STATE OF NEVADA
NUCLEAR WASTE PROJECT OFFICE

PRESENTATION TO THE ADVISORY COMMITTEE ON NUCLEAR WASTE

SUBJECT:	UNCERTAINTY IN MODELING AND PERFORMANCE ASSESSMENT
DATE:	FEBRUARY 24, 1989
PRESENTER:	LINDA L. LEHMAN
PRESENTER'S TITLE AND ORGANIZATION:	PRESIDENT L. LEHMAN & ASSOCIATES, INC. 1103 W. BURNSVILLE PARKWAY, SUITE 209 BURNSVILLE, MINNESOTA 55337
PRESENTER'S TELEPHONE NUMBER:	(612) 894-0357

UNCERTAINTY IN MODELING

I. Sources of Uncertainty

II. Data Limitations

III. Recommendations

I. SOURCES OF UNCERTAINTY

Cranwell and Helton 1981 (NUREG/CP-0022) identify:

- **Process Modeling Uncertainty**
- **Input Data Uncertainty**
- **Scenario Uncertainty**

as primary components of uncertainty

BROAD CLASSES OF UNCERTAINTY

Eisenburg, et al 1987 identify five (5)

- Systematic and Random Error in Measurement
- Spatial Variations in Geologic Parameters
- Conceptual Models
- Physicochemical Process Modeling
- Future States of Nature

Schalla and Leonhart, 1981
NUREG/CP-0022 identify:

- Data limitations as a source of uncertainty in formulating conceptual hydrologic models

Kocher, Sjoreen and Bard, 1983
NUREG/CR-2506 identify:

- Insufficient Site Characterization as a source of uncertainty in estimating ground water transport times

II. DATA LIMITATIONS

- General limitations
- Data limitations due to insufficient Site Characterization

GENERAL DATA LIMITATIONS

- Many hydrogeologic parameters are obtained from inference
- Many parameters are assumed correlated to other parameters
- Representativeness of samples collected
- Number of samples
- Sample disturbance during sampling
- Measurement and interpretation error

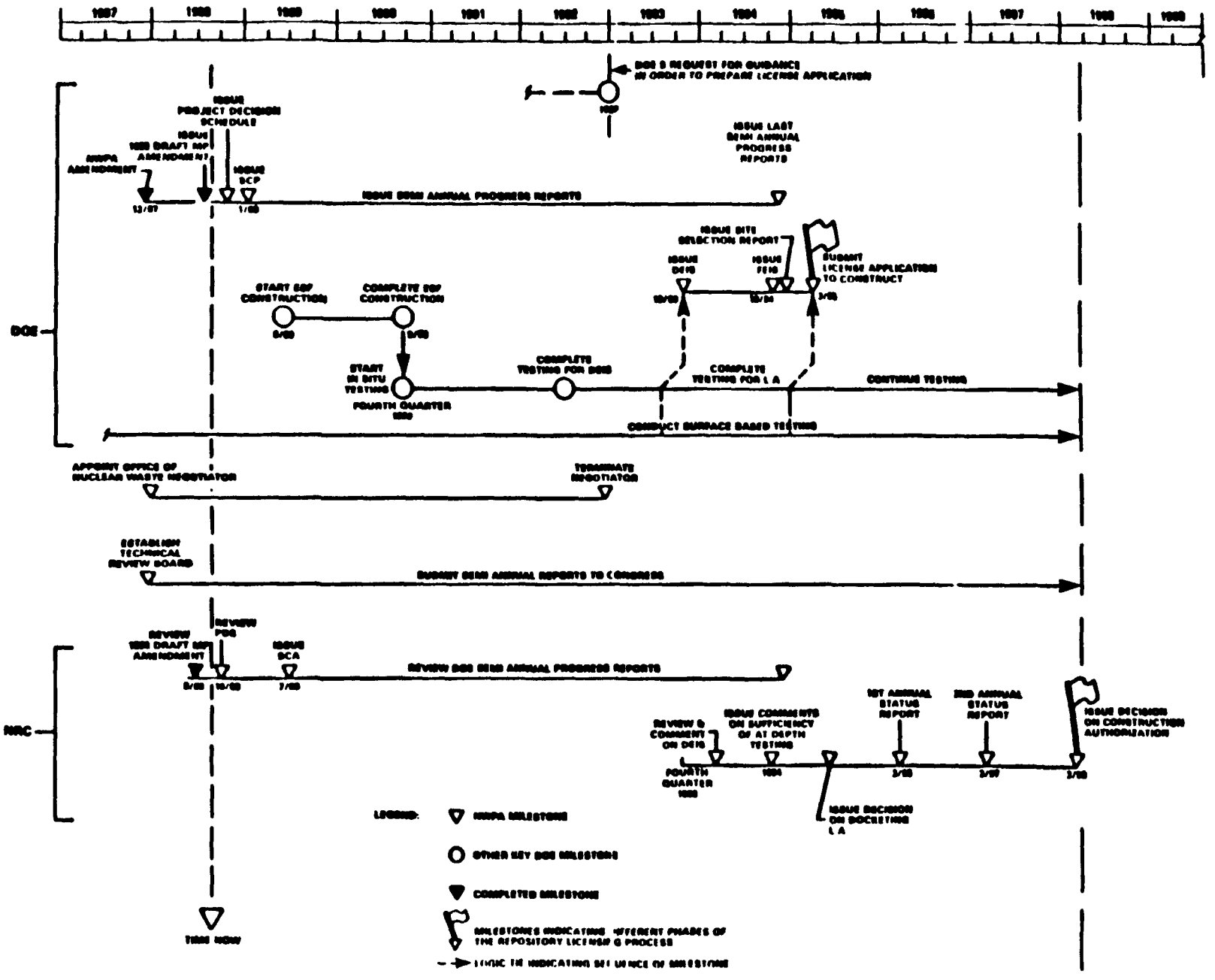
TIME DEPENDENT LIMITATION

(i.e., time allocated for data acquisition)

