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NO-MIGRATION VARIANCE PETITION
FOR THE WASTE ISOLATION PILOT PLANT

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ABSTRACT

The Waste Isolation Pilot Plant (WIPP) is a U.S. Department of Energy (DOE) project to provide a research and development facility to demonstrate the safe disposal of radioactive waste resulting from U.S. defense activities and programs. The DOE is developing the WIPP facility as a deep geologic repository in bedded salt for transuranic (TRU) waste currently stored at or generated by DOE defense installations.

Approximately 60 percent of the wastes proposed to be emplaced in the WIPP are radioactive mixed wastes. Because such mixed wastes contain a hazardous chemical component, the WIPP is subject to requirements of the Resource Conservation and Recovery Act (RCRA) (1). In 1984 Congress amended the RCRA with passage of the Hazardous and Solid Waste Amendments (HSWA), which established in §§3004(d) through (n) a stringent regulatory program to prohibit the land disposal of hazardous waste unless 1) the waste is treated to meet treatment standards or other requirements established by the Environmental Protection Agency (EPA) under §3004(n), or 2) the EPA determines that compliance with the land disposal restrictions is not required in order

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to protect human health and the environment. With respect to the second condition, an opportunity is provided to demonstrate to a "reasonable degree of certainty that there will be no migration of hazardous waste from the disposal unit for as long as the waste remains hazardous."

The DOE WIPP Project Office has prepared and submitted to the EPA a no-migration variance petition for the WIPP facility. The purpose of the petition is to demonstrate, according to the requirements of RCRA §3004(d) and 40 CFR §268.6, that to a reasonable degree of certainty, there will be no migration of hazardous constituents from the WIPP facility for as long as the wastes remain hazardous. This paper provides an overview of the petition and describes the EPA review process, including key issues that have emerged during the review.

INTRODUCTION

The "cradle to grave" management of hazardous wastes is regulated under the RCRA, which is administered by the EPA and authorized state agencies. In 1984, the RCRA was amended by the Hazardous and Solid Waste Amendments Act (HSWA). Stringent new provisions were added that prohibit the land disposal of hazardous wastes unless they meet treatment standards established by the EPA or are subject to an EPA-approved variance or exemption. However, the EPA did not formally determine that the hazardous waste components of radioactive mixed wastes are subject to regulation under the RCRA until July 3, 1986 (2).

Spent solvents, dioxin-containing and "California List" wastes had been restricted from land disposal when the DOE and the EPA began to evaluate the impacts of extending the land disposal restrictions to radioactive mixed wastes. In promulgating restrictions for the "first third" of the remaining wastes in August 1988 (3), the EPA postponed placing any further restrictions on the land disposal of radioactive mixed waste (other than those containing spent solvents, dioxins, and "California List" wastes) until May 8, 1990, the statutory deadline for promulgating the final set of restrictions. This postponement allows time to examine such issues as the availability and

effectiveness of demonstrated treatment technologies for radioactive mixed waste and the potential environmental and human health impacts of exposure to radiation during treatment.

The solvent, dioxins, and "California List" restrictions still apply to mixed waste. The WIPP No-Migration Variance Petition addresses these and all remaining hazardous constituents, including those that are not yet restricted and currently may be land disposed without a variance.

Specific requirements for making a demonstration of no migration are found in 40 CFR §268.6; the EPA has published a draft guidance document to assist petitioners in preparing a variance request. Throughout the course of preparing the WIPP petition, technical staff from the DOE, the EPA and their contractors met frequently to discuss and attempt to resolve issues specific to radioactive mixed waste and the WIPP facility.

Physically, the WIPP consists of aboveground and belowground facilities designed for the emplacement of 6.2 million cubic feet of contact-handled (CH) TRU waste and 250,000 cubic feet of remote-handled (RH) TRU waste in a 100-acre mined geologic repository. The underground disposal horizon is located near the middle of a 2,000-feet-thick bedded salt formation, 2,150 feet below ground surface. As a geologic repository, the WIPP is a "land disposal unit," as defined in the RCRA regulations.

