



## DOE's Collaboration and Underground Research Program: Overall Program and Approach

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Timothy C. Gunter  
Federal Program Manager, Disposal Research & Development  
Office of Spent Fuel and Waste Science and Technology  
Las Vegas, Nevada

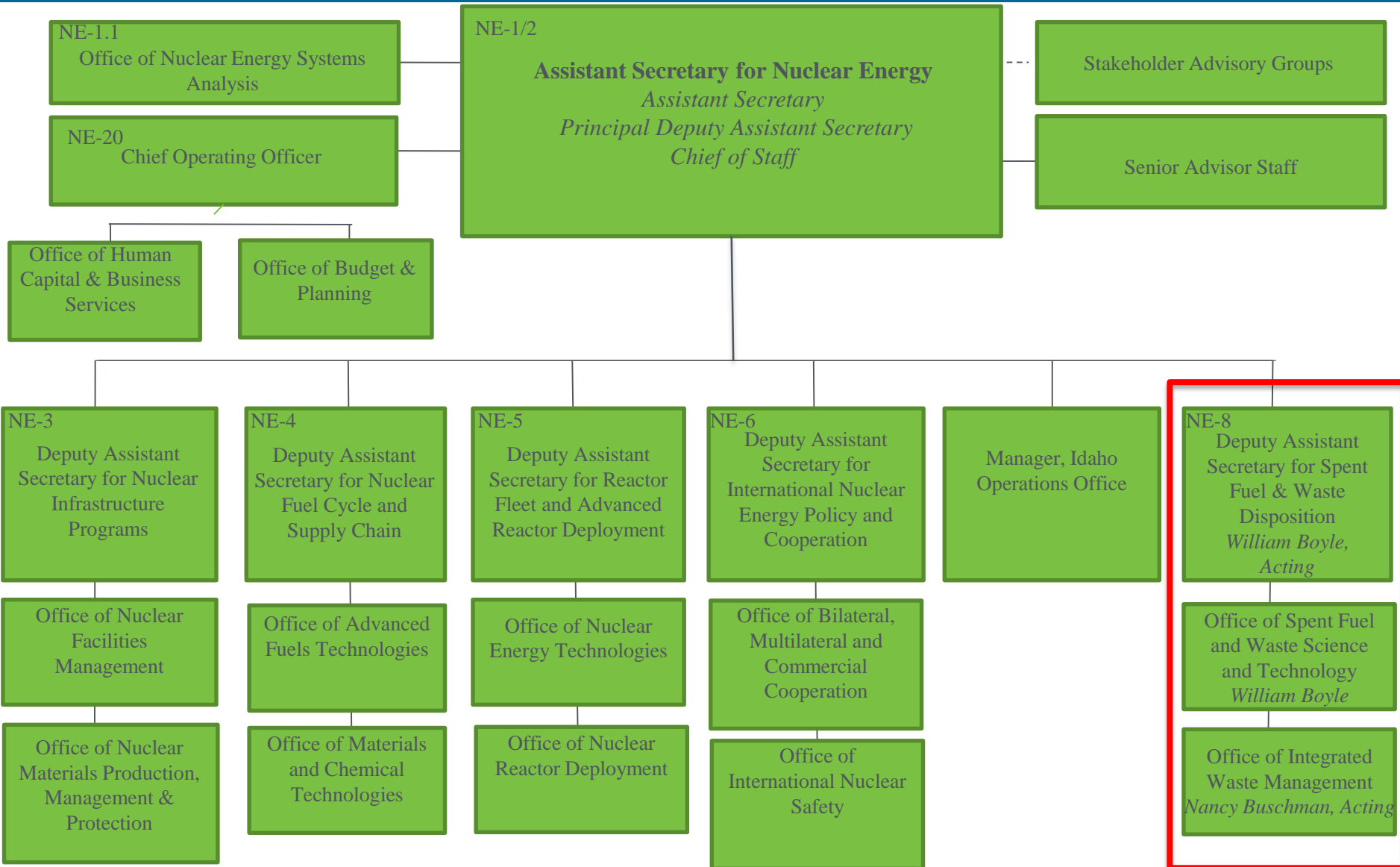
- Organizational Overview
  - Office of Nuclear Energy (NE)
  - Used Fuel Disposition (UFD) Campaign
  - Spent Fuel and Waste Science and Technology (SFWST) Campaign
- Disposal Research & Development (R&D)
- International Program and Collaborations

