MEETING THE CHALLENGE OF RADIOACTIVE WASTE DISPOSAL AT THE WIPP

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ABSTRACT

The Department of Energy (DOE) is constructing the Waste Isolation Pilot Plant (WIPP)* in southeastern New Mexico. This facility will initially store transuranic (TRU) waste generated from defense activities of the United States in a fully retrievable mode during the pilot plant phase. In the next phase, full-scale operations, waste will be emplaced in a permanent disposal configuration. Since last year's Waste Management conference, WIPP has made significant progress in its evolution toward becoming a functioning pilot plant. Facility construction is nearly complete, as are preoperational checkouts. Many 1988 challenges have been overcome, including 1) the implementation of a rigorous operational readiness review (ORR) program; 2) the completion of several major institutional activities; and 3) final testing of the TRUPACT-II. The status of these and other significant activities at WIPP are described in this paper. Although additional requirements have been placed upon WIPP, it is expected that these activities will be completed in time to support a late summer "opening date." The project still remains in conformance with established technical and institutional baselines.

BACKGROUND

WIPP Mission

The Waste Isolation Pilot Plant first appeared as a budget line item, and was designated as Project 77-13f, in Public Law (PL) 94-355. The Department of Energy National Security and Military Applications of Nuclear Energy Act of 1980, Public Law 96-164, directed DOE to proceed with WIPP and defined the WIPP mission as "...a defense activity...for the express purpose of providing a research and development facility to demonstrate the safe disposal of radioactive wastes resulting from the defense activities and programs of the United States exempted from regulation by the Nuclear Regulatory Commission.

WIPP Objectives and Management

The primary objectives of the WIPP project are to design, construct, and prepare for operation of an R&D facility to demonstrate the safe disposal of TRU defense waste, and to procure a transportation fleet for contact-handled (CH) TRU waste shipments to the site. Once the disposal process has been validated as being safe and environmentally acceptable, the final objective will be to permanently dispose of about 6,500,000 cubic feet of TRU waste.

Under the direction of the DOE/WIPP Project Office, the following organizations provide management, scientific, engineering, and construction support to the Project:

Westinghouse Electric Corporation: Management and Operating Contract (MOC), to include design engineering, safety analysis, operational planning, environmental monitoring, construction management, plant maintenance and general management/administrative services.

Sandia National Laboratories: Overall scientific support, with emphasis on environmental compliance, site characterization, and experimental programs.

Bechtel National, Inc.: Architect/Engineer services for facility design and inspection.

Independent Review

New Mexico Environmental Evaluation Group (EEG)

The EEG consists of technical experts who provide independent review of WIPP activities that could affect the public health and safety of citizens and the environment of the state of New Mexico. The EEG serves under contract to the New Mexico Institute of Mining in Socorro, New Mexico and maintains a local office in Carlsbad. Industrial safety, radiological safety, mine safety, and effluent monitoring are several of the major activities overseen by the EEG.

Other independent reviews are provided by the (1) National Academy of Science, (2) Nuclear Regulatory Commission, and (3) Mining Safety and Health Administration, and (4) Occupational Safety and Health Administration, etc.

WIPP Site

The WIPP, located in Eddy County about 25 miles east of Carlsbad, New Mexico, will be used to demonstrate regulatory compliance as well as system-wide operations that include a design capability to receive a maximum of 500,000 cubic feet per year of CH waste and 10,000 cubic feet per year of remote-handled (RH) waste. The actual amount of CH waste projected to arrive on an annual basis is 290,000 cubic feet. The total operational capability of

* See Figures 1 and 2 for an aerial view and isometric diagram of the WIPP site.

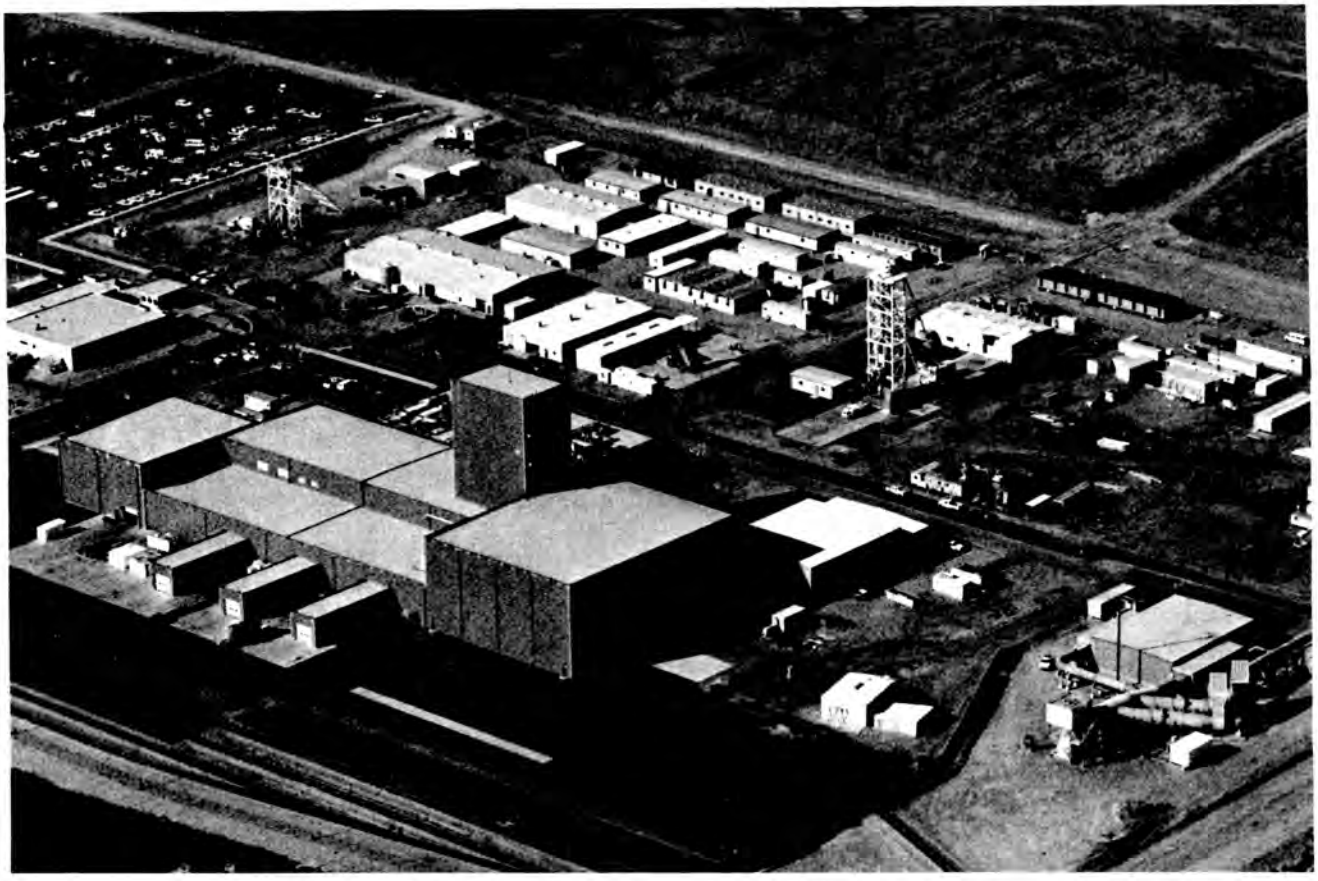

Fig. 1. Aerial View of WIPP.

WIPP LAYOUT

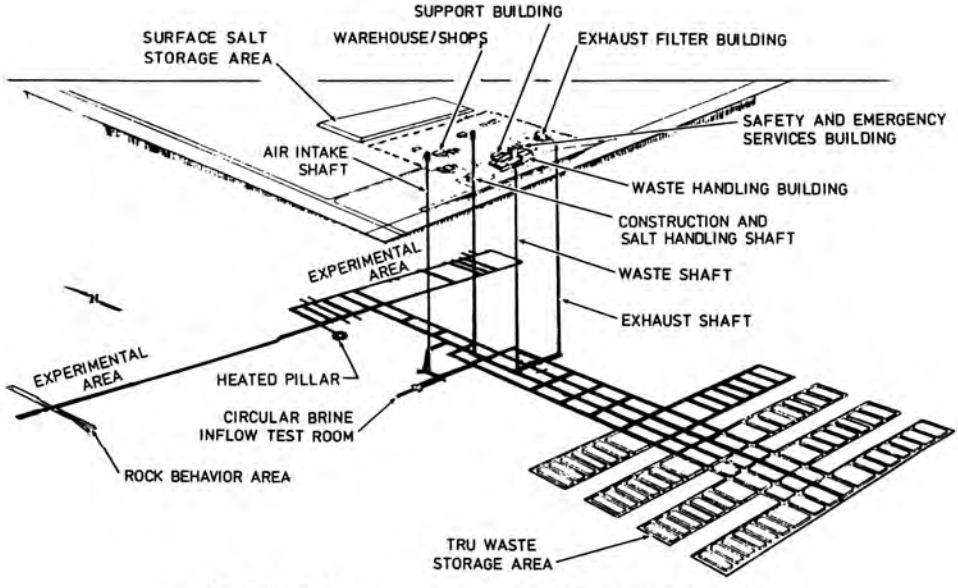

Fig. 2. Underground Isometric Diagram, WIPP Site.

WIPP will be to emplace 6,300,000 cubic feet of CH TRU waste and 170,000 cubic feet of RH waste.

FY 88 ACCOMPLISHMENTS

Construction

WIPP's construction progress in 1988 reveals a number of significant completions and accomplishments. Construction of the Air Intake Shaft and surface modifications to the Exhaust Shaft Ventilation system, which increases underground ventilation from 210,000 cfm (cubic feet minute) to 425,000 cfm and provides mine effluent monitoring, was completed. The final WIPP Site Grading and Paving was completed in December, including the installation of a storm drainage system and security fencing. Significant progress was made towards completing the new Safety and Emergency Services Building (completed in February 1989) which houses all of WIPP's emergency response capabilities in one facility. This physical consolidation of personnel and equipment allows for more efficient and prompt emergency responses.

Air Intake Shaft

WIPP's underground ventilation system was originally designed based on a limited project scope. The design criteria and ventilation requirements were developed for the performance of various activities as then envisioned. However, because additional underground requirements were identified, it became necessary to enhance the existing ventilation system to fully support these requirements. A reassessment of the ventilation system--based on the existing facility and a clearer definition of the scope of the experimental programs, waste storage methodology, mine developmental activities, and current equipment list--indicated a two-fold increase in underground airflows from 210,000 cubic feet per minute (cfm) to 425,000 cfm was necessary.

Various options to provide the increased airflow to the underground facility were considered and analyzed. Based on the techno-economic analysis, environmental considerations, and other conditions unique to a facility like WIPP, construction of a new shaft to serve as the primary fresh air intake was selected as the preferred option.

Construction on the AIS began in December 1987 and proceeded on a moderate schedule. Excavation was by the raise-bore technique, in which a large drill bit was assembled in a mined area 2,150 feet below ground level. The cutting bit was rotated and raised by means of a drill string contained within a previously drilled vertical borehole. The drill string was attached to equipment on the surface which both rotated and raised the bit. This excavation resulted in a world's record for the largest amount of material excavated by this technique.

Operations

RH TRU and CH TRU preoperational checkouts were successfully completed in March and June, respectively. The primary objective of the checkouts was to demonstrate the process of handling waste packages, from receipt through underground emplacement, utilizing equipment, personnel, and procedures that will be used during actual waste handling activities at WIPP. A further objectives was to measure operational time lines which would 1) provide a basis for confirming the WIPP design throughput capability; and 2) verify that operator radiation exposures do not exceed occupational limits. The successful completion of these checkouts are prerequisites to the receipt of actual TRU wastes. Both checkouts were witnessed by state of New Mexico representatives, and the documentation that was issued satisfied a key milestone contained in the Agreement for Consultation and Cooperation with the state of New Mexico.

RH TRU Preoperational Checkout

This checkout was completed March 24, 1988, and included the processing of five simulated RH TRU canisters from receipt to underground emplacement. THe checkout began with cask preparation activities in the Waste Handling Building using a dummy shipping cask. Following processing through the hot cell, the canisters were transferred underground in the shielded facility cask and placed in horizontal boreholes in previously mined rooms using the horizontal emplacement and retrieval equipment. The design of the WIPP hot cell includes provisions to overpack an RH TRU canister, should it be received in a damaged or contaminated condition. To demonstrate this process, one of the five simulated canisters was overpacked. Extrapolation of time line data developed during the checkout confirmed the single shift design throughput of 250 canisters per year at worker exposure rates well below occupational limits.

CH TRU Preoperational Checkout

This checkout was completed June 14,, 1988, and included the processing of ten TRUPACT shipping containers with a cargo of simulated waste from receipt to emplacement in the underground storage area. In order to confirm the WIPP environment of the Overpack and Decontamination room, one TRUPACT was partially processed through the overpack/decontamination sequence of operations to verify this portion of the waste handling process. Extrapolation of time line data using a computer simulation model confirmed that WIPP operations can achieve the design throughput capability of 500,000 cubic feet per year, if required, using two waste handling shifts. The single shift capability was calculated at 273,000 cubic feet per year, at an average individual dose rate of 700 mREM. This exposure level satisfies the radiological requirements of DOE Order 5480.1B.

Dosimetry Program

Another significant step towards total operational readiness at WIPP involved the implementation of the site-wide personnel external dosimetry program, which utilizes a Harshaw-designed multipurpose (beta, gamma, neutron) lithium -fluoride (LiF) thermoluminescent dosimeter (TLD). All WIPP site personnel have been issued TLDs and are trained in the proper use of the devices. Depending on worker job assignment, exposure evaluations will take place on either a monthly or a quarterly schedule. Full external dosimetry program implementation is underway,

including the monitoring of WIPP site visitors as well as site personnel. Development efforts for the algorithm for the TLD system is continuing. Algorithm development and DOELAP (Department of Energy Laboratory Accreditation Program) status must be achieved by December 15, 1989. Until such time as these efforts are complete, dual external dosimetry devices will be issued to all personnel.

A master record and reporting system for all site worker exposure histories (present and past) is being developed as well. The necessary data-gathering will be an ongoing process within the personnel dosimetry program.

Mining: Panel 1 Completion

The total excavation and preparation of underground waste storage Panel 1 was completed in June 1988. Completion of this panel, which consists of seven 13' x 33' x 300' rooms and two entry ways, met a major readiness milestone and is notable for its conformance to extremely exacting specifications. The tolerance range on the vertical plumb of the ribs (walls) is two degrees, and the floor slope and smoothness is well within the two inches per 20 feet in rise. Panel 1 measures 3,700 linear feet and contains over 1.5 million cubic feet of mined space. Mining excavations in 1988 totalled 144,000 tons, while total tonnage to date is approximately 747,000 tons. Total excavated mileage is 10.3 miles.

Research and Development (R&D)

In 1988 the last in a series of three multipad pump tests was completed as was an associated conservative tracer test. These tests confirmed that transport modeling in the Culebra aquifer overlying the WIPP site must consider both fracture and matrix porosity. For transport over large distances the dual porosity may be effectively modelled as an equivalent single porosity medium. Model studies indicate that non-sorbing transport will require more than 10,000 years for contaminants to reach the accessible environment boundary.

Permeability measurements were conducted in the waste shaft showing that very low permeabilities (nanodarcies) exist in the higher salt beds as well as at the disposal horizon. Stress relief effects in the shaft were shown to be confined within two meters of the shaft wall. Electrical and acoustic geophysical techniques were proven useful in examining the disturbed zone and its changes in brine content. Brine seepage testing continued to support the contention that brine seepage will not present a problem to use of the salt beds.

Major improvements were attained in our ability to model salt creep and room closure. The factor of three between observed and predicted creep rate has now been reduced to about 20 percent. Early closure reference points were remotely installed in the newly upreamed shaft to allow recovery of early deformation data.

Results of experiments with small scale seals in 1988 continue to indicate the desirability of two-component plugs using both cementacious and crushed salt/bentonite materials.

All geotechnical and in-situ studies through 1987 were documented in summary reports in 1988.