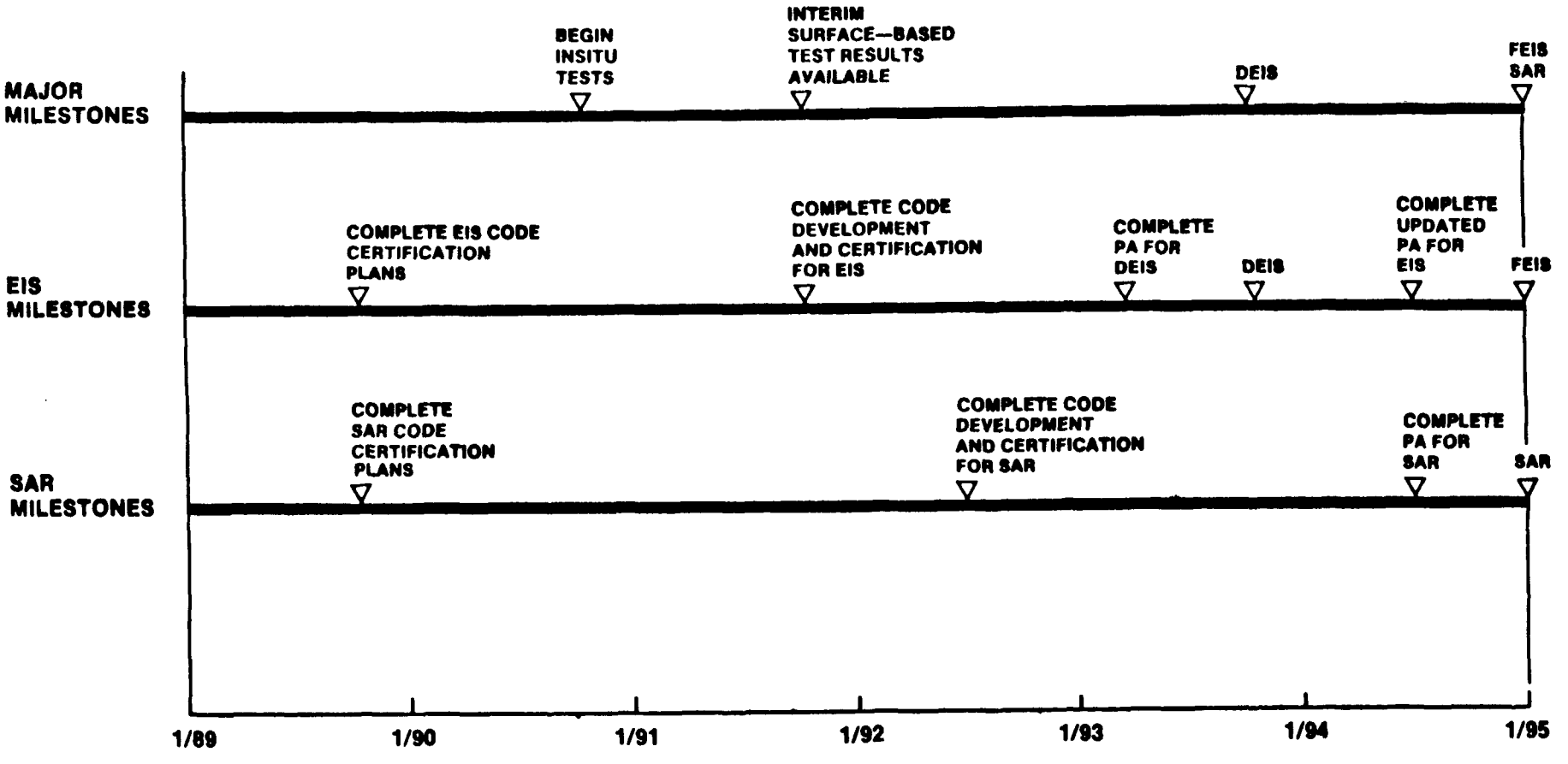
This limitation is correctable.

TIMELINE OF LEVEL I NRC & DOE M\ AJOR REPOSITORY MILESTONES

ENCLOSURE 3



PERFORMANCE ASSESSMENT (PA) MILESTONES FOR LICENSING



At what point does the schedule go from "ambitious" to "unrealistic"?

QUESTIONS

(1) What data will actually be used in the License Application?

(2) What will be its quality?

(3) How long does it take to generate data?

HYDROLOGY DATA - SATURATED ZONE

Type of Data	Period of Record		Date Released	Quality
Water Level - Pressure Transducer (15 wells)	(1983 - Feb. 1987)	Non QA'd QA'd	1988 ?	poor
Water Level - other (28 wells)	(1981 - 1987)		Jan. 1989	fair
Drawdown and recovery (10 wells)	(Oct. 1980 - 1984)	Non QA'd	1988	?

HYDROLOGY DATA - UNSATURATED ZONE

Types of Data	Period of Record	Date Released	Quality
Matric Potential vs. depth (UZ-1) instrumented	(Nov. 1983 - 1989)	not released	Suspect as per USGS
Saturation vs. depth Laboratory analysis of cores, cuttings, neutron probes (8 wells)	(1983, 1984, 1985)	(Preliminary results presented Nov. 1985) raw data not released	?

Historically, reliable, good quality data are not available for at least two (2) years after a test is finished.

This means that for in-situ tests requiring more than two (2) years, the data will not be available for the License Application.

- **prototypes**
- **USGS internal reviews**

License Application will be based largely on sparse, surface-based testing

Freeze and Cherry 1979

". . . it will often seem that the geologic processes have maliciously conspired to maximize the interpretive and analytical difficulties."

