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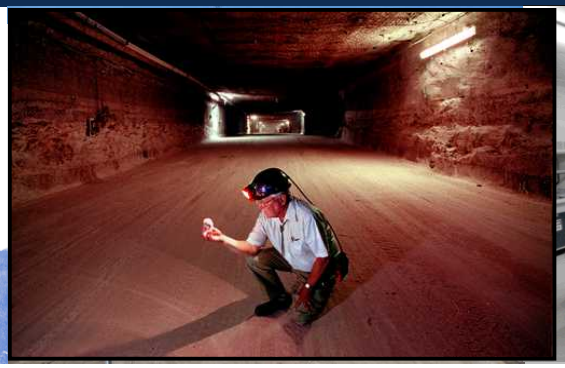


Roles of Sandia National Laboratories at WIPP and in Southeastern NM

Paul Shoemaker, Senior Manager

Defense Waste Programs Group

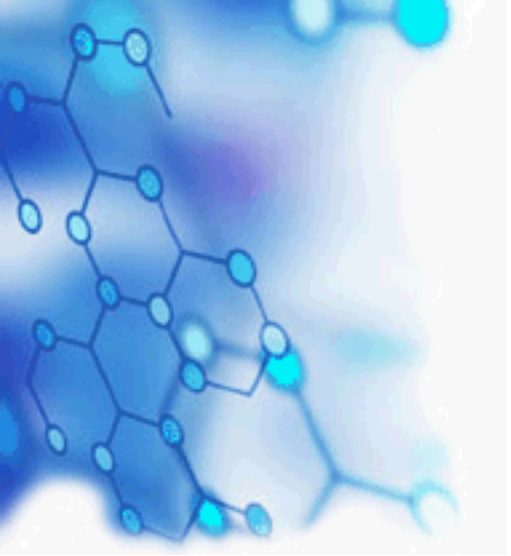
October 11, 2012

U.S. DEPARTMENT OF ENERGY | NNSA

Sandia National Laboratories is a multi-program 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.

Briefing Topics

- Sandia's history with WIPP
  - WIPP history
  - Sandia's current and enduring work on WIPP
  - Sandia's relationship to DOE/CBFO
  - Sandia/Carlsbad's People, Facilities, Funding
- Sandia/Carlsbad Focus Areas
  - Performance Assessment
  - Geomechanics
  - Geochemistry
  - Hydrology
  - Regulatory Compliance
- Nuclear Waste Disposal Challenges/Opportunities
  - Salt Disposal Investigations
  - Nuclear Waste Disposal Futures



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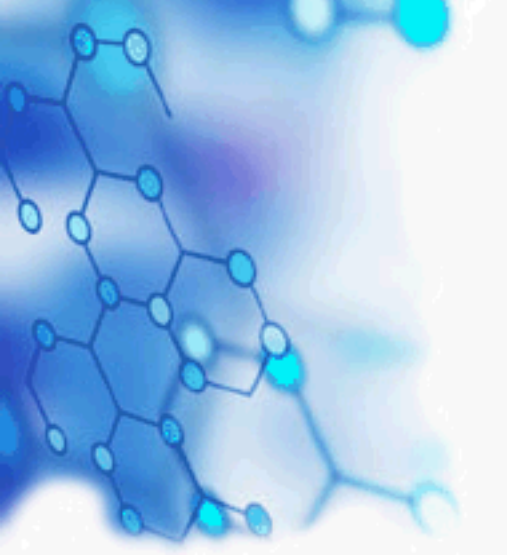
THEORY

Gaining Social and Regulator Acceptance for Nuclear Waste Disposal Activities

- Risk assessments are important tools used to gain social acceptance
- Risk assessments must be performed with high integrity, transparency, and independence
- To the degree possible, rely upon independent scientists to conduct the risk assessment work (rather than “hired guns”)
- Involve scientific organizations with very high levels of public trust and confidence in very visible ways

Gaining Acceptance (continued)

- Refrain from both the fact and the appearance of having made a decision about the acceptability of nuclear waste disposal activities before the risk assessment work is complete, presented, and properly vetted
- This can be very difficult, since the very nature of the process for obtaining regulatory approval to engage in nuclear waste disposal activities obliges the sponsoring government agency to use the risk assessment results to make arguments *for* compliance and to respond to critics who argue *against* compliance
- This regulatory approval process often moves in parallel with the conduct of risk dialogues with the public



