and SNF Research: *Proposed FY17 Control Accounts and Work Packages at $4.5 M Target*

		FY 16		FY17	
DOE Managed HLW & SNF Research Activities		**Target**	**Re-Plan**	**Target**	**NOTES:**
INVENTORY & WASTE CHARACTERIZATION					
SRNL	Organize information needed for repository design assessments	50	33	70	These work activities will be merged into
SNL	Organize information needed for repository design assessments	20	13	45	one work activity in FY17 entitled
SNL	Update inventories for any D-wastes not included in Disposal Options work	30	20	45	*"Organize, Update and Populate Online Waste*
SNL	Complete and populate online waste library (OWL)	150	100	250	*Library (OWL) for DOE Managed HLW & SNF Inventory"*
SNL	Characterization of alternative waste form long-term performance	200	133	310	
PNNL	Characterization of alternative waste form long-term performance			100	
INVENTORY & WASTE CHARACTERIZATION TOTAL		**450**	**299**	**820**	
PRELIMINARY DESIGN CONCEPTS					
SRNL	EBS Concepts & Thermal Analysis	50	33	70	
SNL	EBS Concepts & Thermal Analysis	180	120	270	
SNL	Disposal Overpack & waste package options	180	120	270	
SNL	Repository layout and waste package emplacement	20	15	100	
	Repository sealing systems				
	Repository ventillation				
PRELIMINARY DESIGN CONCEPTS TOTAL		**430**	**288**	**710**	
ORGANZATIONAL & PROCEDURAL FRAMEWORKS					
SNL	Program planning	80	80	135	
SNL	Organizational framework to meet regulator expectations	380	306	350	
SNL	Develop and implement operating procedures	370	200	400	
SNL	Interactions with regulator	50	0	70	
ORGANZATIONAL & PROCEDURAL FRAMEWORKS TOTAL		**880**	**586**	**955**	
SAFETY ANALYSIS & TECHNICAL SITE EVALUATION					
LANL	FEPS Analysis	100	67	180	
LANL	Preliminary regional geology evaluation	180	120	180	
SNL	Complete reference cases for each geolgic media	220	147	350	
SNL	FEPS Analysis	220	147	350	
SNL	Define generic safety/performance objectives	80	0	180	
SNL	Evaluation of alternative EBS concepts	180	173	300	
SNL	Total system performance assessment	180	173	300	
SNL	Documentation of preliminary technical site evaluation plan	80	0	175	
SAFETY ANALYSIS & TECHNICAL SITE EVALUATION TOTAL		**1240**	**827**	**2015**	
D-REP TOTAL		**3000**	**2000**	**4500**	

U.S. DEPARTMENT OF ENERGY
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DOE Managed HLW and SNF Research: Summary of FY17 L2 Milestones

- **Inventory and Waste Characterization**
  - Inventory and Waste Characterization Status Report (SNL, 9/22/2017)
- **Preliminary Design Concepts for the Inventory in Select Media**
  - Preliminary Design Concepts Status Report (SNL, 9/22/2017)
- **Organizational and Procedural Frameworks**
  - Organizational and Procedural Frameworks Status Report (SNL, 9/22/2017)
- **Safety Analysis and Technical Site Evaluations**
  - Safety Analysis and Technical Site Evaluation Status Report (SNL, 09/22/2017)

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DOE Managed HLW and SNF Research: *Inventory and Waste Characterization*

OBJECTIVES:

Work activities in this control account address the technical elements necessary to delineate the inventories of waste forms for disposal and their expected behavior in various disposal concepts.

SCOPE:

- Organize and coordinate information on both waste forms to be disposed and repository concepts for disposal to inform safety assessments
- Develop a listing and inventory of DOE-managed HLW and SNF radioactive wastes which were assessed in the disposal options evaluation work and identify any additional waste forms to be added
- The on-line waste library will be constructed for information on DOE-managed HLW, SNF, and other wastes that are potential candidates for deep geologic disposal, with links to supporting documents
- Characterize long-term performance of alternative waste forms

FUNDING:

	FY 16		FY17
DOE Managed HLW & SNF Research Activities	Target	Re-Plan	Target
INVENTORY & WASTE CHARACTERIZATION TOTAL	450	299	820

LEVEL 2 MILESTONE:

Inventory and Waste Characterization Status Report (SNL, 9/22/2017)

CHANGE FROM FY16: Increase of $370k

U.S. DEPARTMENT OF ENERGY
Nuclear Energy

DOE Managed HLW and SNF Research: *Preliminary Design Concepts for the Inventory in Select Media*

OBJECTIVES:

Work activities in this control account address the technical elements necessary to evaluate the preliminary design concepts for the inventory within select media. Specific geologic media under consideration are those currently investigated within the Used Fuel Disposition Campaign (argillite, crystalline, deep borehole, and salt).

SCOPE:

- Assess feasibility and applicability of Engineered Barrier Systems (EBS) concepts in select geologic media for the technical challenges specific to the inventory. A particular emphasis will be placed on analyzing thermal conditions and their effect on the inventory's compatibility with EBS concepts/disposal media.
- Investigate and evaluate options for both disposal over-pack and waste package design.