The WIPP facility initially will serve as an experimental pilot plant and tests utilizing wastes will be performed. The results will be used to collect, interpret, and refine data necessary for the performance assessment required for radioactive waste disposal by the EPA in 40 CFR 191. Data will also be evaluated to determine if any additional measures are necessary to ensure that no migration of hazardous constituents will occur beyond the unit boundary.

During the test phase, all wastes emplaced will be readily retrievable. In this manner, should the results of evaluations undertaken during the test phase indicate that the WIPP facility is not the appropriate location for the

permanent isolation of these wastes, they can be retrieved with minimal risk. The DOE has prepared a plan that describes the requirements for retrieval of waste from the underground; it has been provided to the EPA and made available to the public as supporting documentation for the WIPP No-Migration Variance Petition.

The facility will enter full-scale operations upon successfully completing the test phase. Although the petition provides a detailed description of all aspects of the facility and all waste handling procedures, the EPA has determined that the No-Migration Variance Petition is to apply to the test phase only. The following sections summarize the major areas of concern addressed in the petition.

WASTE INFORMATION

According to the EPA guidance (4), the most important waste properties with regard to emplacement in geologic repositories are those that could impact waste mobility or repository stability, such as volatility, ignitability, reactivity, corrosivity, solubility in water and susceptibility to phase or species transformation. Petitioners for a no-migration variance must characterize, to the extent possible, each waste to be emplaced in the unit.

As this section describes in greater detail, the hazardous components of the TRU mixed wastes proposed to be emplaced at the WIPP have been characterized through a multistage process utilizing existing data, generator knowledge of the wastes, real-time radiography, and limited analyses. This process has yielded information on the potential hazardous constituents (or properties) present, their physical form and relative volumes.

To begin, an initial survey of TRU mixed waste generators was undertaken, using pre-existing waste information as a starting point. The DOE had already classified the wastes into "waste forms" based on the physical characteristics of the material. Examples of waste forms are "solidified aqueous sludges," "filters," and "metals." Because the waste forms are largely process-specific, the generators were asked to identify the hazardous

materials entering each process for each waste form. The survey are conducted from an "input" rather than "output" perspective, resulting in the identification of all hazardous constituents that could be potentially present in the wastes. Such an approach takes no credit for the consumption or removal of a constituent during a production process, and is thus highly conservative.

Verification of the physical waste form was provided by real-time radiography (RTR) and visual examination. RTR is an x-ray technique that permits examination of a container's contents without the need for opening the container and exposing workers to radiation. RTR is an effective tool for identifying free liquids, bulk particulates, metallic objects and other items and materials (it can detect liquid ink in ballpoint pen, for example). Visual examination of containers after inspection through RTR have confirmed the effectiveness of the technique, as well as the reliability of historical records.

Finally, available analytical data were reviewed. The TRU Waste Sampling Program and the Stored Waste Examination Pilot Plant (SWEPP) Certified Waste Sampling Program conducted at the Idaho National Engineering Laboratory (INEL) have provided verification of waste characterization information obtained from existing records, process knowledge, and RTR. The results of container headspace gas analyses indicate that sources of volatile organic compounds in the waste are limited and that the physical and chemical waste forms restrict the release of vapors into the headspace of containers.

Some inorganic and organic sludge in stored waste of various ages from the Rocky Flats Plant (RFP) additionally were analyzed for total halogenated and nonhalogenated organic compounds. These results further confirmed that sources of volatile organic compounds are limited in the waste. Toxicity Characteristic Leaching Procedure (TCLP) analyses were also performed on a limited number of inorganic sludges from the RFP. Most hazardous constituents were below detection limits and all were below the treatment standards established in 40 CFR §268.41.

With regard to waste transformation mechanisms following emplacement in the WIPP, changes in the waste will occur over time, as radiolytic and microbiological processes affect temperatures, degrade organics, generate gases, and alter the chemistry of brine (e.g., Eh and pH), if present, in the area immediately surrounding the wastes. Changes in temperature are expected to be slight and may increase the rate of other processes to some extent. The degradation or microbial decomposition of organics renders them nonhazardous, although gases such as carbon dioxide, carbon monoxide, methane, oxygen, and hydrogen are produced. The breakdown of plastics, paper, rubber and other solid wastes will contribute the largest portion of decomposition products. Acids may also be produced, although they will be neutralized by the excess of basic cement used in waste solidification.

The rate at which gases will be generated within the repository is not currently well understood, but excessive pressurization of the repository, if in fact it occurs at all, would happen in the period after repository closure. To determine the rate of gas generation within the repository, experiments will be conducted during the test phase, and the results will be used to determine whether engineering changes to the facility or other measures are necessary to ensure the long-term integrity of the repository.

The waste that will be emplaced in the WIPP facility is limited to solid or solidified material. There will be no corrosives, explosives, or pyrophorics placed in the repository. These and other restrictions are detailed in the WIPP Waste Acceptance Criteria (WAC) (5) and, prior to shipment, each waste container must be certified to be in compliance with the WAC. The certification program is described in both the petition and the addendum.

With regard to the WIPP facility, all materials must be compatible to ensure that reactions or byproducts do not threaten human health, the environment, or the integrity of the repository. Chemical compatibilities were considered from several perspectives: waste-waste interactions, waste-brine interactions, waste-salt interactions, and waste-seal interactions. In general, no incompatibilities were identified that could adversely impact repository performance, although additional data on gas generation and the

rate of brine inflow obtained during the test phase will help refine predictions of long-term repository behavior.

SITE CHARACTERIZATION

Geology and hydrology are important site characteristics with regard to waste isolation. The WIPP site has a long history of study and evaluation directed at these and other environmental factors. A complete bibliography of literature on the environment of the WIPP site is included in the petition and supporting materials, as well as a thorough description of all pertinent local and regional characteristics.

The WIPP facility is located in the Salado Formation because it is hydrologically isolated and because the plastic nature of the salt causes any potential fractures to heal before they could spread to connect with any water-bearing formation. Several features of the Salado Formation, including the presence of zones of pressurized gas, brine seepage and marker bed undulations and fractures, have been extensively evaluated with regard to their potential impacts to repository integrity. This information is presented to the EPA in the petition.

MONITORING PROGRAMS

The EPA regulations concerning no-migration petitions require monitoring to demonstrate that waste migration does not occur. The DOE will maintain several monitoring programs at the facility.

Initiated in 1985, the Radiological Baseline Program (RBP) has established statistically sound background radiological data against which operational and post-operational radiation measurements can be assessed. It consists of five subprograms to establish the following baselines: 1) atmospheric radiation; 2) ambient radiation; 3) terrestrial radiation; 4) hydrologic radiation; and 5) biotic.

The Ecological Monitoring Program (EMP) was initiated in 1975 to perform nonradiological baseline studies over a wide area prior to the initiation of

construction activities. Seven permanent ecological monitoring plots continue to be studied. This program consists of six subprograms: 1) meteorology, 2) air quality; 3) water quality; 4) aerial photography; 5) vertebrate census; and 6) salt impact studies. To date, the EMP has identified no significant impacts attributable to construction of the WIPP facility.

The Operational Environmental Monitoring Program (OEMP) was developed to determine what impacts, if any will be experienced by the local ecosystem and geographic area as a result of WIPP operations. It is directed at measuring potential radionuclide releases and is similar to the RBP, except that it is much more flexible to allow investigation of trends or anomalies.

The Occupational Monitoring Program (OMP) was established to ensure a safe working environment for all personnel involved in waste handling operations. Continuous air monitors, explosive gas monitors, and area radiation monitors are located throughout the facility.

Air exiting the WIPP underground facilities will be sampled and analyzed under the VOC Monitoring Program. This is a new program in support of DOE's no-migration demonstration and is being implemented specifically in response to monitoring requirements of 40 CFR §268.6. In addition, radiation and volatile organics will be monitored during the opening of TRUPACT-IIs in the Waste Handling Building. Monitoring of the air evacuated by the vacuum pump will indicate whether any breaching of drums within a TRUPACT-II has occurred so that special measures can be taken to prevent releases to the environment or exposure to workers. All air will be filtered for particulates prior to discharge.

With regard to the monitoring of groundwater during operations, the DOE maintains an interim status groundwater monitoring waiver for the WIPP facility, having demonstrated that there is no potential for the generation of leachate or other mechanisms for groundwater contamination during the operational period. The waiver has been included as an appendix to the petition.

In a broad sense, continuation of preoperational and operational monitoring activities will comprise the Long-Term Monitoring Program, the purpose of which will be the detection of substantial and detrimental deviation from established baseline data and expected performance conditions. Additional elements of the program will be developed and implemented on an as-needed basis, with input provided by the results of the test phase and actual conditions during operations.

RISK ASSESSMENT

The environmental consequences of routine releases during waste emplacement operations were assessed through a conservative risk assessment, in which personnel aboveground and belowground were assumed to spend each eight-hour day of their entire working lives at the points of maximum concentration. The nearest off-site residential receptors were assumed to be continuously exposed to postulated releases throughout their lifetimes. The hazardous constituents examined in the risk assessment were carbon tetrachloride; methylene chloride; 1,1,1-trichloroethane; 1,1,2-trichloro-1,2,2-trifluoroethane; and lead. Of these, the first two are classified by the EPA as carcinogens.

Using the above conservative assumptions, the maximum lifetime excess cancer risk level for occupational receptors is about one hundred times less than the one in 10,000 risk level considered by the EPA to be acceptable for workplace exposures. The maximum lifetime excess cancer risk level for the public is about ten thousand times less than the one in 100,000 risk level considered by the EPA to be acceptable for public exposure. The maximum estimated intakes of noncarcinogenic chemicals by occupational workers and the public are well below health-based levels, indicating no adverse human health effects from routine exposures to the low concentrations of chemicals released.

Potential risks to personnel during several postulated on-site accident events were estimated based on comparison to Threshold Limit Values (TLVs) and Immediately Dangerous to Life and Health (IDLH) criteria. TLVs are standards established to protect workers from eight-hour-per-day exposures throughout their working lives. The IDLH is the maximum concentration in air from which escape within 30 minutes would not result in any impairing symptoms or

irreversible health effects. The use of IDLH criteria is conservative because the postulated accident scenarios are short-term events.

The maximum worker exposure to any hazardous chemical was about 1,000 times less than these health-based levels. Similarly, public exposures to hazardous chemicals during accident scenarios also were extremely low, and no adverse human health effects are indicated.

The WIPP surface facilities will be decommissioned and the repository sealed as part of the closure process. For the purpose of the risk assessment, engineered barriers such as the shaft seals are assumed to function as designed. The impacts of releases through four pathways were examined in the petition: air, surface water, soils, and groundwater.

Examination of impacts associated with the groundwater pathway required projecting the rate at which hazardous constituents would potentially move through the storage panel, drifts, and seals, along the underlying Marker Bed 139, and up through the Waste Handling Shaft. Movement through the ERDA-9 borehole, the closest borehole to the waste, also was considered.

The SWIFT III computer code was used in performing the modeling. Several conservative conditions were assumed to eliminate any possibility of underestimating the travel time of contaminants. Waste mobility modeling based on extremely conservative assumptions about the characteristics of the waste and the disposal system show that hazardous constituents will not migrate beyond the WIPP facility boundary. The modeling effort can be refined based on actual data obtained from experiments, but the results can realistically be expected to lead to even slower travel times.

UNCERTAINTY ANALYSIS

The uncertainty analysis involves the prediction and assessment of infrequent or unexpected events that could adversely impact the integrity of the disposal unit. Natural events, waste- and facility-induced events, and human-induced events were examined in the petition. None was found to pose a significant threat so as to violate the "no migration" requirement, although experimental

data on the rate of gas generation will be obtained during the test phase to determine whether additional engineered measures are required to meet waste isolation goals.

PETITION REVIEW PROCESS

The preparation and review of the WIPP No-Migration Variance Petition has been a lengthy process. The DOE submitted the petition in March 1989. Upon completion of its initial review of the information submitted, the EPA provided to the DOE a Notice of Deficiencies (NOD). The DOE responded to the EPA NOD and met with the EPA reviewers of the petition several times during 1989. In August 1989 the EPA requested that the DOE submit significant additional information addressing a variety of topics including: waste characterization, groundwater hydrology, geology and dissolution features, monitoring programs, the gas generation test program and other aspects of the project. This additional information was provided to the EPA in January 1990 when the DOE submitted Revision 1 of the addendum to the petition.