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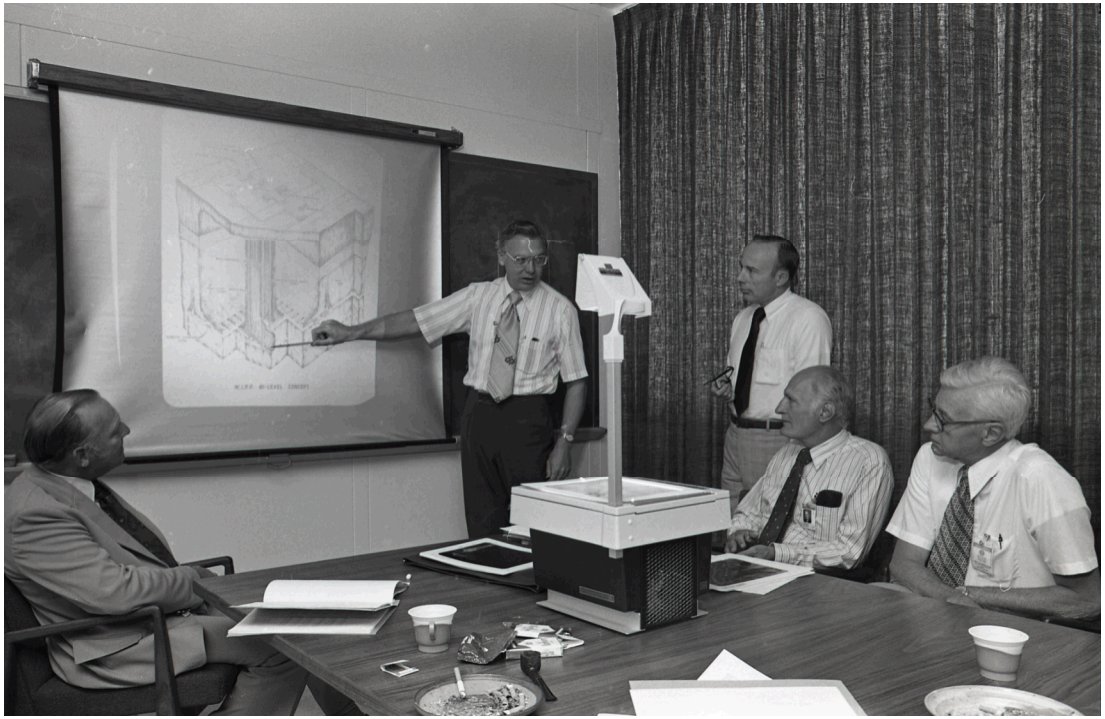
PRACTICE



Sandia's contributions to WIPP date back to 1975, when the ERDA (successor to the AEC) asked Sandia to study whether the nation's defense nuclear waste (including DHLW) could be buried safely in the salt beds near Carlsbad, N.M.

Site Selection

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DOE National Security and Military Applications of Nuclear Energy Authorization Act of 1980

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1979

- Act authorized DOE to construct WIPP and to seek New Mexico endorsement to operate a geologic repository for waste generated for defense purposes (weapons development waste).
  - Act does not allow disposal of waste from civilian power production.
- Substantial influence by both local and state leaders to proceed. Economic impact (jobs) drove influence but good science and safety demanded at every step.

Construction of WIPP

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1981 ▪ Surface construction of WIPP begins

1983 ▪ First underground rooms are completed

1988 ▪ Engineered facility is ready for waste disposal

WIPP Today

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Major WIPP Events
After the Facility Readiness

1989	▪ Nuclear Regulatory Commission certifies the TRUPACT-II shipping container
1992	▪ WIPP Land Withdrawal Act designates EPA as WIPP's primary regulator
1993	▪ EPA issues radiation standards for waste containment.
1996	▪ EPA issues criteria for compliance
1998	▪ EPA certifies that WIPP complies with 40CFR191
1999	▪ First shipment of TRU waste from Los Alamos National Laboratory
1999	▪ New Mexico Environment Department issues a Hazardous Waste Facility Permit
2004	▪ Recertification CRA-2004
2007	▪ Begin Remote Handled Waste Disposal
2009	▪ Recertification CRA-2009
2011	▪ SDI PCN, Panel Closure Re-Design and Repository Reconfiguration PCR


CARLSBAD CURRENT-ARGUS

stand (36 cents home-delivered) 26 Pages SUNDAY April 18, 1999 Serving Eddy County, New Mexico