# DOE Office of Nuclear Energy

The primary mission of the Office of Nuclear Energy is to advance nuclear power as a resource capable of making major contributions in meeting our nation's energy supply, environmental, and energy security needs. By focusing on the development of advanced nuclear technologies, NE supports the Administration's goals of providing domestic sources of secure energy, reducing greenhouse gases, and enhancing national security.

Nuclear power remains an important part of our nation's energy portfolio, as we strive to reduce carbon emissions and address the threat of global climate change.

# DOE NE Organization



# Used Fuel Disposition (UFD) Campaign

- FY09 Planning meeting at Argonne National Laboratory, June 2009
- FY10 R&D funding at \$7.1 M
  - Disposal R&D, modest level of effort on Storage R&D, no Transportation R&D
- FY11 R&D funding at \$23.8 M
  - DOE Office of Used Nuclear Fuel Disposition R&D established in October 2010
  - Nine national laboratories participating in UFD
- FY17
  - DOE Office of Spent Fuel and Waste Disposition formally established in October 2016

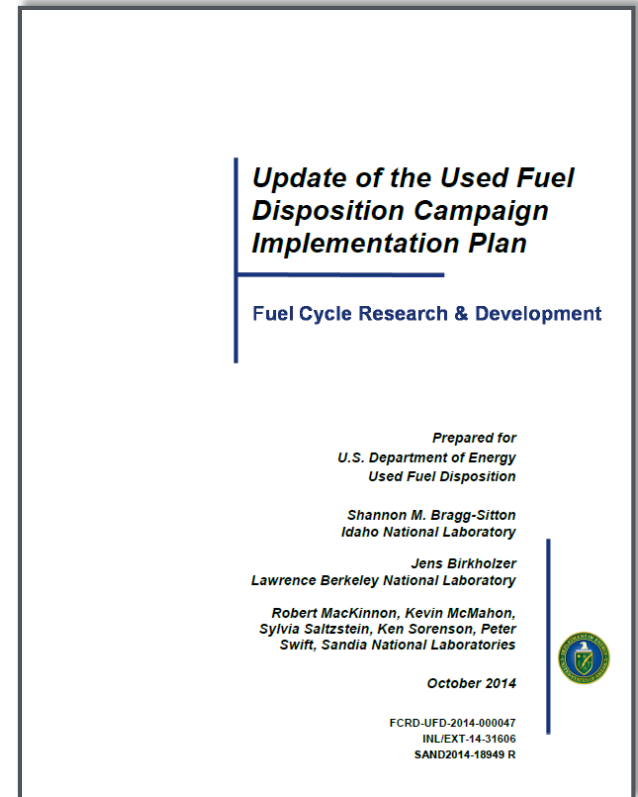


# UFD Campaign Mission

**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

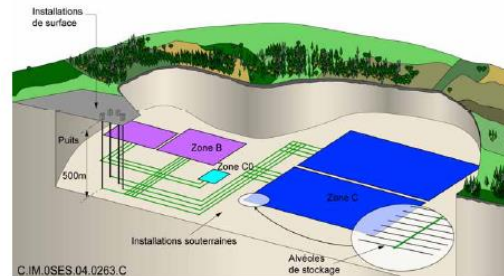


# UFD Campaign R&D

Elements of the UFD Campaign include:

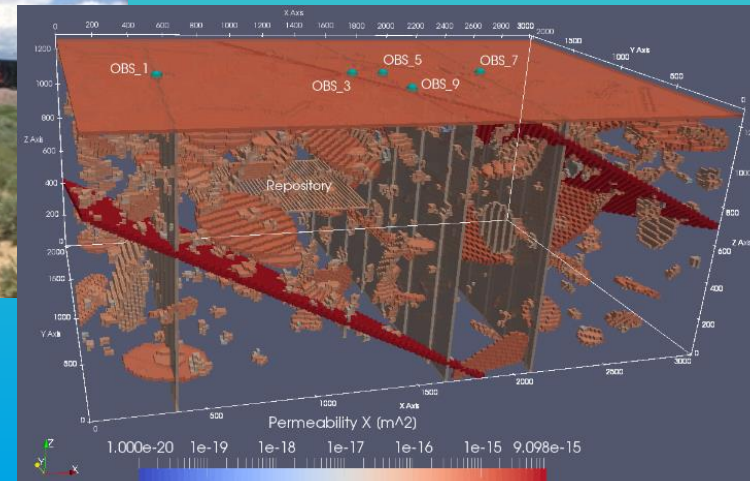


- **Storage and Transportation R&D**



- **Disposal R&D**

## Spent Fuel and Waste Science and Technology (SFWST)

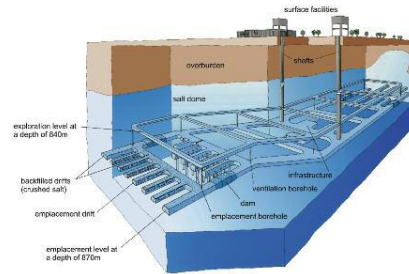


## Spent Fuel and Waste Science and Technology (SFWST) – Disposal R&D

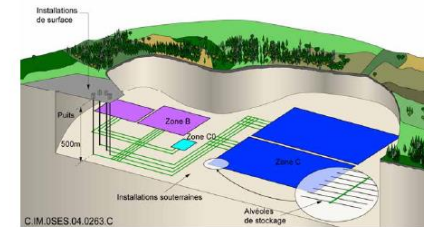


# SFWST – Disposal R&D

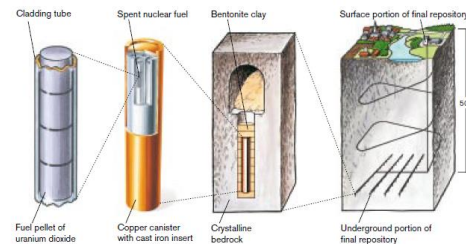
- Provide a sound technical basis for multiple viable disposal options in the US
- Increase confidence in the robustness of generic disposal concepts
- Develop the science and engineering tools needed to support disposal concept implementation
- Conduct R&D on the direct disposal of existing dual purpose (storage and transportation) canisters



