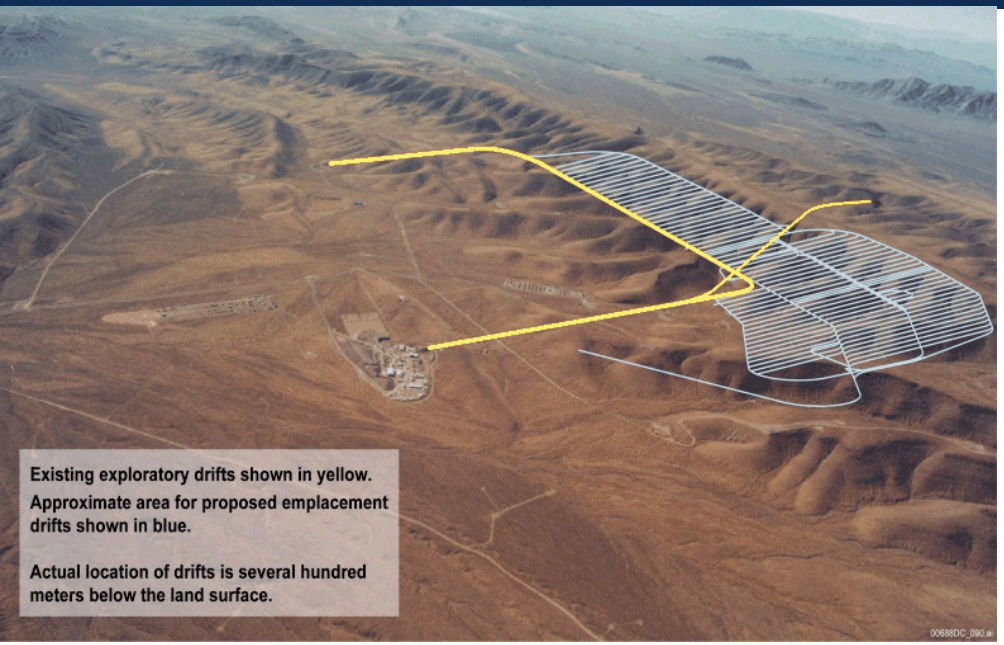
SAND2017-4924PE



Background on Yucca Mountain and Solutions for Management of Spent Nuclear Fuel and High-Level Waste

Peter Swift
Senior Scientist, Sandia National Laboratories
April 18, 2017

NLDC Working Group:

Argonne NATIONAL LABORATORY
INL Idaho National Laboratory
Los Alamos NATIONAL LABORATORY EST. 1943
Pacific Northwest NATIONAL LABORATORY Proudly Operated by Battelle Since 1965
Sandia National Laboratories
Savannah River National Laboratory™ OPERATED BY SAVANNAH RIVER NUCLEAR SOLUTIONS

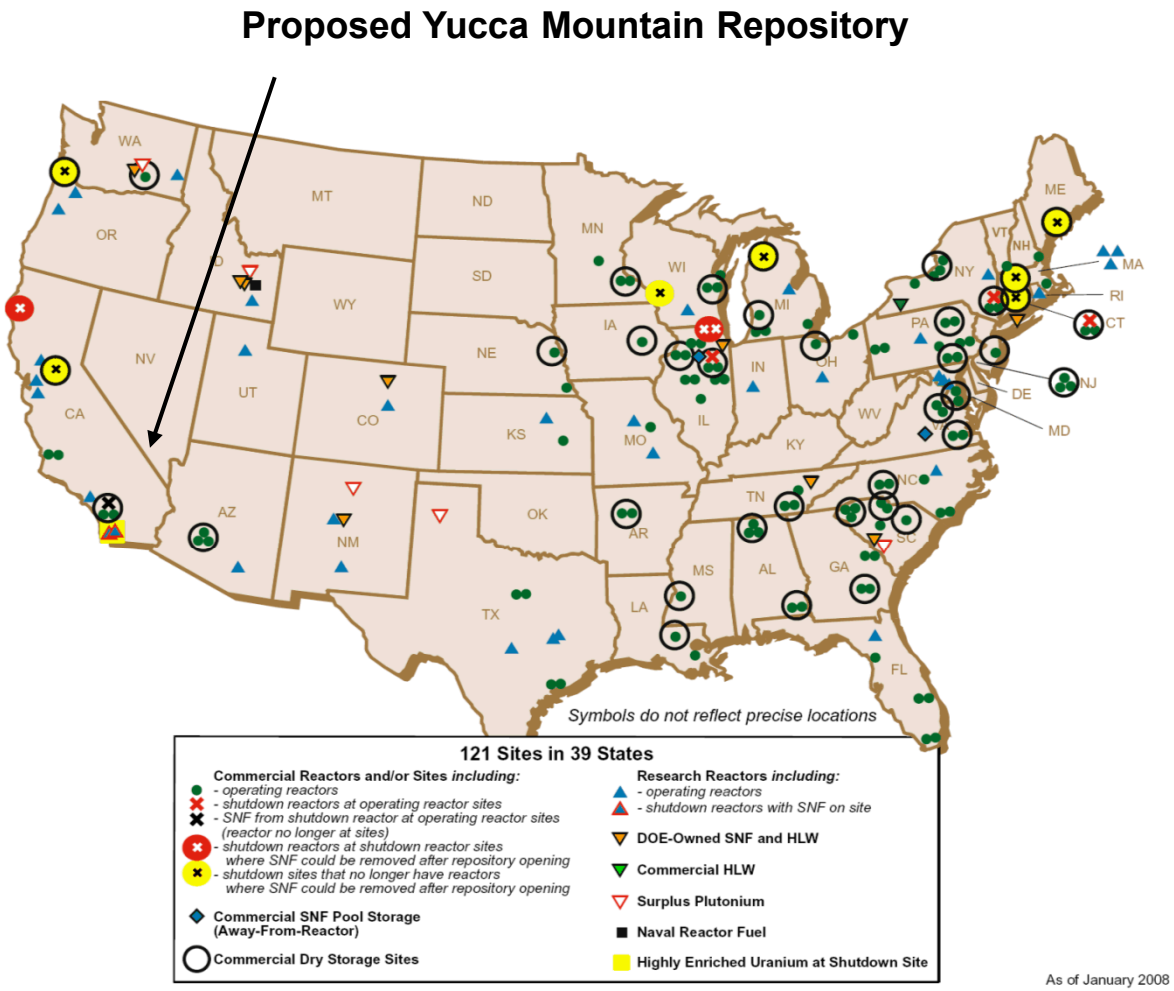
Sandia National Laboratories is a multi-mission laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND NO. 2017-3931 PE