FUNDING:

	FY 16		FY17
DOE Managed HLW & SNF Research Activities	Target	Re-Plan	Target
PRELIMINARY DESIGN CONCEPTS TOTAL	430	288	710

LEVEL 2 MILESTONE:

Preliminary Design Concepts Status Report (SNL, 9/22/2017)

CHANGE FROM FY16: Increase of $280k

U.S. DEPARTMENT OF ENERGY
Nuclear Energy

DOE Managed HLW and SNF Research: *Organizational and Procedural Frameworks*

OBJECTIVES:

Work activities in this control account address development of generic organizational and procedural frameworks aligned with DOE Managed HLW and SNF licensing efforts.

SCOPE:

- Identify the principal elements of a generic repository licensing organization infrastructure such as: information management; quality assurance; systems engineering, including associated IT infrastructure architecture needs, based on prior SNL experience
- Identify the principal operating procedures for a generic repository licensing organization: such as: information management, organizational assurance and quality assurance, based on prior SNL experience.
- Identify and initiate regulatory interactions related to organizational and procedural frameworks

FUNDING:

	FY 16		FY17
DOE Managed HLW & SNF Research Activities	**Target**	**Re-Plan**	**Target**
ORGANZATIONAL & PROCEDURAL FRAMEWORKS TOTAL	**880**	**586**	**955**

LEVEL 2 MILESTONES:

Organizational and Procedural Frameworks Status Report (SNL, 9/22/2017)

CHANGE FROM FY16: Increase of $75k

U.S. DEPARTMENT OF ENERGY
Nuclear Energy

DOE Managed HLW and SNF Research: *Safety Analysis and Technical Site Evaluations*

OBJECTIVES:

Work activities in this control account address the technical elements necessary to establish the safety case associated with select repository sites.

SCOPE:

- Complete reference cases for selected geologic media currently under investigation within the Used Fuel Disposition Campaign (argillite, crystalline, deep borehole and salt).
- Perform Features, Events and Processes (FEPS) analyses for the selected geologic media.
- Create definitions for generic safety performance objectives.
- Evaluate alternative Engineered Barrier Systems (EBS) concepts and provide testing to support the evaluations.
- Develop a total systems performance assessment (TSPA) for repositories in selected media.
- Develop a technical site evaluation plan.
- Perform regional geologic evaluations for technical site selection options.

FUNDING:

	FY 16		FY17
DOE Managed HLW & SNF Research Activities	Target	Re-Plan	Target
SAFETY ANALYSIS & TECHNICAL SITE EVALUATION TOTAL	1240	827	2015

LEVEL 2 MILESTONE:

Safety Analysis and Technical Site Evaluation Status Report (SNL, 09/22/2017)

CHANGE FROM FY16: Increase of $775k

U.S. DEPARTMENT OF ENERGY

Nuclear Energy

BACKUP: FY16 UFD Control Accounts at $41.1 M (based on re-plan Targets)

CONTROL ACCOUNT	ANL	INL	LANL	LBNL	LLNL	ORNL	PNNL	SNL	SRNL	DOE	Total
Campaign Management & Integration	0	0	0	0	0	0	0	800	0		800
ST Experiments	700	100	0	0	0	1000	450	1100	50		3400
ST Transportation	0	0	0	0	0	0	350	400	50		800
ST Analysis	0	0	0	0	0	175	350	250	0		775
ST Field Demonstration Support	0	325	100	0	0	850	575	350	100		2300
ST Security	0	0	0	0	0	0	0	25	0		25
DR Argillite Disposal R&D	50	0	280	465	90	0	50	350	0		1285
DR Crystalline Disposal R&D	45	0	310	195	250	0	50	465	0		1315
DR Salt Disposal R&D	0	0	375	120	0	0	0	605	0		1100
DR Generic Disposal System Analysis	0	0	0	0	0	0	0	560	0		560
DR International Research Coordination	0	0	0	325	0	0	0	5	0	190	520
DR Regional Geology R&D	0	0	0	0	0	0	0	0	0		0
DR Support for Disposal Options Study	0	0	0	0	0	0	0	0	0		0
DR Dual Purpose Canister R&D	0	0	0	0	0	220	0	0	0		220
DR Deep Borehole Field Test	0	135	720	540	0	270	225	2610	0		4500
DR Deep Borehole Field Test Site Mgmt & Drilling Svcs (DOE)										18000	18000
DR Deep Borehole Field Test Engineering Services Contract (DOE)										1000	1000
DOE/EPRI Storage Demonstration										4500	4500
Management & Integration	0	0	0	0	0	0	0	800	0		800
Storage and Transportation	700	425	100	0	0	2025	1725	2125	200		7300
Disposal Research	95	135	1685	1645	340	490	325	4595	0		9310
Total	795	560	1785	1645	340	2515	2050	7520	200	23690	41100