In 1989 most technical investigations will focus on plug and seal design and disposal room behavior. Many permeability measurements will be acquired in the shaft and drifts. Brine seepage will be obtained in openings which range from 4-inch to 36-inch to 10-foot diameter openings. Another planned seepage experiment is the circular/brine room test. This activity is designed to test our brine inflow model for scale-up accuracy and mechanistic assumptions. An integrated data set from this test will include brine inflow rates, closure rates, humidity values, seismic and electrical characteristics of the disturbed rock zone around the room, and pre- and post-test host rock analyses.

Additional experiments will evaluate the gas generation potential of TRU waste. These tests are planned for implementation in early 1990. Experiments to define the source term and to help determine the degree of consolidation in waste rooms after salt creep has reached equilibrium are also planned.

Performance assessment studies will focus on sensitivity evaluations in 1989 to help assess critical areas for study and to evaluate the utility of various engineered modifications.

Waste Transportation

When WIPP becomes fully operational, CH TRU waste shipments will be sent to the WIPP from ten DOE generator sites in vertically designed Transuranic Package Transporters (TRUPACT), termed the TRUPACT-II. RH TRU canisters will be shipped in a shielded cask. Both container packages are Department of Transportation Type B packagings, with separate inner containers.

The TRUPACT-II design concept consists of three cylindrical containers on a lightweight trailer that can carry a maximum of 42 drums with a payload weight of 21,000 pounds. A composite stainless steel and solid foam envelope surrounds two stainless steel containment vessels and provides protection from fire and impact. Before the TRUPACT-II can be used for transporting waste, the package must be certified by the Nuclear Regulatory Commission (NRC) as safe and in compliance with all federal waste transportation requirements. A battery of physical stress tests have already been completed on three full-scale models of the TRUPACT-II, Units 1, 2, and 3.

At the completion of the Unit 1 test program, the package and its test performance were analyzed. The test sequence consisted of three 30-foot drop tests, five pin punches and a burn test. During the pin punch tests the package experienced significantly more punch penetration and exterior skin tearing than had been anticipated. As a

result, a doubler (or stiffening) plate was installed behind the exterior skin on both the vent and seal test parts. The pin punch test was successfully repeated to verify the effectiveness of the design enhancement. Finally, Unit 1 was subjected to the burn test. The TRUPACT-II model was placed on a stand in a shallow pool containing about six thousand gallons of jet fuel, ignited and allowed to burn itself out (approximately 90 minutes).

After evaluation of test results from Unit 1, numerous design enhancements were identified and evaluated, including changing the foam type and composition. Each change was tried on half-scale models to verify it effectiveness and improve confidence before it was incorporated. The material had to perform at temperatures from several hundred degrees Fahrenheit down to -20 degrees Fahrenheit. The final modifications included 1) a thermal insulating blanket attached to the inside of the outer skin and on the outside surface of the Outer Containment Vessel (OCV); 2) two stiffening rings installed around the locking ring area to reinforce the outer skin and prevent foam crush; and 3) a closed cell silicon foam debris shield installed in the lid to prevent debris from contacting the O-rings.

Test units 2 and 3 were rebuilt to incorporate these modifications and testing resumed. Unit 3 was subjected to three 30-foot drops, five pin punches and a pool fire. The test article was then chilled to -20 degrees Fahrenheit and both the OCV and ICV were leak tested. Both vessels were leak tested to less than 1 x 107 cc/second. When Unit 2 was disassembled it was found than the addition of the insulating material had reduced the foam charring dramatically, with virgin foam remaining in all regions of the vessel.

Institutional

Another challenge to the WIPP transportation program is assurance of adequate emergency response capabilities in the unlikely event of a serious transportation accident resulting in the release of radioactive materials. As the WIPP program involves moving wastes through 23 states, a large number of county and local governments, as well as Indian Tribes entitled to recognition as essentially sovereign states, have various concerns about waste transportation. To meet the needs of these numerous entities a more focused emergency response program is required than that which is provided by FEMA (Federal Emergency Management Agency).