U.S. DEPARTMENT OF ENERGY

Summary and Outline

- Overview of Yucca Mountain design and purpose
  - Yucca Mountain license application included about half of the total amount of spent nuclear fuel and defense high-level waste projected by mid-century
  - Yucca Mountain is technically suitable
- What would it take to restart Yucca Mountain licensing?
  - Joint effort by DOE, M&O, legal team, and the national lab team
  - Also requires action by the Nuclear Regulatory Commission
- Making significant progress on Spent Nuclear Fuel disposal requires effective integration across transportation, storage and disposal.

The Yucca Mountain Mission



Office of Civilian Radioactive Waste Management (OCRWM) Mission:

To manage and dispose of high-level radioactive waste and spent nuclear fuel in a manner that protects health, safety, and the environment; enhances national and energy security; and merits public confidence.

Waste for Yucca Mountain

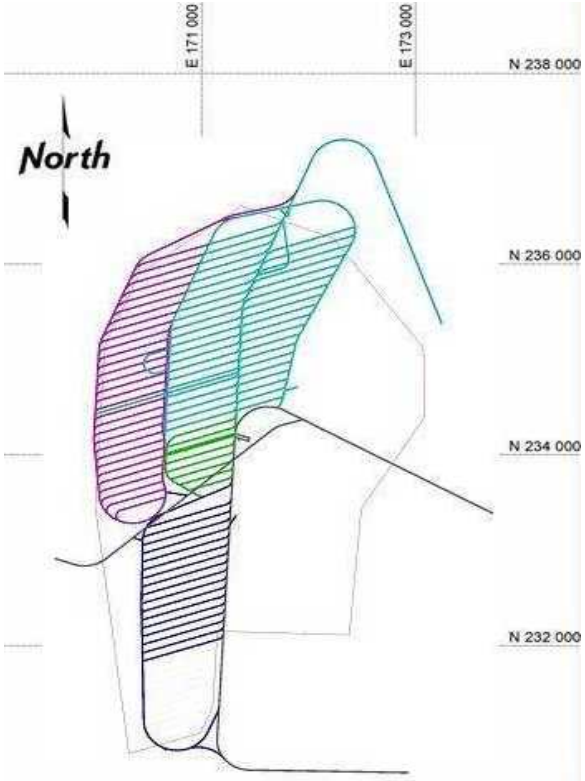
Commercial Spent Nuclear Fuel:
63,000 MTHM (~7500 waste packages)

DOE & Naval Spent Nuclear Fuel:
2,333 MTHM
(~400 naval waste packages)
(DSNF packaged with HLW)

DOE & Commercial High-Level Waste:
4,667 MTHM
(~3000 waste packages of co-disposed DSNF and HLW)

DSNF: Defense Spent Nuclear Fuel
HLW: High Level Radioactive Waste
MTHM: Metric Tons Heavy Metal

Yucca Mountain Subsurface Design



Emplacement drifts

5.5 m diameter

approx. 100 drifts, 600-800 m long

Waste packages

~11,000 packages

~ 5 m long, 2 m diameter

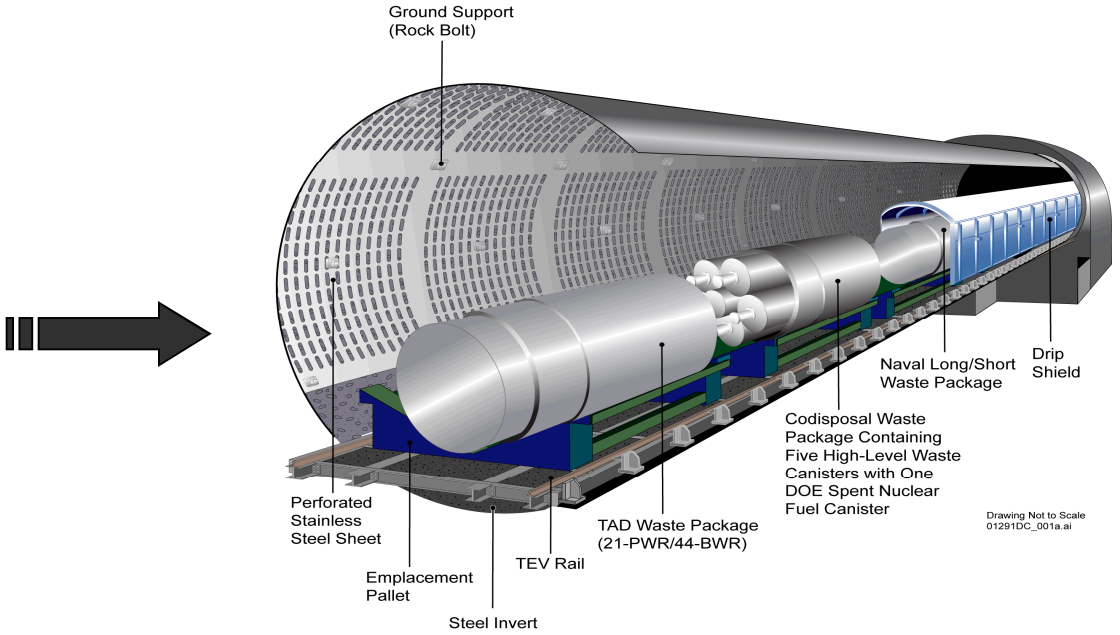
outer layer 2.5 cm Alloy 22 (Ni-Cr-Mo-V)

