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**WIPP's TRANSITION FROM A RESEARCH FACILITY TO AN OPERATING FACILITY: THE PATH INTO THE NEW MILLENIUM**

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**ABSTRACT**

In May of 1998, the United States Environmental Protection Agency (EPA) certified that the Waste Isolation Pilot Plant (WIPP) site met all federal regulations for safe disposal of transuranic waste (TRUW) in a deep geologic repository. With resolution of pending litigation in February 1999, the Department of Energy (DOE) opened the WIPP repository on March 26, 1999. This opening constituted a new epoch in geologic disposal as the solution to the back-end of the nuclear fuel cycle. Through 1999, 55 shipments of TRUW from three of the nation's generator/storage sites had been disposed of at the WIPP site. DOE currently plans to remove all TRUW from 17 of the nation's 23 TRUW generator/storage sites by 2006, and to complete removal at the remaining six and terminate disposal operations at WIPP by 2034.

WIPP's transition from a hazardous & radioactive waste disposal research facility to an operating repository is the subject of this paper. Beginning with enactment of the WIPP Land Withdrawal Act in 1992 (LWA) and followed by seven years of regulatory processes, the DOE's past self-regulatory authority has essentially been replaced by a complex set of external federal and state regulations, conditions, and oversight. To meet these new requirements and challenges, DOE has conducted and is continuing to conduct a thorough re-assessment of the National TRUW program, including the continued safe operation of the repository.

To meet the interim 2006 milestone, many challenges must be met. The most obvious will be to "fill the pipeline to WIPP", which will require timely certification of sites to characterize and ship their waste and a transportation system that meets the required capacity. A three-phased, partially overlapping, approach has been devised to fill the pipeline by the Carlsbad Area Office (CAO). Phase I focuses on the 6-month window following issuance of the hazardous waste disposal permit by New Mexico in October, 1999 and will be completed by the time of the Waste Management '00 Conference. The main objective of Phase I was to identify and close all gaps between prior operating procedures and the strict requirements of the then pending hazardous waste disposal permit, with minimal impact on the flow of waste to WIPP. Phase II focuses on the medium-range horizon of 18 months, and addresses the realities of a fully integrated TRUW system and provides time to undertake data collection. Two Phase II key issues are (1) the streamlining of waste characterization and (2) the build-up of adequate transportation capacity. Phase III (focusing on a three-year horizon and beyond) is geared toward ensuring that the facility is maintained in a readiness state so that the TRUW pipeline stays full, receiving waste at an optimum rate for the life of the facility.

The CAO's scientific program is also being re-assessed, based on conditions stipulated by EPA in their 1998 certification of WIPP. Current knowledge strongly suggests that waste form and near-field environment largely dominate containment and isolation of the disposed waste, even when inadvertent human intrusion is assumed. Thus, research efforts have been streamlined mainly to

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address these two areas and focus on providing increased confidence and assurance that the WIPP repository will be even safer for future generations than depicted in the compliance certification application and the EPA's current certification of WIPP.

### **CLOSING THE CIRCLE ON TRANSURANIC WASTE**

Some 225 million years ago, the area around Carlsbad, New Mexico was a barren salt bed more than 650 meters thick. Dinosaurs had not yet roamed the Earth, and the first humans were in the distant future. The area had been covered by the Permian Sea, which by this time had repeatedly evaporated, leaving behind a salt bed that would eventually be buried more than 350 meters beneath the sands and cacti of the Chihuahuan Desert.

Today, that salt formation houses the Waste Isolation Pilot Plant (WIPP) – an underground repository certified by the Environmental Protection Agency (EPA) and permitted by the New Mexico Environment Department (NMED) – the U.S. solution to the risks currently posed by temporary storage of transuranic radioactive waste (TRUW).

After more than 25 years of study and evaluation, the first shipment of TRUW arrived at the gates of the WIPP at 4:00 a.m. on March 26, 1999. Despite the early hour and low temperature, several hundred employees, local officials, and private citizens turned out to greet the shipment. As the truck and distinctive TRUPACT-II shipping containers emerged from the pre-dawn darkness, the crowd erupted into applause, whistles, and yells. Many there had worked on the WIPP project for years, and some had invested their entire careers to achieve this moment.

The path to WIPP began nearly 60 years before the first TRUW arrived at the repository. The U.S. produced the world's first significant quantities of TRUW in the early 1940s, and idled its plutonium-producing reactors and warhead manufacturing plants at the end of the Cold War. However, the DOE will continue to generate more TRUW as it cleans up these former nuclear weapons facilities. The WIPP is a cornerstone of the effort to clean up these facilities by providing a safe repository to isolate TRUW in disposal rooms mined in ancient salt beds, 667 meters below ground.

#### **The Need for WIPP**

The DOE and its predecessor agencies, beginning with the Atomic Energy Commission (AEC) in the 1940s, designed and tested dozens of nuclear warhead models and manufactured thousands of individual weapons. In recent years, the DOE's emphasis has shifted to the legacy of nuclear arms production: numerous contaminated sites and a large accumulation of radioactive and hazardous wastes in temporary storage. The government must protect present and future generations from exposure to these materials. The primary concerns related to TRUW management are:

- plutonium's long half-life, requiring isolation for tens of thousands of years
- serious health hazards posed by tiny quantities of plutonium, particularly if inhaled or ingested
- radiation exposure to workers who handle, repackage, and transport the waste

Scientists have explored many alternatives for managing TRUW. Since no practical method for destroying radioactive isotopes exists at present, the only option is to wait for them to decay. Temporary surface storage of TRUW has not posed serious imminent hazards to the public, but it is unacceptable for the long term. Many barrels and boxes containing waste have exceeded their design lifetimes and some of them have corroded and leaked. Continued temporary storage would require periodic repackaging, at considerable expense and some risk to workers, for the indefinite future. The land occupied by surface storage cannot be used for other purposes, and the sites must

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be guarded and monitored at an annual cost of hundreds of millions of dollars. These facilities are subject to natural catastrophes, such as fires, storms, and earthquakes. Permanent disposal must satisfy a demanding set of criteria:

- By law (1) (2), the disposal site must isolate its radioactive wastes, causing no significant risk to the public, for at least 10,000 years.
- The disposal facility should be in an area unlikely to be in high demand for agriculture, mineral extraction, residential or industrial use.
- Surface and underground construction of the facility must comply with all safety and environmental standards.
- Waste shipment to the site and emplacement in the repository must pose minimal risk to workers and to citizens along transport routes.
- Due to uncertainty about future cultures and languages, durable and comprehensible warnings must be created to discourage human intrusion.
- During the entire process of establishing and operating the facility, the DOE must fully inform, and listen to, other government agencies, scientific advisory panels, and concerned citizens.
- As a taxpayer-funded project, the disposal site must meet its goals in the most cost-effective manner.

Establishment of the WIPP has not been easy, quick, or cheap, but the process produced a facility that is safe, satisfies scientific and regulatory requirements, has earned awards for safe operation, and served as a model for citizen involvement.

### **Community Leaders Suggest Carlsbad as the Site for the WIPP**

Carlsbad's involvement with the WIPP began in the fall of 1971 when New Mexico State Senator Joe Gant Jr. learned that the AEC had rejected the Lyons, Kansas salt mine for a proposed nuclear waste disposal site. Gant enlisted the support of Carlsbad's Mayor and other community leaders. In October 1971, the president of Continental American Royalty Company, the parent company of U.S. Potash, wrote to the Chairman of the AEC and proposed that a soon-to-be abandoned U.S. Potash mine would make a good site to store high-level radioactive waste.

Nuclear waste disposal deep in salt formations seemed a likely prospect for Carlsbad. Potash mining had been the economic backbone of the town for decades. It seemed only logical to use the vast network of mines to dispose of nuclear waste. As it turned out, the AEC selected federally owned land nearby to create a mine specifically for disposing of radioactive waste.

Community leaders had been working tirelessly to pull the town out of a disastrous economic downturn. In 1967, the largest local employer, U.S. Borax and Chemical, had closed, eliminating 1,000 jobs. The schools lost more than 2,000 students during the next several years. Hundreds of homes went on the market; some were abandoned as families left town to find work. Over the years, city leaders had built strong ties with state officials. When the opportunity for a large, new federal project came to the community's attention, Carlsbad worked vigorously for the WIPP. Local leaders who frequently traveled to Washington to work on other issues, added WIPP to their agenda.

### **Construction of the WIPP**

After nearly a decade of study, the DOE decided in January 1981 to proceed with construction of the WIPP. An exploratory shaft reached a depth of 702 meters. Ten months later, while deepening

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a previously drilled test borehole near the WIPP (about 1.5 kilometers from the current disposal area), the DOE struck a large pressurized brine reservoir. The DOE relocated the proposed repository's footprint approximately 1.8 kilometers south of its original location. In May 1981, the New Mexico Attorney General filed suit against the DOE and the Department of the Interior (DOI), alleging that continued development of the WIPP violated federal and state law. The federal agencies and the Attorney General entered into a "Stipulated Agreement" that required the DOE to perform additional geotechnical studies at the WIPP site, provide the results to the state of New Mexico, and address "off-site concerns" such as emergency response and highway improvements. Laws and regulations that were to govern the WIPP began to take shape.

DOE persevered in conducting the needed studies. Simultaneously, it developed and licensed a shipping container specifically designed to safely transport TRUW in a variety of payload containers. It established designated transport routes and provided training to communities along the route in emergency response. Construction of the design basis repository was completed in about 1988 with the installation of a final air ventilation shaft (Figure 1).

