THE WASTE ISOLATION PILOT PLANT: A SUCCESS STORY HAPPENING NOW

Dr. Inés R. Triay, Mark L. Matthews
U.S. Department of Energy Carlsbad Field Office, P.O. Box 3090, Carlsbad, New Mexico 88221, USA

Leif G. Eriksson
GRAM, Inc, 8500 Menaul Boulevard NE, Suite B-335, Albuquerque, New Mexico 87112, USA

ABSTRACT

The Waste Isolation Pilot Plant (WIPP) repository (Fig. 1) in New Mexico is the world's only operating deep geological repository for safe disposal of long-lived radioactive wastes/materials (LLRM). It has been: 1) certified by the United States (U.S.) Environmental Protection Agency (EPA), and 2) permitted by the New Mexico Environment Department (NMED) for safe disposal of up to 175,584 cubic meters (m^3) of defense-generated, transuranic radioactive waste (TRUW)[a]. The waste includes approximately 12 tons of plutonium with a half-life in excess of 24,000 years, remote-handled (RH)[a] TRUW containers with surface dose rates of up to 10 sieverts per hour (Sv/h), and 50,000 m^3 of regulated hazardous constituents. The WIPP repository is situated at a depth of approximately 650 m a 250-million-year-old, 600-m-thick, virtually impermeable bedded salt formation, the Salado Formation (Fig. 1). Contact-handled (CH)[a] TRUW contained in standard 208-liter drums or standard waste boxes (SWBs) will be stacked three high in the disposal rooms and surrounded by bagged magnesium oxide (MgO) backfill. RH TRUW canisters measuring 0.66 m in diameter with a maximum length of 3.07 m and a maximum weight of 3.63 tons will be emplaced in pre-drilled horizontal holes in the walls of the disposal rooms.

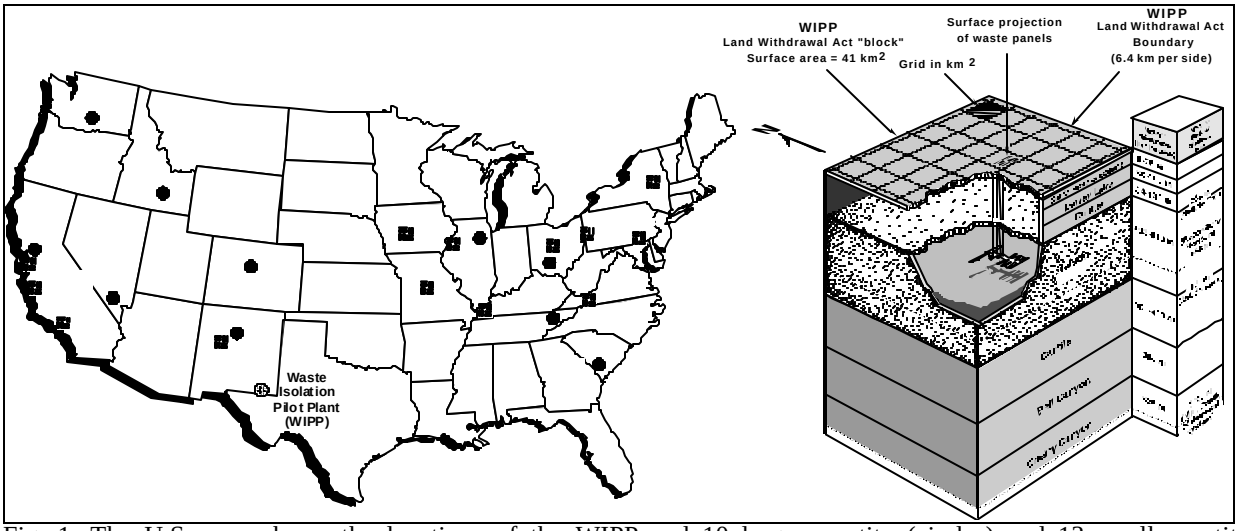

Fig. 1. The U.S. map shows the locations of the WIPP and 10 large-quantity (circles) and 13 small-quantity (squares) TRUW generator and storage sites. The schematic WIPP Land Parcel shows the 41.6 square kilometers (km^2), 1,828-m deep, "controlled (geosphere) area".

The salt surrounding the disposal rooms will gradually encapsulate the emplaced waste within a few hundred years, thereby creating a virtually impermeable monolith. In addition to being virtually impermeable and self-healing, another significant advantage of undisturbed bedded salt like that found at the WIPP site and region is the geological structure. This structure justifies the development and application of relatively simple conceptual and numerical models for post-closure safety and performance assessments (SAs/PAs) that are readily understood and credible. Prior to the certification of WIPP, the ability of the WIPP repository to contain and isolate LLRM, i.e., the WIPP Safety Case, was subjected to

an intense, multi-year review by the public, oversight groups, and regulators. It was credibly demonstrated that the WIPP repository will safely contain the emplaced TRUW for at least 10,000 years, even if breached by multiple human intrusions. Specifically, the natural barriers at the WIPP site provide at least a ten-fold, and more likely at least a 30-fold, safety factor relative to the very stringent requirements defined in the radioactive waste disposal regulations.

The siting, design, construction, and certification process that preceded the March 1999 opening of WIPP was not easy, quick, or cheap. However, it resulted in many valuable lessons learned. Furthermore, conditions embodied in the governing laws,(1,2) certification,(3) and permit(4) for WIPP require the U.S. Department of Energy (DOE) Carlsbad Field Office (CBFO), formerly the Carlsbad Area Office (CAO), to maintain scientific and operational programs for at least another 35 years. By establishing active strategic partnerships and collaborations with the CBFO, other organizations stand to benefit from the intellectual and financial investments residing at CBFO.