*Mined repositories in salt*



*Mined repositories in clay/shale*

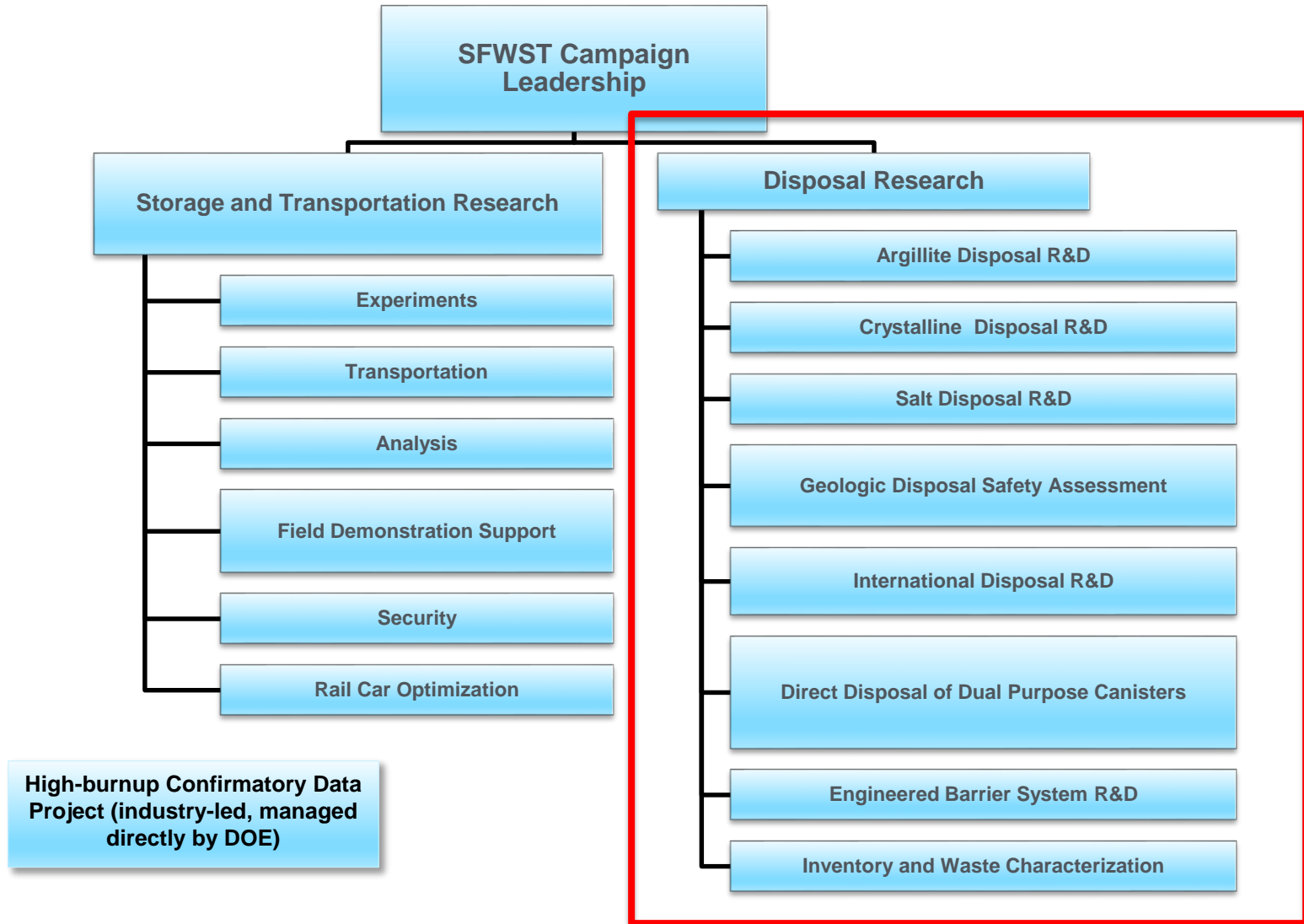


*Mined repositories in crystalline rock*

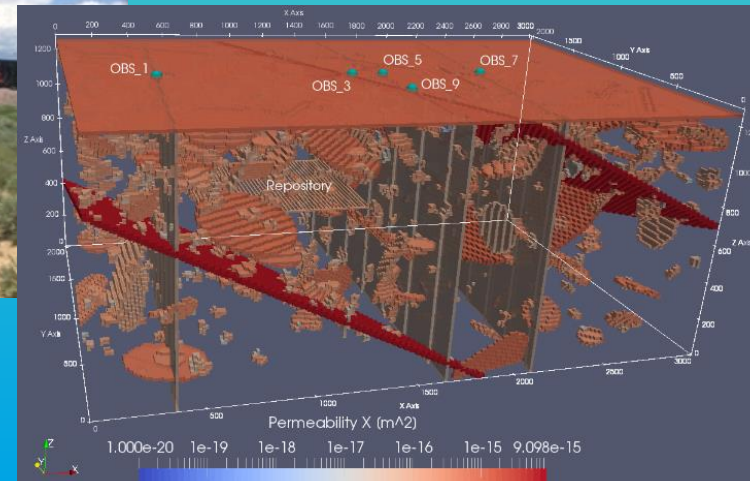
# SFWST Campaign Direction

- Disposal R&D directed toward selected geologic media (Crystalline, Argillite and Salt)
- Focus on generic research aspects of media without considering any specific sites
- Seek opportunities to benefit from ongoing R&D within the technical and international communities