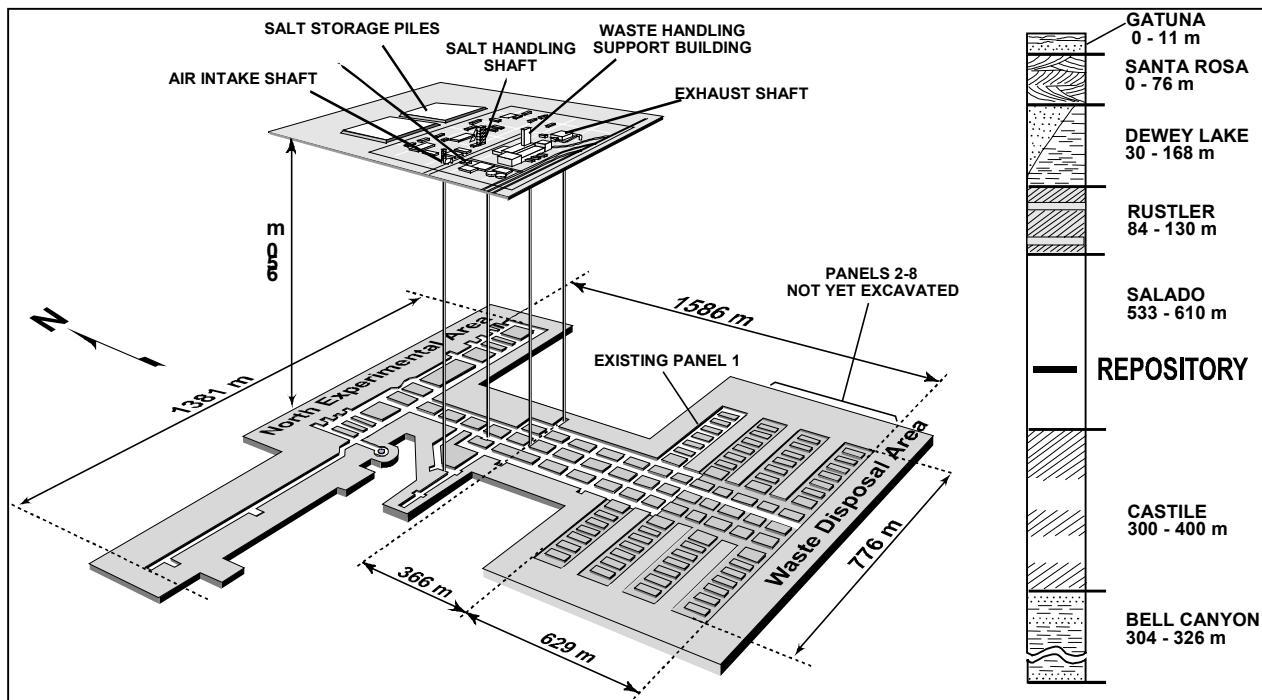


Fig. 1 Schematic illustration of the baseline repository design and the stratigraphy at the WIPP site.

### The WIPP Land Withdrawal Act

In 1992, Congress passed and President George Bush signed the *WIPP Land Withdrawal Act* (LWA) (1). The title of this crucial legislation underscores that Congress "withdrew" from public use the area devoted to the WIPP site. Congress transferred jurisdiction of the site from the Department of Interior to the DOE. The LWA also established an array of conditions covering everything from limits on the kinds and quantities of waste the DOE could place in the repository to transportation safety. The LWA also set requirements for oversight and regulation of the WIPP by federal and state agencies, for publication of information and documents, and for provision of economic assistance to the State of New Mexico. The 1992 Act also established the EPA as the WIPP's regulator for TRUW and limited the waste sent to WIPP to DOE's defense-related waste. It

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also re-affirmed the 1979 prohibition on the disposal of high-level radioactive waste and spent nuclear fuel at WIPP.

In 1996, Congress amended the LWA (2), deleting requirements that the WIPP obtain a “no-migration” variance from the EPA. This meant that the DOE would not need to submit a lengthy application showing why it should be exempt from land disposal restrictions under the Resource Conservation and Recovery Act (RCRA). The rationale was that WIPP was not a shallow landfill of the kind typically used for waste containing toxic chemicals or metals, and that the requirements imposed on radioactive waste disposal and containment were conservatively adequate to also contain any hazardous constituents of waste disposed of at the WIPP.

The LWA is a landmark in the legal history of the site. It serves as a concise record of the essential steps required to establish the WIPP repository, the major institutions involved, and the basic requirements for disposal and decommissioning activities.

### **Waste Volumes and Characteristics**

The capacity of the WIPP was limited by the LWA to 175,584 cubic meters of TRUW. The waste itself can be described in a variety of ways.

- It was generated at DOE defense facilities.
- More than half the waste is considered mixed TRUW (meaning it contains hazardous components, usually metals or organic solvents) and their storage and disposal are subject to regulation by the Resource Conservation and Recovery Act.
- The waste currently in storage at sites around the country was generated after 1970. Most of the remainder will be generated from activities such as environmental restoration, decontamination, and decommissioning.

### **Certification by the EPA**

Since 1992, the EPA has been the WIPP’s primary regulator with responsibility for evaluating and verifying that the WIPP will safely isolate TRUW and protect human health and the environment for at least 10,000 years. To carry out this responsibility, the EPA issued regulatory standards for safe management and disposal of TRUW during handling and after disposal in Title 40 CFR, Part 191 (3). Then, to determine whether the WIPP would meet these standards, the EPA formulated a set of WIPP-specific criteria in Title 40 CFR, Part 194 (4), requiring DOE to provide certain kinds of information and setting forth what the DOE must do to show that WIPP would meet the standards (3). These standards address several crucial aspects of the WIPP and the waste that would be placed in it.