inner layer 5 cm stainless steel

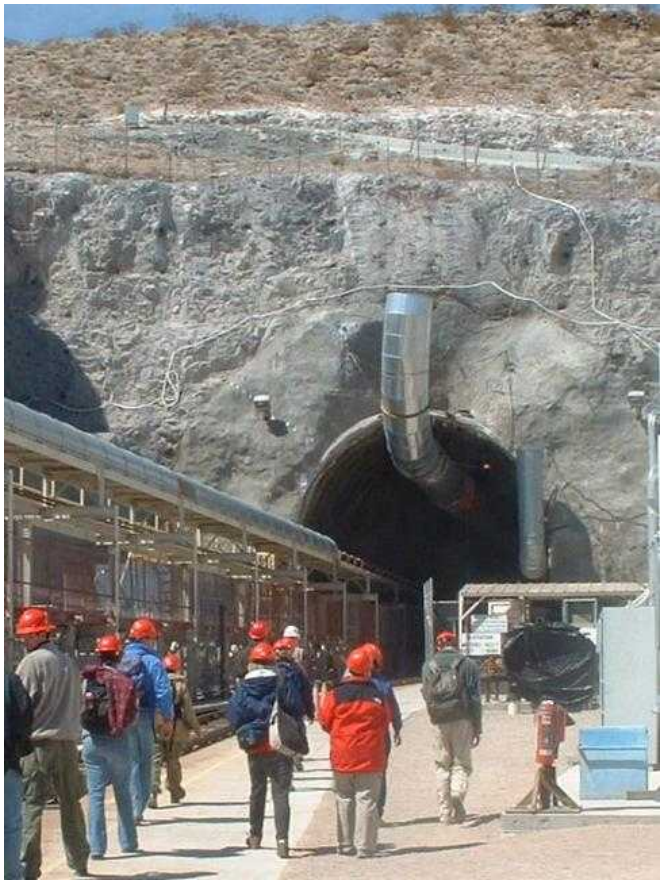
Internal TAD (transportation, aging, and disposal) canisters for commercial spent fuel, 2.5 cm stainless steel

Drip shields

free-standing 1.5 cm Ti shell



Yucca Mountain Exploratory Studies Facility



Yucca Mountain Surface Facilities

North portal access to underground facilities

DOE/RW-0753 Figure GI 1-6

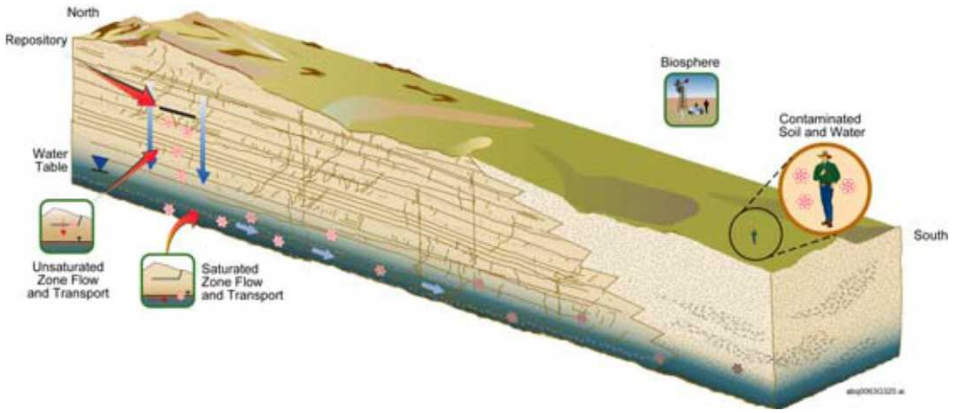
Facilities needed for initial operations shown in brown, including

- Rail car and truck buffer areas
- Initial handling facility
- Wet handling facility
- Canister receipt and closure facility
- Aging pad

Multiple non-nuclear facilities, including control facilities, security, maintenance, utility, power, backup power, fire control, water and sanitation, transportation, etc.

