EEG-61

REVIEW OF THE WIPP DRAFT APPLICATION TO SHOW COMPLIANCE WITH EPA TRANSURANIC WASTE DISPOSAL STANDARDS

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FOREWORD

The purpose of the New Mexico Environmental Evaluation Group (EEG) is to conduct an independent technical evaluation of the Waste Isolation Pilot Plant (WIPP) Project to ensure the protection of the public health and safety and the environment. The WIPP Project, located in southeastern New Mexico, is being constructed as a repository for the disposal of transuranic (TRU) radioactive wastes generated by the national defense programs. The EEG was established in 1978 with funds provided by the U.S. Department of Energy (DOE) to the State of New Mexico. Public Law 100-456, the National Defense Authorization Act, Fiscal Year 1989, Section 1433, assigned EEG to the New Mexico Institute of Mining and Technology and continued the original contract DE-AC04-79AL10752 through DOE contract DE-ACO4-89AL58309. The National Defense Authorization Act for Fiscal Year 1994, Public Law 103-160, continues the authorization.

EEG performs independent technical analyses of the suitability of the proposed site; the design of the repository, its planned operation, and its long-term integrity; suitability and safety of the transportation systems; suitability of the Waste Acceptance Criteria and the generator sites' compliance with them; and related subjects. These analyses include assessments of reports issued by the DOE and its contractors, other federal agencies and organizations, as they relate to the potential health, safety and environmental impacts from WIPP. Another important function of EEG is the independent environmental monitoring of background radioactivity in air, water, and soil, both on-site and off-site.

Since 1978 EEG has been directly involved in quantifying the long-term consequences of radioactive waste releases from WIPP. We evaluated DOE's 1979 analyses contained in the Draft Environmental Impact Statement and published our analysis in 1979. The mission of WIPP at that time included high-level waste as well as transuranic waste.

Consequences were calculated via deterministic analyses in which an event was assumed to occur. EEG published nine reports calculating doses from the long term releases including consideration of brine reservoirs, drilling for mineral resources, sensitivity analysis for hydrological parameters in the Rustler, Breccia chimney and naturally occurring disruptive events. At about the same time that EEG was created in 1978, EPA began drafting standards for the safe disposal of high level and transuranic waste and the first briefing for EEG on this work by EPA occurred in 1979. EEG commented extensively on the multiple drafts and the standards were promulgated in September 1985.

Although not everyone was satisfied, the standards represented a consensus at that time. When the First Circuit Court vacated the standards in June of 1987, following a challenge by the Natural Resources Defense Council, Inc., the state of New Mexico entered into a formal agreement with DOE within a few days to continue to measure the expected performance against the vacated standards. It made sense since the standards were not expected to change much. Although it took 6.5 years for the agency to repromulgate the standards, DOE has been working since 1985 to show compliance and they currently plan to complete the task of the documentation of compliance for safe disposal by November 1, 1996.

The 1985 EPA standards required probabilistic analyses. The approach by DOE to show compliance has been an iterative one that we support. The last iteration of performance assessment was issued by Sandia National Laboratories in 1992.

Although the DOE draft application is substantially incomplete, we urged the Secretary of Energy in March 1995 to issue the draft report to enable oversight organizations to provide feedback to DOE and we commend DOE for issuing this interim application.

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Don Gray and Sally Ballard provided technical review and evaluation. Betsy Kraus prepared the footnotes for references and provided editorial support. Jill Shortencarier and Patricia Fairchild patiently and diligently provided secretarial support through several drafts of this multi-authored report. Contributions of Susan Stokum and Radene Bradley are also gratefully acknowledged.

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ACRONYMS

BHP	Borehole Plugging Program
BIR	Baseline Inventory Report
CSR	Compliance Status Report
CAM	Continuous Air Monitor
CAO	Carlsbad Area Office
CFR	Code of Federal Regulations
CH-TRU	Contract Handled Transuranic
DCCA	Draft Compliance Certification Application
DOT	U.S. Department of Transportation
DOE	U.S. Department of Energy
ESAAB	Energy Systems Acquisitions Advisory Board
EEG	Environmental Evaluation Group
EPA	U.S. Environmental Protection Agency
FEPs	Features, Events and Processes
FSAR	Final Safety Analysis Report
INEL	Idaho National Engineering Laboratory
GCR	Geologic Characterization Report
MDL	Minimum Detection Levels
NAS	National Academy of Sciences
NMVP	No Migration Variance Petition
NMBM&MR	New Mexico Bureau of Mines and Mineral Resources
NAS	National Academy of Sciences
NRC	Nuclear Regulatory Commission
ORNL	Oak Ridge National Laboratory
PBWAC	Performance Based Waste Acceptance Criteria
QA	Quality Assurance
QAPD	Quality Assurance Program Description
RCRA	Resource Conservation and Recovery Acts
RH-TRU	Remote Handled Transuranic
RTR	Real Time Radiography

ACRONYMS (CONT.)

SAR	Safety Analysis Report
SARP	Safety Analysis Report for Packaging
SNL	Sandia National Laboratories
TRU	Transuranic
USGS	U.S. Geological Survey
WAC	Waste Acceptance Criteria
WIPP	Waste Isolation Pilot Plant

EXECUTIVE SUMMARY

Overall Impression

The DOE Draft Compliance Certification Application (DCCA) cannot be considered to be an adequate draft document for demonstrating compliance with the EPA Standards for the Disposal of Transuranic Radioactive Waste (Title 40, Code of Federal Register, Part 191, Subpart B)[ES-1] requirements. It is more a framework for the application than a draft application, since it lacks a logical presentation of the proofs of compliance. A draft document should contain substantial features of the final document. The DCCA preface states that the draft does not provide "detailed information" on a number of topics and the submittal does not present the "complete picture" of long-term performance. In fact, the EEG finds that even the most basic information is lacking in this draft.

History of the Project

The historical sections of the DCCA omit several significant details concerning changes in the purpose and scope of the project, the history of site selection, the site selection criteria, the location of the repository, the design, and the waste acceptance criteria. Many apparent inconsistencies and contradictions in the project can be explained only through a full and accurate description of the history of the WIPP project,

Conceptual Models

The application is weak in describing alternative conceptual models for the projected conditions and processes in the repository and along the potential breach pathways, and in defending the ones selected. For some cases, the experimental data is not currently available to justify a particular model but additional data being collected may do so, as in the case of

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[ES-1] While the title of the DCCA or the text do not state it, the document only addresses compliance with Subpart B of the Standards (40 CFR 191) for disposal. Compliance with 40 CFR 191 Subpart A for the management of TRU waste is required by the Land Withdrawal Act, P.L. 102-579, Section 9 (a), and has to be documented.

radionuclide solubility. In other cases, potentially erroneous interpretations of the data have led to the concepts preferred by the DOE scientists. For example, although EEG clearly pointed out[ES-2] the error in using the limited stable isotope data from the Carlsbad Caverns pools in deciphering the past history of the Rustler aquifers, the DCCA presents only the conceptual model based on that data in estimating the age of the Rustler groundwater.

The EEG and DOE have debated many issues related to conceptual models since 1979, and in many instances additional boreholes or field experiments have led to a general consensus among the scientists; for example, whether pressurized brine exists in the Castile Formation underlying the repository, and whether "deep dissolution" is a threat to the integrity of the repository. However, there remain some instances where relatively inexpensive, but time-consuming, field experiments would provide the answers. The DOE conceptual model of radionuclide retardation in the Culebra aquifer remains a long-standing issue that would require such time-consuming field experiments to resolve; EEG first suggested such field work in 1979. Until the support for the conceptual models is on a solid basis, the WIPP cannot be said to comply with 40 CFR 191.

Hydrology

A basic understanding of the hydrology of the site is yet to be attained. The location of the water table at the WIPP site has not yet been identified; this would require an investigation of the hydrology of the shallow zone overlying the Rustler Formation, including the Dewey Lake Redbeds. The Culebra dolomite plays an important part in the postulated breach scenarios yet knowledge of its recharge and discharge locations and the mechanics of flow and transport in this most important aquifer are currently inadequate. The postulated direction of flow as indicated by the potentiometric heads differs from that obtained from water chemistry--such differences do not lead to confidence in the DOE conceptual models. Several Culebra wells have shown an as yet unexplained rise in water levels in recent years; this, too, should be explained in a compliance application. The DCCA does not adequately address these topics.

[ES-2]Chapman, Jenny B. 1986. *Stable Isotopes in Southeastern New Mexico Groundwater: Implications for Dating Recharge in the WIPP Area.* Albuquerque, NM: Environmental Evaluation Group, EEG-35.

Containment Requirements

The Sandia National Laboratories (SNL) published three iterations of performance assessment (PA) calculations in 1990, 1991, and 1992 to demonstrate compliance with the containment requirements listed in 40 CFR 191.13. These iterations demonstrated that incorporation of improvements in the methodology--better prediction of drilling probabilities, superior addressing of fracturing due to gas pressure, recognition that borehole plugs can degrade, improved methods of breach scenario calculation--were possible, and important. However, the DCCA offers no further improvement in WIPP performance assessment over the 1992 PA calculations.

Containment requirement calculations should be the heart of the application but only rudimentary information on the topic is supplied in the DCCA. The draft application is seriously deficient in not analyzing several potentially disruptive scenarios, in not adequately establishing the probabilities for a number of potential breach scenarios, and in not providing the basis for calculation of consequences. The exclusion of features, events, and processes eliminated on regulatory or low consequence potential has not been adequately justified; 23 of the 53 parameters listed in appendix PAR lack specific information; no sensitivity analysis is included; the number of consequence calculations has been reduced from 70 in the 1992 performance assessment to 20 in the DCCA; no evidence of computer model validation is included, nor quality assurance of data demonstrated; only a single Complementary Cumulative Distribution Function (CCDF) is shown. These lapses make it impractical to make any judgement about the WIPP's compliance with the EPA's disposal standards on the basis of this draft application.

Waste Inventory and Characterization

Various DOE documents present seriously conflicting pictures of the volume and radioactivity of the TRU waste available and expected to be generated. In the DCCA, performance-based waste acceptance criteria are mentioned, but never identified, perhaps because the DCCA also fails to identify the specific waste parameters important to compliance. Reliance on process knowledge for waste characteristics continues to be insufficiently justified. These conflicts and omissions provide little confidence in the DOE's inventory assessments.

Assurance Requirements

The purpose of the assurance requirements (40 CFR 191.14) is to provide confidence for long-term isolation of the waste that cannot be achieved solely by the numerical containment requirements (40 CFR 191.13). The EPA explained the need for the assurance requirements as follows:

> "There are too many uncertainties in projecting the behavior of natural and engineered components for many thousands of years--and too many opportunities for mistakes or poor judgements in such calculations--for the numerical requirements on overall system performance in subpart B to be the sole basis to determine the acceptability of disposal systems for these very hazardous wastes. These uncertainties and potential errors in quantitative analysis could ultimately prevent the degree of protection sought by the Agency from being achieved."[ES-3]

The assurance requirements should not therefore be confused with the containment requirements. The DOE attitude toward demonstrating compliance with the assurance requirements, however, continues to reflect a lack of commitment, and none of the six elements of 40 CFR 191.14 can be said to have been adequately addressed in the DCCA, as explained below.

Institutional Controls and Monitoring: 40 CFR 191.14(a) and (c) concern active and passive institutional controls; the plans for these are not scheduled to be prepared until October 30, 1997. 40 CFR 191.14(b) requires developing a plan for monitoring of the repository after disposal is completed; there is only a commitment to develop such a plan, with no completion date given, in the DCCA.

Engineered Barriers: 40 CFR 191.14(d) requires engineered barriers to be included in the repository. The EPA definition of engineered barriers (*barrier* in 40 CFR 121.12) includes only three examples: a canister, a waste form, and a material placed over and around the waste (backfill). In various sections of the DCCA, however, the DOE has used the repository

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[ES-3]Preamble to 40 CFR 191, Federal Register, Vol. 50, No. 182, p. 38079.

itself, and the shaft and panel seals as examples of engineered barriers--clearly not the intent of this requirement. The DOE also interprets the 1992 Land Withdrawal Act statement that DOE " ...shall use both engineered and natural barriers, and waste form modifications at WIPP to isolate transuranic waste after disposal to the extent necessary to comply with the final disposal regulations"[ES-4] as requiring no engineered barriers if not required to show compliance with the containment requirement (40 CFR 191.13). The assurance requirement (40 CFR 191.13 d) requires engineered barriers whether or not they are needed to show compliance with the containment requirement. Thus, it is necessary to include engineered barriers at WIPP to comply with the EPA Standards and the Land Withdrawal Act. The DOE position on this issue is indefensible.

Natural Resources: 40 CFR 191.14(e) requires that areas with natural resources be avoided in selecting the sites for nuclear waste repositories, "...unless the favorable characteristics of such places compensate for their greater likelihood of being disturbed in the future". The WIPP site was selected in a resource-rich area in 1974, and the WIPP Final Environmental Impact Statement of 1980[ES-5] estimated the crude oil reserves at the WIPP site as "nil" even though information to the contrary was available[ES-6]. Oil and gas wells and potash mines now surround the WIPP site leaving no doubt about the existence of natural resources in the area. The DCCA uses the time of site selection as an excuse to "grandfather" the site into existence, as the provisions of 40 CFR 191 were not published until 1985. There is no "grandfather" provision in 40 CFR 191; and there has been no formal acceptance of WIPP as a waste repository, nor any waste emplaced. To be constructive, EEG has recommended that instead of debating the favorable characteristics of the site and the degree to which they compensate for the existence of resources, the performance assessment should recognize the characteristics of the site as they are, and consider all plausible scenarios for breach. EEG also notes that siting in a resource-rich area provides another reason for the inclusion of robust engineered barriers in the repository design.

[ES-4]Public Law 102-579, Sec. 8(g).

[ES-5]DOE/EIS-026, 1980, Vol. 1, Table 9-14.

[ES-6]Silva, M.K. 1994. *Implications of the Presence of Petroleum Resources on the Integrity of the WIPP site*. Albuquerque, NM: Environmental Evaluation Group, EEG-55, p. 18.

Retrievability: The final assurance requirement, 40 CFR 191.14(f), requires that the removal of the waste be a viable option for a reasonable period of time after disposal. The DCCA offers no plans or data to demonstrate compliance with this requirement.

DOE has failed to adequately address all of the assurance requirements of 40 CFR 191.14 in the DCCA, and no determination of compliance is possible until this important area is adequately assessed.

Individual Protection and Ground Water Protection Requirements

The DCCA has only three pages to show compliance with the requirements of 40 CFR 191.15 and 40 CFR 191.16. The work simply has not been done, and the WIPP's compliance with these requirements cannot be assessed until it is.

DOE Self-Regulation

While the DOE self-regulates several aspects of the WIPP project, and the DOE Orders are applicable to it, the DCCA does not list the DOE in the list of regulatory agencies. The Biennial Environmental Compliance Report (Appendix BECR) provides detailed information on the status of compliance with laws, regulations, and standards by a number of regulatory agencies, but omits any information on the status of compliance with regulations issued by the DOE. An analysis of the DOE Orders, and reviews and approvals by the Office of Environment Safety and Health (ES&H) and the Defense Nuclear Facilities Safety Board (DNFSB) should be included in the BECR. Public accountability of compliance with the DOE requirements is essential.

COMMENTS ON THE DCCA EXECUTIVE SUMMARY

The Purpose of WIPP

Page ES-1

The description of the purpose of the WIPP project continues to remain confused in the DOE documents. "Research and development facility to demonstrate the safe disposal of radioactive waste ..." has never adequately described the purpose of WIPP, even though it is the language in the 1979 Act authorizing WIPP. The second sentence in the Executive Summary of the DCCA, "The facility was constructed in southeastern New Mexico in a manner intended to meet criteria established by the scientific and regulatory community ...", is also convoluted. The following straightforward statement is suggested to describe the purpose of the WIPP project for use in all the WIPP project documents: "The Waste Isolation Pilot Plant is planned to be a permanent geologic repository for transuranic waste generated by the defense activities of the United States."

As appropriate, additional statements about the DOE being the manager of the waste and the repository, the EPA being the certifier of compliance with the environmental regulations, etc., can be added.

Waste Quantity and Radioactivity Limitations

Page ES-2, lines 21 to 25

The paragraph should be changed to correspond with the limitations in the waste amount and radioactivity listed in Sec. 7 of the Land Withdrawal Act.

Assumed Characteristics

Page ES-2, line 28

"Assessments of the repository performance are based in part on <u>assumed</u> characteristics of the waste including factors such as the levels of radioactivity present in the waste, the amount of moisture in the waste, and the quantities of other materials that might have some effect on the potential for the waste to migrate toward the accessible environment." Emphasis added.

The characteristics of the waste should not have to be assumed; they should be known.

The Results of Analyses
Page ES-3, lines 22-27

In addition to the limitations listed, many plausible scenarios were not considered in developing the CCDFs shown in Figures ES-1 and 6-18. Also, the values of many important parameters used for developing these CCDFs were simply guesses by the scientific investigators, and not the values obtained from experiments. Thus, the results presented in this document are no more than a generic demonstration of the performance assessment procedures. They make no contribution towards assessing the WIPP's compliance with 40 CFR 191.13. Compliance with 40 CFR 191.14, 191.15 and 191.24 has also not been demonstrated.

Authorized Wastes
Page ES-2, line 36

It is stated that the DOE may only emplace the radioactive waste at WIPP that meets the definition of TRU waste in the Land Withdrawal Act (LWA) and the DOE waste acceptance criteria.

The waste must also meet the NRC standards for transportation and the EPA standards for long-term disposal.

CHAPTER 1. INTRODUCTION

Total Projected Quantity of Waste in the Repository
Page 1-1, lines 12-17

The Executive Summary states that the WIPP facility is designed to receive up to 6.2 million cubic feet (175,600 m^3) of contact-handled and 250,000 cubic feet (7,080 m^3) of remote-handled transuranic waste. Chapter 1 states that approximately 2.8 million cubic feet (79,300 m^3) of TRU waste is currently in storage and an additional 2.0 million cubic feet (56,640 m^3) is expected to be generated, although this projection may increase. The estimate of 2.8 million cubic feet (79,300 m^3) of retrievably stored TRU waste is much lower than other estimates by the DOE, and the 4.8 (2.8+2.0) million cubic feet (135,940 m^3) estimate is much lower than the 6.2 million cubic feet (175,600 m^3) capacity of the WIPP repository.

Since the allowable release limits in the EPA Standards 40 CFR 191 are based on the inventory (radionuclides and curie content) to be disposed in the repository, it is important to make an accurate projection of the curie content of each radionuclide to be emplaced. If the actual amount placed is lower than the assumption made to calculate the release limits, then the calculations would not be conservative, i.e. would project higher allowable releases than should be allowed, and vice-versa.

Project Overview
Pages 1-2, 1-3

Only through a full description of the checkered history of the WIPP project can the inconsistencies and contradictions in the project be fully explained. For example, The WIPP facility has <u>not</u> been constructed to "determine the efficacy of an underground repository for disposal of TRU waste and TRU mixed waste" (p. 1-2, lines 11,12). Study of the in situ geomechanical and geohydrological behavior of the repository did not require excavation of the full-fledged repository and waste handling facilities, or the heated room experiments. The facility was constructed prior to the decision to apply EPA standards for the mixed (TRU and chemically hazardous) waste. The WIPP facility was constructed in the 1980s because the

DOE had planned to emplace underground all the then retrievably stored (200,000 drums) transuranic contact-handled (CH-TRU) waste, and limited quantities of high level waste for experiments, before assessing the WIPP's suitability as a permanent repository. Similarly, for those who may not be familiar with the DOE desire to conduct a "test phase" involving emplacement of waste in the Panel 1 rooms and in the alcoves, the provisions of the Land Withdrawal Act are hard to explain. This section should describe the plans prior to October 1993, the reasons for the DOE decision to abandon the idea of testing with the waste at WIPP, and the effect of that decision on the requirements of the Land Withdrawal Act.

An illustration of the difficulty caused by the omission of discussion of the "Test Phase" is provided by the following sentence in the Project Overview section (Sec. 1.2).

> The DOE's decision was reached after all prerequisites for ending construction were met and documented (page 1-3, lines 7 and 8).

The *decision* in this sentence refers to the decision by the DOE Energy Systems Acquisition Advisory Board (ESAAB) in 1991 to start the "Test Phase" by shipping one bin of waste to WIPP. Without identifying what the *decision* was for, this sentence is meaningless. The fact is that the site characterization work is still continuing at the WIPP site, and since only one out of the planned eight waste panels has been excavated, the construction has also not ended. This factor also caused delay in initiating several necessary field and laboratory tests for site and waste characterization. Some of these tests are being conducted now under a tight schedule and others have been abandoned or postponed because they do not fit in this tight schedule. This also explains the sentence, "Additional scientific studies may continue during the disposal phase." (p. 1-3, line 15).

The project is finally on the right track. Only an awareness of the past mistakes and disassociation with the past short-sighted approaches will keep it there.

Page 1-2, line 15

"The LWA requirements relevant to this application focus on the criteria for certification of compliance with the radioactive waste disposal regulations issued by the EPA."

The application focuses on the regulations for disposal. The criteria only clarify those regulations.

Page 1-2, line 30

The text fails to note that the site was moved 1.25 miles south after the publication of the 1980 FEIS.

Page 1-3, line 9

What are the documents?

Page 1-3, line 11

Change "Once the DOE demonstrates compliance..." to "Once the EPA certifies compliance..."

Page 1-3, line 14

While the text states that the disposal phase will last 25 years, the DOE/CAO announced in October 1995 that the disposal will take 35 years.

Page 1-3, line 16

"The disposal phase will end when the design capacity is reached."

Since the current estimate of transuranic waste for emplacement at WIPP is only 2/3 of the design capacity, this would mean the disposal phase would not have an end date.

Page 1-3, line 26

The text states that the purpose of the active and institutional controls is to reduce the likelihood of human intrusion to the extent practicable. While this is a laudable goal, the standard states that the purpose is "to indicate the dangers of the wastes and their location" (40 CFR 191.14.d).

Site Selection Process

The discussion of the site selection process should include the following facts:

- One of the most restrictive site selection criteria, primarily because of the Lyons (Kansas) experience, was avoidance of drill holes penetrating through the salt within two miles of the repository border (p. 2-5)[1-1].

- The two-mile criterion caused the potential site to be shifted twice as new oil or gas wells were drilled nearby. The separation distance criterion was changed to one mile after the site at the ERDA-6 borehole was found to be unacceptable (p. 2-10[1-2] p. 2-6, 2-7, 2-12[1-1]), (pp. 6-7)[1-3].

- One of the three locations in New Mexico examined in detail to be the WIPP site was the Mescalero Plains area. The salt depth was adequate in that area but it was rejected because of extensive oil-field development (1980, p. 2-10)[1-2].

[1-1]Powers, D. W., S. J. Lambert and S. E. Shaffer. 1978. *Geological Characterization Report, Waste Isolation Pilot Plant (WIPP) Site, Southeastern New Mexico.* Albuquerque, NM: Sandia National Laboratories. SAND 78-1596/2 vols.

[1-2]United States Department of Energy. 1980. *Final Environmental Impact Statement Waste Isolation Pilot Plant.* DOE/EIS-0026/2 vols.

[1-3]Environmental Evaluation Group. 1979. *Radiological Health Review of the Draft Environmental Impact Statement (DOE/EIS-0026-D) Waste Isolation Pilot Plant, U.S. Department of Energy.* Santa Fe, NM: Environmental Evaluation Group. EEG-3 (EEG-2 Appendix III).

- Extensive oil-field development has occurred in the area surrounding the WIPP site with more than 100 producing oil and gas wells in the two mile zone surrounding the 4 mile x 4 mile WIPP Land Withdrawal area (p. 42)[1-4].

- The original location of the WIPP repository was in the north-central part of the 4 mile x 4 mile WIPP site. After the borehole WIPP-12, located one mile north of the center of the WIPP site, encountered pressurized brine in the Castile Formation in November 1981, the repository was relocated to its present site in the south-central part of the WIPP site. A geophysical electromagnetic survey conducted over the present repository in 1987 indicated the presence of brine in the Castile Formation below the repository.

- Selection of the specific horizon, at 2150 ft (655 meters) below the surface, was a compromise. Salt of highest purity is found in the lower Salado Formation but that is too close to the Castile Formation with its brine reservoirs. A marker bed (MB 139) is only 4-5 ft (1-4 m) below the repository and the Marker Bed 138 is located 39 ft (12 m) above the repository roof. There are several anhydrite and clay layers within the repository horizon.

Page 1-3, line 29

The NAS 1957 report also recommended completion of the site characterization work before making a decision to use the site for a repository and before authorizing construction. The DOE did not follow this advice, causing many difficulties for the WIPP project. Also, "1955" on line 29 should be "1957".

[1-4] Silva, M. K. 1994. *Implications of the Presence of Petroleum Resources on the Integrity of the WIPP.* Albuquerque, NM: Environmental Evaluation Group. EEG-55.

Page 1-4, line 16

The text indicates that the site was shifted twice to keep it two miles away from the then existing deep boreholes. It fails to mention that the criterion was changed to one mile, since the two mile limit could not be met.

Page 1-5, line 10

The text states that the WIPP site was selected but does not point out that it was moved twice.

Page 1-5, line 10

There were two horizons selected; not one.

Page 1-5, line 13

"The facility has been constructed at a horizon such that operational and rock-support problems are minimized." This statement underestimates the extent of problems associated with rock stability at the WIPP repository horizon. The lower purer salt horizon, not selected for the repository due to its proximity to the Castile brine reservoir horizon, would most likely have been better with respect to the rock-support problems.

Regulatory Framework

This section should describe the EPA's and the New Mexico Environment Department's regulatory authorities over WIPP.

Page 1-5, line 23

Add the 1992 WIPP LWA as an additional authority to establish and implement regulatory standards.

Page 1-6, line 4

The description of the history of 40 CFR 191 fails to mention that within four days after the standard was vacated in June 1987, New Mexico entered into a formal Consultation and Cooperation Agreement with DOE within four days to act as though the standards were fully in effect. Hence there has been no lost time in the applicability of the 1985 standards through the present.

Evaluating Long-Term Performance

Page 1-9, line 3

The text states that the results of sensitivity analyses will be provided in the final application. Since such analyses were provided in the 1992 iteration, why aren't they available now?

Page 1-11, Figure 1-2

Nothing is shown for backfill nor on the current work on waste form modifications at INEL, ORNL or other sites.

Bibliography

Page 1-15

There are more recent iterations of the SAR than the 1990 version.

CHAPTER 2. SITE CHARACTERIZATION

The EEG provided detailed comments on the site characterization issues discussed in the "Compliance Status Report for the WIPP"[2-1] to the DOE on November 21, 1994. The DOE response of August 23, 1995, essentially reiterated the DOE position on these issues and therefore the issues remain unresolved. The EEG comments on the Compliance Status Report (CSR), which are included as Supplement 1 to this report (pages S1-1 through S1-28), should therefore be viewed as a part of the EEG comments on the DCCA[2-2]. The following comments address additional issues that were not covered in our comments on the CSR.

The Culebra Dolomite Member

Sec. 2.1.3.5.2, Page 2-37

The Culebra Dolomite Member of the Rustler Formation was discussed in Lowenstein (1987)[2-3], and not in Lowenstein (1988)[2-4]. The post-burial alteration of the Rustler Formation should be discussed in this chapter (in Sections 2.1.3.5.2, 2.1.6.2.2, 2.1.6.2.3) as a different interpretation based on the detailed sedimentological study by Lowenstein[2-2]. This interpretation is different from the one presented by Holt and Powers (1984)[2-5] and Holt and Powers (1988)[2-6].

[2-1]U.S. Department of Energy. 1994. *Compliance Status Report for the Waste Isolation Pilot Plant.* DOE/WIPP-94-019 Rev. 0).

[2-2]U.S. Department of Energy. 1995. *Draft Title 40 CFR 191 Compliance Certification Application for the Waste Isolation Pilot Plant.* Draft-DOE/CAO-2056.

[2-3]Lowenstein, T.K. 1987. *Post Burial Alteration of the Permian Rustler Formation Evaporites, WIPP Site, New Mexico.* Santa Fe, NM: Environmental Evaluation Group. EEG-36.

[2-4]Lowenstein, T.K. 1988. Origin of Depositional Cycles in a Permian "Saline Giant": The Salado (McNutt Zone) Evaporites of New Mexico and Texas. *Geological Society of America Bulletin* 100 (4): 592-608.

[2-5]Holt, R.M., and Powers, D.W. 1984. *Geotechnical Activities in the Waste Handling Shaft Waste Isolation Pilot Plant (WIPP) Project Southeastern New Mexico.* Carlsbad, NM: U.S. Department of Energy. WTSD-TME-038.

[2-6]Holt, R.M., and Powers, D.W. 1988. *Facies Variability and Post-Depositional Alteration Within the Rustler Formation in the Vicinity of the Waste Isolation Pilot Plant, Southeastern New Mexico.* Carlsbad, NM: U.S. Department of Energy. DOE/WIPP 88-004.

The statement, "After dolomite, Sewards et al. (1991, p. IX-1) report that clay is the second, most abundant mineral of the Culebra. Clay minerals include corrensite, illite, serpentine, and chlorite. Clay occurs in bulk rock and in fracture surfaces." (DCCA, p. 2-37, lines 33-35)[2-2] is not entirely correct. The actual statement is, "... the Culebra and Magenta units are primarily dolomite with some quartz and clay ..." (p. IX-1)[2-7]. This is very different than clay being the second most abundant mineral in the Culebra. Of course, some clay signatures were seen in the x-ray diffraction tests on the Culebra rock samples, and some might even be found in fractures. The key question that impacts the performance assessment and the application for compliance, however, is, "how much credit may be taken for chemical retardation due to the presence of clay in the fractures and in the rock matrix?" The EEG does not believe that a case has been made to take any credit for retardation due to the presence of clay. This issue was discussed at length in our comments on the Compliance Status Report (pages S1-1 through S1-28 of this report).

Incidentally, the reference for Sewards et al. (1991)[2-7], should be "SAND 87-7036" and not "SAND 97-7036" (p. 2-181, line 2).

Castile Hydrology

Sec. 2.2.1.3.2, Page 2-94

The following facts should be added in this section.

- Brine from the borehole WIPP-12 <u>did</u> flow to the surface at a rate of approximately 350 gallons per minute (22 liters per second). More than 1.14 million gallons (4.3 million liters) of brine "unavoidably" flowed to the surface and was collected in a large pond on the surface before the well was brought under control[2-8].

[2-7]Sewards, T., Glenn, R., and Keil, K. 1991. *Mineralogy of the Rustler Formation in the WIPP-19 Core*. Albuquerque, NM: Sandia National Laboratories. SAND87-7036.

[2-8]Popielak, R.S., Beauheim, R.L., Black, S.A., Coons, W.E., Ellingson, C.T., and Olsen, R.L. 1983. *Brine Reservoirs in the Castile Formation [Waste Isolation Pilot Plant] Project Southeastern New Mexico*. Albuquerque, NM: Sandia National Laboratories. 2 Vols. SAND78-1596, p. H-9.

- Steve Lambert of Sandia National Laboratories disagreed with the Popielak et al.[2-8] conclusion that "these fluids originated from ancient seawater and that there is no evidence for fluid contribution from present meteoric waters." Using the uranium-isotope disequilibrium method of determining the age of entrapment of groundwater, Lambert (in Appendix A of Popielak et al.)[2-8] presented calculated ages of the WIPP-12 Castile brine to be between 45,000 years to 2,000,000 years, for different assumptions of leaching and rate of injection.

- The electromagnetic survey conducted in 1987 indicated the presence of brine in the Castile Formation below the present WIPP repository[2-9].

Hydrology of the Rustler-Salado Contact Zone
Sec. 2.2.1.4, Page 2-95

The discussion in this section is unsatisfactory because it does not make full use of the available facts from WIPP studies. It should be revised.

Chaturvedi and Channell (1985, p. 34)[2-10] pointed out that the data from hydrologic testing at the WIPP site shows that the "brine aquifer" of the pre-WIPP investigators[2-11] extends east of Nash Draw to the WIPP site. Most of the WIPP boreholes have found brine in the Rustler/Salado contact zone and, in fact, the water-level recovery rate after pumping from this

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[2-9]Earth Technology Corporation. 1987. *Time Domain Electromagnetic (TDEM) Surveys at the WIPP Site, Final Report.* Albuquerque, NM: Sandia National Laboratories. SAND87-7144.

[2-10]Chaturvedi, L. and J.K. Channell. 1985. *The Rustler Formation as a Transport Medium for Contaminated Groundwater.* Santa Fe, NM: Environmental Evaluation Group. EEG-32.

[2-11]Robinson, T.W., and Lang, W.B. 1938. *Geology and Ground-Water Conditions of the Pecos River Valley in the Vicinity of Laguna Grande de la Sal, New Mexico, with Special Reference to the Salt Content of the River Water.* Twelfth and Thirteenth Biennial Reports of the State Engineer of New Mexico for the 23rd, 24th, 25th, and 26th Fiscal Years, July 1, 1934 to July 30, 1938. Santa Fe, NM: State Engineer.

zone was much faster than the Culebra recovery rate in borehole P-18, east of the WIPP site[2-12].

Mercer (1983, p. 53)[2-13] proposed the possibility of leakage from the overlying Culebra as the source of water in the Rustler/Salado contact zone at the WIPP site. With respect to the rate of movement of brine in the Rustler/Salado contact zone, Mercer (1983, p. 20)[2-13] had this to say:

> The rate of movement in the Rustler-Salado contact residuum at the WIPP site has not been determined because the hydraulic properties are extremely variable and because of the lack of a valid value for the effective porosity.

Since 1983, the focus of the WIPP subsurface hydrology program has been almost exclusively on the Culebra member as the most permeable zone in the Rustler. The Rustler/Salado contact zone should also be considered as a pathway of migration of radionuclides from the WIPP site to the Pecos River.

The Culebra Member of the Rustler Formation
Sec. 2.2.1.5.2, Page 2-99

The subject of the remaining uncertainties in the characterization of fluid flow and transport mechanisms in the Culebra should be addressed in this section.

The postulated groundwater travel time in the Culebra from the WIPP repository area to the accessible environment is between 100 and 1000 years. Current projections of transport showing compliance with 40 CFR 191.13 rely on dilution of concentration by diffusion into the static fluid volume of the rock matrix, and additional chemical retardation along the flow

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[2-12]Mercer, J.W., and Orr, B.R. 1979. *Interim Data Report on Geohydrology of Proposed Waste Isolation Pilot Plant Site, Southeast New Mexico.* Albuquerque, NM: U.S. Geological Survey. Water Resources Investigations 79-98, p. 120.

[2-13]Mercer, J.W. 1983. *Geohydrology of the Proposed Waste Isolation Pilot Plant Site, Los Medanos Area, Southeastern New Mexico.* Washington, D.C.: U.S. Geological Survey. Water Resources Investigations 83-4016.

path. Furthermore, if channeling, instead of the presently assumed dual porosity, is the dominant mechanism of flow and transport, the retardation will be considerably reduced. Thus, the mechanism of flow and the degree of physical and chemical retardation of radionuclides as they are transported through such flow, are critical issues affecting the outcome of the performance assessment. These issues, along with the description of the seven well field tracer tests and the laboratory tests and how they are expected to resolve the issues, should have been discussed in this section.

The issue of the Culebra water chemistry remains unresolved. A full discussion with respect to the flow directions, vertical seepage, karst, present day recharge and paleo-recharge is needed. Chapman's[2-14] criticism of the basis of dating the Culebra water to be "tens of thousands of years" old (DCCA, p. 2-100, line 24)[2-2] should be included. The EEG has never accepted the concept of the Culebra being "a relict of a flow regime of a wetter climate" (p. 2-100, lines 28-29). Chapman[2-14] clearly argued against accepting that concept. Chapman, Ingraham and Hess[2-15] provide additional support for the Chapman[2-14] arguments against using the enrichment in heavy isotopes in the Carlsbad Caverns pools to date the Rustler water.

Finally, this section should also provide an account of the anomalous rise in the water-levels in the Culebra at and south of the WIPP site and discuss possible mechanisms for this phenomenon. The possible causes mentioned in the WIPP Annual Site Environmental Report for C.Y. 1993 (DCCA[2-2] Vol. IX, App. SER, Sec.7.2, page 7-5) are insufficient to explain the anomalous water level rises.

[2-14]Chapman, J.B. 1986. *Stable Isotopes in the Southeastern New Mexico Groundwater: Implications for Dating Recharge in the WIPP area.* Santa Fe, NM: Environmental Evaluation Group. EEG-35.

[2-15]Chapman, J.B., N.L. Ingraham and J.W. Hess. 1992. Isotopic Investigations of Infiltration and Unsaturated Zone Flow Processes at Carlsbad Caverns, New Mexico." *Journal of Hydrology* 133: 343-363.

The Dewey Lake Redbeds

Sec. 2.2.1.6.1, Page 2-104

Much more information about the occurrence of groundwater in the Dewey Lake Redbeds (DLR) Formation, at and surrounding the WIPP site, is available compared to that presented in this section of the report. The water table at the WIPP site is believed to be in the Dewey Lake Redbeds. Water was observed in the DLR in wells H-1, H-2 and H-3, and in the Air Intake Shaft in the center part of the WIPP site. The well P-9 (H-11 hydropad) produced 25 gallons per minute from the DLR. Wells H-14, P-15, P-17, the Barn well and the Ranch well produce water from DLR. The latest WIPP well to produce water from the DLR is the well WQSP-6A, located between H-1 and H-14. It produced 28 gallons per minute in late 1994/early 1995. The statement, "in the vicinity of the WIPP shafts, the Dewey Lake has not produced water" (DCCA, page 2-104, lines 14-15)[2-2] is incorrect.

The statement, "Hydrologic properties of the Dewey Lake are characterized based on only a few measurements compared to the more extensive data set available for member of the Rustler. As a result, the position of the water table is not well known." (DCCA, p. 2-104, lines 7-9)[2-2] is inexcusable for an important document such as this.

The EEG position is that without an understanding of the basic regional hydrologic parameters of an area, such as the water table and the recharge and discharge areas and amounts, the knowledge about the site is incomplete. The EEG has long advocated studies to obtain knowledge of the basic hydrologic framework of the site. This should be done without further delay.

Groundwater Elevation Measurements in 1991

Sec. 2.2.1.7, Page 2-107

Why does the discussion in this section utilize data only until 1991, when observations on the water levels have continued until now, and the application was prepared in 1995?

The water-level rise at and surrounding the WIPP site is a major issue because it potentially implicates the activities in the oil and gas fields in that area. Much information exists in a number of Sandia National Laboratories (SNL) Memoranda, and it should be used to rewrite this section.

Surface-Water Hydrology
Sec. 2.2.2, Page 2-108

This section should describe the karst topography and hydrology of the WIPP site and vicinity. See, e.g., Chaturvedi and Channell (1985)[2-10].

Groundwater Discharge and Recharge
Sec. 2.2.3, Page 2-110

The recharge area for the Rustler Formation water at the WIPP site has never been identified. On the basis of potentiometric surfaces, Mercer[2-13] suggested Bear Grass Draw (T.18S, R.30E) and the Clayton Basin as possible areas of recharge. After a detailed study, Hunter[2-16] however, concluded, "Existing data are inadequate to determine evaporation from and recharge to the groundwater system in the vicinity of the WIPP site." Several studies suggested by Hunter[2-16] and endorsed by EEG (Chaturvedi and Channell, 1985, p. 71-74)[2-10] have never been carried out.

Similarly, the discharge area has never been identified. We agree with the general concept (DCCA[2-2] p. 2-113, lines 7-11) that the Culebra probably discharges into the Pecos River and some water may flow into the Balmorhea-Loving trough alluvium. As shown by Chaturvedi and Channell (p. 40-42)[2-10], the hydraulic distinction between the water-bearing zones of the Rustler Formation is obliterated at least 2 miles east of the Livingston Ridge and thus the water flowing into Laguna Grande de La Sal and the Pecos River at Malaga Bend may not be identified as belonging to a particular zone of the Rustler Formation.

[2-16]Hunter, R.L. 1985. *A Regional Water Balance for the Waste Isolation Pilot Plant (WIPP) Site and Surrounding Area.* Albuquerque, NM: Sandia National Laboratories. SAND84-2233.

Detailed arguments against the use of isotopic data to conclude the slow rate of recharge or the age of the Rustler groundwater (DCCA[2-2], p. 2-113, lines 18-25), have been provided by the EEG in commenting on the WIPP Compliance Status Report[2-1]. Those comments are provided at the end of this chapter.

Resources

Sec. 2.3, Page 2-113, line 34

The opening sentence incorrectly states that the section refers only to resources beneath the WIPP Site. The section also refers to resources adjacent to the WIPP Site.

Page 2-113, lines 35 through 37

The definitions for the terms *resources* and *reserves* are given without reference. On the next page the DCCA then ignores its own convention and randomly interchanges the words *reserves* and *resources*.

Page 2-114, lines 1 through 6

The definitions for the terms *proven reserves*, *probable reserves* and *possible reserves* are incorrect. The correct terms are proved reserves, probable resources, and possible resources (See Figure 1).

The DCCA definitions are given without reference and are inconsistent with the definitions used in Broadhead et al.[2-17], as discussed below.

[2-17]Broadhead, R.F, Luo, F. and Speer, S.W. 1995. Oil & Gas Resource Estimates, Chapter XI, in *Evaluation of Mineral Resources at the Waste Isolation Pilot Plant Site, New Mexico Bureau of Mines and Mineral Resources*. Carlsbad, NM: Westinghouse Electric Corporation.

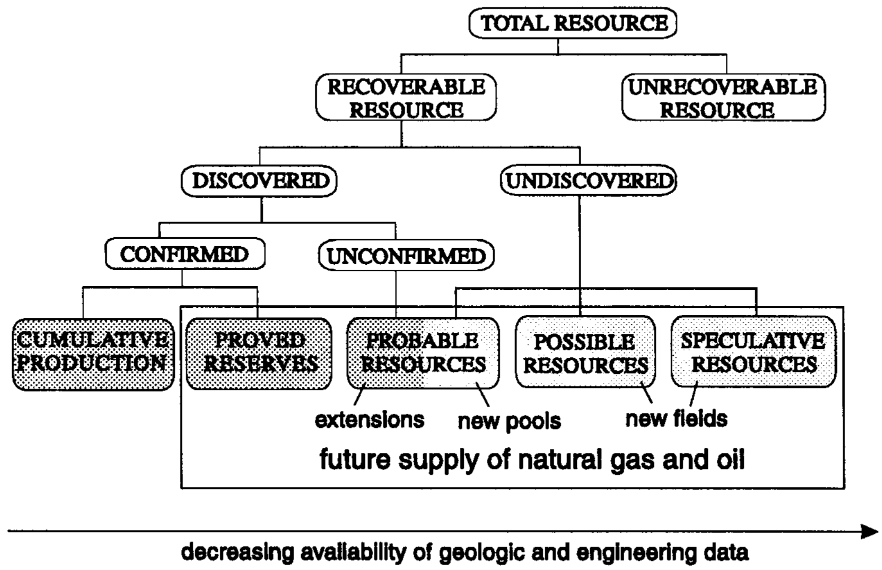

Figure 1. Oil and natural gas resource categories. After Broadhead et al., 1995.[2-17]

Proved Reserves

DCCA definition: For hydrocarbons, *proven reserves* can be expected to be recovered from new wells on undrilled acreage or from existing wells where a relatively major expenditure is required to establish production.

NMBM&MR definition: *Proved reserves* are an estimated quantity of crude oil, natural gas condensate, or natural gas that analyses of geologic and engineering data demonstrate with reasonable certainty to be recoverable in the future form discovered oil and gas pools. Pools are considered proved that have demonstrated the ability to produce by either actual production or by conclusive formation tests[2-17], that is by drilling. This report restricts the definition proved reserves to those producible resources identified as producible by existing wells (whether currently producing or abandoned).

Probable Resources

DCCA definition: *Probable reserves* refer to reserves of hydrocarbons suspected of existing in certain locations based on favorable engineering and/or geologic data.

NMBM&MR definition: *Probable resources (extensions)* consist of oil and gas in pools that have been discovered but have not yet been developed by drilling; their presences and distribution can generally be surmised with a high degree of confidence. *Probable resource (new pools)* consist of oil and gas that are surmised to exist in undiscovered pools within existing fields.

Possible Resources

DCCA definition: *Possible reserves* are based on condition where limited engineering and/or geologic data support recoverable potential.

NMBM&MR definition: *Possible resources* are less assured; they are postulated to exist outside known fields but within productive stratigraphic units in a productive basin or geologic province.

Extractable Resources

Sec. 2.3.1, Page 2-117, line 22

Rather than refer to the United States Geological Survey (USGS) for established grades of potash, it might be better to refer to the U.S. Bureau of Land Management (BLM).

Page 2-117, lines 23 through 26.

The DCCA appears to be making a policy statement that has already been challenged by the BLM. The DCCA maintains that the USGS assumes that the "lease" and "high" grades comprise reserves because some lease-grade ore is mined in the Carlsbad Potash District. Most of the potash that is mined, however, is better typified as the high grade. Even the high-grade resources may not be reserves, however, if their properties make processing uneconomic. The BLM policy with respect to leasing criteria was recently reiterated in the October 12, 1995, letter from the BLM District Manager[2-18]. The BLM currently uses a leasing criteria of a minimum thickness of 4 feet and an ore grade of 4% K_2O for Langbeinite and 10% for Sylvite as a measure of the quality of potash ore. In use since they were established in 1969 by the USGS, these standards are still effective today. Our records show that during the last five years a significant amount of sylvite ore has been mined at or below the 10% minimum standard. This is also true for langbeinite, meaning the ore is being mined at or below the 4% minimum standard.

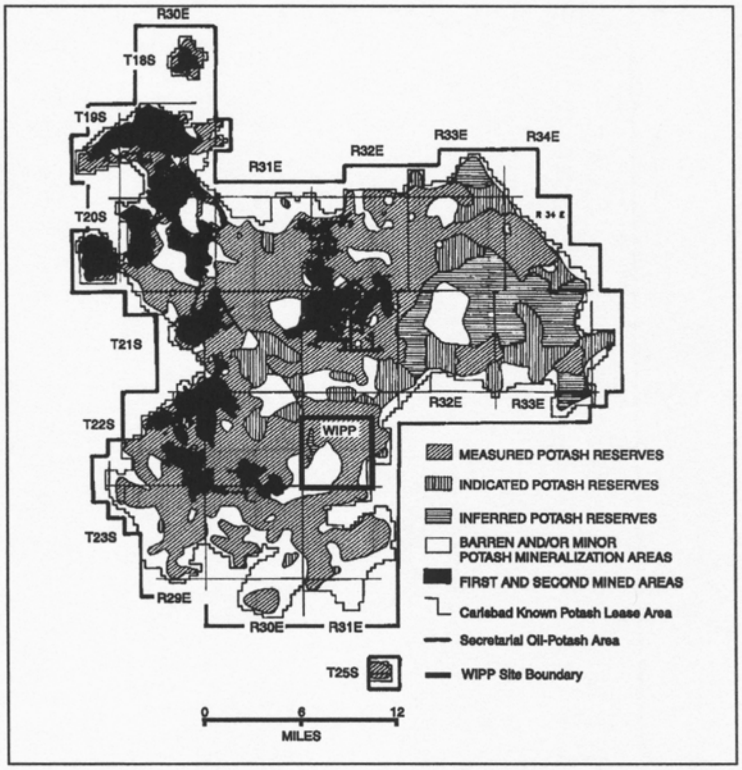

Figure 2. Potash resources. Adapted by M.K. Silva, EEG, from J.A. Olsen, 1993, Federal Management of the Potash Area in Southeastern New Mexico, in *New Mexico Geological Society Forty-Fourth Annual Field Conference, October 6-9, 1993: Carlsbad Region, New Mexico and West Texas*, pp. 39-41. Socorro, NM: New Mexico Geological Society.

Page 2-117, line 34 and Table 2-5.

It appears that the quantities of potash summarized by this table are incorrect and do not reflect the higher quantities considered by the BLM to be reserves as a matter of official policy. The discussion would benefit from maps of the potash resources such as that prepared by Griswold and Broadhead et al.[2-17], and those prepared by Silva for the June 13, 1995, EEG Workshop on waterflooding as shown in Figures 2 and 3.

[2-18]Cone, L.M., Roswell District Manager, BLM. 1995. October 12 letter to G. Griswold.

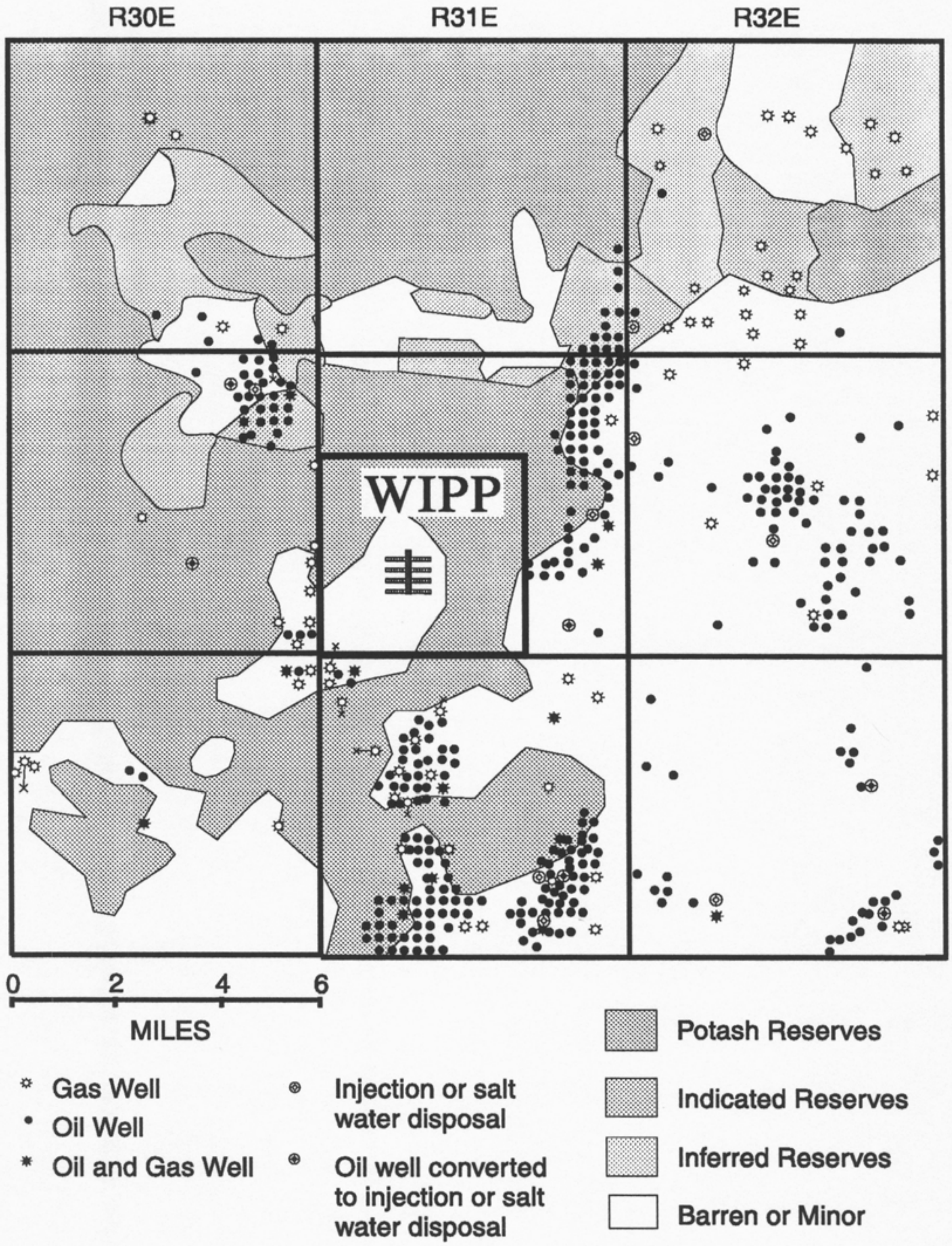

Figure 3. Oil and gas wells restricted from drilling through potash resources. Prepared by M.K. Silva (EEG).

Hydrocarbon Resources at the WIPP Site

Section 2.3.1.2, Page 2-118

The section on hydrocarbon resources would benefit from a presentation of a map of current well locations and a map of existing oil and gas wells and applications for permit to drill as indicative of the interest of the oil and gas industry (Figures 4 and 5). The 1995 summary of previous evaluations by Broadhead et al.[2-17] is mentioned in this section but the 1994 summary and analysis by Silva[2-19] is not mentioned. Proper citation procedure dictates citing Silva[2-19]. It would also be worthwhile to provide a map of proven and probable reserves for the various formations such as those contained in Broadhead et al.[2-17].

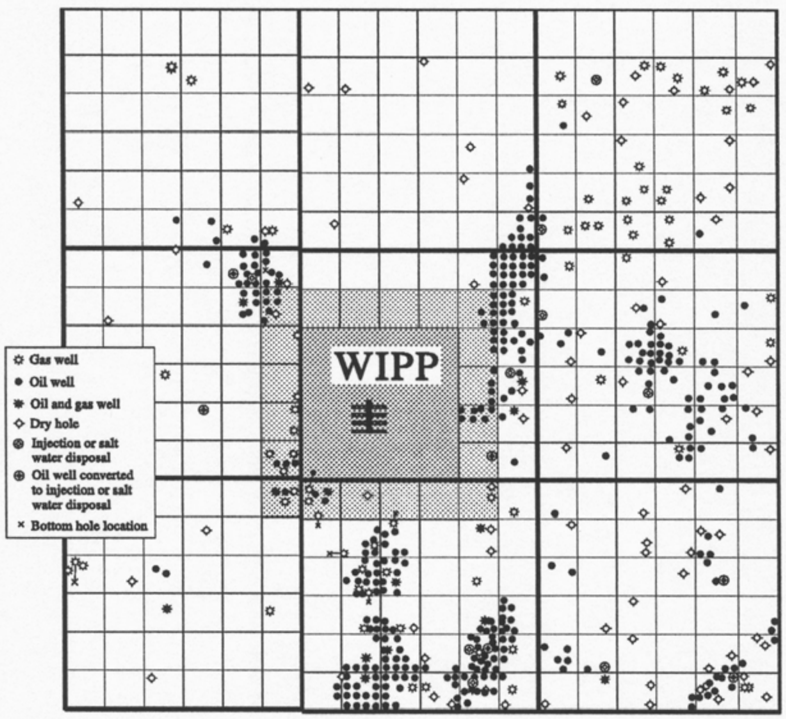

Figure 4. Oil, gas, and injection wells in nine-township project study area. Adapted from Broadhead et al.[2-17] by Matthew Silva (EEG).

[2-19]Silva, M.K., 1994. *Implications of the Presence of Petroleum Resources on the Integrity of the WIPP*. Albuquerque, NM: Environmental Evaluation Group. EEG-55.

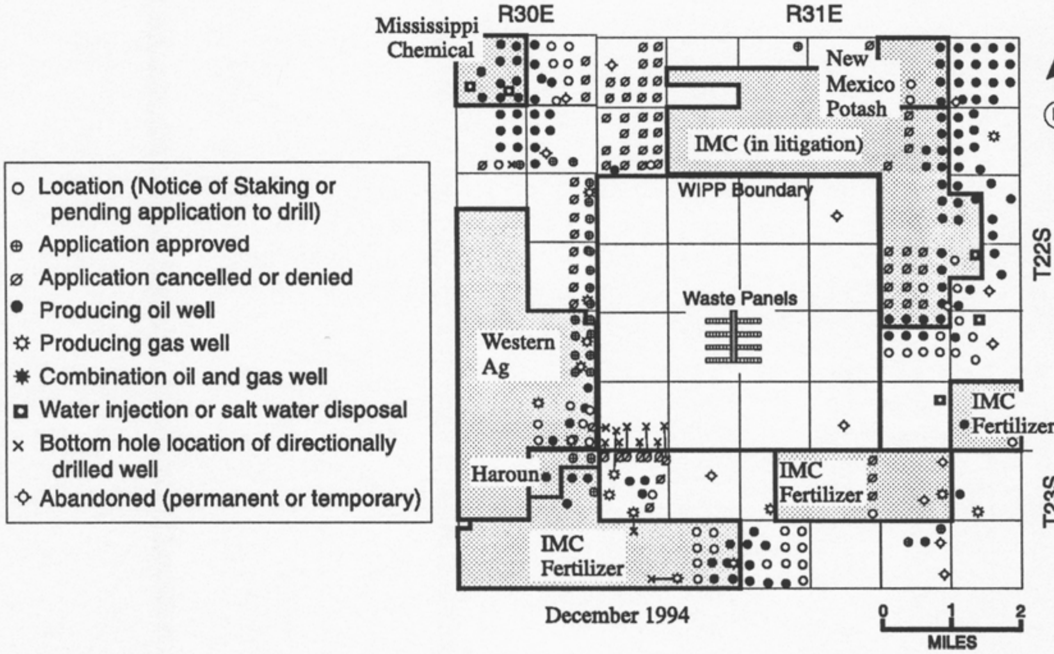

Figure 5. Resource activity and interest in the immediate vicinity of WIPP. Prepared by M.K. Silva (EEG).

Environmental Monitoring

Page 2-133, lines 2-8

The DCCA[2-2] states that WIPP has conducted a radiological monitoring program to "...determine the widespread impacts of nuclear tests at the Nevada Test Site and to evaluate the effects of Project Gnome." The WIPP environmental monitoring program has not included soil, water, biota or air particulates collected from the Gnome site. The only DOE work in the vicinity of the Gnome site was an April 1988 aerial gamma survey. Although the survey detected elevated gamma activity from ^{137}Cs, the presence of other radionuclides such as ^{241}Am, ^{238}Pu and ^{239,240}Pu was not detected. The EEG has measured these actinides at the Gnome site and published a report[2-20] in 1995.

[2-20]Kenney, Jim W., Paula S. Downes, Donald H. Gray, and Sally C. Ballard. 1995. *Radionuclide Baseline in Soil Near Project Gnome and the Waste Isolation Pilot Plant.* Albuquerque, NM: Environmental Evaluation Group. EEG-58.

Incorrect Measured Concentrations of Radionuclides

Page 2-137, Table 2-9

The reported concentration of 7.2×10^{-4} Bq/g (19.4 pCi/l) of ^{137}Cs in the water samples from water wells around the WIPP site exceeds levels measured elsewhere in the U.S. Similarly, the reported concentration of 12×10^{-4} Bq/g (32.4 pCi/l) for ^{60}Co appears to be incorrect. In addition, all the reported minimum detection levels (MDL) appear needlessly high. For example, the MDL for ^{90}Sr is considerably lower than the reported value of 7.4×10^{-4} Bq/g (20 pCi/l). EEG has an MDL for ^{90}Sr of 0.5×10^{-4} Bq/g water.

Historic Climate Conditions

Sec. 2.5.1, Page 2-137

There appear to be significant recent scientific advances in the area of reconstruction of the past climatic changes that have not been reported in this section. The EEG is conducting a review of the most current scientific literature in this area and will provide the results of that review in due course.

Seismology

Sec. 2.6, Page 2-143

It appears that the seismicity concerns are mainly for the short-term during the operational period, rather than the long-term (10,000 years). We have provided comments on this subject in our January 17, 1996 review of the Safety Analysis Report. If long-term safety concerns due to postulated earthquakes at the site are identified during our continued review of this topic, we will comment on it later.

Rock Geochemistry

Sec. 2.7, Page 2-151

The last paragraph of this section should be updated to reflect much additional experimental and modeling work on the occurrence of brine in the Salado salt, that has been performed since the publication of the Geologic Characterization Report (GCR)[2-21] in 1979. The baseline position paper by Howarth et al.[2-22] provides a summary of the WIPP project position on this subject and should be used to update this section.

[2-21]Powers, D.W., S.J. Lambert, and S.E. Shaffer. 1978. *Geological Characterization Report, Waste Isolation Pilot Plant (WIPP) Site, Southeastern New Mexico.* Albuquerque, NM: Sandia National Laboratories. SAND-78-1596/2 vols.

[2-22]Howarth, S. et al. 1994. *Salado Formation Fluid Flow and Transport Containment Group-White Paper for Systems Prioritization and Technical Baseline,* Rev. 1. Carlsbad, NM: U.S. Department of Energy.

CHAPTER 3. FACILITY DESCRIPTION

Need for more information

The DOE should document the process of demonstrating compliance with the EPA regulations for the management and storage of transuranic waste, contained in Subpart A of 40 CFR 191.

This chapter should describe the important features of the WIPP facility and the operational safety issues, at least those that relate to radiological safety. We realize that the Safety Analysis Report is the primary publication dealing with such issues, but at least a brief description in this chapter would be very beneficial. Such a description should cover at least the following topics:

- A description of the various components of the surface and underground facilities that play a role in the safe handling of the waste from unloading to emplacement in the repository. This discussion should include, for example, the safety features of the waste handling building and either why any accidents involving radioactive material are not likely to happen or what provisions have been made for a quick cleanup if such an event occurs. A discussion of the probability of waste hoist accidents should also form a part of this description.

- A description of the waste handling procedures, from unloading the TRUPACT-II to emplacement underground.

- A description of the underground facilities, including the mining and radiological safety issues. This should include a discussion of the safety of the Panel 1 and approach drifts, operation of continuous air monitors, maintenance operations for mining safety, and measures expected to be taken to keep the operations safe for 35 year operational life of the facility starting in 1998.

- Plans for waste emplacement. This discussion should include the expected rate of waste arrival, initially and later for 35 years; expected time to fill the 7 rooms of Panel 1; plans for emplacement of backfill; plans for closing the entry to each room and the panel; ventilation provisions at various stages; plans for carrying out the maintenance operations such as rockbolt detensioning during the emplacement operation; plans for emplacing the remote-handled TRU (RH-TRU) waste, including the date of first arrival and expected rate; description of the "panel closure system" (previously called the panel seals) as shown in Fig. 3-1 of DCCA[3-1], etc.

- The DCCA does not discuss the continuous air monitoring (CAM) systems currently in use at the WIPP. These CAM systems are an important part of the defense in depth philosophy at WIPP. The FSAR[3-2] classifies the repository CAMs as class IIIA and the Station A CAM as class II. Such important systems should be included in the DCCA repository configuration.

  DOE and the "Energy Systems Laboratory" at Texas A&M University have developed the use of a shrouded probe for single point aerosol sampling. This EPA approved shrouded probe is used in the repository and in the exhaust duct systems to deliver a representative particulate sample to the CAM system at WIPP. The shrouded probes should be identified as a part of the repository configuration in the DCCA.

- This chapter should include a discussion of the impact of abandoning the experimental area north of the shafts, without backfill and without sealing the boreholes that were drilled up to 50 ft above and below the excavated area.

[3-1]United States Department of Energy. 1995. *Draft Title 40 CFR 191 Compliance Certification Application for the Waste Isolation Pilot Plant. Draft-DOE/CAO-2056.*

[3-2]U.S. Department of Energy. 1990. *Final Safety Analysis Report, Waste Isolation Pilot Plant.* WP 02-9.

Waste emplacement requirements

Page 3-1, line 20

In addition to meeting the requirements of the definition of TRU and those that can be certified to the WAC, the TRU waste must also meet the NRC shipping criteria, the RCRA requirements, and approval by EPA.

Time to emplace waste

Page 3-1, line 32

The 25 year waste emplacement period was revised by the DOE in October 1995 to 35 years. The impact of this change does not appear to have been addressed.

WIPP design criteria

Page 3-5, line 6

Although the design criteria in DOE Order 6430.1, General Design Criteria, were applied to the WIPP, DOE is reevaluating the facility in the context of DOE Order 5480.23, April 1992; new DOE safety analysis report guidelines; and 10 CFR 835. The DOE Implementation Plan[3-3], calls for the rewriting and approval of a new disposal phase safety analysis report (SAR), and the disposal phase SAR is not complete. Particular concerns are the DOE regulations and the New Mexico Consultation and Cooperation Agreement, requiring worker and public dose assessments. The dose assessments are a necessary prerequisite to facility risk classification. Before final classification of facilities and structures, the disposal phase SAR must be completed and approved.

[3-3]U.S. Department of Energy. 1994. *Implementation Plan for the FY-95 Annual Update of the WIPP Safety Analysis Report for the Disposal-Phase Operations.* Revision 1.

Self-regulation

Page 3-5, lines 5-36

The approval of the design, the construction and documentation of safety of the DOE WIPP facility is by the DOE Carlsbad Area Office. The system should require approval by another DOE organization such as the Office of Environment Safety and Health.

Engineered barriers

Page 3-9, Sec.3.3

The text states that the design includes engineered barriers that significantly delay the migration of waste. The barriers are not identified nor are calculations presented quantifying the significant delay. The EEG does not consider the panel and shaft seals to be engineered barriers because they represent, at best, an imperfect attempt to undo the damage done to the natural environment by excavation and will not "prevent or substantially delay movement of water or radionuclides toward the accessible environment" any more than the natural environment would have. The definition of *barrier* in 40 CFR 191.12 includes, as examples, "a geologic structure, a canister, a waste form with physical and chemical characteristics that significantly decrease the mobility of radionuclides, or a material placed over and around waste, provided that the material or structure substantially delays movement of water or radionuclides." This definition does not include panel and shaft seals. This point was clarified by the EPA in 1987, as follows:

> It is EPA's intention that a barrier is a material or structure that prevents or substantially delays the movement of water in all directions emanating from the radionuclides in the waste. This would include at least the waste form, the canister overpack, and the geologic formation. While we encourage any added protection, even if not meeting these requirements completely, *it would not include items such as room and shaft seals*[3-4]. (Italics added).

[3-4]Meyers, S. 1987. May 22 letter from S. Meyers, Director, Office of Radiation Protection, EPA, to G.A. Smithwick, Principal Deputy Assistant Secretary, DOE/ES&H.

The DOE should use proper engineered barriers at WIPP, such as stabilizing waste in a low-solubility waste-form, robust containers, and engineered backfill. All references to the shaft seals as engineered barriers should be deleted from the DCCA and other documents.

Seals and Plugs
Page 3-9, Sec. 3.3.1

This section should be renumbered so that it is not a subsection of the Engineered Barriers section.

The DOE will have to demonstrate, through use of experimental data, that the postulated lowest value of the permeability of the seal system used in the performance assessment for assessing compliance with 40 CFR 191 as well as the No Migration Variance Petition, will be met. To the extent that the DCCA has not demonstrated it, this section is incomplete.

Upper salt column
Page 3-16, line 14

What is the basis for concluding that the upper salt column has no compliance related requirements?

Recompaction of salt
Page 3-16, lines 17, 21, and 34

A number of statements predict the performance of the salt column (80% of density produces intact salt permeability, 85% density results in permeability nearly equivalent to intact WIPP host rock salt), but no supporting evidence is provided.

Lower salt column

Page 3-21, lines 16-19

"Because of uncertainty regarding the marker beds and clay seams in the vicinity of the shaft station, efficient sealing functions are not currently modeled in the performance assessment for either the lower shaft salt component or the shaft station concrete monolith."

When and how will this be done?

Plugging of Boreholes

Page 3-21 to 3-25, Table 3-2

The DOE had planned to develop special borehole plugging procedures for boreholes at the WIPP site. It now appears that conventional plugging procedures for commercial wells will be followed.

The reference to the Christensen and Peterson paper[3-5] (page 3-21, line 35) is made in a wrong context. They do not provide "an evaluation of all vertical penetrations". Christensen and Peterson[3-5] and several other reports and papers by them and their colleagues at Sandia National Laboratories provide the results of research conducted under the Sandia Borehole Plugging Program (BHP), a program "specifically designed to support plugging activities for the proposed Waste Isolation Pilot Plant"[3-5] (Foreword).

This section (3.3.3 Borehole Plugs) should describe the results and recommendations of the BHP and should describe the plans and schedule of plugging the boreholes in the WIPP site area.

[3-5]Christensen, C.L. and E.W. Peterson. 1981. Field-Test Programs of Borehole Plugs in Southeastern New Mexico. In *The Technology of High-Level Nuclear Waste Disposal Advantages in the Science and Engineering of the Management of High-Level Nuclear Wastes*, edited by P.L. Hofman and J.J. Breslin. Oak Ridge, TN: U.S. Department of Energy. DOE/TIC-4621, vol. 1: 354-369 and SAND79-1634C.

The statement, "Only ERDA-9 is drilled to the repository horizon, near the WIPP underground" (page 3-21, lines 26-27) is incorrect. First, the borehole ERDA-9 was drilled to a total depth of 2887 ft, 51 ft into the Castile Formation and 737 ft below the repository horizon. Secondly, there are six boreholes within the WIPP site (ERDA-9, WIPP-12, WIPP-13, DOE-1, Badger Federal, and Cotton Baby), and at least ten just outside the WIPP site boundary, that are deeper than the repository horizon.

CHAPTER 4. WASTE DESCRIPTION

The material in this chapter does not indicate that there are problems in describing the physical, chemical and radiological characteristics of the waste to be emplaced in the repository. DOE states that the chapter documents the characteristics of the waste and provides the bases for the compliance assessments. However, the statement appears on page 4-1, line 9, "Assessments of the performance of the repository are based on assumed characteristics of the waste to be emplaced in the WIPP." [underline added]. The project has yet to identify which waste parameters are significant to compliance (page 4-8, line 21) and specific characterization techniques to determine these parameters have not yet been developed (page 4-8, lines 25-26). Furthermore, the estimated quantities of waste shown in this Chapter do not match values listed in the Baseline Inventory Report (Volume III, App. BIR).

Conflicting Information on the Purpose of the Baseline Inventory Report

The DOE's September 14, 1995, (pages 14 and 15) comments to EPA on the proposed 40 CFR 194 argue for general waste characterization requirements rather than specific waste characterization requirements, citing the Transuranic Waste Baseline Inventory Report as an example of general waste characterization. But the DCCA specifically states that the WIPP Baseline Inventory Report is not a waste characterization document (page 4-2, line 22). Which document specifies the waste characterization requirements of the WIPP?

RH-TRU Waste
Page 4-3, line 16

The DCCA suggests that the amount of RH-TRU is a small percentage of the WIPP TRU inventory. While this is true by volume, the RH-TRU waste is 37% of the total radioactive inventory according to the B.I.R. (Vol. III, page 4-11), and 33% of the total according to Volume I, page 4-15.

The inventory shown in Table 4-1 (page 4-4) does not agree with the inventory shown in Table 4-1 (page 4-5) of the Baseline Inventory Report published in Volume III, the supporting appendix (BIR). The RH-TRU projected inventory has varied widely over the years, as shown at the right[4-1] (Figure 6). DOE should make an effort to explain why the latest values are correct. Rev. 1 of the BIR increased the RH-TRU inventory by a factor of 3 to 4 and Rev. 2, December 1995 (received 2/9/96) increases the RH-TRU inventory by a factor of 5.6 over Rev. 1 to 27.000 m^3, considerably larger than the existing design capacity of 7080 m^3 for the RH-TRU.

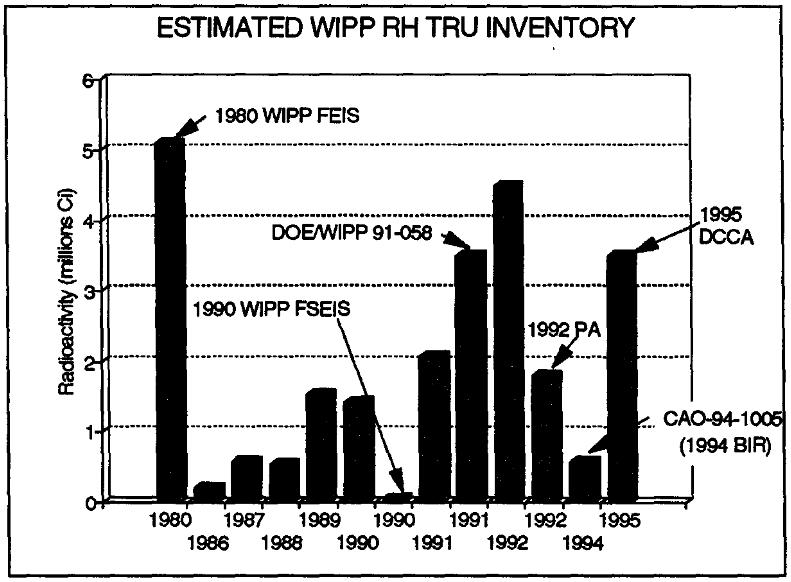

Figure 6. Estimates of WIPP RH-TRU Inventory from 1980 to 1995.

The term "Newly Generated Waste" in Table 4-1, (page 4-4) implies that the waste exists. Since it does not exist, the term "yet to be generated" would be more appropriate.

Actinide Inventory
Page 4-5, line 16

While the list of radionuclides identifies all of them as actinides, ^{90}Sr and ^{137}Cs are not actinides.

[4-1]Silva, M.K and R.H. Neill. 1994. *Unresolved Issues for the Disposal of Remote Handled Transuranic Waste in the Waste Isolation Pilot Plant,* figure 1. Albuquerque, NM: Environmental Evaluation Group, EEG-56.

Waste Acceptance Criteria

Page 4-6, line 22

This section states the objectives of the WAC.

> The primary objectives of the WAC are: (1) to ensure that all TRU wastes are packaged so that handling and subsequent disposal can be performed safely, and (2) to maintain the repository's ability to isolate the waste. Emphasis added.

But in two instances (page 4-6, lines 16 and page 4-7 line 11) DOE states that the existing and current WAC does not include the second objective listed above.

> The current WAC are based on transportation requirements and safe handling and storage criteria. If required, long-term performance-based WAC will be applied to the WIPP inventory baseline when the overall assessment of the disposal system's performance is complete.

The final Waste Acceptance Criteria have not yet been published. Further, the transportation criteria for RH-TRU have not been submitted to NRC for review and approval. The most recent WIPP Disposal Decision Plan, dated October 6, 1995[4-2], indicates that due to delays at DOE Headquarters, the transportation Safety Analysis Report for Packaging (SARP) will be sent to NRC in September 1996 rather January 1996. Current waste acceptance criteria can not be based on RH-TRU transportation criteria because there are none. Further, the waste acceptance criteria are based in part on transportation requirements and cannot be completed until the NRC completes its review of the SARP, which will not even be provided to the NRC by the DOE until September 1996. DOE notified EEG in November 1995 that the WAC were being revised.

[4-2]Dials, G.E., Manager, DOE Carlsbad Area Office. 1995. October 12 letter of transmittal with *WIPP Disposal Decision Plan*, Rev. 2, October 6, 1995, to R.H. Neill, Director, Environmental Evaluation Group.

Performance Based Waste Acceptance Criteria

Page 4-7, line 15

While the text states that the performance based waste acceptance criteria (PBWAC) identify the bounding characteristics of waste for repository performance, there are no published performance based WAC and this program has not yet been developed. It appears that for this draft application, the DOE has not done the calculations to determine the impact of various waste parameters. As part of the draft application, the DOE appears to be relying on a yet to be specified PBWAC to assure compliance. Without the calculations and a detailed PBWAC program, it is not possible to assess the contributions and limitations of these yet to be determined criteria. PBWAC is not even defined in the Glossary, Chapter 8, Vol. III.

Waste Characterization Program

Page 4-8, line 10

The discussion in this section indicates that the project has not yet identified which specific waste parameters are important to compliance, and if found to be important, they will be developed. This section also mentions a yet to be published load management alternative "to ensure the proper mix of waste forms on both panel and room scales." (line 27). If such a load management plan exists, please reference it. The paragraph suggests there may be problems with some waste characteristics. If so, what are they?

Accountability of Radioactivity

Page 4-8, line 19

The sentence, "The DOE must account for more than 1% of the total activity in the container, prior to shipment to WIPP." appears incomplete.

Waste Streams

Page 4-8, line 30

This section describing waste streams should either provide the details or a reference for specific information. It does note that categorizing wastes in specific streams is based on the availability of information.

There are questions on the availability of information, particularly RH-TRU waste. As observed by previous studies at generator/storage sites, records on RH-TRU waste are scarce (Jensen and Wilkinson, 1983, p. 91) and actual data on stored RH-TRU waste are minimal (Stewart et al., 1989).

Recent reports from the generator/storage sites strongly suggest that reliable information is not available for many waste streams. For example, a recent report on the feasibility of treating TRU waste at Oak Ridge National Laboratory states:

> Uncertainties in the characterization—isotopic, physical, and chemical—of TRU waste affect operation and maintenance costs, the retrieval method, processing options, and disposal locations. TRU waste streams at ORNL are not as yet fully characterized. Moreover, there are uncertainties in the characterization data available for TRU waste sludge. Isotopic data are based on best available sample obtained in single-point sampling of only 8 of the 13 BVESTs and MVSTs.[4-3] Detailed physical data such as particle size, hardness, viscosity, and particle distribution are unknown. Chemical data on tank contents are not completely known. To a lesser extent, uncertainties also exist in available characterization data on TRU waste solids. Generally data are available on the physical and radiological content of remotely and contact-

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[4-3]Three types of TRU waste stored at ORNL were included in the study: (1) 225,000 gallons of RH-TRU waste stored in eight 50,000 gallon Melton Valley Storage Tanks (MVSTs) and five 50,000 gallon Bethel Valley Evaporator Storage Tanks (BVESTs); RH-TRU waste stored in approximately 300 concrete casks, 2 steel drums, and 13 wooden boxes, and; (3) CH-TRU waste stored in 2600 drums and 60 boxes.

handled TRU waste solids, but there are numerical disparities within this documentation.[4-4]

The DOE has access to this site information and should provide it as part of the application, rather than settle for a statement in the WIPP Baseline Inventory Report, such as:

> The number and types of documents can very greatly from site-to-site so it is impractical to list them as references in this document[4-5].

It is unclear why the "completeness of documentation" (page 4-9, line 11) determines the uncertainty assigned to process knowledge. The Baseline Inventory Report was developed from "best available information and process knowledge."[4-6] According to the DOE Glossary, Vol. III, process knowledge is a qualitative evaluation of the contents of a waste container through study of existing records of production history of the waste. Best available information includes on-site documents and records. In considering the limits of reliability, it is important to remember that documents and records are derived from sources including "...interviews with existing and former workers...".[4-7]

It seems that the statistical analyses of measured waste characteristics rather than the completeness of documentation would be a more scientific and defensible approach to quantifying the reliability and uncertainty in process knowledge. In general, a statistical

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[4-4]Parallax, Inc. 1995. *Feasibility Study for Processing ORNL Transuranic Waste in Existing and Modified Facilities, Management Summary.* Oak Ridge, TN: Lockheed Martin Energy Systems, Inc.

[4-5]U.S. Department of Energy. 1995. *Draft Title 40 CFR 191 Compliance Certification Application for the Waste Isolation Pilot Plant,* vol. III, Appendix BIR vol. 1, section 2.2.1, DRAFT-DOE/CAO-2056.

[4-6]U.S. Department of Energy. 1995. *Draft Title 40 CFR 191 Compliance Certification Application for the Waste Isolation Pilot Plant,* vol. III, Appendix BIR vol. 1, section 1.2, DRAFT-DOE/CAO-2056.

[4-7]U.S. Department of Energy. 1995. *Draft Title 40 CFR 191 Compliance Certification Application for the Waste Isolation Pilot Plant,* vol. III, Appendix BIR vol. 1, section 2.2.1, DRAFT-DOE/CAO-2056.

analysis should first determine the number of samples needed from each waste stream population. The waste inventory and the characteristics for a waste stream should be determined by process knowledge and be recorded prior to sampling. Then the selected waste containers from each stream would be characterized by a physical sampling program to determine the contents of each container. From the measurements of the physical contents, the statistics for that waste stream, including uncertainty (variance or standard deviation), could be calculated. The inventory, as determined by process knowledge, could be compared with the statistics to determine if process knowledge represents the same population.

RH-TRU waste forms

Page 4-12, line 7

The DCCA incorrectly states: "Free liquid or particulate wastes are not associated with processes that generate RH-TRU waste."

For example, in a report on unresolved issues with RH-TRU waste, the EEG notes there are 1900 cubic meters (500,000 gallons) of TRU contaminated liquids and sludges in underground tanks.[4-8,4-9] There are 225,000 gallons of RH-TRU waste stored in eight 50,000 gallon Melton Valley Storage Tanks and five 50,000 gallon Bethel Valley Evaporator Storage Tanks[4-10].

[4-8]Silva, M.K. and R.H. Neill. 1994. *Unresolved Issues for the Disposal of Remote Handled Transuranic Waste in the Waste Isolation Pilot Plant.* Section 3.1. Albuquerque, NM: Environmental Evaluation Group, EEG-56.

[4-9]U.S. Department of Energy. 1991. *Recommended Strategy for the Remote-Handled Transuranic Waste Program.* DOE/WIPP 90-058, Rev. 1, p. 4-2.

[4-10]Parallax, Inc. 1995. *Feasibility Study for Processing ORNL Transuranic Waste in Existing and Modified Facilities, Management Summary.* Oak Ridge, TN: Lockheed Martin Energy Systems, Inc.

Free Liquid Content

Page 4-12, line 14

The project relies on real time radiography to determine the presence of free liquids, which are prohibited by the Waste Acceptance Criteria. While the DCCA notes that drums have been excluded from the WIPP program due to non-conformance with the criteria of no free liquids, the DCCA fails to mention that real time radiography is limited. It is well documented that real time radiography can not detect all free liquids. For example, the visual examination of WAC certified drums for the bin test turned up a drum that contained a full can of free liquid, which was a flammable volatile organic compound[4-11]. The DOE response stated:

> The second concern expressed in your letter was that real time radiography (RTR) did not detect the "flammable organic compounds which were in liquid form." I am sure you are clearly aware the RTR is essentially an x-ray and cannot be used to assess the flammability of any compounds, liquid or solid. The fact that the RTR cannot distinguish between a completely full can or completely empty can is an acknowledged limitation. All measurement technologies have limitations. In the case of RTR, these limitations are known and understood. RTR error is anticipated and is accepted in the same way that all measurement technologies occasionally produce a result outside the accepted confidence interval. We continue to evaluate RTR at the sites where it is used and, through the Interface Working Group on Non-Destructive Evaluation, we will continue to make appropriate enhancements to this and other measurement systems[4-12].

[4-11]Neill, Robert H., Director, Environmental Evaluation Group. 1992. Letter of July 29 to W. J. Arthur III, WIPP Project Integration Office.

[4-12]Arthur, W.J., WIPP Project Director, WIPP Integration Office. 1992. Letter of October 29 to R.H. Neill, Director, Environmental Evaluation Group.

The DCCA should discuss these RTR limitations and provide the references to published reports reflecting the commitment to the continued evaluation of RTR at the sites subsequent to 1992.

Analytical Methods
Page 4-15, line 10

The limitations of each analytical method, radioassay, non-destructive examinations such as real time radiography, and, visual examinations should be discussed in detail with supporting references. For example, there is no system in place to radioassay RH-TRU waste.

Visual Examinations
Page 4-16, line 14

This section cites a miscertification rate of only 2 percent at the INEL. Further, the DCCA claims that this miscertification includes all WAC and Transuranic Package Transporter (TRUPACT)-II Authorized Methods for Payload Control (TRAMPAC) criteria, not just the presence of free liquids. This claim doesn't match data provided in the DOE's annual reports to the EPA on the TRU waste characterization efforts for the now abandoned bin tests. Out of 80 drums selected from a WAC certified population at INEL, 46 failed to meet the WAC and/or the TRAMPAC for a miscertification rate of 58%. The list of excluded drums from the annual report[4-13] to the EPA is shown below (Table 1). The observation tends to support the notion of requiring a thorough characterization as the EPA did for the No-Migration Determination for the Bin Test Program.

[4-13]U.S. Department of Energy. 1993. *No Migration Determination Annual Report for the Period September 1992 through August 1993.* DOE/WIPP 93-062.

TABLE 1. MISCERTIFIED DRUMS EXCLUDED FROM USE IN BINS

Drum Number	Bin Number	Nonconformance	Reason for Exclusion
RF004500559	IDRFBN9100001	Contained U-235[1]	Not applicable
RF002800598	IDRFBN9100001	Contained free liquid	WIPP WAC
RF001902106	IDRFBN9100004	Possible pressurized container	WIPP WAC
RF003101490	IDRFBN9100004	Possible pressurized container	WIPP WAC
RF005400341	IDRFBN9200005	Contained free liquid	WIPP WAC
RF005500375	IDRFBN9200005	Excessive decay heat	TRUPACT-II C of C
RF002800659	IDRFBN9200005	Excessive decay heat	TRUPACT-II C of C
RF000241353	IDRFBN9200005	Excessive decay heat	TRUPACT-II C of C
RF002201038	IDRFBN9200005	Excessive decay heat	TRUPACT-II C of C
RF002800703	IDRFBN9200005	Excessive decay heat	TRUPACT-II C of C
RF002301549	IDRFBN9200005	Less than 100 nCi/g	WIPP WAC
RF003100946	IDRFBN9200005	Less than 100 nCi/g	WIPP WAC
RF001901607	IDRFBN9200005	Possible pressurized container	WIPP WAC
RF001901991	IDRFBN9200005	Excessive decay heat	TRUPACT-II C of C
RF000239134	IDRFBN9200005	Excessive decay heat	TRUPACT-II C of C
RF000108833	IDRFBN9200006	Contained free liquid	WIPP WAC
RF074403825	IDRFBN9200006	Drum flammable VOC[2] >500 ppm	TRUPACT-II C of C
RF000237798	IDRFBN9200006	Excessive decay heat	TRUPACT-II C of C
RF002302673	IDRFBN9200006	Excessive decay heat	TRUPACT-II C of C
RF002202850	IDRFBN9200006	Excessive carbon tetrachloride	NMD
RF001908888	IDRFBN9200006	Excessive decay heat	TRUPACT-II C of C
RF001905358	IDRFBN9200006	Excessive decay heat	TRUPACT-II C of C
RF002203352	IDRFBN9200006	Excessive decay heat	TRUPACT-II C of C
RF001905574	IDRFBN9200006	Excessive decay heat	TRUPACT-II C of C
RF001215294	IDRFBN9200006	Excessive decay heat	TRUPACT-II C of C
RF002500316	IDRFBN9200006	Excessive decay heat	TRUPACT-II C of C
RF074403768	IDRFBN9300007	Contained free liquid/ Excessive decay heat	WIPP WAC TRUPACT-II C of C
RF005500406	IDRFBN9300007	Less than 100 nCi/g	WIPP WAC
RF074403890	IDRFBN9300007	Contained free liquid	WIPP WAC
RF000108844	IDRFBN9300007	Less than 100 nCi/g	WIPP WAC
RF074403907	IDRFBN9300007	Contained free liquid	WIPP WAC
RF074403900	IDRFBN9300007	Contained free liquid	WIPP WAC
RF074403740	IDRFBN9300007	Excessive decay heat	TRUPACT-II C of C

RF001901846	IDRFBN9300007	Excessive decay heat	TRUPACT-II C of C
RF002500319	IDRFBN9300007	Excessive decay heat	TRUPACT-II C of C
RF000210253	IDRFBN9300007	Excessive decay heat	TRUPACT-II C of C
RF002500321	IDRFBN9300007	Excessive decay heat	TRUPACT-II C of C
RF001901850	IDRFBN9300007	Excessive decay heat	TRUPACT-II C of C
RF001901849	IDRFBN9300007	Excessive decay heat	TRUPACT-II C of C
RF001904355	IDRFBN9300007	Excessive decay heat	TRUPACT-II C of C
RF001904149	IDRFBN9300007	Excessive decay heat	TRUPACT-II C of C
RF001905199	IDRFBN9300007	Excessive decay heat	TRUPACT-II C of C
RF000210256	IDRFBN9300007	Excessive decay heat	TRUPACT-II C of C
RF000108870	IDRFBN9300007	Excessive decay heat	TRUPACT-II C of C
RF001905261	IDRFBN9300007	Excessive decay heat	TRUPACT-II C of C
RF001905674	IDRFBN9300007	Excessive decay heat	TRUPACT-II C of C

[1]At present, INEL is not capable of certifying drums suspected of containing, or determined to contain, U-235.

[2]Usage of the TRUPACT-II prohibits the transportation of containers exceeding the 500 ppmv limit. For this reason, Drum RF074403825 was excluded from Bin IDRFBN9200006.

CHAPTER 5. QUALITY ASSURANCE

Overview

While a compliance application should show evidence that specified requirements have been met, the material in this chapter does not address the requirements of 40 CFR 191, and specifically states that it does not address the proposed 40 CFR 194 QA requirements.

This chapter is mostly a description of the conceptual framework of the current CAO QA program. Many of the sentences seem to be simply lifted from NQA-1 or other such documents, with the verb "shall be" replaced by "is" or "are".

Model Validation

There is no discussion of model validation, which is vital to demonstrating compliance with the containment requirement through performance assessment. A detailed QA process is needed for performance assessments with a complete discussion of plans for model validation.

This chapter does not mention quality assurance for analysis. The Sandia procedures for analysis, choice of parameter values, performing calculations, and software quality control are only peripherically mentioned on the last page of Chapter 5.

Comparison of Chapter 5 (QA) and 40 CFR 191

There are no direct requirements in 40 CFR 191 concerning QA.

A description of the QA/QC performed on the data used to show compliance with the 40 CFR 191 requirements should be included. The requirements in 40 CFR 191 concern containment (191.13), institutional controls, post-closure monitoring, permanent markers, engineered and natural barriers, and waste removal (191.14), individual protection (191.15) and groundwater protection (191.16). Chapter 5 does not address QA for any of these areas.

Comparison of Chapter 5 (QA) and the Proposed 40 CFR 194

The proposed EPA criteria, 40 CFR 194, contain a list of specific QA requirements. However, Chapter 5 lumps QA (194.22) with expert judgment (194.26) and peer review (194.27), and states: "These requirements are not addressed in this document" (page 5.1 lines 15-17).

The draft compliance application should address them. DOE and EPA should develop a common understanding before a final compliance application is written. An examination of DOE WIPP QA documents and 40 CFR 194 requirements shows a gap that needs to be bridged.

The proposed 40 CFR 194.22(a)(1) states that DOE "...shall implement a quality assurance program that meets the requirements of ASME NQA-1-1989 edition, NQA-2a-1990 addenda (part 2.7) to ASME NQA-2-1989 edition, and NQA-3-1989 edition (excluding 2.1 (b) and (c))". DOE is not currently fulfilling this requirement.

DOT Shipping Container Requirements
Page 5-2, line 9

Various federal requirements codified in the Code of Federal Regulations are identified including 10 CFR 71 for Type B shipping containers. Since all CH-TRU waste will be placed in Type A containers, the list should also include 49 CFR 173, the DOT requirements for Type A shipping containers including tests.

QA Program Requirements
Page 5-2, lines 9-14

The NQAs are listed as sources for the QA program. These, and other "sources", are "...directed through the DOE Environmental Management (EM) QA Requirements and Description to the DOE CAO". In the CAO QAPD Revision 0, an appendix to the draft DCCA, only NQA-2 part 2.7 is specifically required (for software). The CAO QAPD Revision 0 is only partly based on NQA-1, and NQA-3 is not mentioned at all.

Revision 1 to the CAO QAPD is currently being developed; the draft also does not specifically require full implementation of the NQA requirements.

The Revision 0 software portion requires NQA-2 part 2.7 but the proposed Revision 1 does not, though it implements many (but not all) of its provisions. It is worthy of note that the proposed 40 CFR 194.23(b) also requires NQA-2 part 2.7 compliance.

The proposed 40 CFR 194.22 (b)(1) also specifies that the NQA-1, 2, and 3 requirements must be met for environmental monitoring, geological measurements, computations, codes, and models used to demonstrate compliance, expert judgements, disposal system design, all other data used to support compliance applications, and anything else "...important to the containment of waste in the disposal system." Documentation of most parts of all of these precede the only evidence provided in the July 15, 1994, CAO QAPD Revision 0 (Appendix QAPD), effective July 15, 1994.

Chapter 5 of the DCCA presents no evidence that full compliance with the NQAs occurred in the past.

WIPP Site Monitoring Programs
Page 5-7

This section describes the system used to assure the validity of the measurements of the environmental surveillance at WIPP. Unfortunately the data for radioactivity in water samples as well as the minimum level of detectability reported in water wells at WIPP on page 2-137 of the DCCA are incorrect. It might be helpful for DOE to reference the data obtained by EEG in our monitoring program for the past eight years.

Program Assessment
Page 5-8, line 10

The text states "Managers at all levels periodically assess the performance of their organization". This is an ideal; at INEL, Argonne West, the September 1995 CAO DOE audit discovered that no assessment of the waste characterization program at the Argonne

West facility had been performed since the previous WIPP-level audit in September 1993. If the statement was "Managers at all levels *are required to* periodically assess the performance of their organization" it would reflect the real QA program as it exists now, which may not necessarily have been true at the time data was gathered.

Qualifications of Existing Data
Page 5-9, line 1

Most of the activities cited in other sections of the DCCA were performed before the conceptual framework shown in Chapter 5 was in place. There are no specific descriptions of QA during the gathering of data for these earlier activities.

Page 5-9, lines 1-17 briefly describe Sandia's "Qualification of Existing Data" program, but provide no information as to which data are involved, what the status is, or when the information will be available.

Evolving requirements
Page 5-9, lines 19-31

This section briefly describes the evolution of the WIPP QA program requirements. Reference is made to NQA-1 as a "standard" for the program over the last 15 years. The proposed 40 CFR 194 requires compliance with NQA-1, NQA-2 part 2.7 (software), and NQA-3 (site characterization). Currently, the CAO QA program still does not require full implementation of ASME NQA-1, NQA-2, and NQA-3. It should be required.

Description Postdates Other Compliance Activities

Most of the activities cited in other sections of the DCCA were performed before the QA system described here was in place. There are no specific descriptions of QA for data obtained during these earlier activities. The work in Chapter 2 on site characterization, in Chapter 3 on the design and building of the WIPP facility, and in Chapter 6 on PA were mostly completed before the CAO QAPD (which became effective on July 15, 1994) was in place. The CAO QAPD (included as the appendix QAPD) is the only objective evidence presented in this document concerning QA activities.

CHAPTER 6. CONTAINMENT REQUIREMENTS

Basis of Review

The performance assessment in the DCCA has been reviewed by state-of-the-art terms in performance assessment. Because the compliance criteria for the standards were not finalized during our review, the DCCA has not been judged against the requirements of 40 CFR 194. It should be noted, that even with all the disclaimers, the DCCA is in the form of an application. It is no longer a demonstration of the methodology or a dry run. The DCCA must meet a higher expectation and after several iterations of performance assessment, the work is finally ready for a review to assess compliance with the EPA disposal standards for transuranic waste. In particular, the EEG evaluation is focused upon these questions:

Have all relevant scenarios been analyzed?
Are probabilities of scenarios adequately established?
Have consequences been properly stated?

Have All Relevant Scenarios Been Analyzed?

Not all potentially disruptive scenarios have been analyzed. Previous performance assessments for the WIPP analyzed only the effect of human intrusion by inadvertent drilling. In the DCCA, other possible disruptive events and processes have not been considered. Justification has not been provided for Features, Events and Processes (FEPs) not considered for regulatory reasons, or eliminated for low consequence.

What scenarios need to be considered? The EPA Standards stipulate that performance assessments need not consider events or processes that are estimated to have less than one chance in 10,000 of occurring over 10,000 years. In terms of analyzing human intrusion, the EPA suggests inadvertent and intermittent intrusion by exploratory drilling for resources (other than any provided by the disposal system itself) may be the most severe intrusion scenario assumed.

The EPA standards further state:

> Furthermore, the performance assessments need not evaluate in detail the releases from all events and processes estimated to have a greater likelihood of occurrence. Some of these events and processes may be omitted from the performance assessments if there is a reasonable expectation that the remaining probability distribution of cumulative releases would not be significantly changed by such omissions. (40 CFR 191, Appendix C).

Examination of the EPA's guidance for implementation of 40 CFR 191, subpart B, reveals the following:

- The lower limit for events and scenarios to be considered is 10^{-8} per year. That means, events and processes with a probability of occurrence of between 1 and 10^{-8} per year must be analyzed.

- The most severe human intrusion scenario that requires analysis is drilling into the repository. Less severe scenarios should be analyzed in accordance with the rule above.

- To omit the analysis of a particular event or process because of the lack of impact, first the lack of impact must be demonstrated by an analysis, not an assumption.

Certain human-initiated events and processes are known to be on-going in the vicinity of the WIPP (p. 6-36)[6-1] and have been retained for further analysis. However, these same on-going events and processes have been screened out from further analysis in the postclosure phase, presumably because of EPA's regulatory guidance.

Water injection for secondary recovery of oil and brine reinjection remains to be analyzed. Consider the impact of a specific case of water injection for secondary recovery. In 1991,

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[6-1]U.S. Department of Energy. 1995. *Draft Title 40 CFR 191 Compliance Certification Application for the Waste Isolation Pilot Plant*, Draft-DOE/CAO-2056.

Hartman, a small oil and gas operator, purchased a worked-out lease in the extreme southeast corner of New Mexico and started drilling. While drilling through the Salado Formation, Hartman encountered a massive salt-water blowout. Brine flowed from the well for five days before being controlled. A total of 5.7 x 10^6 L of brine was trucked away before a pipeline was installed. A New Mexico court determined that a major oil company's water flooding project 3.5 km away was responsible. This incident occurred at the southeastern corner of New Mexico, in the same Salado Formation that overlies the WIPP and is of relevance to the WIPP because within 3.2 km (2 mi) of the WIPP perimeter, there are over 120 producing oil and gas wells. Furthermore, secondary recovery by water flooding and brine re-injection has begun in these recently discovered fields.

Unexpected water flows are not rare events. Between 1978 and 1993, 189 unexpected water flows were reported to the New Mexico Oil Conservation Division for Region One, which encompasses approximately 6000 km^2 in the southeast corner of the state.

One example of a yet to be addressed scenario is as follows. Water or brine is injected into Marker Bed 138 or 139, introducing massive amounts of water into the repository, which carry dissolved radionuclides to the accessible environment.

Other potentially disruptive events that should be analyzed include the impact of potash mining. Over 80% of the potash in the United States is produced within 100 km of the WIPP. From the WIPP site one can see the surface works of three major potash mines. The potash is midway between the Culebra aquifer and the repository horizon. Potash mining has an extraction ratio well above 80%, and potash miners do not usually backfill mined out volumes. Thus massive underground cavities may exist in the future, and may be an additional pathway for radionuclide transport. Subsidence remains a concern that could affect the hydraulic properties of the overlying aquifers.

Are Probabilities of Scenarios Adequately Established?

Because the scenarios of water flooding and potash mining were not considered in the DCCA, no probabilities for these disruptive events have been estimated. The implication is that there is insufficient specification of probabilities.

Have Consequences Been Properly Stated?

The results of the performance assessment described in the DCCA are questionable because "place-holders" are substituted for the most important data.

During 1994 and 1995, the WIPP project undertook a Systems Prioritization study to focus resources on the key variables that control compliance demonstration. The study identified eight groups of variables which needed additional work for the final compliance certification application. For the DCCA, the values used for the eight variables are only estimates made by Sandia National Laboratories staff conducting the experiments. The data from these experiments are expected sometime in 1996 and later. Difficulties caused by using the predictions of the results of the experiments, rather than the experimentallly obtained values, are discussed below.

Solubility

Upon human intrusion by drilling, the release rate of radionuclides is the product of actinide solubilities and brine flux. In the DCCA, generic actinide solubilities are used. For example, the solubilities of Pu(III) and Np(III) are assumed to be equal. If this were true, then there would not be any need for solubility experiments in progress now.

For actinides with multiple oxidation states, they are partitioned according to the following scheme. Let n_1, n_2, n_3, n_4 be random numbers.

$$
\begin{aligned}
VI &= n_1/5, \\
V &= n_2\ (1.0 - VI)/(n_2 + n_3 + n_4), \\
IV &= n_3\ (1.0 - VI)/(n_2 + n_3 + n_4), \\
III &= n_4\ (1.0 - VI)/(n_2 + n_3 + n_4),
\end{aligned}
$$

This partitioning scheme implies that various oxidation states might exist jointly. At a specific pH and Eh, there is likely to be a unique dominant species and attendant oxidation state. (See WIPP P.A. Dept., 1992, p. 3-43).[6-2] One does not have a 10%, 30%, 30%, 30% mixture of oxidation states.

The solubility of actinides in oxidation state *y* is then sampled from 1 to 10^{-10} molar. In EEG-57[6-3] we commented on the futility of sampling from a wide range of solubility, and the lack of confidence such a procedure conveyed.

The partitioning of actinides into oxidation states is inconsistent with experimental evidence. In WIPP-commissioned Pu solubility measurements, no matter what the initial oxidation states were at the start of the experiments, 70% to 95% of the final oxidation state at steady state was Pu(VI) (Nitsche, et al., 1994 in Novak.[6-4] Yet in the above partitioning by oxidation states, only 20% or less of the total inventory is allowed to be in VI. The experimentalists could not explain the move to VI, and conjectured that it might be due to α-radiolysis. In the DCCA, it is reasoned that the repository would be reducing. However, the solubility experiments were carried out in contact with the atmosphere, resulting in the final oxidation state being VI. If the conditions in the repository are expected to be reducing, then the oxidation state will not be VI in the repository and the results of the experiments in contact with the atmosphere would not be applicable to the expected repository conditions. All of the aqueous separation processes for plutonium utilize the fact that Pu has a variety of oxidation states, each with widely varying chemical properties. Hence the interconversion of Pu among

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[6-2]WIPP PA (Performance Assessment) Department. 1992. *Preliminary Performance Assessment for the Waste Isolation Pilot Plant, December 1992 — Volume 1: Third Comparison with 40 CFR 191, Subpart B.* Albuquerque, NM: Sandia National Laboratories, SAND92-0700/1.

[6-3]Lee, W. W-L., L. Chaturvedi, M. K. Silva, R. Weiner, and R. H. Neill. 1994. *An Appraisal of the 1992 Preliminary Performance Assessment for the Waste Isolation Pilot Plant.* Albuquerque, NM: Environmental Evaluation Group. EEG-57.

[6-4] Novak, C.F. 1995. *Actinide Chemistry Research Supporting the Waste Isolation Pilot Plant: FY 94 Results.* Albuquerque, NM: Sandia National Laboratories, SAND94-2274.

its various oxidation states has been the topic of much study.[6-5] Literature on the effect of radiation on the oxidation state of Pu in solution suggests that radiolysis and exposure to oxygen would actually decrease the average oxidation number. In HCl, the medium of the solubility experiments, the average oxidation number did not decrease, consistent with the experimental results. Thus the discrepancy between the experimental results and the partitioning rule needs to be explained.

Perhaps the most important note about the solubilities used in the DCCA is that DOE assumed a distribution of aqueous solubilities with large uncertainty (Appendix PAR, p. 250, 253, 256, 259, DCCA, vol. 1).[6-1]

No attempt has been made to justify the probability distribution used.

Conceptual Model for Flow in the Culebra

The DOE has identified intrusion scenarios that result in contaminated brine discharging into the Culebra Dolomite member of the Rustler Formation. However, for the calculation of direct discharge to the ground surface through borehole cuttings, the contaminated fluid is discharged to the ground surface bypassing entry into the Culebra. Thus, the two scenarios are inconsistent. How can brine enter the Culebra if a well-casing is present? Or, if the well is uncased, why shouldn't the brine enter the Culebra instead of flowing to the surface? The following quotation from the Disposal Room Model Position Paper summarizes current technology in drilling in the Delaware Basin.

> Within the Delaware Basin near the WIPP site, gas and oil wells are started by clearing the site and drilling a shallow hole (40') to house a conductor pipe. The conductor pipe is set in cement and serves to prevent surface sands from sloughing into the wellbore during later drilling. