SAND2000-2131C

Successes and Experiences of the WIPP Project

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ABSTRACT

In May 1998, the United states Environmental Agency (EPA) certified the United States Department of Energy's (DOE) Waste Isolation Pilot Plant (WIPP) as being in compliance with all of the applicable regulations governing the permanent disposal of spent nuclear fuel, high-level waste, and transuranic radioactive waste. The WIPP, a transuranic waste repository, is the first deep geologic repository in the United States to have successfully demonstrated regulatory compliance with long-term radioactive waste disposal regulations and be certified to receive wastes.

Many lessons were learned throughout the 25-year history of the WIPP – from site selection to the ultimate successful certification. The experiences and lessons learned from the WIPP may be of general interest to other repository programs in the world. The lessons learned include all facets of a repository program: programmatic, managerial, regulatory, technical, and social. This paper addresses critical issues that arose during the 25 years of WIPP history and how they influenced the program.

INTRODUCTION

The WIPP, located in a semi-arid desert in southeastern New Mexico, USA (Fig. 1), is excavated in bedded salt 650 meters below ground surface. The repository is designed to dispose of about 175,000 cubic meters of transuranic waste (waste containing alpha-emitting radionuclides with atomic numbers greater than 92, half lives greater than 20 years, and at concentrations greater than 100nCi [3700 bq] per gram of bulk waste) derived from defense-related activities in the United States government. Total activity of the wastes to be disposed is estimated to be about 7.4 million curies.

Evaluation of the suitability of the site for disposal of radioactive waste began in 1974, and extensive site characterization activities continued throughout the late 1970s and the 1980s. Although excavation of the underground facilities began in 1981, the process of regulatory certification by the United States Environmental Protection Agency (EPA) did not begin until 1992 (1). Following a series of iterative safety assessment in the early 1990s and the subsequent refocusing of scientific programs to support specific compliance-related needs, the DOE submitted a Compliance Certification Application (CCA) (2) to the EPA in October 1996. The EPA certified WIPP's compliance status in May 1998 (3). The first disposal of TRU waste at

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WIPP began in March, 1999. The 10-month delay was due to permit activities required from the State of New Mexico who regulates the hazardous material component of the transuranic waste.

KEY ELEMENTS LEADING TO WIPP'S SUCCESS

Looking back into the 25-year history of the WIPP, it is apparent that several key elements had played crucial roles leading to the ultimate success of the program. These included strong leadership, prioritization of R&D activities, mission focus, and an open and transparent process between regulators, the DOE, the public, and the scientists.

Strong Leadership and Commitment

In 1975, Sandia National Laboratories was assigned responsibility to conduct the investigations needed to select and characterize the WIPP site, and to implement the scientific studies necessary to establish the long-term safety of the WIPP repository. Frequent and open interactions with the local community and with the State of New Mexico political leaders established the credibility and integrity of the scientific team.

In 1992, the Congress set forth the responsibilities of the DOE as the manager of WIPP and of the EPA as the independent regulator responsible for developing disposal regulations and criteria for evaluating and certifying the long-term safety of WIPP. The manager of the DOE's Carlsbad Area Office (CAO) responded by assembling a team of key people from the DOE, Westinghouse (operating contractor), and Sandia, and immediately implemented a compliance-focused program to address a Congressionally mandated, aggressive schedule. This program was implemented by prioritizing technical research and development activities according to their expected impacts on compliance, as determined by performance assessment modeling, and by creating a compliance-focused QA program. This compliance-focused approach allocated resources and budget to the most important activities and later proved to be a crucial strategy for the success of the WIPP program.

Clear and Simple Management Structure

The DOE/CAO, which reports to the DOE/Headquarters, divided the responsibilities of the WIPP program into two main areas: operations and scientific support. The Westinghouse Waste Isolation Division has been responsible for operations and regulatory compliance for WIPP, and Sandia National Laboratories has taken the responsibility as the science advisor for the program since 1975. In addition, many supporting teams were used that report directly to these two lead organizations. With this management structure, the ultimate responsibilities of the program in the operations and science areas had been clear and constant. This transparent and simple management structure has been attributed by many as a key element in the success of the WIPP program.

Prioritization of R&D Activities

Following nearly two decades of general scientific investigations and model development, in 1994 scientific resources were focused on specific problems determined to be important to compliance with the EPA regulations. Mainly, these focused programs collected key data or developed improved models for key processes. This prioritization process evaluated plausible proposed technical activities for their effect on compliance with regulations, project budget, and schedule. A set of probabilistic performance assessment (PA) calculations predicted the improvements to total system performance resulting from plausible combinations of alternative technical activities. As a result of this prioritization process, several planned research and development (R&D) activities were terminated and resources were focused on those data collection and model development activities shown to be most beneficial to compliance. For example, new activities on colloids and entrainment of waste-spall during drilling were initiated, and the groundwater flow and transport research program was focused on matrix diffusion.