- The longevity and potential dangers of TRUW require any permanent disposal facility to be highly reliable. The nation’s responsibility toward future citizens, who have no say in decisions made before their time, means that TRUW disposal standards must be particularly rigorous.
- The WIPP is the world’s first deep geologic disposal site designed specifically for TRUW, and it is one of a very small number of permanent repositories in salt beds for any type of waste. People have had no opportunities to observe such a site for more than a few decades. Therefore, EPA regulation could not be based upon actual measured performance over the short term. Instead, the DOE must perform research, simulation, and independent reviews to demonstrate that the WIPP could satisfy the long-term standards.

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- The EPA and the DOE must be very confident that the WIPP repository will perform as expected, because removing wastes from the salt bed becomes more difficult and costly as time passes.

In late 1996, the DOE submitted its WIPP Compliance Certification Application (CCA) to the EPA (5). This document, consisting of more than 25,000 pages, contained the results of decades of research, review, and public comment. The EPA evaluated whether the application demonstrated that the WIPP could comply with the stringent disposal requirements for TRUW (3) (4). In May 1998, the EPA certified that the repository system would meet the standards.

The EPA's certification of the repository, followed by the Secretary of Energy's decision to proceed with waste disposal, completed one of the major steps in opening the WIPP. During the course of the disposal phase, every five years the EPA will review whether to continue or modify its certification of the WIPP.

### **The National Environmental Policy Act**

The National Environmental Policy Act requires government agencies to analyze the environmental impacts of any proposed project. The DOE has made decisions about the WIPP based on the results of three extensive environmental analyses of the WIPP facility and its environment.

The first study, in 1980, was called the Final Environmental Impact Statement for the Waste Isolation Pilot Plant (6). The DOE decided (in a Record of Decision) to begin surface and underground construction of the facility.

After constructing all surface facilities and a portion of the underground repository, the DOE prepared another environmental study to assess impacts of proposed underground research using radioactive materials. In its 1990 decision based on this study, called the Final Supplement Environmental Impact Statement for the Waste Isolation Pilot Plant, the DOE chose to proceed with a test phase using radioactive materials at the facility (7). This research, however, was never conducted at the WIPP. Instead, national laboratories performed the tests.

In its 1990 Record of Decision, the DOE committed to prepare another study before deciding whether to dispose of waste at the WIPP. The new study was to analyze long-term performance of the underground repository based on information obtained after 1990. The DOE would also study the expected effects of disposal operations at sites that prepare and ship wastes to the WIPP, and would complete an environmental study of the proposed transportation system.

In a 1998 Record of Decision, the DOE decided to dispose of its defense-generated TRUW at the WIPP after the material was prepared to meet specific waste acceptance criteria. The DOE also decided to transport the waste by truck, although rail transportation might still be used in the future. These decisions were based upon the Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement, completed in September 1997 (8). That study evaluated waste treatment, disposal, and transportation alternatives.

Compliance with the National Environmental Policy Act has been an important part of decision-making at the WIPP. The DOE considered these environmental studies, along with other important regulatory and policy requirements, at critical junctures of the repository's development.

### **The Resource Conservation and Recovery Act**

Congress passed the Resource Conservation and Recovery Act in 1976 to establish requirements for the management of hazardous waste. The term "hazardous" refers to the chemical hazard of the material and is usually associated with chemical toxicity, corrosivity, ignitability or flammability. Much of the waste to be disposed of at the WIPP is mixed waste, meaning that it contains hazardous

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waste in addition to TRUW, though in the case of the WIPP, corrosive, ignitable or flammable materials are prohibited. Therefore, the WIPP must comply with RCRA to dispose of mixed waste. The EPA delegated its RCRA regulatory authority to the New Mexico Environment Department in 1990, which became responsible for enforcing its requirements and issuing the WIPP RCRA permit.

The RCRA permit application consists of two parts; Part A and Part B. Part A is a standard form that identifies the types and quantities of waste intended for disposal at the site. Timely submission of a Part A application and notification of hazardous waste activities usually qualifies owners and operators of existing hazardous waste management facilities for "interim status". A facility with interim status is treated as having been issued a permit until the EPA or an authorized state makes a final determination on the facility's Part B RCRA permit application. DOE submitted the WIPP RCRA Part A application to NMED in 1991. Almost immediately, the New Mexico Attorney General and others filed a court challenge as to whether or not WIPP qualified for interim status in court. This resulted in a 1992 injunction that was not resolved until March 1999 when the U.S. District Court of the District of Columbia ruled that WIPP indeed qualified for interim status.

Part B of the permit application offers an extensive set of requirements on how the facility will operate to meet RCRA requirements. Part B includes waste characterization information on the hazardous wastes to be handled at the WIPP, a description of procedures for handling hazardous wastes, security procedures and equipment, seismic and flood plain information, and closure and post-closure plans, including groundwater monitoring. WIPP submitted its Part B RCRA Permit application to the State of New Mexico in 1995.

After three years of amendments, evaluation and requests for additional information, the New Mexico Environment Department (NMED) issued a draft RCRA permit for WIPP in May 1998. After receiving an initial round of public comments, the NMED issued a revision in November 1998 and subsequently held public hearings in Santa Fe and Carlsbad, New Mexico. The process culminated when NMED issued the final permit in October 1999. A standard hazardous waste permit is issued for a fixed term not to exceed 10 years. Several permit renewals will be necessary during the projected 35-year operation of the repository.

### **Disposal of Non-Mixed TRUW**

After receiving EPA certification for disposal of TRUW in May 1998, and with the RCRA permit still pending, it became clear that WIPP would not receive its hazardous waste permit as early as had been expected. An earlier agreement between the State of Idaho and the DOE that waste shipments from the Idaho National Engineering and Environmental Laboratory to WIPP would begin by April 1999 loomed over the decision whether to open WIPP and begin waste disposal before receiving the RCRA permit. In May 1998, the DOE decided to proceed with non-mixed TRUW disposal (TRUW that contained no hazardous materials regulated under RCRA). Despite its belief that the WIPP had interim status and therefore was legally able to accept mixed waste, the DOE decided to ship only non-mixed waste to the repository.

In June 1998, the DOE delayed plans for the first shipments from Los Alamos National Laboratory (LANL) to the WIPP because of NMED concerns about the DOE's characterization of the waste and claims by the New Mexico Attorney General that the 1992 injunction on the WIPP was still in effect.

The first issue was resolved by confirmatory sampling and analysis in accordance with a plan that NMED approved. The sampling confirmed that the wastes were not mixed and therefore were not regulated under RCRA. The DOE sent the results to the Environment Department, which agreed in December 1998 that the Los Alamos waste was non-mixed. The second issue was resolved in court.

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### **Court Rulings Deny Request for Further Delays**

After the EPA certified that the WIPP met the standards for disposal of TRUW in May 1998, the New Mexico Attorney General asserted that the lack of a hazardous waste permit from the state of New Mexico and lack of interim status prevented the WIPP from receiving any waste. On March 22, 1999, Judge John Garrett Penn of the U.S. District Court of the District of Columbia denied a request for injunctive relief that would have prevented the first shipment of waste to the WIPP.

The Court's March 22, 1999 ruling made several key points:

- The injunction entered in 1992 no longer applied and therefore did not prevent the shipment of waste from Los Alamos to WIPP.
- The WIPP has interim status under RCRA. - The Los Alamos waste was not hazardous waste under RCRA, so even without interim status the DOE could ship it to the WIPP.
- The plaintiffs failed to demonstrate that they had a likelihood of success on the merits.
- The interest of the public would not be served by an injunction.

On March 24, 1999, eight federal judges in three separate courts agreed that WIPP's opening should not be delayed. The long-awaited first shipment of TRUW to the WIPP was now just hours away.

### **The First Shipment**

The first shipment of TRUW to WIPP left LANL on March 25, 1999 at 7:49 p.m. Los Alamos residents cheered as the truck departed. The truck traveled through the City of Santa Fe after rush hour traffic had ended. Demonstrations against the shipment in northern New Mexico were peaceful.

The historic first shipment rolled through Carlsbad, New Mexico amidst cheers, flashing lights, and honking horns of support early on March 26. By the time the truck reached the WIPP, it was 4:00 a.m. Despite low temperatures and the early hour, several hundred employees and local officials gathered to witness the arrival.

When the distinctive TRUPACT-IIs on the back of the truck appeared, the crowd erupted into applause, cheers, and whistles. Many had worked toward this moment for years. After WIPP workers completed security and radiological inspections on the containers and the truck carrying them, they were allowed through the main gates and into the Waste Handling Building.

Inside the Waste Handling Building, WIPP workers unloaded the first TRUPACT-II and placed its waste in the repository by early afternoon on March 26. Workers unloaded the two remaining TRUPACT-IIs and placed their contents underground on March 30.

Eleven years after the WIPP was initially scheduled to open, its first waste receipt was a monumental step forward in the safe management of nuclear waste. Far from being an ending, however, the WIPP story has really just begun. For the next 35 years, the DOE will face many challenges as it manages a complex characterization, shipment and disposal schedule from TRUW sites across the United States and continues to ensure that the repository complies with all regulatory requirements.

### **TRANSITION FROM NON-MIXED TO MIXED TRUW DISPOSAL OPERATIONS**

On October 27, 1999, the WIPP reached another regulatory milestone when NMED issued a long-awaited hazardous waste permit under RCRA. The permit enables the DOE to dispose of TRUW



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that is mixed with hazardous constituents. More than half of the waste to be placed in the WIPP is mixed waste.

When the final RCRA permit was issued on October 27, 1999 and became effective 30-days later, it brought an end to the uncertainty about how the RCRA requirements would affect WIPP operations. The permit requirements provide for WIPP operations mostly in line with the processes and procedures that DOE offered in its permit application. However, there were several important differences that required significant changes to WIPP's planned operations. These changes are described in the following sections.

### **Waste Characterization at Generator Sites Affected by RCRA Permit**

As part of WIPP's RCRA permit application and the Compliance Certification Application to EPA, WIPP had developed a certification process that it applied to each of the generator sites for characterization, preparation and packaging of the waste. For the non-mixed waste received prior to the RCRA permit, Los Alamos, Idaho, and Rocky Flats facilities were the first three sites to obtain this certification and all shipped waste to the WIPP. The RCRA permit, however, added a requirement that NMED must approve DOE's certification at each site and introduced a lengthy prescriptive checklist process for their approval. At the time of manuscript preparation, the time duration to receive NMED approval was unknown. The NMED approval process is "open ended". However, a prudent estimate involving nominal interaction and understanding of the characterization process would indicate about 45 days for NMED to approve each generator site will be required. WIPP is currently assisting the sites (in the near-term focused primarily on Rocky Flats and Hanford) in modifying their characterization programs to meet the permit requirements. On the permit's date of effect (November 27, 1999), shipment of non-mixed waste to WIPP ceased. It is DOE's intent to receive NMED approval of the waste characterization processes at Rocky Flats and Hanford and resume disposal operations of mixed waste shipments from these sites by February 2000.