At the time of this writing (February 1990), the EPA reviewers anticipate that a Federal Register notice on EPA's proposed approval or denial of the WIPP petition will be published in April 1990. This notice will offer the public an opportunity to comment on EPA's proposed action. Final approval or denial of the petition is expected in the late summer or early fall of 1990.

KEY ISSUES

During the EPA's review of the WIPP petition, several key issues have surfaced. Several of these are summarized below:

- Human Intrusion - For the purpose of the No-Migration Variance Petition, it has been established that an evaluation of human intrusion scenarios is not required. This scenario would involve exploratory drilling for hydrocarbons through the WIPP waste-emplacement horizon at some time in the future, once knowledge of the presence of the closed repository is lost. Loss of this

knowledge is deemed unlikely, given DOE's commitment to construct permanent markers at the WIPP site upon closure of the facility.

- Unit Boundary Definition - To successfully demonstrate "no migration," a point-of-compliance or unit boundary must first be established. At the WIPP, the unit boundary is defined vertically as the upper and lower extent of the Salado Formation. Horizontally, the unit boundary is defined as the lateral extent of the Salado Formation where it meets an imaginary vertical line through the surface boundary of the WIPP site. This encompasses an area of 16 square miles.
- Migration Threshold Values - The EPA provided to the DOE threshold values to be applied to analyses of the potential for contaminants to migrate. These values are based on one in one million excess cancer risk to the hypothetical person residing at the unit boundary throughout his 70-year lifetime. These are the same values the EPA is proposing to apply as decontamination criteria at the RCRA corrective action sites.
- VOC Monitoring - The EPA is requiring that the DOE monitor the presence of volatile organic compounds in the air exiting the WIPP underground. The threshold values required by the EPA are very low, in the low parts-per-trillion range, for several VOCs. Because these concentrations are not detectable utilizing commercially available analytical equipment, a plan has been developed to monitor concentrations at their source (the waste) and to calculate subsequent concentrations at the unit boundary.

SUMMARY

To obtain a variance from the RCRA land disposal restrictions, the owner or operator of a land disposal facility is required to demonstrate that, to a reasonable degree of certainty, there will be no migration of hazardous wastes beyond the unit boundary for as long as they remain hazardous. The EPA relies on health-based standards as the basis for evaluating such demonstrations, along with other stringent criteria outlined in its guidance manual.

The WIPP facility relies on both the inherent characteristics of the salt in which the repository is constructed to permanently isolate the wastes that will be emplaced, as well as operational procedures that protect workers and the public during waste emplacement activities. The DOE believes that the No-Migration Variance Petition thoroughly demonstrates that there will be no releases of hazardous constituents from the WIPP facility in excess of specified threshold values.

The EPA is now reviewing the DOE's No-Migration Variance Petition for the WIPP. During its review, the EPA has requested considerable additional information, which has been prepared by the DOE. Upon completion of its review of all of the data submitted by the DOE, the EPA will publish a Federal Register notice describing its intent to approve or deny the petition. This notice will include justification for the EPA decision and offer the public an opportunity to comment on the proposed EPA decision. The EPA decision-making process is currently projected to be completed by mid-to-late 1990.

REFERENCES

1. Resource Conservation and Recovery Act (RCRA), 42 U.S.C. 6901 et seq.
2. U.S. Environmental Protection Agency (EPA), State Authorization to Regulate the Hazardous Components of Radioactive Mixed Wastes Under the Resource Conservation and Recovery Act, 51 Fed. Reg. 24504, July 3, 1986.
3. U.S. EPA, Land Disposal Restrictions for First Third Scheduled Wastes, 53 Fed. Reg. 31138, August 17, 1988.
4. U.S. EPA (Draft), "Guidance Manual for Hazardous Waste Disposal in Geologic Repositories," Washington, D.C., May 29, 1987.
5. U.S. Department of Energy, "WIPP Waste Acceptance Criteria" (WIPP/DOE-069, Rev. 2), WIPP Project Office, Carlsbad, New Mexico, 1985.