Open and Transparent Interactions between the DOE, the EPA, and the Public

Once the EPA was designated as the regulator of long-term performance of the WIPP, the WIPP team began a program of technical exchanges and training with the EPA staff, which was also open to technical oversight groups. Furthermore, throughout the WIPP history, a very open process has been used to inform the general public and stakeholders on the status of the program. In many of the WIPP technical meetings, stakeholders and the public were invited to actively participate. Also, the public is allowed to access any information in the WIPP Records Center. This openness has provided opportunities for exposing technical as well as non-technical issues early, resulting in improvements in the quality of the compliance application as well as building trust with the public/stakeholders.

Supportive Local Community

Carlsbad is a small town where the extractive industries of oil and gas development and potash mining have been the principal base of employment. The Carlsbad community has been very supportive of the WIPP program since the early days. The reasons for the support have been twofold: opportunity for economic development to replace the declining extractive industries and the local familiarity of mining-related activities similar to those used at the WIPP repository. Unlike many other locations where anti-nuclear sentiments are usually very strong, Carlsbad has provided constant positive support to the WIPP program. This local support from the Carlsbad, New Mexico community was a critical part of WIPP's success.

LESSONS LEARNED

Integrated Approach to Geologic Repository Development

There are six parts of a repository program (Fig. 2). From our experience at WIPP, it is most important to recognize that the development of a repository program needs to be done in an integrated manner within these six parts. In the initial stage of the repository program the first question to be addressed is: What is the programmatic objective of the project, i.e. what is the regulatory framework, what is the safety standard for the repository? The second question is: What kind of waste will be disposed of in the repository? What are the characteristics of this waste? Once the waste characteristics and the regulatory framework are established, an initial site selection coupled with an initial repository conceptual design can proceed. At this point, a technical "feasibility study" can be conducted using the safety standard and a preliminary performance assessment tool. Once the general feasibility of a deep geologic repository has been established, detailed site characterization can be conducted along with selected R&D activities. At this point, performance assessment plays a critical role for the program as it is used to guide the program activities.

Some of the important elements of this integrated approach are discussed in more detail below.

Early Implementation of a Regulatory Framework

Although activities on WIPP started in 1974, it was not until 1992, when the EPA was established as the independent regulator, that the safety standard for disposal was finalized. Before that, various safety standards were proposed and conservative criteria were established by the DOE and used for the WIPP program. Without a "safety objective" for a repository program, it is very difficult to focus on the important activities during site characterization as well as for R&D decisions. For example, a dose-based safety standard and a cumulative-release standard may impact the site selection decisions differently.

Based on our WIPP experience, regulatory standards will include much more than disposal standards, they may also include regulations for transportation, waste characterization, and handling. In many ways, these regulations are inter-related and therefore should be considered in their entirety early in the program. These regulations/standards should be developed at a "systems level" so inconsistency and redundancy in the regulations can be avoided.

Early Use of Performance Assessment as a Prioritization Tool

Performance assessment is the process that provides the technical basis for decision-makers to determine whether or not the repository will meet the programmatic (safety) and regulatory objectives. At the most basic level, performance assessment answers the questions, "how well will the repository work?" and "will it be safe?" Answers to these questions allow an informed decision to be made on whether to proceed with waste disposal or whether modifications will be required to comply with regulations. However, since direct physical observation of the repository performance will not be possible over thousands of years, the answers to these questions must be based on predictive modeling supported by experimental or analogue data. The goal of performance assessment is therefore to provide reliable and meaningful estimates of future performance of the repository system, while fully acknowledging the uncertainty inherent in those estimates.

During the development of a repository program, many issues arise: what data do we need? How do we know we have collected enough data? How do we know we adequately understand the physical processes? How do we determine which R&D activities will provide most value in the licensing application?

A major lesson we have learned from WIPP is that iterative performance assessment provides a very powerful tool to identify important components of the repository system and therefore to prioritize research. The WIPP performance assessment program conducted detailed sensitivity and uncertainty analyses in 1989, 1990, 1991, and 1992. Results of these analyses were important in guiding research activities. In 1994 and 1995, the WIPP conducted a formal system prioritization using performance assessment models to rank experimental and field activities in terms of their impact on regulatory compliance. The ranking was the basis for programmatic decisions that directly impacted the scope of work to support the compliance certification application.

Early implementation of Quality Assurance Program

In 1996, the EPA imposed a formal Quality Assurance (QA) standard on the WIPP project. Prior to that, Sandia had applied QA to this work as part of good business and scientific practice. Th QA program ensures that technical work maintains the quality characteristics of traceability, transparency, reviews, reproducibility, and retrievability. Traceability is the clear identification of data sources and decision rationales. Transparency is clarity of logic and decisions. Reviews are independent and documented. Reproducibility is whether a qualified peer could reconstruct the experiment or thought process based on the documentation provided. Retrievability is whether records can be rapidly and reliably obtained, for example through the used of an indexed record center. For the WIPP program, a least-work approach was used to help balance the demands of strict QA procedures within the constraints of budget and schedule.

A repository program typically takes at least a couple of decades to complete. For a long-term program such as this, a QA program becomes essential since many changes could happen during the course of the program and individual and institutional knowledge are not retained over this time span. A good QA program can eliminate re-start of efforts, can provide clear rationale of previous programmatic decisions, and provide a vital bridge when changes take place.

Use of Credible Independent Peer Review

Peer review is an essential part of sound science and engineering. Two long-term, continuing external peer review groups have contributed greatly to the success of the WIPP: the National Academy of Sciences (NAS) and the Environmental Evaluation Group (EEG). Since 1978, the NAS WIPP Panel has published more than 13 reports, providing objective, independent and broad oversight of policy and science issues on the WIPP. The EEG, established in 1978 by an agreement between the State of New Mexico and the DOE, provides critical oversight for the State on technical issues affecting both short- and long-term safety. The WIPP team also convened many expert review panels for specific critical scientific topics. Examples are the WIPP PA Review Panel, WIPP Fracture Expert Group, and the IAEA/NEA WIPP International Review Group.

The benefits of expert review are many. Over time, use of expert review for critique and program guidance builds confidence in the integrity of the repository science program. It also familiarizes the scientific community with details of a science-intensive R&D program, its experiments, and predictive models. It ultimately enhances the confidence of the public and stakeholders in the safety of the repository.

SUMMARY AND CONCLUSIONS

The WIPP team's success in demonstrating that the WIPP repository complies with EPA regulations can be attributed to several key program elements and the dedication of organizations and their staff to overcoming many challenging problems while maintaining a commitment to quality work. Key elements to the successful demonstration of compliance were the emergence of strong leadership; implementation of a direct, simple management structure; prioritization of technical programs to serve compliance-specific needs; implementation of open and transparent communications with stakeholders and regulators; and the support of the local community. There are also many important lessons learned from the WIPP program. The number one lesson is the importance of implementing an integrated program during repository development. This integrated program requires an early decision on regulatory and safety standards for disposal (and other related activities), and using performance assessment as a tool for programmatic guidance from very early in the Project. Other lessons learned included the importance of a comprehensive QA program from the inception of the project and the value of frequent and extensive peer review to enhance the credibility of the program. It is hoped that through sharing these "lessons learned", other organizations pursuing deep geologic disposal will profit from the WIPP experience.

REFERENCES

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL8500.

Location Map of WIPP in the US

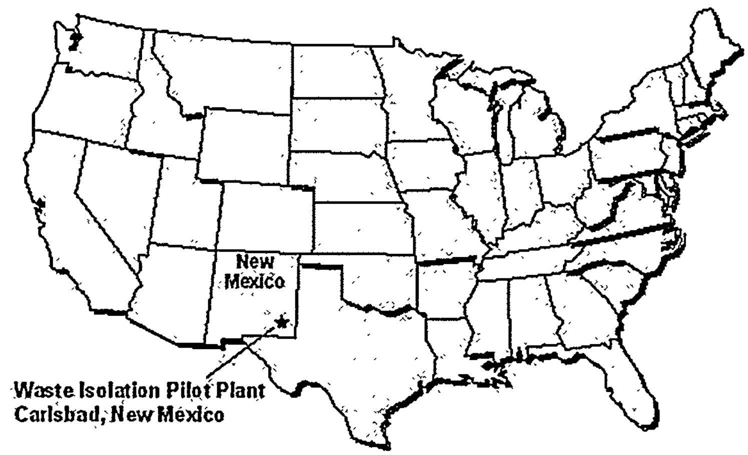
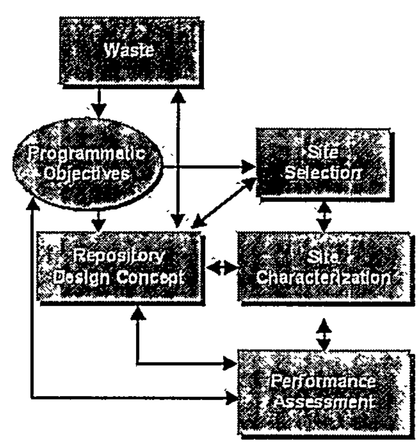


Figure 1

Six Key Parts of a Repository Program



- Identify the waste
- Define the goals
- Select a site
- Design a facility
- Characterize the site
- Demonstrate that the goals have been met

Figure 2