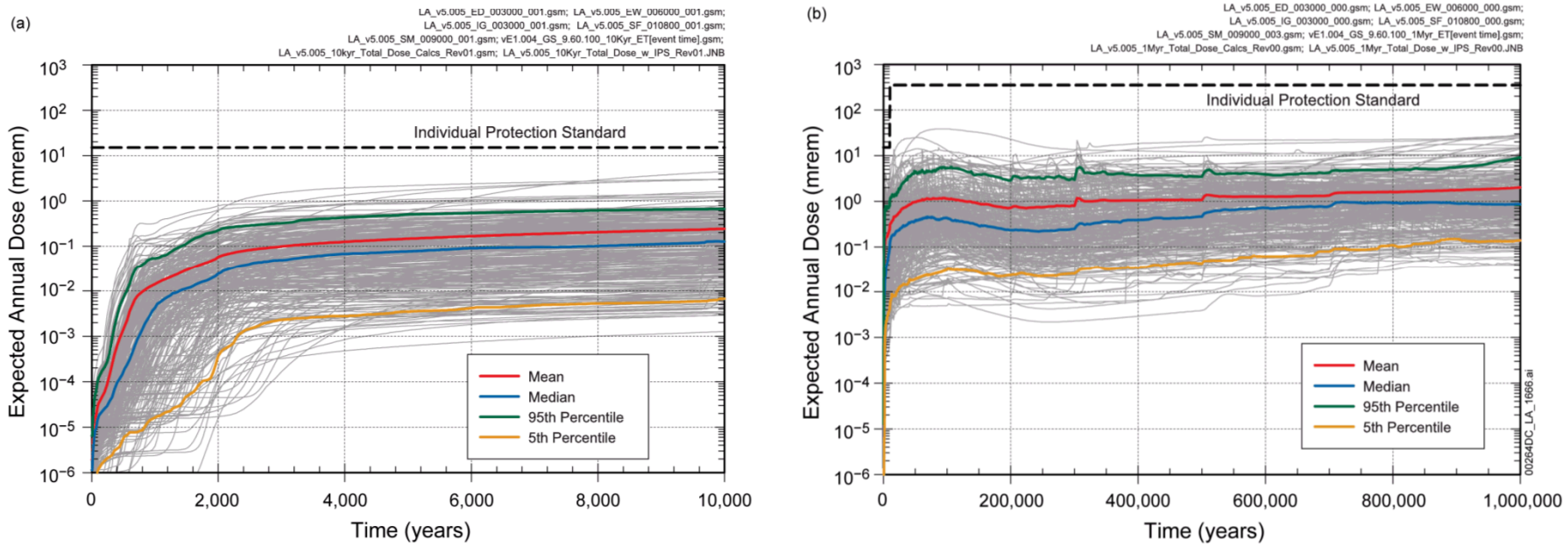
Long-Term Performance of Yucca Mountain

- Water provides the primary release mechanism
  - Precipitation infiltrates and percolates downward through the unsaturated zone
  - Corrosion processes degrade engineered barriers, including the waste form



  - Radionuclides are mobilized by seepage water and percolate downward to the water table
  - Lateral transport in the saturated zone leads to biosphere exposure at springs or withdrawal wells

Long-Term Performance of Yucca Mountain



DOE/RW-0573 Rev 1 Figure 2.4-10

10,000 years

10,000-year Standard:
Mean annual dose no more than 0.15 mSv (15 mrem)

TSPA-LA estimated 10,000 yr maximum mean annual dose: 0.0024 mSv (0.24 mrem)

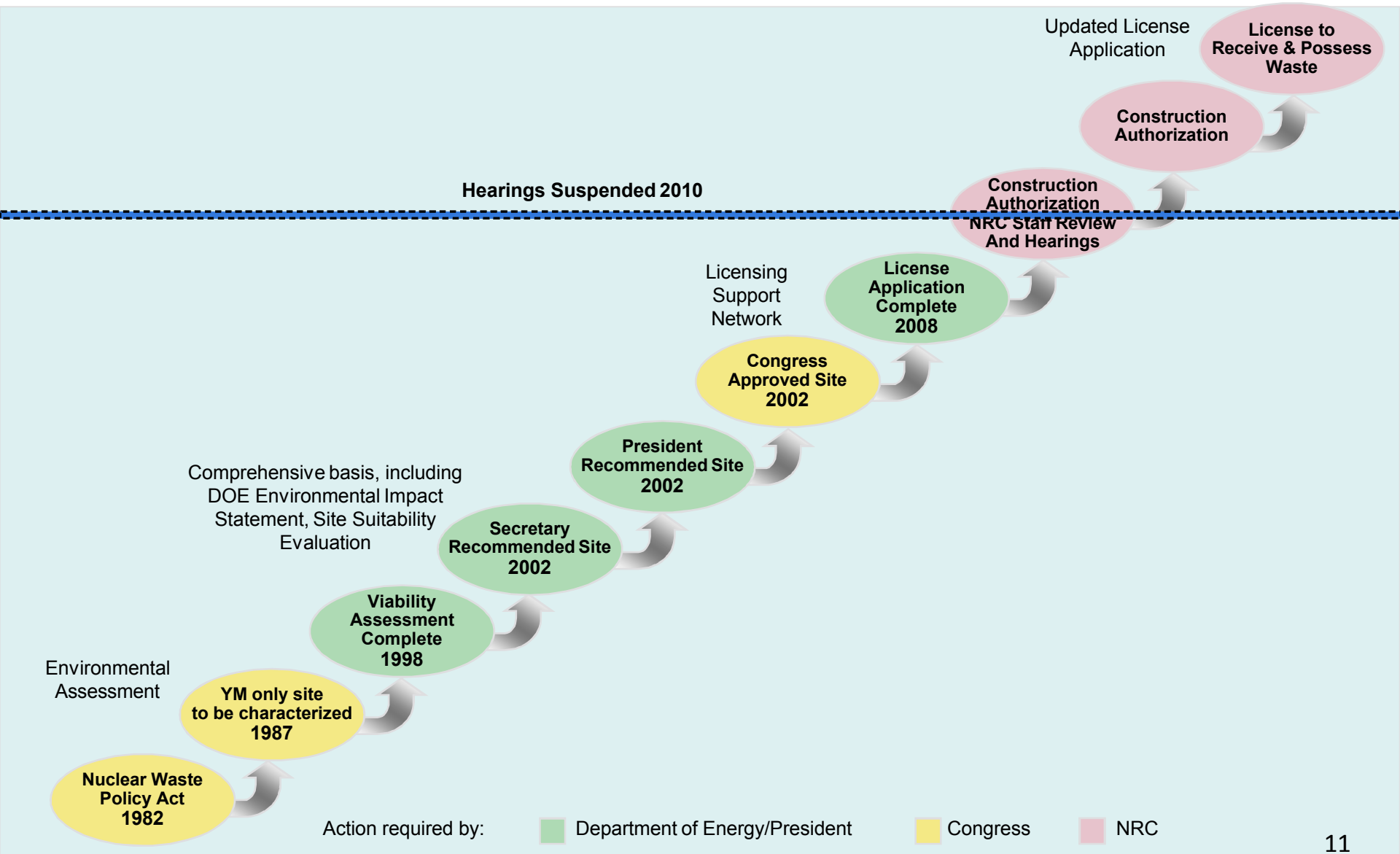
1,000,000 years

1,000,000-year Standard:
Mean annual dose no more than 1 mSv (100 mrem)