III. RECOMMENDATIONS

To ensure a high quality and complete LA, DOE/NRC should move immediately to correct this time-limited data deficiency.

- **Determine immediately how much in-situ data will be required in the LA and its quality.**
- **Extend deadlines to allow these data to be reliably collected, and interpreted.**
- **Stop compressing the data collection phase (deadlines must be moved commensurate with delays).**

RECOMMENDATIONS - continued

Expand research into basic processes

- o Unsaturated flow in fractured/porous media
- o Analog studies
- o Tectonic coupling to flow field

IN SUMMARY

- Performance Assessment and Modeling Uncertainties are extremely large
- Data limitations are severe - some are correctable
- Even with good data, we will not be able to reliably model and predict the unsaturated zone (processes)
- Schedule compression must stop (Quality of License Application is at risk)
- Deadlines moved commensurate with delays
- License Application will be based on sparse, low-quality surface-based test data

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Cranwell, Robert M. and Helton, Jon C., 1981. "Uncertainty analysis for geologic disposal of radioactive waste," in *Proceedings of the Symposium on Uncertainties Associated with the Regulation of the Geologic Disposal of High-Level Radioactive Waste,* U.S. Nuclear Regulatory Commission (Washington, D.C., March 9-13, 1981), NUREG/CP-0022, pp. 131-143.

Eisenberg, Norman A., Rickertsen, Larry D. and Voss, Charles, 1987. "Performance Assessment, Site Characterization, and Sensitivity and Uncertainty Methods: Their Necessary Association for Licensing" in *Proceedings on the Conference on Geostatistical, Sensitivity, and Uncertainty Methods for Ground-Water Flow and Radionuclide Transport Modeling,* DOE/AECL (San Francisco, CA, September 15-17, 1987), pp. 9-38

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RESUME

Linda L. Lehman, President
L. LEHMAN & ASSOCIATES, INC.
1103 W. Burnsville Parkway, Suite 209
Burnsville, Minnesota 55337
(612) 894-0357

EDUCATIONAL BACKGROUND:

University of South Florida, M.S., 1978, Hydrogeology
Florida Atlantic University, B.S., 1975, Geology
University of Minnesota, Ph.D. candidate/Hydrogeology, 1989

WORK HISTORY:

President/Principal Hydrogeologist
L. Lehman & Associates, Inc.; 1985 - Present

Private Consultant
Hydrogeology; 1983 - 1985

Hydraulic Engineer
U.S. Nuclear Regulatory Commission; 1979 - 1982

Hydrogeologist
Parsons, Brinkerhoff, Quade & Douglas, Inc.; 1977 - 1979

EXPERIENCE:

Ground Water Modeling

- Currently developing modeling efforts as the representative of the State of Nevada at the international flow and transport model validation effort for nuclear waste repository performance codes (INTRAVAL).
- Directed the development of conceptual flow models at solid and hazardous waste sites contaminated with volatile organic contaminants and other pollutants.
- Performed ground water flow and contaminant transport modeling of high-level nuclear waste sites (the Hanford Site Washington).
- Performed time series analyses using computerized data bases to establish baseline ground water conditions at high-level nuclear waste sites.

Expert Witness Testimony

- Served as primary technical expert regarding the ground water contamination at the Flying Cloud Landfill under litigation procedures, public hearings, and formal governmental agency meetings at various levels.
- Hydrogeologic expert for a class-action suit in Fernald, Ohio regarding ground water contaminants from defense-related nuclear operations.
- Provided the primary expert testimony regarding potential ground water contamination and site suitability for a solid waste landfill in McHenry County, Illinois.
- Provided expert testimony concerning potential ground water contamination from sewage sludge land application and agricultural runoff.

Hydrogeologic Investigations

- Directed the development of site characterization studies, environmental sampling and analytical program as part of the Remedial Investigation/Feasibility Study (RI/FS) for the Union Scrap Superfund Site.
- Technical review and analysis of the RI/FS at the Flying Cloud Landfill regarding ground water contamination and design of the ground water pump-out system.
- Directed staff in hydrogeological studies of potential solid waste disposal sites in Minnesota and Illinois.
- Directed the evaluation of the RI/FS for the Fernald nuclear defense facility in Ohio with regard to ground water contamination at that site.

Technical Program Management

- Provided overall project direction to the Yakima Indian Nation regarding the disposal of high-level nuclear waste and defense wastes at the Hanford reservation, including scientific and engineering efforts related to waste disposal design and siting issues.
- Served as prime contractor to the Minnesota Governor's Nuclear Waste Council for high-level nuclear waste Crystalline Repository Project and provided technical assistance in the areas of hydrology, geology, ground water modeling and regulatory/program analysis.

- Provided technical management assistance to the Nevada Governor's office in regards to scientific and engineering contractor support regarding the high-level nuclear waste repository at the Nevada Test Site.

Regulatory Development and Analysis

- Directed the development of rules to regulate the siting, design, construction, operation and closure of a low-level radioactive waste storage or disposal facility in the State of Maine.

- Participated in the development of siting criteria for the Federal Regulation (10 CFR 60) for high-level nuclear waste repositories.

- Provided formal review and comment efforts for various clients in regards to ground water and waste management regulations related to solid waste, hazardous waste, high-level and low-level nuclear waste, U.S. defense wastes, agricultural impacts on ground water, and ground water quality standards.

- Developed site suitability and selection criteria for radioactive waste disposal facilities keyed to various federal and state statutes.