# SFWST Campaign Structure



## Spent Fuel and Waste Science and Technology (SFWST)



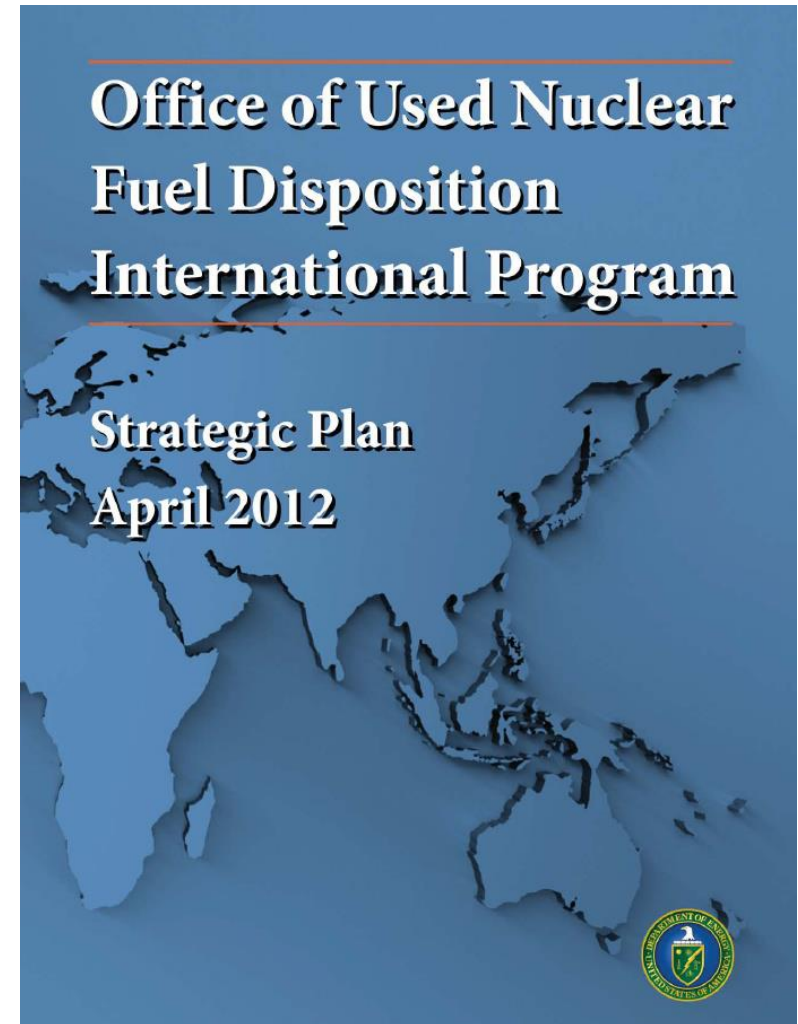
## Spent Fuel and Waste Science and Technology - International Program and Collaborations

# Strategic Plan for International Program

The DOE Office of Nuclear Energy has four strategic goals for the International Program

- Leverage global knowledge to meet domestic goals
- Increase global deployment of advanced technology
- Build a foundation for collaboration, trust, and joint action
- Accelerate global learning and innovation

<http://www.energy.gov/ne/downloads/office-unf-disposition-international-program-strategic-plan>



# Program Scope and Priorities – DR Roadmap

- The Disposal Research (DR) Roadmap was developed on the basis of “Features, Events and Processes” (FEPs) that affect waste isolation in geologic media
- Work Packages (WPs) were developed to address “high” importance FEPs with technical scopes, budgets and schedules
- Initial DR Roadmap developed 2010-2011, updated in 2013, and another update planned for 2019 – reflecting progress made and any change in priorities
- The 2019 DR Roadmap update will focus on integration, levels of current knowledge, and relevance to the safety case for each geologic media and design conditions