It's official: WIPP's open for business

Richardson, N.M. congressmen on hand for grand opening ceremony

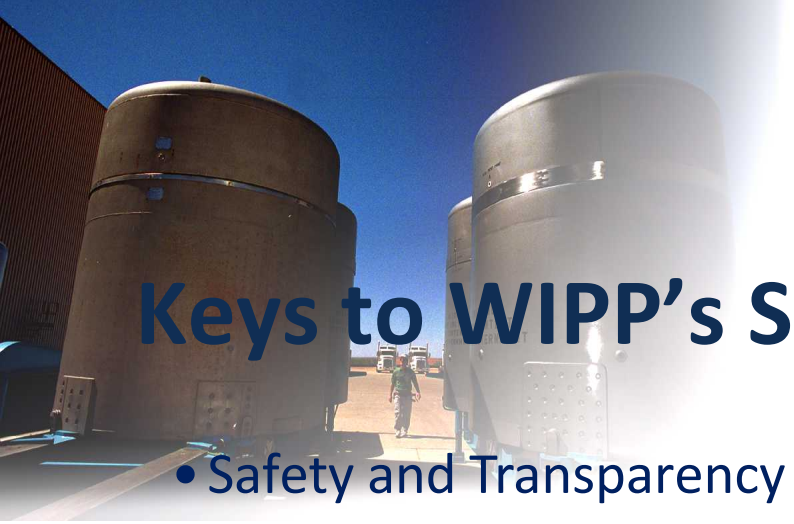
By Victoria Parker-Stevens

CARLSBAD — As a thank you to those who worked more than 25 years to see a nuclear waste repository open, the Waste Isolation Pilot Plant held special ceremonies Saturday morning.

While the first shipment arrived at the plant March 26 with [illegible]

"Today I'm especially proud to be an American and associated with those who made this possible."

LOUIS WHITLOCK RD



Keys to WIPP's Success

- Safety and Transparency at every phase of the project has been of utmost importance
  - Site selection, construction and operation
  - Site characterization/data collection
  - Performance assessments
  - Compliance demonstrations and license decisions
- Assembled the strongest technical team possible, effectively use expert panels, and focus on documentation, QA and safety
- Developed a relationship of "mutual respect" with the regulator, ensuring appropriately resourced dialogue and face-to-face meetings with regulators
  - Independent regulatory standards and criteria
  - Recognize regulators will represent applicants to public

Keys to WIPP's Success (continued)

- Early involvement of stakeholders and independent oversight group(s)
- Involved and educated the public and sincerely addressed their concerns
- Recognized that some opponents probably would probably not be convinced; expected and prepared for legal challenges
- Balanced desire to increase public confidence, achieve transparent processes, with resources needed to meet regulatory requirements
  - Committed and focused project management

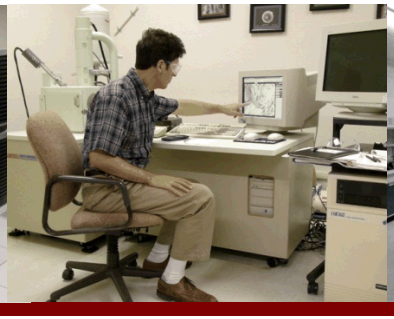
  Recognized the time to go from R&D to compliance (certification/licensing)
- Success directly related to strong local and political support

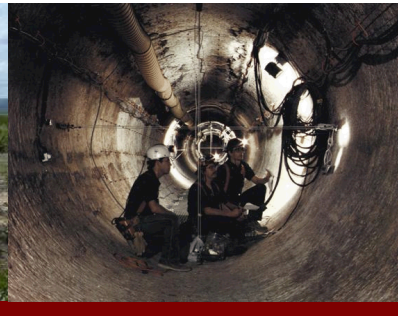
Sandia's Work in Carlsbad

- Our WIPP and Other Missions
- Our WIPP Work Scope
- Our People
- Our Facilities/Capabilities
- Out Funding Profile

WIPP and Other Missions for SNL/Carlsbad

- Sandia is the scientific advisor for the DOE Carlsbad Field Office (CBFO).
  - Provides scientific support in performance assessment, geomechanics, geochemistry, and hydrology for continued WIPP compliance with EPA regulations.
- The Sandia/Carlsbad advances the state of repository science and solves problems in domestic and international nuclear waste management.
  - Advances the Nation's capabilities in repository science.
  - Supports new nuclear waste disposal strategies for the Nation.
  - Supports domestic and global nuclear waste projects.
- Supports local technology-based economic development and education programs.