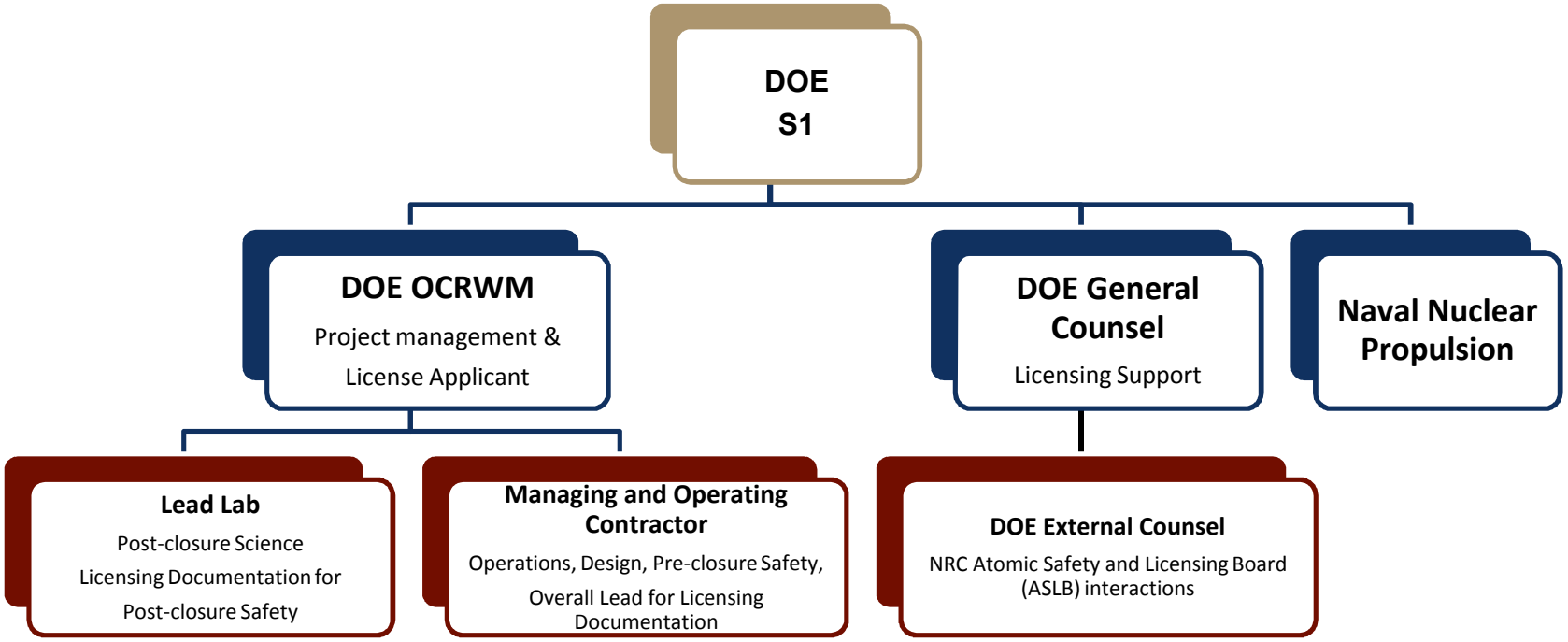
TSPA-LA estimated 1,000,000- yr maximum mean annual dose: 0.02 mSv (2.0 mrem)

Restarting the Yucca Mountain Licensing Proceedings

Yucca Mountain under the NWPA



YMP Participants in 2006-2010



Regulator: NRC Atomic Safety and Licensing Board
Intervenors with Standing in Licensing Hearings: State of Nevada, State of California, Nuclear Energy Institute, seven NV counties, one CA county, Timbisha Shoshone Tribe, one intertribal Native American council
Advisory technical oversight: Nuclear Waste Technical Review Board

Sandia National Laboratories

The Lead Laboratory provided management and integration services for all YMP science R&D in support of DOE's License Application and its defense in the NRC's review and licensing process

- Commitment to using "best in class" resources and capabilities wherever they reside
- Strong focus on providing effective support for the License Application

Pacific Northwest National Laboratory
Proudly Operated by Battelle Since 1965

Los Alamos National Laboratory

Berkeley Lab

Oak Ridge National Laboratory

Argonne National Laboratory

INL Idaho National Laboratory

Lawrence Livermore National Laboratory

University of Nevada, Reno

The University of Texas at Austin

UNLV University of Nevada Las Vegas

DRI Desert Research Institute

- Apogen / QinetiQ
- Areva
- Beckman & Associates
- Galson Sciences
- Geotrans
- Intera
- ISSI
- Itasca
- John Hart and Associates
- JKRA
- Kleinfelder
- Longenecker & Associates
- RESPEC
- RHYM
- SAIC
- Sala & Associates
- Stoller
- URS

NRC Staff Conclude DOE Met Requirements

"The NRC staff has found that DOE has met the applicable regulatory requirements, subject to the proposed conditions of construction authorization … except for the requirements in 10 CFR 63.121(a) and 10 CFR 63.121(d)(1) regarding ownership of land and water rights, respectively. The NRC staff is not recommending issuance of a construction authorization at this time because the ***NRC staff determined that DOE has not met these regulatory requirements regarding ownership and control of the land*** where the GROA would be located and certain water rights. In addition, a supplement to DOE's environmental impact statement has not yet been completed." [*emphasis added*]

From Volume 5 of the *Safety Evaluation Report Related to Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain* (NUREG-1949, vol. 5, January 2015)

None of the NRC staff's proposed licensing conditions are unanticipated. NRC staff completed the EIS supplement in May 2016.