The program devised by the WIPP, the States Training and Education Program (STEP), supplements the emergency response (ER) training provided under the FEMA program. It is directed to the aspects of emergency management involved with the hazardous properties of defense TRU wastes. In the course of developing STEP, WIPP consulted at length with ER professionals in the states of New Mexico and other western states, as well as with appropriate representatives of the Western Interstate Energy Board.

TEP developed into three distinct courses: a one-day presentation for first responders; a longer two- or three-day course for ER officials who would be responsible for command and control over an accident site; and a one-day course for health physics professionals who might be responsible for overseeing the clean up and decontamination of an accident site.

The initial waste shipments for WIPP are planned to be shipped from INEL in Idaho. Idaho, Utah, Wyoming, Colorado and New Mexico constitute the five first corridor states. STEP training commenced in Idaho in April 1987, and was completed in Wyoming in September 1987. Overall, the STEP provided fifty first-responder training sessions, twenty-one command and control courses and five mitigation courses over this period. A total of some 2100 individuals received this specialized training. The effectiveness of the STEP training is demonstrated by the fact that over 85% of the students rated the quality of the training as "Excellent" or "Above Average."

Public Affairs

The WIPP Visitor Center in Carlsbad, NM was completed and dedicated in July. Walkthrough displays covering 1,083 square feet detail various technical and environmental aspects of WIPP, explaining everything from the different types of radiation to the typical miner's outfit and gear. This hands-on exhibit encourages visitors of all ages to learn more about WIPP, and provides concise information about the waste storage problems facing not only our country, but the world. Spokespersons are on hand to speak directly with visitors and answer more in-depth questions as may be requested.

Three Community Days were held at the WIPP site during 1988; over 2300 visitors were provided with surface and underground tours, lectures and questions and answer sessions. Overall in 1988, the visitors program accommodated 4,238 visitors.

Operational Readiness Review

Throughout FY 1988 the Operational Readiness Review (ORR) team provided an independent oversight of the activities necessary for the receipt of CH waste. The readiness of hardware, personnel, and management systems supporting the systems critical to the receipt of CH waste were assessed. The ORR used the Management Oversight and Risk Tree (MORT) methodology to identify specific areas of concern and ensure that these concerns were satisfactorily addressed. The MORT, coupled with other verification means, (requirements definition, audits, corporate oversight, probability risk assessment, technical safety assessment, documentation validation, etc.) constituted the entirety of the ORR process.

WIPP's ORR process identified 12,278 criteria items. At the time of this writing there are 74 acceptance items and 29 open verification records requiring response. Validation of project documentation, a CH critical systems risk assessment, and the completion of the Phase II and Phase III technical safety assessment by the DOE/Albuquerque office remain to be completed to close the ORR activities related to CH critical systems.

FY 89 OPENING DATE IMPACTS

Although the WIPP site will be physically ready to being

operations in June of 1989, five major items requiring resolution must be completed before startup can be initiated. These include 1) the Performance Assessment and Operations Demonstration Plan; 2) the Final Safety Analysis Report (FSAR); 3) NRC certification for the TRUPACT-II; 4) the Supplemental Environmental Impact Statement (SEIS), and 5) Land Withdrawal. The first three items are on schedule for completion prior to June; however, the completion of the SEIS and obtaining Congressional land withdrawal are two important elements which are independent of WIPP influence. A brief discussion of these five items and their respective completion schedules follows.

Performance Assessment and Operations Demonstration Plan

The first objective of the pilot-plant phase is to assess WIPP's potential to comply with the requirements of Subpart B of the U.S. Environmental Protection Agency's (EPA) Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes ("the Standard," 40 CFR Part 191). This Performance Assessment objective includes completing the design of the engineered-barrier components of the disposal system, and, if necessary, providing design modifications of the underground disposal areas to assure adequate waste isolation. The second objective is to demonstrate the safe disposal of TRU wastes, as directed by Congress. Operations testing will provide an opportunity to demonstrate compliance with Subpart A prior to the decision on whether the WIPP will become a disposal facility. During the pilot-plant phase, the performance predictions and results of the demonstration will be used to determine whether the WIPP will become a permanent disposal facility. Incorporation of review comments into a revised draft plan will be completed in March 1989.