PROFESSIONAL ACTIVITIES:

President, Minnesota Ground Water Association (1988)
Chairwoman, Subcommittee on Ground Water Protection Strategies; Environmental Quality Board Advisory Committee on Ground Water Protection (1988)
Member, Minnesota Pollution Control Agency Joint Hydrology Task Force

Certifications

Registered Geologist, State of Indiana
Professional Hydrogeologist, American Institute of Hydrology

Associations

International Association of Hydrogeologists
National Water Well Association
American Geophysical Union
Engineers Club of Minneapolis
American Institute of Hydrology

SELECTED PUBLICATIONS:

Nguyen, V.V., G.V. Abi-Ghanem and L.L. Lehman; Fractal Mixing in a Class of Composite Media; Preprints of Proceedings of the Stochastic Approach to Subsurface Flow, Montvillargenne, France; 6/85.

Lehman, L.L.; Factor Analysis of Groundwater Flow Paths in the Central Columbia Plateau; Comments of the Yakima Indian Nation on the Draft Environmental Assessment for the Hanford Site, Washington under the Nuclear Waste Policy Act, Volume 2; 3/85.

Lehman, L.L., GeoTrans, Inc.; Preliminary Sensitivity Analysis of Rockwell Flow Path Using SWIFT; Comments of the Yakima Indian Nation on the Draft Environmental Assessment for the Hanford Site, Washington under the Nuclear Waste Policy Act, Volume 2; 3/85.

Lehman, L.L.; Model Comparison; Comments of the Yakima Indian Nation on the Draft Environmental Assessment for the Hanford Site, Washington under the Nuclear Waste Policy Act, Volume 2; 3/85.

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Lehman, L.L., Eric Hansen; Secondary Concentration of Air-Released Uranium through Watershed Runoff at the Feed Materials Production Center, Fernald, Ohio; 3/88.

Nguyen, V.V., L.L. Lehman; Interscale Transfer of Information in Nuclear Waste Repository Multibarrier Systems; Proceedings of Western Regional Conference Society of Groundwater Scientists and Engineers; 1/85.

Bennett, R.H., L.L. Lehman, et.al.; Interrelationships of Organic Carbon and Submarine Sediment Geotechnical Properties; Marine Geotechnology, Volume 6, Number 1; 3/84.

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WASTE MANAGEMENT '91

STATUS OF THE WIPP PROJECT

by

Robert H. Neill
Lokesh Chaturvedi

Environmental Evaluation Group
State of New Mexico

February 28, 1991

STATUS OF THE WIPP PROJECT

Robert H. Neill and Lokesh Chaturvedi
New Mexico Environmental Evaluation Group
7007 Wyoming Boulevard, NE, Suite F-2
Albuquerque, New Mexico 87109

ABSTRACT

The Waste Isolation Pilot Plant (WIPP), located in southeastern New Mexico, has been constructed to be a repository for transuranic (TRU) radioactive wastes generated from the U.S. defense activities. In order to use WIPP as a repository for permanent disposal of TRU waste, the U.S. Department of Energy (DOE) has to demonstrate compliance with the "Standards for the Management and Disposal of Spent Nuclear Fuel, High Level and Transuranic Radioactive Wastes" promulgated by the U.S. Environmental Protection Agency (EPA) in the U.S. Code of Federal Regulations 40 CFR Part 191. The DOE initially plans to perform experiments with a small quantity of waste at WIPP and would like to bring additional quantities for "operational demonstration", before determining whether WIPP is to be a repository for permanent disposal. There are serious problems in pursuing this course of action from an operational point of view. It would be wiser to take the actions necessary to decide whether the facility should be used as a permanent repository, before emplacing a substantial quantity of waste in it.

INTRODUCTION

The Waste Isolation Pilot Plant (WIPP) is an underground geologic repository for the disposal of transuranic (TRU) wastes resulting from defense activities of the U.S. Government. The 50 hectare repository is located in southeastern New Mexico, 40 km east of Carlsbad, New Mexico. The repository has been designed to dispose of approximately 178,000 cubic meters of contact-handled transuranic (CH-TRU) waste and 7,100 cubic meters of remote-handled (RH-TRU) waste for a total maximum radioactive inventory of 14 million curies (9 million curies CH-TRU and 5 million curies RH-TRU).

WIPP is a facility of the U.S. Department of Energy (DOE). The Public Law (P.L. 96-164, 1979) authorizing WIPP exempted it from licensing by the Nuclear Regulatory Commission (NRC). While the U.S. Congress has required NRC regulation and licensing of the disposal of defense high-level waste and uranium mill tailings, defense transuranic waste was exempted from NRC licensing and is self-regulated by DOE. For demonstration of long-term integrity of waste in the WIPP repository, compliance with the Environmental Protection Agency (EPA), "Standards for the Management and Disposal of Spent Nuclear Fuel, High level and Transuranic Radioactive Wastes" contained in 40CFR191 will have

to be documented. The EPA, however, does not have the authority to assess WIPP's compliance with these Standards, nor is EPA seeking such authority. As a consequence, DOE will determine whether or not the DOE WIPP project meets compliance with the EPA standards. In contrast, the NRC has codified EPA's 40CFR191 into NRC's regulation, "Disposal of High-level Radioactive Wastes in Geologic Repositories" (10CFR60) and compliance of the DOE's high-level waste repository with these standards and regulations will be assessed by NRC after a formal license hearing by the Commission. It should also be noted that even within the Department, DOE has not identified those individuals or organizations who have the responsibility to demonstrate compliance and those who will judge how well that task is done.

In order to provide a robust review and oversight capability, the State of New Mexico established the Environmental Evaluation Group (EEG) in 1978 for the sole purpose of providing an independent technical review of WIPP. Through Public Law 100-456 (the 1989 National Defense Authorization Act), the U.S. Congress provided for continued independent review and funding for EEG through DOE. Thus, for the past 13 years since 1978, EEG has provided the only full-time interdisciplinary technical review and oversight of the WIPP Project. The effort has been totally funded by the U.S. Department of Energy (DOE). EEG also conducts an environmental monitoring program for background radioactivity in air, water and soil, both on-site and in surrounding communities. Both DOE and EEG have monitoring stations in the exhaust air discharge which will document any releases of radioactivity. EEG's evaluation has resulted in several recommendations for changes in the plans and for additional studies to resolve questions of the long and short-term safety of the project. EEG currently has a staff of 18, 8 in Albuquerque and 10 in Carlsbad.

DOE had planned to start shipping the waste to WIPP in October, 1988 (1). As the deadline approached, it became clear that DOE had not completed all of the preparations necessary to start this activity. The physical facility was not completed, one of the four shafts had not been drilled and outfitted, the underground ventilation system was not completed, the equipment for continuously monitoring the air for radioactive releases underground had not been installed and tested, and the safety and emergency services building had not been completed. The Final Safety Analysis Report had not been completed. Testing of the transportation container (TRUPACT) for the CH-TRU waste had not been completed and the application for its certification had not been submitted to the U.S. Nuclear Regulatory Commission (NRC). And, perhaps most importantly, DOE had not prepared a justification for shipping the waste to WIPP. While DOE has always maintained that WIPP is a facility for performing research and development with radioactive waste for the first five years,

plans for experiments requiring waste had not been developed when the deadline of October, 1988 arrived.

Since October, 1988, much progress has been made to prepare the facility to start receiving waste, both physically and through paper documentation. However, as of February, 1991, the facility is not yet operationally ready to start receiving waste and DOE's latest projection is that Idaho National Engineering Laboratory (INEL) will be ready to start shipment in August, 1991. This projection does not, however, take into consideration the impact of compliance with the conditions imposed by EPA with respect to the requirements of the Resource Conservation and Recovery ACT (RCRA). The projected amount of waste needed for experiments at WIPP has been reduced from 25,000 drums of contact-handled transuranic (CH-TRU) waste (1987 plans) to 516 drums of CH-TRU waste (1991 plans). There are projected operational problems even with this small amount.

This paper evaluates the technical and programmatic status of the WIPP Project as of February 1991 and reviews the work that is yet to be done before waste may be brought to the WIPP site in New Mexico.

CHARACTERISTICS OF THE SITE

The characteristics of the WIPP site and the history of site characterization at WIPP are discussed in Chaturvedi and Rehfeldt, 1984 (2); Chaturvedi, 1986 (3); Chaturvedi, Chapman, Neill and Channell (4); Chaturvedi, Channell and Chapman, 1988 (5); and Neill and Chaturvedi (6). Only a brief description is provided here for background information.

The Delaware Basin in southeastern New Mexico was selected for WIPP by the U.S. Geological Survey (USGS) and the Oak Ridge National Laboratory (ORNL), contractors to the U.S. Atomic Energy Commission (AEC), following the abandonment of the Lyons, Kansas site in 1972. Geologic characterizations started in 1974. In 1975, the responsibility for the WIPP site selection and characterization was passed on to the Sandia National Laboratories (SNL) in Albuquerque, New Mexico.

The WIPP repository is located in southeastern New Mexico, 40 km east of Carlsbad, New Mexico, at a depth of 653 meters in the lower part of a 600 meter thick Permian age (225 million years old) salt formation known as the Salado Formation. The Salado extends from a depth of 260 meters to a depth of 860 meters at the WIPP site. Overlying the Salado Formation is the Rustler Formation. It is 95 meters thick at the WIPP site and consists of anhydrite and siltstone with two water-bearing, fractured, dolomite beds. The lower one of the two, called the Culebra Member, has higher permeability and contains more water. It is 8 meters thick at the repository and is located from 218

meters to 225 meters below the surface (430 to 438 meters above the repository). The upper water-bearing dolomite bed is known as the Magenta Member and is located between 185 meters and 193 meters below the surface (7). Much of the WIPP site characterization effort has been spent on the hydrologic characterization of the Rustler water-bearing zones because these are expected to provide potential pathways for radionuclide migration to the biosphere in case of a breach of the WIPP repository.

An important geologic feature of the WIPP site is the presence of pressurized "brine reservoirs" in the upper part of the Castile Formation (underlying the Salado Formation) that have been encountered in several boreholes surrounding the WIPP site. The first exploratory borehole for WIPP (ERDA-6), drilled 7 km northeast of the center of the present site in 1975, encountered pressurized artesian brine and the site was abandoned. Another borehole (WIPP-12) located 1.6 km north of the center of the present site was drilled to a depth of 850 meters to the top of the Castile Formation in 1978. Accepting EEG's suggestions to explore the anticlinal structure indicated by seismic surveys at this location, DOE deepened this borehole in November, 1981. The hole encountered a pressurized brine reservoir at a depth of 920 meters. The initial flow rate of brine, under artesian pressure, was 1,600 liters per minute and after extensive testing, DOE estimated that the brine reservoir penetrated by WIPP-12 contains 2.7 billion liters (17 million barrels) of brine. Since it had been planned to construct the repository in the northern part of the site that would have brought it within 140 meters of WIPP-12, DOE accepted EEG's suggestion to once again relocate the repository to its present location, 2 km south of the previous location.

At EEG's insistence, DOE had electromagnetic geophysical surveys performed over the WIPP repository area. The results (8) show a clear indication of the presence of brine under parts of the WIPP repository. Based on a) the encounter of brine in 13 out of 60 boreholes in the vicinity of the WIPP site, one of which (Belco-Hudson) is only 5 km southwest of the repository (2), b) the encounter at WIPP-12 and, c) the geophysical survey results, it is necessary to assume that pressurized brine exists at a depth of approximately 250 meters below the repository.

The question of the amount of brine expected to seep from the repository salt into the excavations is another important parameter that needs to be understood for reliable predictions of future behavior of the repository and potential breaches. It appears that the Salado salt may be saturated with brine and the brine-inflow from it, albeit at low permeability and low porosity, may fill the repository with brine once the ventilation of the facility ceases to remove moisture (9). The effects of this on a human intrusion scenario could be unacceptable (5).

DOE is therefore performing a series of in situ tests to determine the permeability and porosity of the salt beds of the WIPP repository and to actually measure the amount of brine-inflow.

When completed, the WIPP repository will consist of eight panels with seven rooms in each panel. Each room is designed to be 300 feet (91.5 meters) long, 33 feet (10 meters) wide, and 13 feet (4 meters) high. CH-TRU waste will be emplaced in 55-gallon ($0.21m^3$) drums stacked three high in the rooms and in the drifts connecting the rooms. Waste of odd-sizes and shapes will be emplaced in specially designed boxes. Remote-handled (RH-TRU) waste will be disposed in 36 inch (0.91 meter) diameter horizontal holes in the walls of most of the rooms. A total of 850,000 drum-equivalents of CH-TRU and 7500 casks of RH-TRU will be disposed in the WIPP repository. About 1/3 of the waste has been generated and is temporarily stored at DOE weapons laboratories awaiting transfer to WIPP. The rest is projected to be generated during the next 25 years.

Measurements in WIPP excavated areas show that the creep rate of WIPP salt is about 3 to 4 times the originally predicted rate. Results of 6 years of convergence rate data in the four SPDV (Site and Preliminary Design Validation) rooms that were excavated in 1983 shows that the roof to floor closure is between 3 and 4 inches per year (as high as 5 inches per year in Room 1) and the wall to wall convergence is about 2 inches per year (10). The repository horizon as well as several meters above and below it contains several layers of anhydrite and clay seams. As the salt deforms to fill an excavation, fractures appear along these "impurities" in salt. With additional deformation, the fractures widen and cross-fractures at angles to the bedding planes appear. The roof starts sagging, the floor heaves up and the walls develop fractures parallel to the walls as well as some vertical fractures perpendicular to the walls. Within a few years, the roofs have to be rock-bolted and the floors have to be "reconstituted" to make them stable for operations.

The four SPDV rooms in the northern experimental area of the WIPP repository were excavated with the same dimensions 91 m x 10 m x 4 m (300 ft x 33 ft x 13 ft) as the waste rooms, to study the geomechanical behavior of such excavations. These rooms were excavated in March and April, 1983. All four rooms have been showing signs of unstable floors and roofs and entry to two of them has been barred since 1989. On February 4, 1991, the roof of Room 1 failed. A slab of rock approximately 2.5 m (8 ft) thick, 45 m (150 ft) long and 9 m (30 ft) wide, weighing an estimated 2500 tons separated from the roof and crashed on the floor. This room was fitted with only 0.6 meter (2 feet) rock bolts to hold the wire mesh.

LONG-TERM INTEGRITY

The long-term safety of the WIPP site and the design of the repository will be judged through an assessment of WIPP's compliance with the EPA Standards (40CFR191). The Standards require a probabilistic assessment of potential scenarios for release of radionuclides from the repository to the biosphere (groundwater, air or soil) and set the limits of probabilities and magnitude of such releases. The requirements of the Standards and the procedure necessary to demonstrate compliance with them is discussed in detail in Chaturvedi, et al, 1987 (4). The procedure of assessment of compliance with the Standards is called, "performance assessment" and is defined in 40CFR191.12(q). The Standards do not require experiments with waste in a repository.

The EPA Standard contains two subparts. Subpart A limits the radiation exposure of members of the public from the management and storage of radioactive waste and also applies to facilities designed for temporary retention of the waste. Standards for disposal contained in Subpart B were developed to assure long-term integrity of a geologic repository for nuclear waste and would apply to the Nevada repository of high-level waste and to WIPP. Since the waste containers should be received, handled, examined and transported underground before permanent emplacement, Subpart A provisions also apply to a geologic repository for that phase of the work. Compliance with Subpart A is required for WIPP during waste handling operations. Before a decision can be made to leave the waste underground for permanent disposal, DOE has to demonstrate projected compliance with Subpart B of the Standards.

Subpart B of the Standards was vacated by the First Circuit Court of Boston in June 1987 on grounds that they were less stringent than the Clean Water Act of 1971, and no explanation was provided by EPA for this discrepancy. The Standards were remanded to the EPA for revision and repromulgation. Shortly after this action, New Mexico entered into a modification to the Consultation and Cooperation Agreement with DOE to continue to evaluate WIPP against the vacated 1985 Standards because the technical requirements of the revised Standards were not expected to differ substantially. Even though the Standards were vacated for what appears to be a technicality, EPA has not re-promulgated the revised Standards that have been vacated for 3 1/2 years in February, 1991. New approaches to long-term risk predictions are being recommended. It has been suggested that the quantitative probabilistic approach be replaced by a qualitative assessment backed by expert judgement, human intrusion scenarios be deleted and require population dose limits instead of environmental release limits. Demonstration of compliance of WIPP with the vacated Standards is scheduled by DOE to be in 1995. If the Standards are modified substantially, compliance with the new

Standards may require additional years. The compliance may indicate a need for modification of the waste - deletion of metal, grouting of waste, compaction or even incineration with fixing the ashes in an insoluble matrix. Thus, the shipment of TRU waste to WIPP for permanent disposal will not start until 1995 at the earliest and quite likely at a much later time.

WASTE EXPERIMENTS

The DOE has viewed WIPP as a "Pilot Plant" and a "Research and Development" facility from its inception in 1974. Congress authorized WIPP (Public Law 96-164, December, 1979) as "a defense activity of the Department of Energy, administered by the Assistant Secretary of Energy for Defense Programs 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." DOE has viewed this authorization to allow construction of a full-scale facility to permanently dispose of all the defense transuranic waste that is retrievably stored at DOE weapons-complex sites and that to be generated for 25 years in the future. At the same time, DOE maintains the WIPP is only an R and D facility for experimenting with waste to "demonstrate safe disposal" and only after a Test Phase lasting 5 years or more during which waste will be brought to WIPP, DOE will determine if WIPP may be used as a repository.

A detailed history of the evolution of DOE's plans for experiments with waste at WIPP is provided in Chaturvedi, 1989 (11). Even before any plans for waste experiments were available, DOE (Wade, 1987) announced plans to ship 126,000 drums (15% of the total capacity of WIPP) to WIPP for Research and Development (12). Dr. Wendell Weart of Sandia National Laboratory clarified, "For the gas generation aspect, we believe that we need something on the equivalent of four full rooms of radioactive waste" (13). Weart further pointed out that the additional amount was needed for "operational demonstration" (13).

A draft of the first report that outlined the DOE plans for experiments with TRU wastes at WIPP was issued in 1988 (14). The report proposed filling four of the WIPP rooms with CH-TRU waste to monitor gas generation. The specific quantity of waste was not identified, but at approximately 6000 drums per room, it would be about 24,000 drums (2.8% of the total volume). A new plan published by DOE in 1990 (15) proposed performing Laboratory Scale, Bin Scale and Alcove Scale experiments for the production, depletion and composition of gases from the TRU waste. Out of the three scales of testing, laboratory tests were proposed to be done in laboratories away from WIPP. DOE acknowledged that the Bin-Scale tests do not have to be performed at WIPP (16) but

provided justification based on logistics, economics and schedule (17). The alcove tests to be performed in situ at WIPP underground were proposed as necessary for the following reason: "Due to potential uncertainties introduced by extrapolating laboratory, small, or even bin-scale results to the full-scale repository configuration, it becomes necessary to validate gas generation models and the predicted impacts and consequences of gas generation by conducting room-scale tests with actual CH-TRU waste in the WIPP facility" (15, p. 2-112).

A total of 600 drums (100 bins) were proposed for the bin test (17) and 3800 drums for the alcove test (18). A bin is a rectangular steel box, 124.5 cm x 111.8 cm x 86.4 cm (49" x 44" x 34") designed to fit snugly in a Standard Waste Box (SWB) for transportation, and fabricated of mild steel plate. Each bin can hold 6 CH-TRU drums volume of waste and weigh up to 1818 Kg (4000 pounds) (17). An alcove is a room 30.4 m x 7.6 m x 4 m (100 ft x 25 ft x 13 ft) that can hold 1100 CH-TRU drums.

Soon after publication of the experimental plans for the WIPP Test Phase, it became clear in early 1990 that the bin-scale tests that involved sampling of liquids from the bins could not be performed at WIPP because the WIPP is not designed to handle liquid plutonium-contaminated samples. The bin-scale tests have therefore been curtailed to include only 86 "dry bins" or 516 drum-equivalent (19). The plan is to emplace the bins in two rows along the edges of Rooms 1 and 2 of Panel 1 with two bins stacked in each row. Gas measurements from the bins would continue for 5 years. There are a number of problems in performing this test at WIPP, as described below:

o The upheaving salt floor in a mined room is not a suitable place for placing double-stacked bins, each weighing up to 2 tons (17). Even without any loading, the floor has to be dug up and "reconstituted" with compressed crushed salt every two years. There is no published report of the analysis of loading on this floor. It appears that at a minimum, the bins would have to be removed to reconstitute the floor every few years.

o Because of the experience of the SPDV rooms that were excavated in 1983 and the roofs of which became unstable within 6 years, the Panel 1 rooms where bin-tests are planned, have been rock-bolted with 3 m (10 ft) rock-bolts. The February 4, 1991 roof fall in SPDV Room 1 that only had 6 m (2 ft) rock bolts, included a slab about 2.5 m (8 ft) thick and possibly extending to 3.5 meters (11 ft) thickness in the center. It is not clear whether the 3 m (10 ft) rock-bolts in Panel 1 rooms will be sufficient to maintain safety from roof-fall during the Test Phase period. Room 1 of Panel 1 was excavated in May to August, 1986 and will be 5 years old in 1991 (20).

o Under RCRA authority, EPA granted 10 year approval to DOE's request to conduct experiments in the mine for 5 years (21). Amongst various requirements, the Department must show that the concentrations of flammable gases are less than 50% of the lower explosive limit (LEL) in air. The LEL of hydrogen is 4% and it is 5% for methane. DOE states, "no internal concentration of potentially flammable, gaseous mixtures when mixed with air will be allowed in a test bin... If potentially flammable mixtures when mixed with air have occurred, then the bin will be purged." (22). This suggests frequent purging might be required. Using drum equivalency, a 33% void space in a 210 liter drum would limit the hydrogen generation to 1.4 liter/year. This is equivalent to 1.4/22.4 = .0625 moles/drum-year. For the expected amounts of hydrogen generation of 1 mole/drum-year, the drums may have to be purged 8 times a year for 5 years. This could introduce an error in estimating the total volume of H_2 gas by summing 40 measurements. A limit of 50% of the LEL could require 16 purges per year.

DOE has claimed that the results from the waste experiments are essential for performance assessment to determine compliance with the EPA Standards. In fact, the "Bin and Alcove Tests" have been used synonymously with "Performance Assessment Tests". EEG has therefore urged the Department since 1989 to conduct these tests at other locations so that data would be available now. The decision by DOE not to do this appears more logistical (work force available at WIPP) and symbolic (emphasis in bringing radioactive waste to WIPP) than scientific (need to experiment in the mine even though there may be delays in obtaining data).

With respect to the alcove-tests, DOE engineers have attempted to seal the alcoves with inflatable seals that have not been successful. DOE now plans to design and test a rigid concrete seal, but the latest revision (January 16, 1991) to the WIPP Decision Plan published by DOE has deleted the alcove test as a program being pursued. Because of the nature of the WIPP geologic strata where fracturing rapidly occurs parallel to the roof, floor and walls within a year or two after excavation, it may not be possible to expect the alcoves to remain sealed for the duration of the Test Phase, even if a seal can be designed that would be effective soon after excavation.

OPERATIONAL READINESS

WIPP is not yet (February 1991) operationally ready to start receiving radioactive waste. According to DOE's schedule, all items for readiness should be completed by the end of February, 1991. However, EEG has reservations in the following areas.

o Staffing and Training: The radiation safety program is not fully staffed. The adequacy of the Health Physics technician staff training and operational experience is in doubt. EEG has

also recommended that radiation safety programs should be kept separate from non-radiological operational safety programs.

o Policy: The WIPP Project Office has not adequately documented policy for radiation safety administration in the area of air monitoring, contamination control, ventilation balancing, auditing and facility use.

o Audits: DOE should define an organization within DOE that would be responsible for regulatory authority over WIPP and the WIPP Project Office (WPO) should be held strictly accountable by that organization for regulatory compliance. DOE will require an integrated systems checkout audit that is not due to be initiated until May or June, 1991.

o ALARA: The WPO program for ALARA is inadequate. Problems such as poor design for TRUPACT dock hood illustrate the reason for EEG's perception of an inadequate ALARA program at WIPP.

o Air Monitoring: The effluent continuous air monitoring systems continue to have reliability and sensitivity problems.

DESIGNATION OF ROUTES

Since the only TRU wastes intended for experiments by DOE in the next four years are slated to come from Idaho National Engineering Laboratory (INEL) and Rocky Flats Plant (RFP), the New Mexico state agency with the authority to designate routes, Environmental Improvement Board (EIB), has designated one route to WIPP from the north. Controversy exists over the need to reconsider portions of the route that are on secondary roads.

ADMINISTRATIVE LAND WITHDRAWAL PROBLEMS

In order to bring transuranic waste to WIPP, the DOE must receive temporary authorization by the U.S. Department of Interior or permanent authorization by an Act of Congress. On January 28, 1991 the U.S. Department of the Interior issued 43CFR Public Land Order 6826 granting permission to bring TRU Waste for experiments. Some concerns that relate to protection of the public health and safety are as follows.

o No numerical limit was established on the amount of TRU waste DOE may bring to WIPP prior to demonstrating compliance with EPA Standard for safe disposal. The Land Order requires DOE not to ... "exceed the amount that can feasibly be removed should the site not be selected as a permanent repository." While the DOE identified a need of 0.5% by volume (4500 drums) of the CH-TRU waste for experiments, the most recent version of the DOE WIPP decision plan (January 16, 1991) has deleted the solubility

tests and the alcove tests. Hence the identified need for waste for experiments is 516 drums (0.06% by volume) or a total of 15 truckloads. DOE has a self-imposed limit of 10% (16).

- o RH-TRU waste is not precluded.
- o Land remains open for mineral leasing.
- o The prohibition on 'burial of radioactive materials" in the 1983 Public Land Order 6403 has been deleted. Hence it appears that burial is no longer precluded.
- o The Land Order is unclear whether operational demonstration with waste is allowed.
- o The Order permits experiments through mid-1997, 6 years hence. While the DOE petition to EPA for experiments requested 5 years, EPA authorized 10 years (21).
- o The Order does not require any plans as to the disposition of the waste after the Test Phase.
- o Authorization does not require the experiments to be of value in performance assessment.

SUMMARY

Construction of the WIPP facility both above and below ground has been completed, including 7 out of the planned 56 waste rooms of the repository. The facility was designed for a 25 year operation because of the predicted difficulties in keeping it safe for operations much beyond that period, due to the rapid closure of excavations in salt. Geomechanical measurements in the WIPP excavations show that the closure rate due to the creep of salt is 3 to 4 times faster than predicted. Because of this, those parts of the facility that were excavated in 1983 and were not rock-bolted, are already unsafe and closed for personnel entry.

While the facility has been designed and constructed to be a full-scale repository for permanent disposal of up to 850,000 drums of contact-handled(CH) and 7500 casks of remote-handled (RH) transuranic (TRU) waste, the U.S. Department of Energy (DOE) plans to use it as a research and development facility for experimenting with TRU waste for a Test Phase lasting 5 years or longer. DOE had planned to measure gas generation from 4,500 CH-TRU waste drums in the WIPP repository. However, the WIPP repository is not an ideal place for performing these experiments and operational problems are being encountered. Solution to these problems is expected to become more difficult with the aging of the facility.

In order to use WIPP for its intended purpose as a repository for permanent disposal of TRU wastes, satisfactory compliance with the Environmental Protection Agency (EPA) Standards coded in 40CFR191 has to be demonstrated. These

Standards were promulgated in 1985 but were vacated by a court in 1987. Revised Standards have not been promulgated and are not expected until 1993-94. The State of New Mexico encouraged DOE to continue work on assuring compliance with the vacated Standards and signed an agreement to that effect in 1987. DOE did not pursue this work aggressively during 1985 to 1988, but the work is now being pursued diligently. Initial assessments show some difficulties in meeting compliance with long-term disposal in Part B of the Standards. It is possible that compliance may require modification or reprocessing of the waste and incorporation of robust engineered barriers.

If WIPP is to be used as a permanent repository, DOE should concentrate its efforts on demonstrating compliance with 40CFR191 and developing and testing waste modification processes to achieve such compliance. It appears that too much effort is currently being expended to start shipping a small quantity of waste underground for experiments.

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