The final RCRA permit also introduced additional waste characterization requirements at the sites. Instead of analyzing a single sub-sample of a cored sample from homogeneous waste types, the permit requires that three sub-samples (of the same single core) be analyzed during characterization. While this seems to be an insignificant requirement over that offered by DOE in its permit application, it forces the sites to re-sample the many waste containers that have previously been analyzed with only a single sub-sample, resulting in a significant potential risk to workers and additional costs.

Another change in the final permit from DOE's proposed analysis methods in the application is the number of containers that must be re-opened and visually examined. To confirm real-time-radiography (RTR) results, DOE proposed in its application that a certain mis-certification rate be employed to determine the number of containers that would be re-opened and visually examined. The final permit modified the process to determine the number of containers to be visually reexamined such that the number and frequency would increase substantially. Because the visual examination process is only one of confirmation, and because visual examination results in potential dose to workers, this increase is considered very significant.

### **Waste Disposal Operations Affected by RCRA Permit**

One of the unexpected requirements in the final permit seriously impacts smooth disposal operations. The following requirement is excerpted from Module IV.b.2.b of the final permit:

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IV.b.2.b Specific prohibition – after this permit becomes effective, (1) the Permittees shall not dispose non-mixed TRU waste in any Underground HWDU unless such waste is characterized in accordance with the requirements of the WAP specified in Permit Condition II.C.1, and (2) the Permittees shall not dispose TRU mixed waste in any Underground HWDU if the Underground HWDU contains non-mixed TRU waste not characterized in accordance with the requirements of the WAP.

Part 2 of this unexpected requirement essentially precludes WIPP from placing waste characterized according to the permit requirements alongside non-mixed waste disposed of before the permit was issued (the WAP contains all characterization requirements of the permit – including the new requirements outlined in the preceding paragraphs). The non-mixed waste shipped prior to the permit was not characterized using the new requirements (e.g., three sub-samples from cores of homogeneous solid waste). DOE did not expect such an arbitrary and capricious requirement and had always believed that both non-mixed and mixed waste could be placed together in Panel 1. While disagreeing on the need for such separation, DOE immediately modified its mining plans to accelerate the completion and readiness of Panel 2 for mixed waste disposal by July 2000. If permit modifications cannot be effected to allow co-disposal of waste characterized before and after the permit in the same disposal unit (Panel 1), then disposal operations will not resume until Panel 2 is ready.

Part 1 of Module IV.b.2.b also significantly affects disposal operations. Even if non-mixed and mixed waste were separated with non-mixed in Panel 1 and mixed in Panel 2, Part 1 of the permit requirement precludes DOE from disposing of non-mixed waste in Panel 1 unless it was characterized according to the permit WAP. With a considerable inventory of non-mixed waste already characterized using methods prior to the permit, this waste would have to be re-characterized according to the WAP before it could be placed in either Panel 1 or 2.

Another significant permit requirement is actually a prohibition. The permit specifically prohibits DOE from disposing remote handled waste at WIPP. Remote-Handled (RH) TRUW contains the same types of items and materials as Contact-Handled (CH) waste, but has a higher level of radioactivity (>200mrem per hour on contact with the container). RH waste is handled and shipped in shielded containers to protect people and the environment from exposure. Unlike CH waste, RH waste will not be shipped in a TRUPACT-II. Instead, it will be shipped in a cask called the RH72-B. Both shipping containers require Nuclear Regulatory Commission certification. The Commission has already certified the TRUPACT-II, while certification of the RH72-B is pending. RH disposal operations could begin in 2002 with two shipments per week, eventually increasing to 4 shipments per week. However, the specific prohibition of RH TRUW in the RCRA permit casts uncertainty on these plans.

A delay in beginning RH shipments will also affect disposal operations. The emplacement concept at WIPP calls for placing RH canisters in horizontal cavities drilled into the walls of the disposal room within each panel. After placing RH canisters in the walls, the disposal rooms are then filled with CH containers. This phased emplacement sequence results in a reduction of the total amount of RH that could be accepted depending on how much “wall space” is lost by filling up disposal rooms during a delay in shipment of RH waste.

Finally, the permit requires that the WIPP Maintenance and Operating Contractor for DOE to post financial assurance for the closure and monitoring of WIPP. This requirement has never before been imposed on DOE facilities across the country. With the full resources of the Federal Government guaranteeing closure and monitoring by law, the permit still requires private financial assurance by the WIPP M&O contractor. At the time this manuscript was prepared, DOE had

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announced that it would pay for this financial assurance using the economic assistance funding to the State of New Mexico (annual \$20 million) which was originally introduced by the Land Withdrawal Act. The State has already earmarked the vast majority of these economic assistance funds for highway and road work.