# Selection of Projects to Support DR Roadmap Priorities

- Waste Containment
  - Container/Waste form material degradation – exchange of information via published or international conference participation
- Engineered Barrier Systems
  - Backfill (Bentonite) studies – active participation in International Underground Research Laboratory (URL) projects
  - THMC (Thermal, hydrological, mechanical and chemical) effects – experimental and modeling studies – active international projects
- Natural Barriers
  - Colloid formation and transport – participation with international project (informal collaboration)
  - Flow and transport – fracture characterization, THMC modeling – active international projects
- Modeling and Benchmarking – active international projects

# Evaluation of International URL Programs

- Initially developed an understanding of ongoing research activities at international disposal research programs and interacting with key researchers in the respective scientific and technical fields
- Identified international program opportunities (URL and non-URL related) for enhancing and complementing SFWST scope both underway and planned
- Ongoing R&D efforts at international URL sites were evaluated to identify opportunities for SFWST campaign research advances (process understanding, modeling and monitoring methods, data)



# Considerations for DOE Participation in International Activities

- Benefit to the SFWST campaign and the international partners
- Complementary to US National Laboratory staff capabilities in disposal sciences
- Participate and contribute to disposal research in a cost effective manner
- Gaining research experience and taking advantage of established URLs in a short period of time
- Opportunities for peer reviews of data and analyses among international experts

## International Collaborations

- Participation in International Underground Research Laboratories in Europe, Japan and Korea and in multi-national disposal research activities
- Bilateral agreements on storage and disposal R&D with Korea, Japan, China
- Memorandum of Understanding (MOU) for salt disposal R&D with Germany

# International Portfolio with URL Focus

Status 2019

## Multinational Initiatives

- ❑ **Mont Terri Project**
  - Participate in experiments at Mont Terri clay URL in Switzerland
- ❑ **DECOVALEX Project**
  - Participate in model comparison initiative for several URLs related tasks in different host rocks
- ❑ **Colloid Formation and Migration Project**
  - Participate in colloid research at Grimsel granite URL in Switzerland (SFWST participation ended in 2015)
- ❑ **FEBEX DP**
  - Participate in FEBEX dismantling project, which evaluates bentonite-rock behavior after 18 years of heating
- ❑ **SKB Task Forces**
  - Participate in crystalline rock research centered around Äspö HRL in Sweden
- ❑ **HotBENT (starting soon)**
  - Conduct a high-temperature heater test to evaluate feasibility of 200°C waste disposal

## Bilateral Research Collaborations

- ❑ **US-Republic of Korea (ROK)**
  - Participate in KAERI Underground Research Tunnel (KURT) experiments in crystalline rock
  - Joint Fuel Cycle Study (JFCS), information exchange in used fuel disposal
- ❑ **US-Germany Salt Collaboration**
  - Participate in testing and modeling studies for thermal-mechanical and hydrological behavior of domal and bedded salt
- ❑ **US-Sweden COSC Collaboration**
  - Participate in testing hydrogeological characterization methods
- ❑ **Other Potential Opportunities**
  - Explore use of existing Memorandum of Understanding (MoU) between DOE and Spain (ENRESA), France (ANDRA), Japan (JNEAP) and Belgium
  - Plans for new URLs in China and Korea

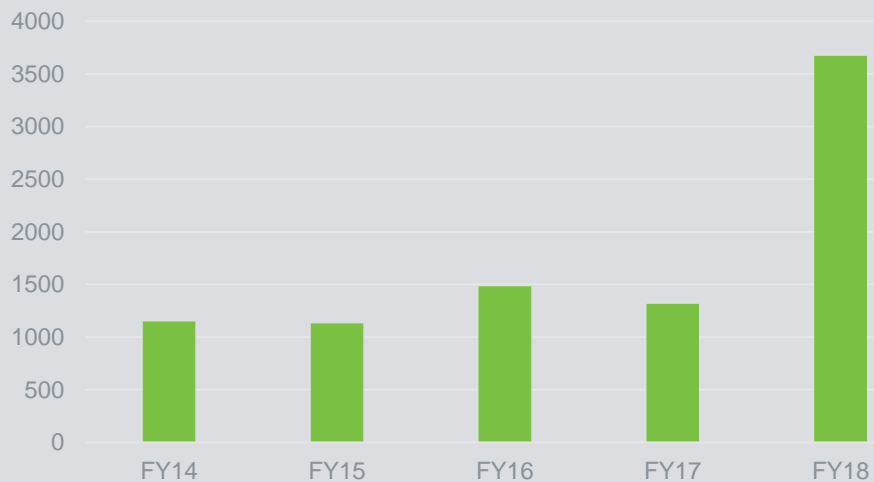
*There are several other international collaboration activities not focused on URL access and participation, e.g., the Thermodynamic Database Project, or NEA's Clay, Salt and Crystalline Clubs.*

# Management of DOE Participation in International Projects

- Participation in active International projects often involves annual fee payments
- Typically, agreements between DOE/Labs and the host international organizations are executed for multiple years (usually < 5 years) at a time
- Participation in most international projects entitles DOE labs to access all technical data developed at the URL

# International Activities Budget Over Past 5 Years

International Spending



Number of Activities



- Ramp-up for existing activities
- Addition of Salt and EBS Activities

# International Collaboration Report

## Content of Report:

- International Opportunities and Strategic Considerations
- Multinational Cooperative Initiatives
- Bilateral Collaboration Opportunities
- Selection of International Collaboration Activities
- Disposal Research Activities Associated with International Collaborations

## ***International Collaboration Activities in Different Geologic Disposal Environments***

### ***Spent Fuel and Waste Disposition***

*Prepared for  
US Department of Energy  
Spent Fuel and Waste Science and  
Technology  
Jens Birkholzer & Boris Faybishenko  
Lawrence Berkeley National Laboratory  
With Contributions from  
Patrick Dobson, Patricia M. Fox,  
Jonny Rutqvist, Liange Zheng (LBNL),  
Florie Caporuscio, Paul Reimus,  
Hari Viswanathan (LANL),  
Carlos Jové-Colón, Yifeng Wang,  
Kristopher L. Kuhlman, Edward Matteo,  
Kevin McMahon (SNL),  
Mavrik Zavarin (LLNL)*

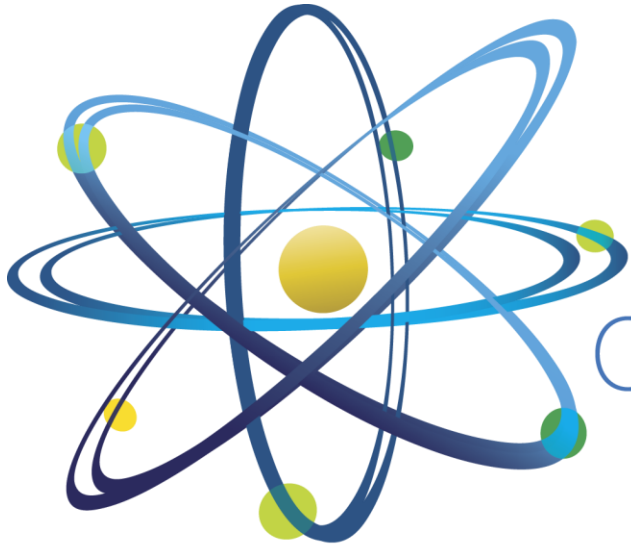
*September 2018  
LBNL-2001178*

SFWD Working Document: External Release

# Summary and Conclusions

- **Active collaboration with international programs, initiatives, or projects is beneficial to SFWD's disposal research program, providing access to decades of experience gained in various disposal environments**
- **DOE has pursued avenues for international collaboration and has joined formal collaborative R&D agreements with international partners**
- **Focus is on partnerships that allow for “active” R&D collaboration, often with access to field data and respective interpretation/modeling**
- **DOE/NE-81 has a balanced portfolio of international R&D activities in disposal science**

# Questions?



Clean. **Reliable. Nuclear.**