
First shipment to WIPP marks end of a 25-year era, and a new beginning, for Sandia

Labs provided a steady scientific hand in the design, construction, certification, and acceptance of the world's first deep geological repository for radioactive waste disposal

By John German

For the big rig carrying the first containers of transuranic waste to DOE's Waste Isolation Pilot Plant (WIPP) near Carlsbad, N.M., in the late hours of March 25 and early hours of March 26, 1999, it was an easy, mostly downhill trek. From lofty Los Alamos, the satellite-tracked flatbed coasted to White Rock, bypassed Santa Fe, breezed past Clines Corners, glided through Vaughn, side-stepped Roswell, and finally, amid a state police escort and the cheers of a 500-strong WIPP crowd, rolled onto the repository site, a mere 3,400 feet above sea level, at about 3:45 a.m. MST. It arrived to a hero's welcome.

"This is indeed historic -- for DOE and the nation," said Energy Secretary Bill Richardson in an official statement.

"A most welcome decision for one of the most rigorously reviewed projects in the world," said Sen. Pete Domenici, R-N.M.

"A victory for environmental protection and for health and safety," said Rep. Joe Skeen, R-N.M.

Then, on the afternoon of March 26, two waste boxes were lowered down a half-mile-deep elevator shaft into the world's first permanent repository for radioactive waste. The event marked the beginning of 35 years of waste-disposal operations at WIPP and represents a major milestone in DOE's efforts to clean up Cold War "legacy" waste at 23 nuclear weapons complex sites in 13 states. (See WIPP photo feature on pages 6 and 7.)

Your mission ... should you accept

But the right to make that celebratory descent off "the Hill" belied the grueling uphill marathon that preceded it -- a 25-year endurance event wrought with delays, false starts, setbacks, uncertainties, and disappointments. And Sandia was there the whole way, providing the steady scientific hand that ultimately guided the WIPP project through that course's never-endeavored gauntlet of regulatory roadblocks, political obstacles, and legal landmines.

Sandia's 25-year involvement in WIPP represents the longest-running project in Sandia's nearly 50-year history, notes Labs President C. Paul Robinson. "The hurdles were many, and I am

proud that WIPP is finally open to fulfill its original purpose with the knowledge that your own exceptional service played such a critical part," he says.

Sandia's contributions date back to 1974, when the Atomic Energy Commission (AEC, one of DOE's predecessor agencies) asked Sandia to study whether the nation's defense nuclear waste could be buried safely in the 250-million-year-old salt beds near Carlsbad, N.M. Since then, literally hundreds of Sandians have contributed.

"We've had so many people play roles, it's impossible to recognize everyone adequately," says Wendell Weart, who in 1974 began his career-long dedication to the project by serving on Gov. Bruce King's state advisory committee on the repository. "It's been a real team effort."

Sandia the official science advisor

Sandia served as WIPP's official scientific advisor throughout the project. Labs geologists, engineers, and scientists studied and helped select the site, provided the facility's conceptual design, generated the first Environmental Impact Statement, tested the transportation casks, and, most important, provided the scientific understanding and documentation that formed the basis upon which regulatory agencies eventually certified the repository.

But the 300-mile journey from Los Alamos to Carlsbad began even before 1974. In 1957 a committee of the National Academy of Sciences, concerned about the nation's growing inventory of defense-generated radioactive waste, first recommended disposal of radioactive waste in deep geologic salt deposits. That led to studies on whether waste could be emplaced in abandoned salt mines near Lyons, Kansas, and at other sites.

Eventually, in 1972, those plans were rejected, and the eyes of the nation's nuclear community turned toward southeastern New Mexico and, ultimately, a site 26 miles east of Carlsbad where a 3,000-foot-thick layer of sedimentary salt centered half a mile underground had been geologically stable since long before the dinosaurs. In 1975 the AEC asked Sandia to take over the salt-bed repository study from Oak Ridge National Laboratory.

In the earliest days of the project, Labs geologists oversaw drilling of test wells and analyzed geophysical surveys to find the best location for the mine. They looked at natural processes that might affect its long-term safety -- volcanism, tectonics, hydrology, salt dissolution, erosion, geochemistry, mineral resources, and other site characteristics.

Simultaneously, Labs engineers began to redraw Oak Ridge's proposed repository design to adapt to the site's geologic conditions.

Science in the political arena

In the late 1970s, Sandians pulled together the available geologic information, new test data, and model predictions and issued a final Environmental Impact Statement (EIS) in spring 1980. The EIS asserted that the site-characterization work had uncovered no natural geologic or hydrologic processes that could breach the repository for millions of years.

In addition, it said, the salt's depth provided a good natural barrier to contain the radioactive waste; its plasticity (the ability of mined salt to close in on itself and cocoon the waste) provided

additional containment; its thermal properties would dissipate any heat generated by the waste; and the absence of existing boreholes in the area ensured that radioactive gases or liquids could not make their way into the overlying aquifer or to the surface.

With that report, Sandia unwittingly entered a political fray that continues to this day. "It was a new area of exposure for a national lab in terms of doing science in a political and regulatory and litigious environment," says Al Lappin (6115), who contributed to the early site-characterization work. "It turned out to be a lot more complex than Sandia or DOE anticipated."

A Congressional decision in 1979 mandated that only low-level transuranic waste, not high-level defense waste, could be placed in WIPP. That decision, along with the EIS and agreements negotiated with the State of New Mexico in the early 1980s, established clear goals for WIPP, and many believed the already-delayed repository might open as early as 1988.

But the regulatory scenario was changing, and it wasn't clear against what criteria the facility's compliance would ultimately be measured. Those uncertainties and political maneuvering by a growing list of WIPP opponents began to delay the plant's debut.

One point became clear: WIPP would not open until DOE proved scientifically that the repository could safely store transuranic waste without release of radioactivity to the biosphere for thousands of years. (See "What is transuranic waste?" on page 8.)

It was up to Sandia to design a testing regimen that could amass the technical evidence needed to prove that WIPP was safe.

The testing decade

Toward that end, construction of the first underground passageways, called drifts, began in 1983, and a series of experimental chambers was excavated by 1985, in which a host of in situ tests was carried out to complement the laboratory testing.

Already Sandia and site-management contractor Westinghouse had begun accumulating vast amounts of technical data about the salt, the waste, waste containers, and transport options. Sandia provided the instrumentation, data recording, and data analysis for all the tests.

In laboratories and underground, they tested how the mined salt healed itself over time, how it reacted to heat from simulated waste canisters, and how trapped brine (salt water) is squeezed from the salt walls into the repository rooms.

They tested how the waste containers were affected by the chemical environment in the waste rooms, how the salt rooms closed in and cocooned the drums, how interactions between the salt and waste generated gases, and how quickly those gases would build up or be dissipated into the salt walls.

They designed plugs and seals made from salt compacted into bricks and tested methods for sealing off shafts, drifts, and boreholes to prevent them from becoming pathways for contaminated gases or liquids to the aquifer or surface above.

They concocted dozens of scenarios for ways humans might unwittingly intrude into the

repository in the future, examining the likelihood and consequences of each scenario. (Based on the conclusions of an expert panel convened by Sandia, Westinghouse eventually designed a system of markers to warn off curious humans thousands of years into the future.)

In 1978 Sandia initiated studies on a transport system for safely shipping waste to WIPP from DOE sites across the country. A transport container was designed, tested at Sandia, and then redesigned by companies under contract with Sandia. (State objections to this first vented transporter led to its abandonment.)

In 1989 a second-generation, unvented container, TRUPACT-II, was tested at Sandia in drop, puncture, and fire tests, establishing the container's ability to withstand even the worst highway accident. TRUPACT-II was certified by the Nuclear Regulatory Commission in 1989 and is today the container being used to ship waste to WIPP.

Sandia also conceptualized the remote handling and waste emplacement operations, later refined by Bechtel and formalized by Westinghouse, used to unload waste drums from the TRUPACT containers on arrival at WIPP and queue them for disposal in the repository.

In the end, the in situ and laboratory testing generated more than 2,600 technical reports on geology, hydrology, rock mechanics, and chemical interactions.

The compliance years

In 1992, Congress settled the compliance issue: The Environmental Protection Agency (EPA) was to be WIPP's official certifier. That established a clear path toward WIPP's opening. If DOE demonstrated to EPA's satisfaction that WIPP complied with Title 40 of the Code of Federal Regulations, Part 191 (40 CFR 191), EPA would certify the repository.

The regulation required that Sandia incorporate much of the technical data generated during the testing into computational models that predicted whether the repository would continue to comply with the regulations for 10,000 years into the future.

Called Performance Assessment (PA), this activity required Sandia to examine failure scenarios, quantify their likelihoods, estimate potential releases to the surface or the site boundary, and explore potential consequences. The modeling showed that any releases to the aquifer or the surface would be well within the compliance limits.

In response to a lawsuit filed by several groups opposing WIPP, a US District Court judge in 1992 issued an injunction against shipping waste to WIPP until legal questions raised in the lawsuit were answered. With the repository under legal scrutiny, Sandia and DOE needed to ensure their technical work was defensible in both the legal and regulatory environments, and "quality assurance" (QA) became more than a buzzword at the WIPP site.

"Defensibility is really the key issue," says Susan Pickering, Manager of Quality Assurance Dept. 6811. "We've had to do good research and then prove that it's good."

QA required much more rigor in how Sandia and Westinghouse planned, carried out, and documented their work. Sandians helped establish formal procedures for every task. They helped

prepare the site for audits. They developed a corrective-action reporting and tracking system, new training programs, and a records-management regimen.

80,000-plus pages

In October 1996 DOE submitted to EPA the Compliance Certification Application (CCA), 80,000-plus pages of documentation representing the more than 20 years of scientific study, including Sandia's work in site characterization and performance assessment. The CCA was DOE's request to officially certify the repository.

In May last year, EPA rendered its judgment: WIPP is safe for permanent disposal of transuranic waste.

On Monday, March 22, 1999, U.S. District Judge John Garrett Penn lifted the seven-year-old injunction on WIPP's opening. He also declared that a prepared Los Alamos shipment was not deemed hazardous under the Resource Conservation and Recovery Act (RCRA), signifying that the shipment did not require a state permit. Failure by opposition groups to get an emergency stay cleared the way for the March 25 shipment.

An end and the beginning

In the end, jumping through even the most rigorous compliance hoops wasn't enough for WIPP critics.

A lingering controversy brews over whether mixed waste -- transuranic waste that also contains RCRA-regulated hazardous constituents such as lead and solvents -- can also be shipped to WIPP. (DOE has said it won't ship mixed waste without a state RCRA permit, but the Judge Penn decision may leave that possibility open.)

The New Mexico Environment Department (NMED) plans to issue a final RCRA permit in the fall that would allow disposal of mixed waste. The RCRA permit application was submitted to NMED in May 1995.

Because mixed waste constitutes about 60 percent of DOE's transuranic waste inventory, the state approval is necessary if WIPP is to carry out its intended mission.

"The RCRA permit is the final piece of the puzzle that will allow DOE to clean up more than 20 sites nationwide," says Wendell.

Despite the continuing uncertainties, seeing the first boxes of transuranic waste stacked up in the farthest reaches of the repository signifies a major victory for the people who have worked so hard and waited so long to see WIPP open, he says. It also begins a new chapter in Sandia's history.

A moment of great elation

"It was a moment of great elation," Wendell says. "Then, after a couple of days, you realize that you've achieved the overriding, single-minded goal that you've worked toward for two-and-a-half decades, and as the elation begins to fade you start to ask 'What do we do for an encore?'"

In fact, Sandia has a lot more work to do in Carlsbad, according to Ned Elkins, Manager of Carlsbad Operations Dept. 6810. "We're looking into the future as opposed to just getting compliance behind us." (See "So what does Sandia do now?" on page 5.)

"The road to WIPP has been long and rocky," adds Wendell. "I thank the hundreds of current, retired, and former Sandians and a host of contractors who, together, made the trip.

"The quality of their work has stood the test of time and enabled us to achieve a certified and operating repository that meets the EPA's very stringent rules."

"What a singular pleasure it is to be able to congratulate all of you who were involved in making WIPP a reality," says Paul Robinson. "On behalf of everyone in the Laboratories, congratulations to you for a job well done."