Final Safety Analysis Report (FSAR)

The FSAR for WIPP is being prepared to document that a systematic analysis of hazards has been performed and all risks adequately accommodated in the facility design. The FSAR describes the facility as it was designed, based on an assumed 25-year operating cycle.

The FSAR is expected to be submitted for approval by late April 1989. Independent reviews of the FSAR have been performed by the EEG and by Brookhaven National Laboratories.

TRUPACT-II Certification

The TRUPACT-II will be certified by the Nuclear Regulatory Commission prior to its use as a waste transporter by DOE. The TRUPACT-II testing was completed in January; the Safety Analysis Report for Packaging (SARP) will be submitted to the NRC by February 1989. Certification of the TRUPACT-II is expected by May 1989.

Supplemental Environmental Impact Statement

In 1980 the DOE published the Final Environmental Impact Statement (FEIS) for the WIPP project in order to satisfy the requirements of the National Environmental Policy Act (NEPA) as implemented by the Council on Environmental Quality (CEQ). The FEIS discussed four alternatives and in 1981 a Record of Decision was published in which DOE stated its conclusion that the construction of the WIPP facility was the least impactive alternative in dealing with defense wastes. The process of arriving at this decision involved a great deal of public comment and participation.

DOE has spent the eight years since the Record of Decision systematically designing, constructing, testing, and documenting the WIPP facility. This process has resulted in a large amount of additional data as well as changes in the originally proposed configuration of the plant. CEQ guidelines contain provisions for agencies to prepare a Supplemental Environmental Impact Statement if 1) significant changes have occurred to proposed action; or 2) if significant new information becomes available. While none of the changes to the WIPP project are considered significant in terms of environmental impacts, DOE has concluded that sufficient change has occurred to justify additional public comment and participation prior to initiation of waste storage activities. As a result, DOE announced on December 16, 1988 its intent to prepare an SEIS for the WIPP facility.

This SEIS will focus on four areas. These are:

1. An assessment of impacts associated with changes in the quantity and activity levels of TRU wastes to be shipped to WIPP.
2. An assessment of impacts associated with the hazardous waste constituents in some of the TRU wastes to be shipped to WIPP.
3. An assessment of transportation impacts, considering recent developments in transportation packaging, routing, and modal mix (all truck).
4. An assessment of long-term impacts using the most recent information on the geological, hydrological, and geotechnical characteristics of the WIPP facility.

As required by regulation the SEIS is being prepared independent of the WIPP Project. The SEIS should be available for public review and comment in early April. Public hearings are expected in mid-May. DOE currently expects the SEIS process to be completed in late summer, 1989.

Land Withdrawal

In order for WIPP to begin its pilot plant phase, i.e., storing defense-generated radioactive waste, the land on which the project is situated (10,000 acres) must be permanently transferred from the U.S. Department of the Interior to the Department of Energy. This change of ownership requires sanction from the U.S. Congress. In 1988 a bill (known as the Land Withdrawal Bill) was submitted to the 100th Congress. Although considered by both the House and the Senate, the bill did not pass. The approach is to now move ahead on a "dual track" plan for obtaining land transfer. It is expected that the 101st Congress will also consider a WIPP Land Withdrawal Bill and the Department strongly supports this as the preferred option; however, since WIPP will soon complete all actions

required for beginning operations, it is prudent to petition for a continuation of Administrative Withdrawal with the additional stipulation that actual waste materials are permitted in order to perform necessary environmental compliance and operational demonstrations prior to a determination of whether WIPP should become a permanent TRU waste disposal facility.

CONCLUSION

WIPP has faced many challenges since this time last year: A Land withdrawal, ORR, TRUPACT-II certification, and others. Plans to begin operations in October 1988 were modified as additional requirements were placed upon WIPP. These additional requirements have been thoroughly identified and are aggressively being worked at this time.

Significant progress continues to be made. All major construction has been completed. The Final Safety Analysis Report, the Operational Readiness Review, TRUPACT certification, and the Performance Assessment and Operational Demonstration Plan will soon be completed.

The project remains in conformance with established technical and institutional baselines. All requirements for initiation of WIPP's pilot plant phase should be met to support a late summer "opening date." At that time, the DOE is confident the results will show that WIPP is the most viable answer currently available to our country's TRU waste problems.