Table I summarizes the major issues that impact WIPP operations as a result of unexpected RCRA permit requirements. It also shows the result of DOE's efforts to have these requirements lifted or even loosened as reflected in the final permit.

Table I Major RCRA Permit Issues Impacting WIPP Operations

<b>Draft Permit Requirement - Significant Concerns -</b>	<b>Resolution in Final Permit</b>
NMED to approve final audit report at generator sites. Public afforded review of report. No process for approval time frame identified.	Requirement unchanged.
Requirement for three solid core sub-samples to be collected from the vertical core when sampling homogeneous solids and soil/gravel.	Requirement unchanged.
Requirement for 11% initial mis-certification rate when determining number of containers to visually examine to confirm RTR results.	Requirement unchanged.
Mixed and non-mixed TRUW must be characterized in a manner identical to the Waste Analysis Plan.	Provision reworded, requirement unchanged.
Waste not characterized according to permit requirements cannot be placed in the same disposal unit (Panel 1) as waste regulated under the permit (IV.b.2.b).	Provision reworded, requirement unchanged.
Prohibition of RH TRUW disposal.	Requirement unchanged.
Requirement that WIPP M&O provide liability coverage and financial assurance for closure.	Requirement unchanged.

WIPP is preparing to meet all of the final RCRA permit requirements. However, DOE has mounted an aggressive effort to quickly develop permit modification applications to ameliorate the impacts of many of the requirements on characterization and disposal operations, including legal challenges.

**Buildup of WIPP's Transportation Capacity**

While the requirements of the RCRA permit have significant impact on characterization and disposal of waste, the transportation between the generator sites and WIPP was largely not affected by its issuance. The unique design of the TRUPACT-II shipping containers makes the transportation of waste one of the most noticeable activities of the disposal phase. For the transportation of CH TRUW, each shipment consists of a truck and trailer with up to three TRUPACT-II containers. Upon certification by the Nuclear Regulatory Commission, a shorter, lighter version of the shipping container, called the HalfPACT, may substitute for one or more TRUPACT-IIs.

When WIPP began shipment of non-mixed TRUW, there were only 15 TRUPACT-II containers in its inventory. This number is sufficient to efficiently make 4-5 shipments per week from sites in the Rocky Mountain region. However, WIPP's planned nominal disposal rate is about 17 shipments of CH waste and 4 shipments of RH waste per week coming from across the DOE complex. With the

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pending RCRA permit allowing mixed waste disposal, the DOE accelerated its plans to procure additional payload containers (TRUPACT-IIIs) and additional transportation services from fleet operators. In October 1999, DOE awarded contracts to manufacture 12 additional TRU- PACT-IIIs, which will begin use in 2000.

### **WIPP'S NEXT FEW YEARS**

At the end of 1999, plans were being developed to meet the new RCRA permit requirements assuming that little, if any, relief can be obtained via the permit modification process. Acceleration of mining for Panel 2 had begun. Beginning with Rocky Flats and Hanford, the generator sites' waste characterization processes were being changed to strictly follow the permit provisions. Permit modification applications were aggressively being prepared to eliminate or ameliorate those provisions that were unnecessary or overly restrictive. Additional payload containers were being constructed and pressed into service. WIPP intends to be disposing of TRUW at a rate of 17 CH shipments and 4 RH shipments per week in a few years. The goal of closing the majority of the TRUW sites and disposing of their nuclear weapons legacy by 2006 is a reality.

### **Safety Plays a Key Role in all aspects of WIPP**

Safety is no accident. It is the result of careful planning and practice. WIPP employees at every level have the authority and responsibility to stop others from working in an unsafe manner. This approach includes sites around the country that package and store TRUW, as well as the transportation system that carries waste to southeastern New Mexico. The WIPP has earned "Star Status" in the Voluntary Protection Program, was awarded the Operator of the Year mine safety award eight consecutive times from 1988 through 1995, and performs exceptionally well during Mine Safety and Health Administration inspections. In addition, on January 16, 1998, WIPP employees celebrated the completion of one million work hours without an on-the-job injury that would prevent an employee from working as usual.

With the aggressive buildup in shipping and disposal rates over the next two years, the WIPP workforce is keenly aware of the continued emphasis on maintaining safe operations.

### **Future Regulatory Compliance Efforts**

EPA's certification of WIPP must be re-instated every 5 years from first waste disposal. However, DOE can elect to request a modification at any time to reduce costs or improve efficiency as long as there is no significant change in compliance with the EPA requirements. DOE plans to submit a modification request in 2002 to reduce the amount of Magnesium Oxide (MgO) placed as backfill with the waste. MgO was originally proposed to reduce solubility of the actinides in any brine that might enter the repository. Since the Compliance Certification Application was submitted to EPA in 1996, additional research has shown that the amount of MgO originally proposed is conservative. Other effects of MgO backfill (other than its affect on actinide solubility) were not taken into consideration in the original performance demonstration. These other effects (e.g., brine consumption by hydration, Carbon Dioxide consumption, MgO cementation of disposal room contents, etc) all have a positive (improved performance) effect. Therefore, DOE can reduce costs as well as reduce worker exposure by reducing the amount of MgO backfill employed. In 2003, DOE plans to submit a re-certification application to EPA with the MgO reduction as well as other operational improvements. Re-certification in 2004 by EPA is expected.