SNL's WIPP Work: Foundation for Compliance

- Performance Assessment
  - Features, Events and Processes Scenario analysis
  - Process modeling
  - Total System Performance Assessment
- Geomechanics
  - Salt creep modeling and void space analysis
  - Analysis of hydrodynamic shear strength of nuclear waste
- Geochemistry
  - Fe/Pb solubility and corrosion experiments
  - MgO hydration/carbonation experiments
  - Actinide solubility analysis
  - Geochemical modeling in high ionic strength, aqueous systems
- Hydrology
  - Ground water level monitoring and analysis in WIPP vicinity
  - Geochemical study of all water samples collected in WIPP vicinity
  - Groundwater flow modeling
- Quality Assurance
  - Pervasive QA culture
  - Sandia WIPP Records center
- Regulatory Compliance
  - Regular reporting
  - Regulator and stakeholder interactions

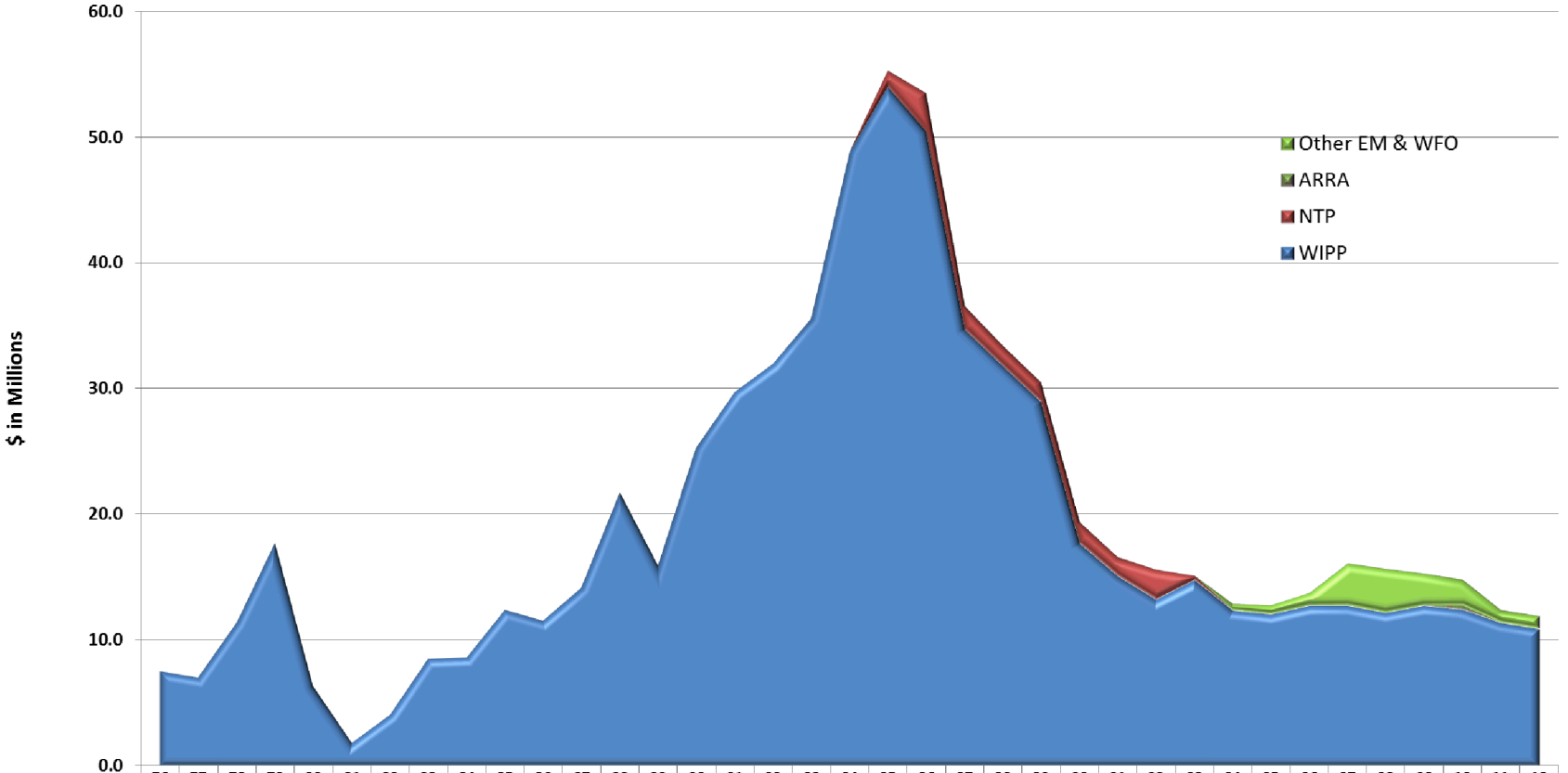
People

- Sandia has maintained a presence in Carlsbad since the late 1970's
- At various times, we have occupied office space on Canal, South Main, North Main, and now National Parks Highway
- Four departments and **53** members of the workforce.
  - Carlsbad Programs Group
  - PA and Decision Analysis Department
  - Repository Performance Department
  - Business Management Support Staff

Facilities

- Leased space
  - NPHA (15000 ft^2 office)
  - NPHB (7000 ft^2 laboratories/servers)
- Hydrology field equipment
  - Two well-testing trailers
  - Downhole video inspection system
- Geochemistry laboratories
  - JEOL Scanning Electron Microscope
  - X-Ray Diffraction