INTRODUCTION

The CBFO is responsible for: 1) the continued safe operation of WIPP, the world's only currently operating, regulator-certified, deep geological repository for LLRM, and 2) the establishment of an effective national system for management of TRUW[a] from generation to disposal.(1,2) Summarized below under separate headings are:

- Background information on historical WIPP milestones, the geology of and facilities at the WIPP site, and the WIPP Safety Case.
- Current status of WIPP.
- Current CBFO plans, goals, and challenges.
- Conclusions.

References shown by numbers in parenthesis in the text are listed at the end of the main text.

BACKGROUND

The conception of WIPP occurred in the fall of 1971, when New Mexico State Senator Joe Gant Jr. learned that the Atomic Energy Commission (AEC) had rejected the Lyons salt mine in Kansas for a proposed spent nuclear fuel and high-level radioactive waste (HLW) disposal site (repository).(5) Senator Gant enlisted the support of Carlsbad's Mayor and other community leaders. They then approached the AEC and indicated that the thick salt deposits in the northern portion of the Delaware Basin in the southeastern portion of New Mexico should be considered for a future radioactive waste repository. The AEC followed the suggestions and sponsored a literature study that indicated the Permian-age, thick salt deposits in southeastern New Mexico were very suitable for containment and isolation of LLRM.

In 1975, surface-based site characterization efforts commenced in the vicinity of the current WIPP site.(5) Between 1981 and 1988, an underground research laboratory (URL), the North Experimental Area (NEA), and a portion of the repository were constructed (and characterized) in a carefully selected bedded rock salt horizon in the lower half of the approximately 250-million-year-old, 600-m thick, laterally extensive, tectonically and seismically undisturbed, virtually impermeable Salado Formation.(5) The stratigraphic column at the WIPP site is shown in Figure 2.

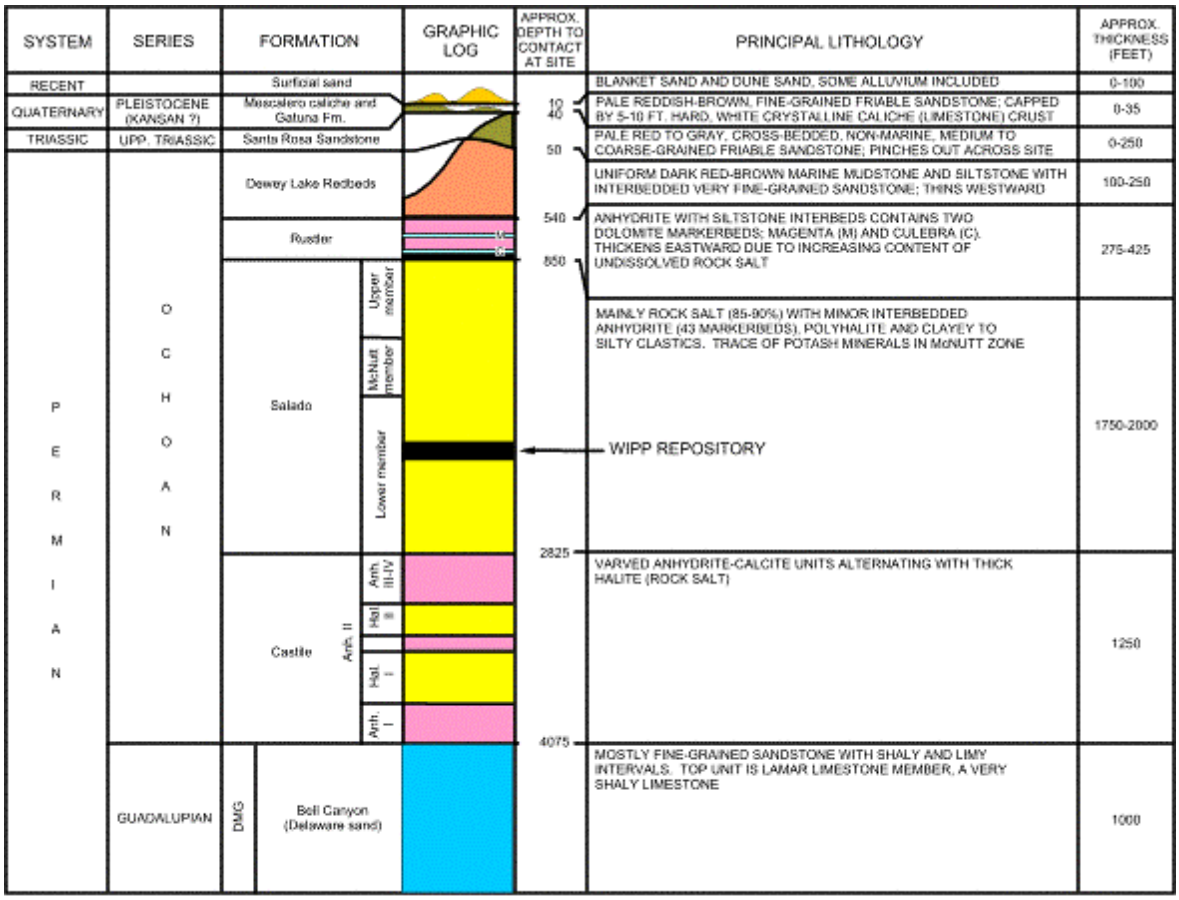

Fig. 2. Generalized Stratigraphy at the WIPP Site

CH-TRUW contained in standard 208-liter drums or SWBs will be stacked three high in the disposal rooms and surrounded by bagged MgO backfill.(3,6) RH-TRUW contained in shielded canisters measuring 0.66 m in diameter with a maximum length of 3.07 m and a maximum weight of 3.63 tons will be emplaced in pre-drilled horizontal holes in the walls of the disposal rooms.(6) The salt surrounding the disposal rooms will gradually encapsulate the emplaced waste within a few hundred years, thereby creating a virtually impermeable monolith that will contain and isolate the disposed LLRM.

In 1987, the DOE agreed with the State of New Mexico to comply with the EPA's environmental radiation protection standards (40 CFR 191). However, three aspects of 40 CFR 191.15 and 191.16 were remanded, and a federal court vacated 40 CFR 191 in 1987. An ambitious effort by the EPA to also revise other portions of 40 CFR 191 than those remanded by the federal court delayed the repromulgation of 40 CFR 191.

In January 1993, the U.S. Congress enacted the WIPP Land Withdrawal Act of 1982 (LWA).(1) In addition to withdrawing the 41.6 km^2 WIPP land parcel from public use (Fig. 1), it directed:

- The DOE to integrate the management of the nation's TRUW, including (a) characterizing and preparing the nation's TRUW for shipment to WIPP, and (b) developing, operating, and closing the WIPP TRUW repository in compliance with all applicable regulations.
- The EPA to repromulgate 40 CFR 191 for site-specific application to WIPP within one year and only revise the three aspects of 40 CFR 191.15 and 191.16 that had been remanded by the federal court.

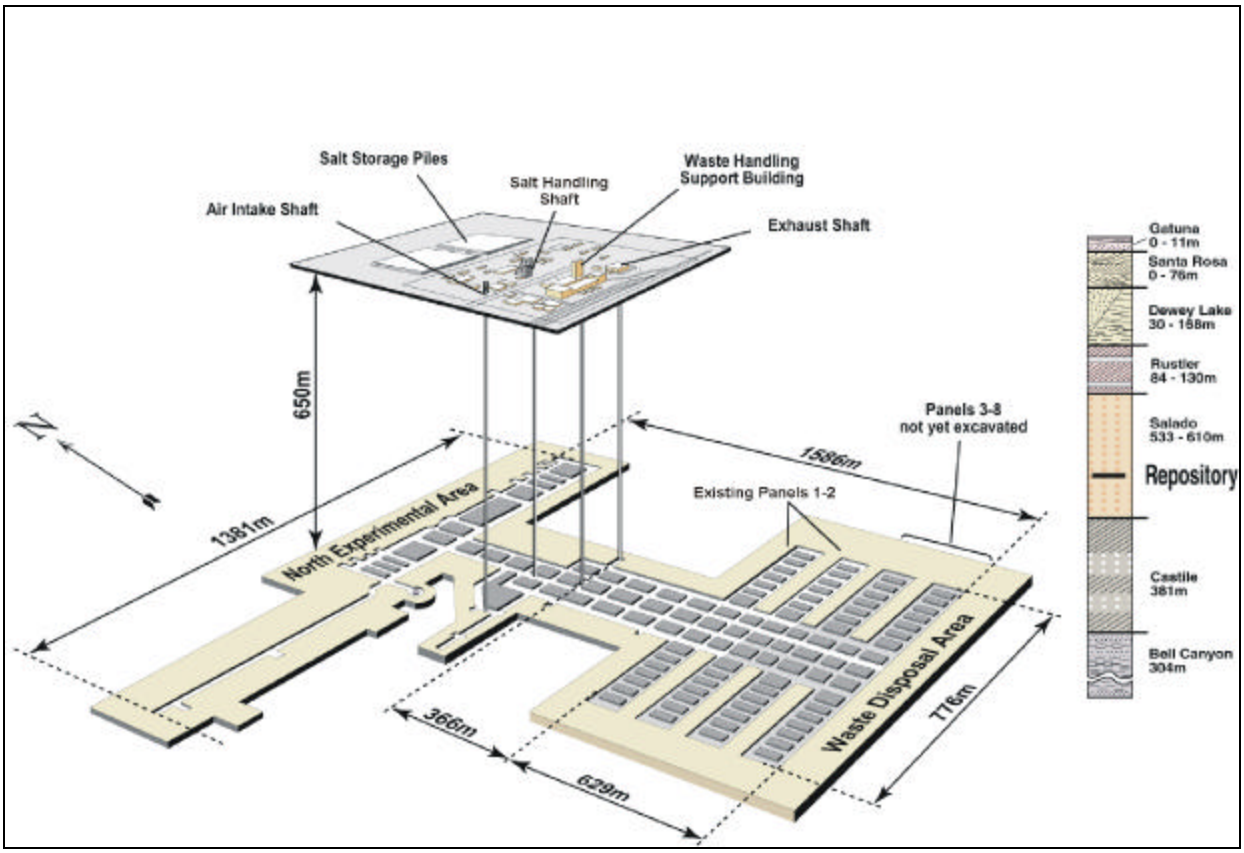

Fig. 3. Schematic illustration of surface and subsurface facilities (left), and main stratigraphic formations/units (right) at the WIPP site.

The EPA repromulgated 40 CFR 191 in December 1993,(7) followed by the promulgation of 40 CFR 194 in February 1996,(8) which provided criteria for compliance with 40 CFR 191.

In December 1993, the DOE created the CAO to implement the directions of the LWA. The establishment of the CAO reinforced the DOE's good relationship with the local communities. In April 1994, the CAO published the WIPP Disposal Decision Plan (DDP). It integrated all activities required to certify and permit the WIPP repository. In August 1995, the manager of the CAO decided to focus the scientific program on eight activity sets that, according to the System Prioritization Method (SPM) analysis, would provide 96 % probability of providing the scientific information required to certify WIPP.

In July 1996, the U.S. Congress amended the LWA.(2) In October 1996, the DOE submitted the WIPP Compliance Certification Application (CCA)(6) to the EPA for review and approval. On May 13, 1998, the EPA announced that, based on the radionuclide inventory in the projected 175,584 m^3 of TRUW to be disposed of at WIPP, including approximately 12 tons of plutonium and containers with surface dose rates of up to 10 sieverts per hour, the WIPP deep geological repository met all applicable federal regulations for safe disposal of TRUW. The EPA's Certification Decision was published on May 18, 1998.(3) The WIPP Safety Case was one of the key contributors to the successful certification of the WIPP. Key components and the results of the WIPP Safety Case are concisely described below.

The operational and post-closure safety and performance of any repository are governed by the combined radionuclide containment and isolation characteristics of: 1) the geological setting surrounding the

repository (natural system); and 2) man-made engineered barrier systems (EBS). Today, most repository development programs focus on crystalline/igneous and clayish rocks, and many place considerable reliance on the EBS for radionuclide containment and isolation. The WIPP design relies principally on the natural system to provide the regulatory-required, 10,000-year radionuclide containment and isolation of the waste. The shaft seals and a controlled chemical environment in the disposal rooms are used to support the natural system. In other words, there is no distinct near-field or far-field EBS involved in the WIPP SAs/PAs, and the long-term containment and isolation of the disposed TRUW largely relies on the natural setting at the WIPP site. This design is based on more than 25 years of generic and site-specific R&D augmented by several highly conservative, widely-reviewed SAs/PAs.

It should be noted that the WIPP site is located in an area with economic natural resources. For example, potash is mined around the site in a horizon in the upper part of the Salado Formation, the McNutt potash zone, which is located approximately 200 m above the WIPP repository horizon. Oil and gas are produced around the WIPP site from strata situated at least 585 m below the WIPP repository horizon.(6) This presence of natural resources around and below the WIPP site drastically increased the frequency of projected post-closure inadvertent human intrusions.(6)

The primary scientific and technical reasons for the successful certification, opening, and public acceptance of WIPP for safe disposal of LLRM are:

- The very favorable radionuclide containment and isolation characteristics of the geologic setting at the WIPP site;
- The simplicity, uniformity and lateral consistency of the geological setting at and adjacent to the WIPP site; and
- The very high long-term (post-closure) safety provided by the WIPP repository.

For example, prior to the certification of WIPP, the WIPP Safety Case had been scrutinized for several years by interest groups, oversight groups, members of the public, concerned scientists, two independent regulators, and two independent international organizations. The concerns expressed fundamentally evolved around the quality of the database and discrete models and/or parameter values used in the SAs/PAs. In other words, the long-term safety of WIPP was never a major issue. As a case in point, under "undisturbed" repository conditions, the maximum annual radiation exposure to an individual from WIPP predicted in the 1996 CCA(3) is a factor of 32 lower than the limit (i.e., 3 % of the limit) defined as safe by the EPA in the disposal regulations and $1/768^{th}$ (0.13 %) of the average natural background radiation in the USA. As another case in point, even if breached by multiple, low-probability, hypothetical human intrusions, the "disturbed" WIPP repository will safely contain the emplaced TRUW for at least 10,000 years. As illustrated on the right side of Figure 4, the CBFO projected in the CCA that the total amount of radionuclide releases during the 10,000-year regulatory period from a fully loaded WIPP repository would be lower than 3 % of the applicable regulatory limits.(6) The subsequent EPA-requested PA verification test (PAVT) for the "worst case" of radionuclide releases during the 10,000-year regulatory period were less than 10 % of applicable regulatory limits. Thus, the post-closure safety of the WIPP TRUW repository is very high. Indeed, the very high safety factor is one of the main reasons the CBFO feels comfortable to offer other organizations access to WIPP for R&D collaborations.

On March 26, 1999, after the CBFO overcame two legal challenges and obtained the NMED's consent, WIPP received the historical first shipment of non-mixed CH-TRUW from Los Alamos National Laboratory (LANL), and the long awaited opening of WIPP was realized. The 1998 certification and the 1999 opening of the WIPP TRUW repository are domestic milestones that were achieved by state-of-the-art means and measures. Indeed, the March 1999 opening of the WIPP repository commenced a new DOE era, facilitating significant national risk reduction and environmental improvement by:

- Safe disposal of LLRM currently stored in temporary surface and near-surface structures, several of which are located adjacent to population centers; and
- Accelerated clean up of radioactively contaminated sites(9-11).

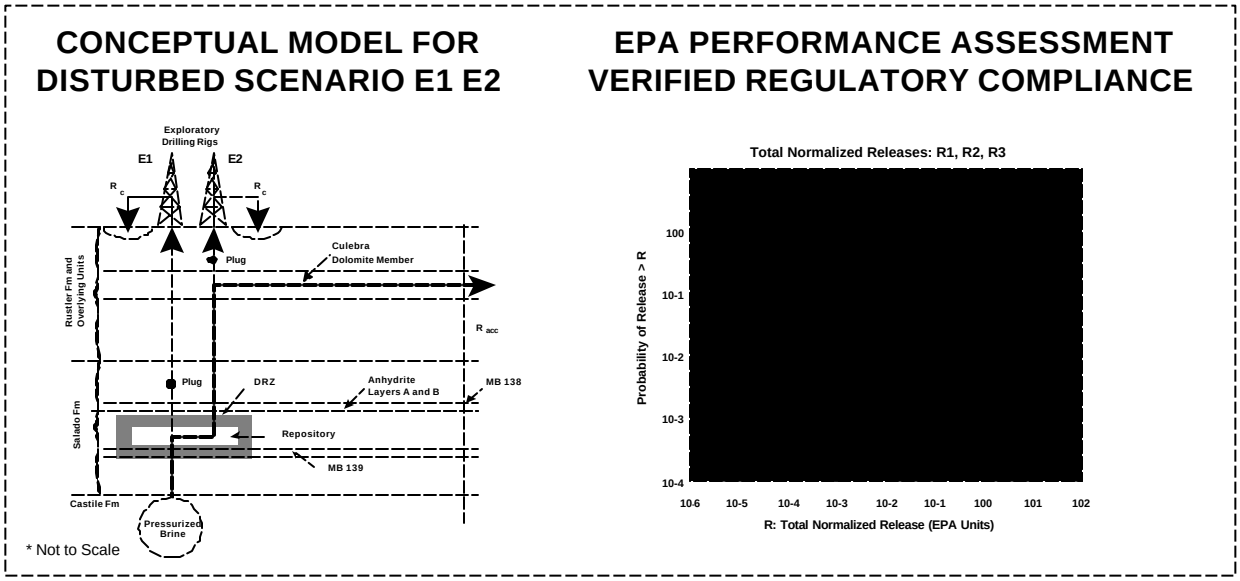

Fig. 4. Schematic illustration of the "highest-consequence" disturbed scenario (left) and the mean complementary cumulative distribution functions (CCDFs) for all undisturbed- and disturbed-scenario radionuclide releases during the 10,000-year regulatory period, where CCA depicts the mean CCDFs presented in the CCA and PAVT depicts the mean CCDFS for the "worst-case" conditions evaluated by the EPA before certifying WIPP (right).

The certification, opening, and safe operation of the WIPP TRUW repository also signal a new era for enhanced acceptance and credibility of deep geological disposal of LLRM both in the USA and abroad. It demonstrates to the world that deep geological disposal of LLRM can be safely done at a carefully selected site in a specially designed repository. Indeed, one of the most apparent and inescapable conclusions is that, if primary reliance for the containment and isolation of long-lived waste is placed on the natural barriers rather than specially designed engineered barriers, rock salt is a very suitable geologic medium.

It should be noted that more than 50 % of the nation's 109,000 m^3 of existing TRUW may be mixed with regulated hazardous constituents.(9,11) Consequently, in order for the DOE to dispose of this mixed-TRUW at the WIPP site, the WIPP also needs to be permitted for hazardous waste disposal by the State of New Mexico. The Resource Conservation and Recovery Act of 1976 (RCRA)(12) and related federal regulations(13-15), plus State of New Mexico laws and regulations govern the disposal of the regulated hazardous constituents at the WIPP site.

In May 1995, the DOE submitted the WIPP RCRA Part B Permit application to the New Mexico Environment Department (NMED) for review and approval. On October 27, 1999, the NMED announced its intent to issue a final RCRA Part B Permit that would become effective after 30 days and that would allow the CBFO to receive and dispose of mixed TRUW at the WIPP site(4). In November 1999, the CBFO postponed any further TRUW shipments to allow the CBFO and the nation's TRUW generator and/or storage sites to adjust to the conditions set forth in the RCRA Part B Permit. At that time, 44 shipments of non-mixed CH-TRUW from three generator and storage sites (LANL, Idaho Engineering and Environmental Laboratory [INEEL], and Rocky Flats Environmental Technology Site [RFETS]) had been safely received and disposed at the WIPP site. In March 2000, the CBFO resumed

non-mixed CH-TRUW shipments to WIPP. On July 14, 2000, a fourth site, the Hanford site, shipped non-mixed CH-TRUW to WIPP. On September 9, 2000, the INEEL provided the historical first mixed CH-TRUW shipment to the WIPP site.

CURRENT STATUS AT WIPP

The 28-year-long repository siting, design, construction, certification, and permitting process at WIPP was not easy, quick, or cheap. However, it provided a multitude of lessons learned(5,16) that will be implemented during the continued operation of WIPP and that also apply to similar programs in other rock types. Two of the globally applicable lessons learned at WIPP are:

- Science is only one of many disciplines required for a successful repository program, and
- Strategic partnerships and collaborations with national and international radioactive waste management organizations provide cost-effective means to: (a) acquire information that supports and justifies programmatic strategies and models, and (b) enhance acceptance among the general public, oversight groups, and regulators.

To date, eight national and two international radioactive waste management organizations have recognized the value of the experience and lessons learned (and to be learned) at WIPP. These foreign organizations have established strategic partnerships with the CBFO, thereby facilitating broad-based information exchanges and collaborations. Continued cost-effective and timely information exchanges and scientific collaborations with these and other national and international radioactive waste management organizations are integral components of the CBFO's future programs. The CBFO's current focus is on increased development and utilization of existing resources and facilities at WIPP. The "Prospectus on Waste Management and Repository Development Collaborations with the U.S. Department of Energy Carlsbad Area Office"(17) summarizing past experiences, lessons learned, and future programs at WIPP has been prepared and distributed. This information is of particular value to waste disposal programs that stand to benefit from appreciable rock salt deposits within their national boundaries.

At the end of the year 2000, WIPP had received 128 truck shipments of mixed and non-mixed TRUW from four sites. The trucking/shipping capacity was up to four shipments per week, and the CBFO had a fleet of 19 TRUPACT-II shipping containers and 17 TRUPACT-II trailers.(9) Recently awarded contracts have secured two shipping and two TRUPACT-II container manufacturers that will provide the resources and equipment required by the CBFO to accomplish its transportation goals. In addition, based on the recommendations received from the National Academy of Standards in an Interim Status Report,(18) the CBFO is investigating rail shipments and the elimination of certain waste characterization requirements.

CURRENT CBFO PLANS, GOALS, AND CHALLENGES

As described below, the CBFO's current plans, goals, and challenges are directed at:

- Increasing the transport of TRUW to WIPP, denoted as "filling the pipeline" to WIPP.
- Obtaining long-term operational efficiencies.
- Preparing the first recertification application for WIPP.
- Expanding the WIPP mission to include providing solutions for waste management needs of broad national concern.

To meet the operational, scientific, and regulatory challenges facing the continued safe operation, recertifications, and decommissioning of WIPP, the CBFO has developed and implemented operational and scientific programs governed by the following goals and objectives:

1. First and foremost, the CBFO will continue to operate WIPP in compliance with all applicable laws(1,2,12), federal regulations(7,8,13,14,15), the EPA's Certification Decision(3), the NMED's RCRA Part B Permit(4), and other regulatory requirements, agreements, and DOE Orders.
2. Operate an integrated system to dispose of the nation's defense-generated TRUW.(9-11)
3. Optimize TRUW disposal operations.(9,10)

Following are the CBFO's main current operational milestones:

- Commence RH-TRUW shipments and disposal in February 2002.
- Submit the first recertification application for WIPP to EPA, including operational improvements, in 2003.
- Remove all TRUW from 17 of the nation's 23 TRUW generator and storage sites by 2006.
- Remove all TRUW from the remaining six sites by 2034.

The primary challenge to accomplishing the 2006 and 2034 goals is the filling of the pipeline to WIPP. The related operational challenges are largely embodied in the RCRA Part B Permit. Therefore, the CBFO has mounted an aggressive effort to develop permit modification applications to clarify and improve the requirements on characterization and disposal operations. In mid-1999, the CBFO devised a three-phased, partially overlapping program to fill the pipeline to WIPP. Phase I was the non-shipping period following the issuance of the RCRA Part B Permit by NMED. The main objective of Phase I was to identify and close all gaps between prior operating procedures and the strict requirements and new conditions of the RCRA Part B Permit. Phase II covers the 18 months that follow Phase I. It addresses the realities of a fully integrated TRUW system and provides time to undertake additional data collection(9,10,17). Two Phase II key issues are:

- The streamlining of waste characterization.
- The build-up of adequate transportation capacity.

Thus, the CBFO's main current operational challenges are to:

- Gradually increase the end of year 2000 capacity rate of four CH-TRUW shipments per week (and the related waste characterization capacity) to 17 shipments per week by the end of year 2001 to meet the year 2006 and year 2034 milestones;
- Commence RH-TRUW shipments in 2002; and
- Establish an RH-TRUW shipment capacity of four shipments per week by the end of year 2002.

Phase III focuses on ensuring that WIPP is maintained in a readiness state so that the TRUW pipeline stays full and that WIPP receives TRUW at an optimum rate for the 35-year operational life of the facility.(9,10)

As indicated above, one of the critical path activities for accomplishing the goals set out by the CBFO is waste characterization. Past strategies were based on characterizing all TRUW at the respective TRUW generator and storage site. However, the initial cost and effort involved in setting up the characterization infrastructure and achieving site certification is large. Thus, the CBFO is now pursuing an alternative strategy for small-quantity sites based on characterizing the waste for transportation only at these sites and then sending the waste to the WIPP site for disposal characterization in a Central Characterization

Facility (CCF).(9,10) This strategy would expedite the removal of the TRUW from the involved generator and storage sites. The CBFO has requested approval for this strategy from the NMED. Therefore, the first challenge to this strategy is to obtain the NMED's approval.

The scientific program of the CBFO has also been re-assessed, based in part on the conditions stipulated by the EPA in the May 1998 Certification Decision on WIPP.(3) Many of the conceptual and numerical models and parameter values used in the CCA were very conservative. During the operational period, the CBFO will continually improve databases, refine the conceptual and numerical models, and reduce uncertainties in SAs/PAs. This will increase the post-closure-safety and broaden the acceptance of WIPP. Current knowledge strongly suggests that the waste form and the near-field (disposal room) environment largely govern the containment and isolation of the disposed TRUW under both undisturbed and disturbed repository conditions. The research efforts of the CBFO have thus been streamlined to address these two areas.(17) The research efforts also provide increased confidence and assurance that the WIPP repository will be even safer for future generations and the environment than the scenario depicted in the 1996 CCA(6), the EPA's 1998 Certification Decision(3), and the NMED's 1999 RCRA Part B Permit(4).

The CBFO has maintained a vigorous international program since 1994, including the preparation and distribution of informational material.(5,16,17) It currently participates in multi-national initiatives and activities coordinated by the European Union/Commission of European Communities, the International Atomic Energy Agency (IAEA), and the Organisation for Economic Co-operation and Development/ Nuclear Energy Agency. The CBFO is also discussing strategic partnerships with four more organizations in four additional countries. In addition, the CBFO intends to identify areas for closer collaborations with German organizations, including a topical workshop with 18-20 representatives from 13 German radioactive waste management organizations in April 2001. Another topical workshop on repository siting will be held with key representatives of the Swedish radioactive waste management program in May 2001.

The DOE has also proposed to provide the WIPP facilities and infrastructure to scientists who wish to conduct experiments, provided the experiments can be conducted without interfering with WIPP's primary TRUW disposal mission. The underground facilities at WIPP (Fig. 3) provide a suitable environment for experiments in many scientific disciplines, including particle astrophysics, waste repository science, mining technology, low radiation dose physics, fissile materials accountability and transparency, and deep geophysics. Scientists see the WIPP site as having three principal advantages over other underground facilities throughout the world. First, since WIPP is owned by the U.S. government and is not in the business of trying to sell any resources extracted during excavation, access to WIPP is not affected by the economic demand for any extracted resources, as it is in a commercial mining environment. In other words, privately owned mines do not offer the same level of stability, particularly for experiments that may take decades or more to reach conclusions. Second, because the WIPP site is in the USA, use of the WIPP site would reduce travel and living expense costs for U.S. scientists. Allowing the use of the WIPP facilities for these experiments would further the missions of the scientific community, the National Science Foundation and the DOE Office of Science. This will ultimately benefit taxpayers by decreasing the total cost of experimental programs funded by the government. Third, the salt formation hosting both the WIPP experimental facility and repository is naturally very low in primordial radioactive isotopes. Typical underground environments produce significant background radiation interference for the sensitive particle detection experiments, due to uranium, thorium and potassium present in the host rock. WIPP's salt environment presents several orders of magnitude lower background radiation interference than typical hard rock mines.

Of particular interest to the current astrophysics and basic science proposals is the NEA (Figs. 3 and 5), which was once used for underground experiments that studied the suitability of the host salt formation to

effectively isolate both TRUW and heat-generating waste from the environment. The NEA is currently largely unused, with no plans to use it for disposal.

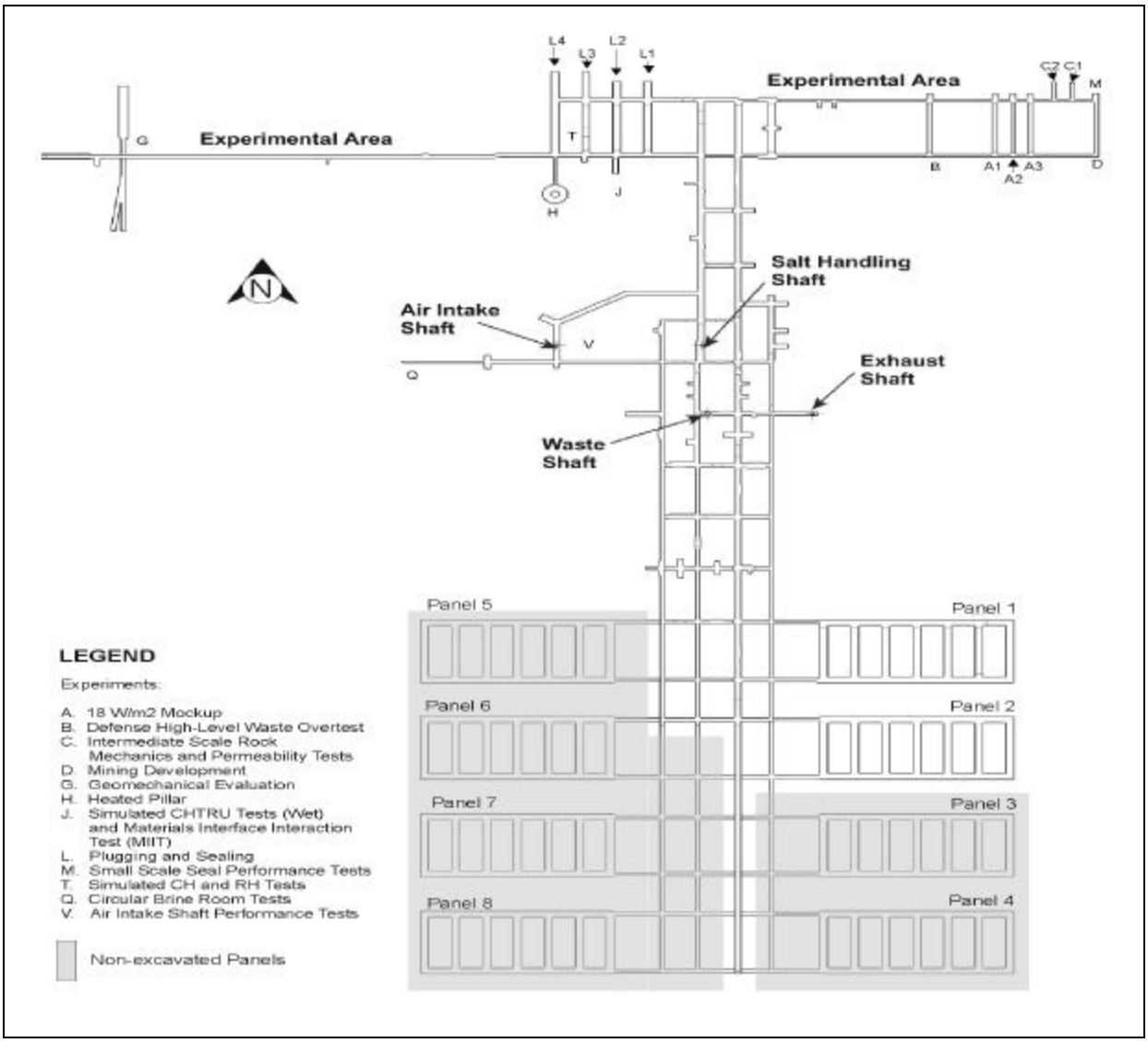

Fig. 5. Layout of underground facilities and locations of past in-situ tests at the WIPP site.

As illustrated in Figure 3, the NEA is almost a kilometer distant from the repository disposal area and includes more than one kilometer of underground openings, approximately 10-m wide and 6-m high. As shown in Figure 5, during its almost 20 years of existence, the NEA has hosted a suite of in-situ tests designed to establish the ability of salt to contain and isolate both TRUW and long-lived heat generating waste.(17,19) The CBFO has prepared an Environmental Assessment for Conducting Astrophysics and Other Basic Science Experiments at the WIPP site, and this Assessment reached a Finding of No Significant Impact. Currently, one LANL experiment in astrophysics is conducted. This experiment gallery will be well lighted, with power and data communications available for use by the science experiments. Prototype detectors, for monitoring neutrinos from supernovae and measuring neutrino-less double beta decay, are planned for installation in the spring of 2001. Discussions with others are ongoing. For example, six other teams of scientists have proposed astrophysics experiments to the DOE and are seeking funding from the scientific community for those experiments. In addition, the CBFO has

volunteered the underground facilities at the WIPP site to the IAEA-sponsored International Repository Demonstration Project, including a full-scale, multi-year, in-situ, retrievability demonstration under elevated temperatures.

CONCLUSIONS

The 28-year repository siting, design, construction, and certification process culminating in the 1999 opening of WIPP was not easy, quick, or cheap; however, it resulted in the only operating deep geological repository for safe disposal of LLRM in the world. This process served as a model for citizen involvement, satisfied all scientific and regulatory requirements, and resulted in a facility that has earned several awards for safe operation. The lessons learned during this process will be implemented and augmented during the continued operation of WIPP.

The characteristics of the WIPP repository and infrastructure make it uniquely suited for underground research by providing access to an existing, operating underground research laboratory with ventilation, power, extensive data communications, safety oversight, surface support, emergency services and security in place. Indeed, this area can serve as a test-bed for the scientific community to perform experiments in a deep geologic setting at a lower net cost by sharing an existing infrastructure and database. In other words, experiments can be conducted for less net research dollars at WIPP than at other typical choices open to the underground research community. This research, which can and will be conducted without compromising the primary disposal mission of WIPP and the priority on safety, will achieve tremendous benefit from the DOE's significant financial and intellectual investment in the WIPP.

In summation, WIPP is currently the only facility of its kind, and will serve as a unique state-of-the-art source, resource, and role model for other similar programs in the future. Thus, strategic partnerships and collaborations with the CBFO offer cost-effective and timely access to a multitude of lessons learned and being learned at WIPP, as well as access to WIPP expertise and facilities

FOOTNOTES

[a]TRUW destined for WIPP must contain at least 3,700 becquerels (Bq) of alpha-emitting, transuranic (atomic weight/number greater than ^{92}uranium) isotopes with half-lives greater than 20 years, per gram of waste, but the canister surface dose rate may not exceed 10 sieverts per hour (Sv/h). There are two categories of TRUW: 1) contact handled (CH) has a maximum canister surface dose rate of 0.002 Sv/h and 2) remote handled (RH) has a canister surface dose rate between 0.002 Sv/h and 10 Sv/h.(1)

REFERENCES

1. Public Law 102-579, *"The Waste Isolation Pilot Plant Land Withdrawal Act of 1992"* (January 7, 1993).
2. Public Law 104-201, *"The Waste Isolation Pilot Plant Land Withdrawal Amendments Act of 1996"*, (July 30, 1996).
3. U.S. Environmental Protection Agency, "Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the Disposal Regulations: Certification Decision; Final Rule", Federal Register, Volume 63, pp. 27354-27406, May 18, 1998, Radiation Protection Division, Washington, D.C.
4. New Mexico Environment Department, "Hazardous Waste Facility Permit" (for the Waste Isolation Pilot Plant), signed by the Secretary of New Mexico Environment Department on October 27, 1999.
5. U.S. Department of Energy Carlsbad Area Office, "The Waste Isolation Pilot Plant Pioneering Nuclear Waste Disposal", DOE/CBFO-00-3124 (February 2000).

6. U.S. Department of Energy Waste Isolation Pilot Plant, "Compliance Certification Application 40 CFR 191 Subpart B and C" (October 26, 1996).
7. U.S. Environmental Protection Agency, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes; Final Rule", Title 40, Code of Federal Regulations, Part 191 (December 20, 1993).
8. U.S. Environmental Protection Agency, "Criteria for Certification of the Waste Isolation Pilot Plant's Compliance With the 40 CFR 191 Disposal Regulations: Final Rule", Code of Federal Regulations, Title 40, Part 194 (February 7, 1996).
9. U.S. Department of Energy Carlsbad Field Office, "The National TRU Waste Management Plan", (DOE/NTP-96-1204, Revision 2) (in preparation).
10. U.S. Department of Energy Carlsbad Field Office, "National TRU Waste System Optimization Plan" (in preparation).
11. U.S. Department of Energy Office of Environmental Management, "Accelerating Cleanup, Paths to Closure", DOE/EM-0362 (June 1998).
12. Public Law 94-580, *"The Resource Conservation and Recovery Act of 1976"*.
13. U.S. Environmental Protection Agency, "Identification and Listing of Hazardous Waste", Code of Federal Regulations, Title 40, Part 261.
14. U.S. Environmental Protection Agency, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities", Code of Federal Regulations, Title 40, Part 264.
15. U.S. Environmental Protection Agency. "Land Disposal Restrictions", Code of Federal Regulations, Title 40, Part 268.
16. M.H. McFadden, and L.G. Eriksson, "The Successful 1998 Certification of the Waste Isolation Pilot Plant Transuranic Waste Repository-Ten Important Lessons Learned", Waste Management 1999 Conference Proceedings (1999).
17. U.S. Department of Energy Carlsbad Area Office, "Prospectus on Waste Management and Repository Development Collaborations with the U.S. Department of Energy Carlsbad Area Office", (DOE/CAO-00-1000/Rev. 1) (May 2000).
18. National Research Council, Committee on Radioactive Waste, Board on Radioactive Waste Management, Commission on Geosciences, Environment, and Resources, "Improving Operations and Long-Term Safety of the Waste Isolation Pilot Plant-Interim Report", National Academy Press, Washington, D.C., ISNM No. 0-309-06928-9 (2000).
19. U.S. Department of Energy, "In Situ Testing at the Waste Isolation Pilot Plant", prepared by R.V. Matalucci, Sandia National Laboratories, SAND87-2382 (1988).