Fastest Path to Opening Yucca Mountain

DOE

NRC

Institutional Framework

- Quality Assurance
- IT
- Records
- Nuclear Safety Culture
- Maintain Databases
- Procurement
- Personnel

Frequent Dialog

- Nevada
- Congress
- Local Communities
- Nuclear Industry
- Public Utilities
- Other Stakeholders

Federal Team

1. Establish Mission-Focused Organization
2. Ensure interim storage & transportation
3. Obtain Land Permits

Lead Lab

1. Provide Post-Closure Safety Experts
1. Defend the License Application /Post-Closure Safety Analysis

M&O Contractor

1. Complete Final Design of Facility
2. Defend Pre-Closure Safety Analysis

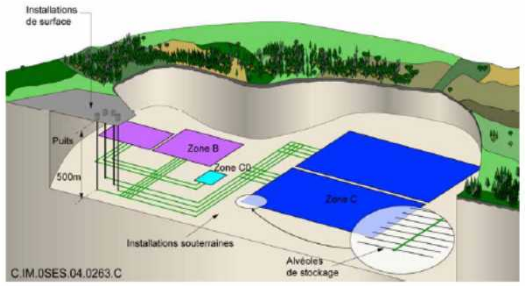
Legal

1. Defend the License Application (300+ Contentions)

1. Reconstitute Safety Licensing Board
2. Reconstitute Legal Team to adjudicate 300+ contentions
3. Re-open hearing facilities