  - Multiflow Gas Control System
- Geomechanics
  - Horizontal/vertical flume tester
- Computing facility
  - OpenVMS 8.2 Compaq/HP Alpha cluster
  - Solaris 10 Sun blade server with Intel Quad CPUs

Funding Profile for Sandia/Carlsbad



	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12
Other EM & WFO																													0.5	0.7	1.0	3.3	3.5	2.5	2.0	1.0	1.0
ARRA																																			0.3		
NTP																				1.3	3.0	1.9	1.6	1.5	1.7	1.5	2.4	0.3									
WIPP	7.6	7.1	11.5	17.8	6.4	1.9	4.1	8.6	8.7	12.5	11.6	14.2	21.8	16.0	25.3	29.8	32.0	35.6	48.9	54.0	50.5	34.7	31.8	29.0	17.7	15.1	13.3	14.8	12.4	12.1	12.8	12.8	12.2	12.8	12.5	11.4	10.9

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PERFORMANCE ASSESSMENT (PA)

- Introduction to Performance Assessment
- PA Objectives, Focus, and Requirements
- PA Methodology
- FEPs and Scenarios
- Conceptual Models
- Release Pathways and Mechanisms
- WIPP Performance Assessment Summary

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GEOMECHANICS

- Shear Strength
- Parameter TAUFAIL
- Specialized Experiments
- Waste Model Improvement
- Behavior of Present Model
- Improving the Situation

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GEOCHEMISTRY

- Fe/Pb solubility
- Fe/Pb corrosion
- Colloidal source-term
- Actinide solubility and uncertainty
- MgO Hydration

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HYDROLOGY

- KARST
- Groundwater Level Monitoring
- Monitoring Well Network
- Groundwater Flow and Transport
- ASER Contour Maps for NMED