RCRA permit modification applications will likely continue for many years as DOE develops operating experience and data that demonstrate that the current RCRA requirements are overly restrictive or unnecessary.

### **Payload Container and Packaging Changes**

The results of the re-engineering effort were still being considered at the time this manuscript was prepared. However, several obvious changes can be predicted with some certainty. First, the present limitation on shipping TRUW is not a result of RCRA considerations, but is related to potential hydrogen gas generation by radiolysis. Several advances, based on thorough research are being pursued through the Nuclear Regulatory Commission licensing process for the TRUPACT-II containers. Credit for matrix depletion (radiolysis decreases as the hydrogen content of a waste matrix becomes depleted over time), and the use of hydrogen getters will allow DOE to safely ship the majority of TRUW at all sites.

Second, direct loading of a ten-drum overpack will allow DOE to minimize efforts to size reduce some waste streams because of their large container size. Currently, only articles that can fit in a standard waste box can be shipped to WIPP.

### **Mining**

The WIPP repository will eventually consist of eight panels, each of which contains seven waste disposal rooms (see Figure 1). Panel 1 walls and floors, (Panel 1 was completed in 1988) have been maintained by shaving off the salt that creeps, or closes in on open areas, due to the plastic nature of the salt formation. In addition, workers have installed roof bolts in Panel 1 to reinforce the ceiling.

The DOE will mine the remaining panels as they are needed. Completion of the mining of Panel 2 is anticipated in July 2000. Panels will be closed as they are filled, and waste disposal will continue in the next panel. When a panel is half filled with waste, mining will begin on the next panel. Each panel is expected to take approximately 4-5 years to mine, fill, and close. The access drifts to the panels on both sides will become disposal rooms themselves, once Panels 1-8 are filled.

### **Active and Passive Institutional Controls**

One of the WIPP's greatest challenges will begin at the end of the disposal phase: minimizing the risk of human intrusion for thousands of years. The DOE plans to use active institutional controls-fences and guards-to prevent intrusion into the repository for 100 years after the disposal phase ends. Concurrently, the DOE will develop and construct passive institutional controls. These controls will inform people in the future of the nature of the repository and discourage them from digging into it.

The messages will be delivered by a combination of:

- Permanent markers located directly above the "repository footprint" (the boundary at the surface of the underground waste disposal rooms) and at the outer boundary of the land reserved for the WIPP (16 square miles)
- Records in archives, such as the Library of Congress and the United Nations, and in libraries around the world
- Government ownership documents and land use restrictions to warn those seeking natural resources in the area
- Other means of distributing knowledge about the WIPP, such as encyclopedias, text books, and maps

One challenge is to anticipate the possibility that, within the next 10,000 years, people living in this area may not understand any language currently in use. Messages on the permanent markers will be engraved in seven languages. Pictograms will complement the written information or convey it independently.

**Future returns on the investment in WIPP**

The characteristics of the WIPP repository and its infrastructure make it uniquely suited for research, that may or may not be related to radioactive waste disposal. DOE recently established the Center for Applied Repository and Underground Science (CARUS) at WIPP as an efficient way to leverage its existing infrastructure and provide a vehicle by which WIPP's unique attributes could be used for R&D activities in addition to the primary mission of TRU waste disposal.

The WIPP repository is mined from an ancient massive sequence of salt beds 650 meters below the surface. With halite in all directions, the repository is naturally shielded from cosmic rays. In addition, the salt contains virtually no naturally occurring radioactive elements like uranium and thorium. Thus, the natural radioactivity environment within the repository is extremely low – possibly lower than any other land-based location in the world. This extremely low background radiation environment makes it possible to make extremely sensitive measurements (of many kinds) of radiation and radiobiological effects that would otherwise be confounded by the presence of typical background radiation. Another unique attribute of WIPP that makes many diverse research efforts possible is the nature of the massive sequence of salt beds. The relative homogeneity of the thick salt deposit and its geophysical and seismic stability open the possibility for new subterranean gravity and other deep geophysics experiments.

As an operating radioactive waste disposal facility, WIPP also makes it possible to design and conduct tests of actual nuclear material management and control. CARUS is presently supporting the demonstration tests related to non-proliferation “transparency” using the TRU waste disposal system as a model test-bed. WIPP can also serve as a test bed for experiments and research conducted by or for other nations that are evaluating bedded salt as the repository medium.

CARUS allows the scientific community to perform experiments in a deep geologic setting at a lower net cost by sharing an existing infrastructure. Access to the underground with ventilation, power, extensive data communications, safety oversight, surface support, emergency services and security are all in place. More, and more-extensive experiments can be conducted for the net research dollar through CARUS than at other typical choices open to the underground research community.

Such research, which can and will be conducted without compromising the primary disposal mission and the priority on safety, will achieve tremendous benefit from the DOE's significant financial and intellectual investment in the WIPP.

Lastly, the opening of WIPP was preceded by 25 years of research and development resulting in formidable experience across all areas involved in safe management of hazardous and long-lived radioactive waste, and the selection, characterization, development, certification/permitting, and operation of a deep geologic repository. This knowledge and expertise, albeit still valuable to future re-certification of WIPP, is probably of greater value to other similar programs in the US and abroad.

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