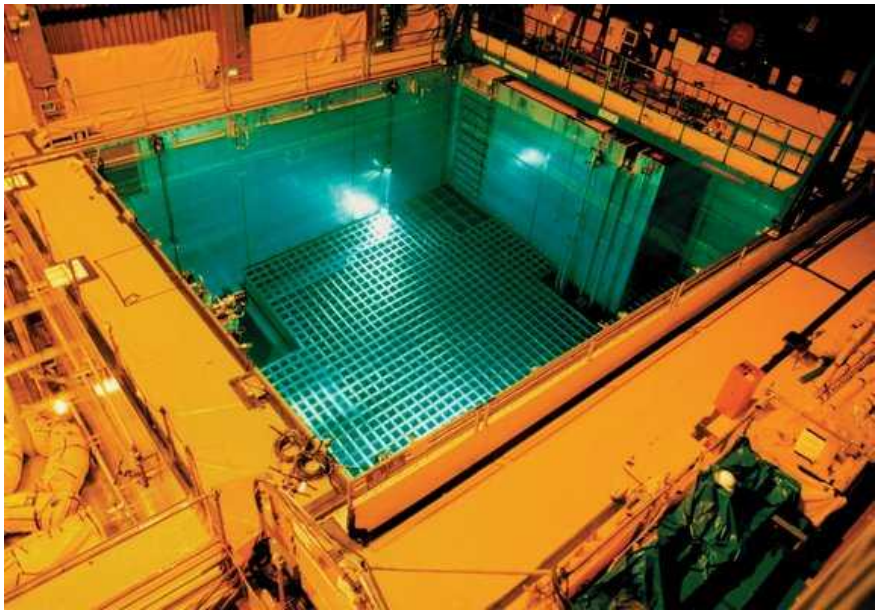
Construction Authorization

Integration Across Storage Transportation & Disposal



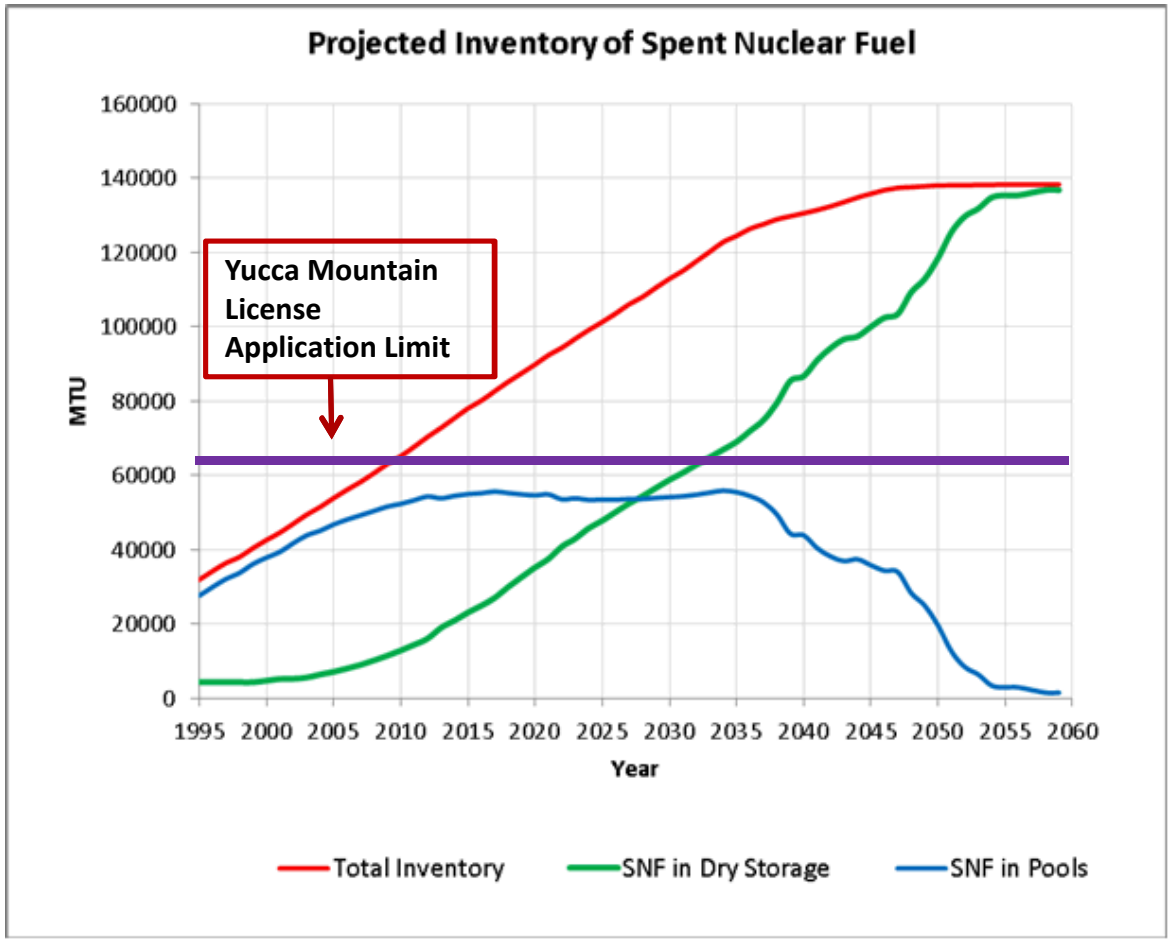
Standard Industry Practice

On-site storage of spent nuclear fuel is the only option available

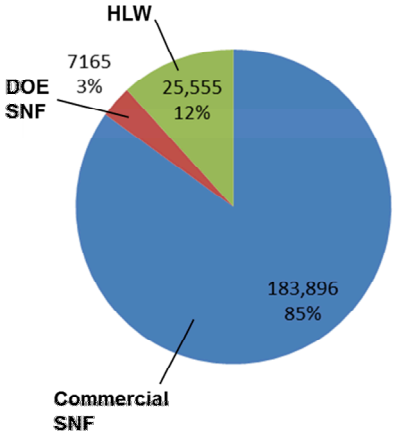


Future Projections

Projection assumes full license renewals and no new reactor construction or disposal



Projected Volumes of SNF and HLW in 2048



Volumes shown in m^3, assuming constant rate of nuclear power generation and packaging of future commercial SNF in existing designs of dual-purpose canisters

Storage and Transportation R&D and Design Will Enhance Regulatory Confidence

Provide technical support for:

- Extended storage of used nuclear fuel
- Fuel retrievability and transportation after extended storage
- Transportation of high-burnup spent nuclear fuel

Security for Interim Storage

Source: www.us.arevablog.com/2015/07/29/cisf/

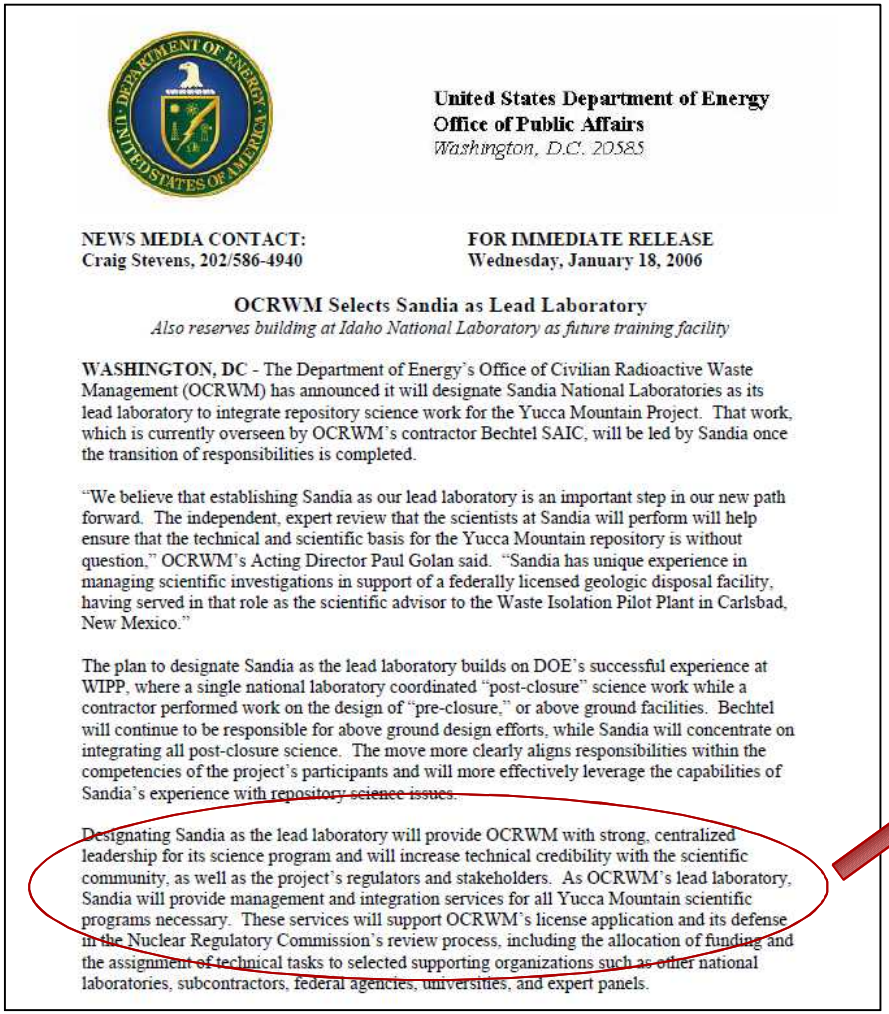
Conclusions

- Yucca Mountain is technically suitable
- Yucca Mountain is the fastest path to permanent disposal of spent nuclear fuel and high-level waste
- Some spent nuclear fuel and high-level waste will remain in temporary storage for decades regardless of when Yucca Mountain opens

Backup material not included in 4/18 briefing

- Three topics
  - Additional background on the Lead Lab
  - Additional background on the 2008 License Application
  - Additional background on activities needed for a restart

Sandia Designated OCRWM Lead lab



United States Department of Energy
Office of Public Affairs
Washington, D.C. 20585

NEWS MEDIA CONTACT:
Craig Stevens, 202/586-4940

FOR IMMEDIATE RELEASE
Wednesday, January 18, 2006

OCRWM Selects Sandia as Lead Laboratory
Also reserves building at Idaho National Laboratory as future training facility

WASHINGTON, DC - The Department of Energy's Office of Civilian Radioactive Waste Management (OCRWM) has announced it will designate Sandia National Laboratories as its lead laboratory to integrate repository science work for the Yucca Mountain Project. That work, which is currently overseen by OCRWM's contractor Bechtel SAIC, will be led by Sandia once the transition of responsibilities is completed.

"We believe that establishing Sandia as our lead laboratory is an important step in our new path forward. The independent, expert review that the scientists at Sandia will perform will help ensure that the technical and scientific basis for the Yucca Mountain repository is without question," OCRWM's Acting Director Paul Golan said. "Sandia has unique experience in managing scientific investigations in support of a federally licensed geologic disposal facility, having served in that role as the scientific advisor to the Waste Isolation Pilot Plant in Carlsbad, New Mexico."

The plan to designate Sandia as the lead laboratory builds on DOE's successful experience at WIPP, where a single national laboratory coordinated "post-closure" science work while a contractor performed work on the design of "pre-closure," or above ground facilities. Bechtel will continue to be responsible for above ground design efforts, while Sandia will concentrate on integrating all post-closure science. The move more clearly aligns responsibilities within the competencies of the project's participants and will more effectively leverage the capabilities of Sandia's experience with repository science issues.

Designating Sandia as the lead laboratory will provide OCRWM with strong, centralized leadership for its science program and will increase technical credibility with the scientific community, as well as the project's regulators and stakeholders. As OCRWM's lead laboratory, Sandia will provide management and integration services for all Yucca Mountain scientific programs necessary. These services will support OCRWM's license application and its defense in the Nuclear Regulatory Commission's review process, including the allocation of funding and the assignment of technical tasks to selected supporting organizations such as other national laboratories, subcontractors, federal agencies, universities, and expert panels.

January 18, 2006

"Designating Sandia as the lead laboratory will provide OCRWM with strong, centralized leadership for its science program and will increase technical credibility with the scientific community, as well as the project's regulators and stakeholders. As OCRWM's lead laboratory, Sandia will provide management and integration services for all Yucca Mountain scientific programs necessary."

Lead Lab Funding and Staffing

FY	Total Funding	Carryover Funds	Total MOWs	SNL FTEs
2007*	$116,640,861	$10,389,991	550**	90
2008	$70,381,866	$9,033,018	425	61
2009	$54,748,900	$8,760,334	338	52
2010	$23,000,779	$16,150,250	195	30
2011	$0	$9,985,146	6	6
2012	-$2,516	$5,456,364	1	1
2013	$0	$4,790,020	< 1	< 1
2014	$0	$4,082,830	< 1	< 1
2015	$0	$3,290,938	< 1	< 1
2016	$0	$2,084,567	< 1	< 1

*Harry Reid Becomes Senate Majority Leader, January 2007
**160 MOWs in Las Vegas, NV

DOE's YM timeline as of January 28, 2009

Repository License Application
Next Steps

- **Licensing Process**
  - Requests for additional information (129 received)
  - Petition for leave to intervene, including contentions (321 received)
- **NRC issues Safety Evaluation Report – 2010**
  - Atomic Safety and Licensing Board conducts hearings – 2010
- **NRC decision on Construction Authorization – 2011**
  - NRC can request a fourth year as allowed by law
- **The Department submits application for license to receive and possess – 2016**
- **NRC decision on license to receive and possess – 2019**
- **Repository Operations – 2020**
  - Firm date cannot be set until funding issue resolved

Yucca Mountain licensing numbers

- The 2008 License Application
  - 17 volumes, 8,646 pages
    - 3,518 pages of postclosure safety and performance confirmation documentation contributed by the Lead Lab
  - Accompanied by 198 supporting documents (approx. 38,000 pages)
    - Approx. 100 technical documents from the Lead Lab
- NRC staff Requests for Additional Information (RAIs)
  - Approx. 673 RAIs received between September 2008 and March 2010
    - 313 mapped to postclosure safety, with Lead Lab responses totaling approx. 2,400 pages
  - Additional 31 requests to Lead Lab for supplemental information following RAI responses
- Approx. 305 Contentions admitted by the ASLB
  - 152 contentions map to postclosure safety, total 177 with Lead Lab input

Elements of a Successful Restart

- Engagement from the NRC
  - Reconstitute the Atomic Safety and Licensing Board
    - Four separate panels in 2009
    - Dedicated hearing facility in Las Vegas in 2009
  - Engage NRC staff and counsel
    - Following 2015 NRC Safety Evaluation Report, NRC staff will play major role in representing conclusions regarding the YMP LA
- Establish DOE Organization
  - DOE management and staff (OCRWM)
  - DOE General Counsel and external counsel for licensing interactions
  - Design, operations and preclosure safety experts (M&O contractor)
  - Postclosure safety experts (Lead Lab)
  - Institutional support functions
    - Everything from office space to records management

Representative support functions that need to be in place at the time of restart

- Quality Assurance
- Nuclear Safety Culture, Employee Concerns Program, Safety Conscious Work Environment, Corrective Action Program
- Regulatory and Licensing Support
- Licensing Support Network
- Human Resources support
- Training
- Procurement support
- Records Management
- Information Technology
- Operating processes and procedures

Representative Technical Expertise Required for Postclosure Science

- Yucca Mountain expertise needed before depositions and hearings begin
  - Future climate
  - Infiltration
  - Unsaturated zone flow and transport
  - Emplacement drift environment
    - Drift degradation/rock mechanics
    - Thermal hydrology
    - Geochemistry
  - Waste Package and Drip Shield performance
  - Waste Form performance
  - Saturated zone flow and transport
  - Biosphere
  - Seismic hazard
  - Igneous hazard
  - Criticality
  - Other (i.e., all) potentially relevant features, events, and processes
  - Total System Performance Assessment

Additional Detail of Restart Activities

- Begin Licensing Support Activities
  - Review information that has become available since 2010 to evaluate potential impacts on the LA
  - Re-start LA configuration management
  - Review/update proposed LA revisions
  - Review process model status and capabilities
  - Test TSPA capabilities
- Hearing preparation
  - Receive ASLB schedule for discovery and hearing
  - Review and update strategies for addressing postclosure contentions
  - Prepare expert witnesses
- Restart Performance Confirmation Program
  - Monitoring, include surface and subsurface activities
  - Sample management

Possible Support Organization Chart

- Many of the listed support functions are required for an NRC applicant or licensee
- All existed in the 2008 YM Project
- Most will need to be in place quickly after a restart
- The Lead Lab maintained its own staff for many of these functions
- The new support organization does not need to reproduce the 2008 structure, and could be simpler as long as it meets the functional needs