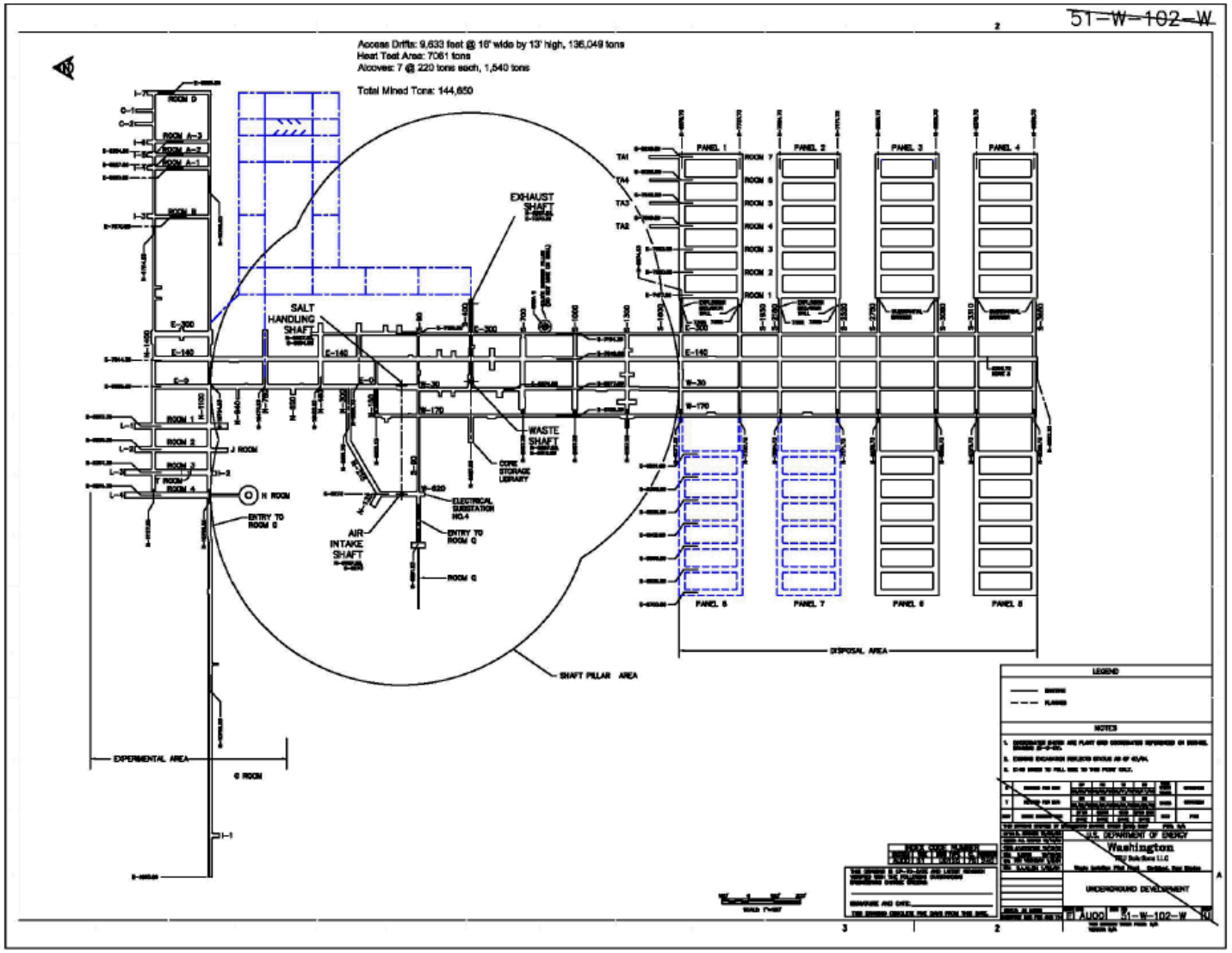
REGULATORY COMPLIANCE

- SNL Role in WIPP Certifications and Permitting
- Certification/Recertification Cycle
- WIPP Planned Changes

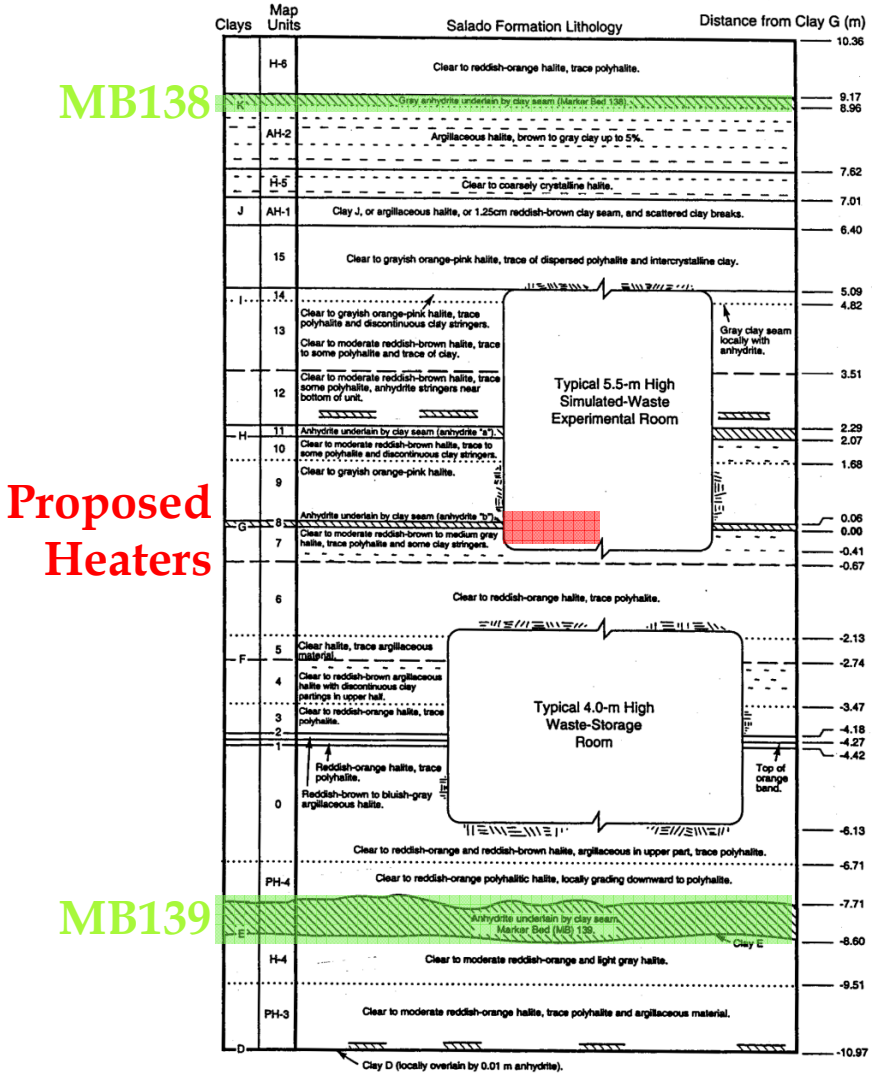
SALT DISPOSAL INVESTIGATIONS

Underground Configuration
Impact Analysis for SDI
Impacts to Total Releases

SDI Configuration



Long-Term Thermal Effects

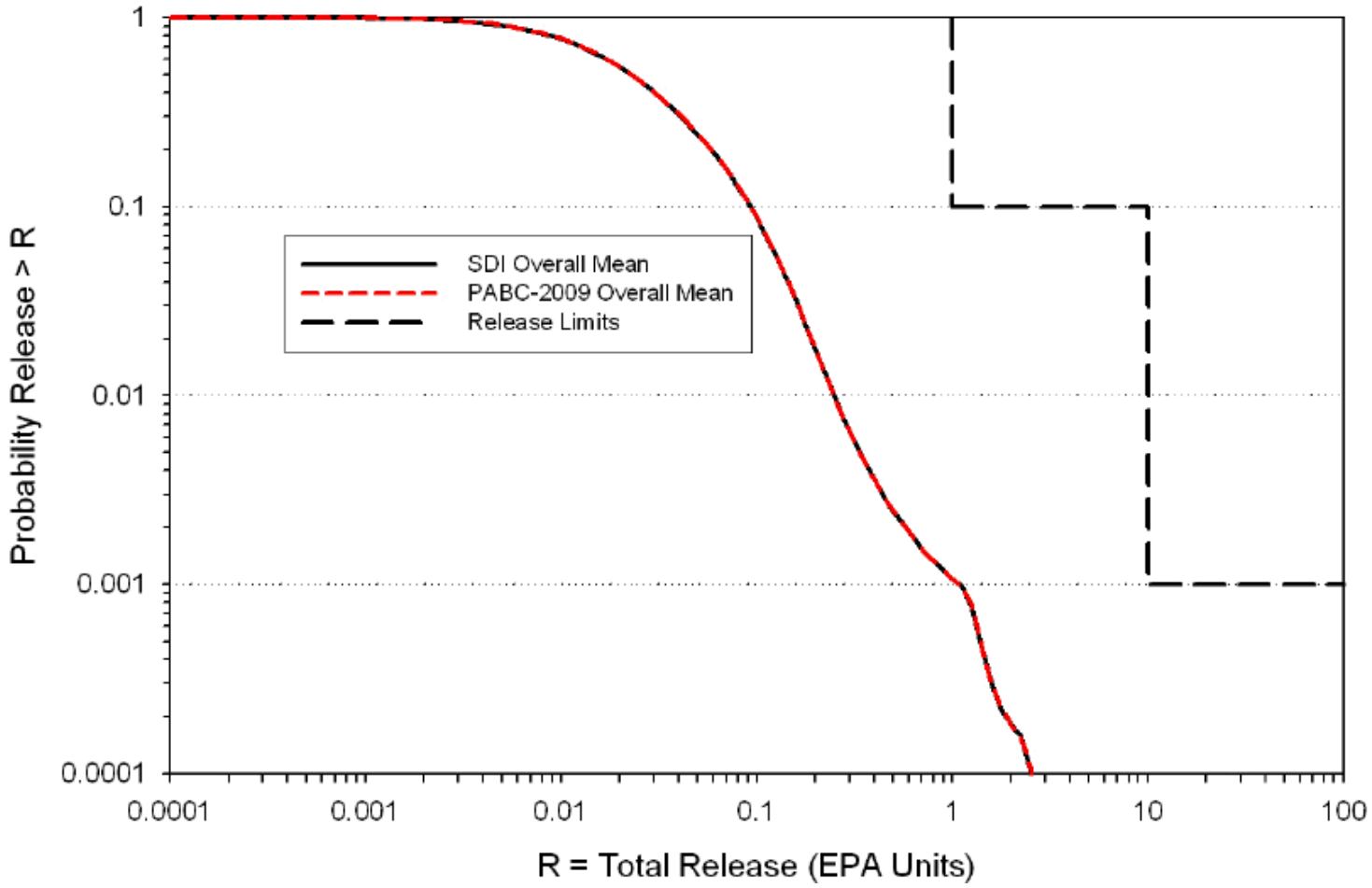


- 2D approximation to heat conduction in halite between Marker Beds 138 & 139
- Anhydrite has lower thermal conductivity than halite.
- Assume marker beds are perfectly insulating
- Not accounting for heat removed by ventilation system
- Accurate assumption at very large distances and long time scales, but not at scale of tests.
- Analytic solution from Carslaw & Jaeger “Conduction of Heat in Solids” textbook (2003)
- Five 8,500 Watt heaters.
- Heaters operating for 2 years

Impact Analysis for SDI

- **Additional excavation for SDI and associated heater testing required a FEPs re-assessment to determine if current FEPs baseline is appropriate for SDI**
  - Not a “show-stopper” for the PCN
  - EPA may require additional FEPs work in the future
- **The proposed SDI heaters will result in**
  - Basically no (< 0.02 K) temperature rise at any time at any of the Waste Panels (Panel 1 being closest)
  - Rise predicted at short distances and short times are not physically realistic for operational effects
- **Additional excavation for SDI results in**
  - Lower average pressure in repository waste regions
  - Slightly higher brine saturation in waste regions
  - An overall reduction in spallings releases
  - Effectively no change to DBRs
  - No noticeable change to Total Releases

Impacts to Total Releases



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NUCLEAR WASTE DISPOSAL FUTURES

WIPP TRU Waste is Only the Beginning

- Other low- to intermediate-level radioactive waste awaits development of disposal options/pathways
  - Greater-Than-Class-C (sources, activated metals, etc.)
  - Pu from the Savannah River Site
  - Buried TRU at Hanford
  - Hanford Tank Waste
  - Vaulted Waste
- Substantial quantities of high-level radioactive waste similarly awaits development of disposal options/pathways
  - Defense-related high-level waste
  - Navy spent nuclear fuel
  - Commercial spent nuclear fuel

Salt Science Program Goals

- Extend the existing technical basis by adding to the state of knowledge
- Develop a guiding program and its specific elements in the context of needs
- Anticipate future licensing and safety-case defensibility
  - Data and test designs that are non-site specific and generic will need to incorporate fundamental physics that support salt-science first and foremost.
  - Quality Assurance from the outset (including decision-making)
- Exercise good stewardship of taxpayer dollars
  - Careful design leads to maximum utility of limited program funding
  - Should leverage international collaborations
- Meet the needs and constraints of the DOE/NE and DOE/EM, serve the nation's need for disposal options and prompt development of repository capacity

What to do?

- Develop a quantitative safety case (detailed FEP screening and a preliminary PA) for use in identifying licensing and safety assessment issues and to test the state of defensibility of existing scientific information at each salt domain level

Salt >> Bedded Salt >> Permian Basin >> Delaware Basin >> WIPP LWA >> WIPP Site >> WIPP Horizon

- Identify those technical issues that span multiple domains (showing them clearly to be non-site-specific) and design the R&D portfolio around issues where uncertainty exists, that exhibit sensitivity to the generic risk assessment, that improve defensibility, or that address experimental and analytic methodology
  - SDDI in-drift disposal proof of principle is generic to all salt domain levels and methodology for measuring brine/water vapor liberation and movement is generic
  - Leverage all existing data (US, German, etc.) to support multiple lines of argument for a safety case
- Use the mined underground space as an internationally-accessible URL to support multiple activities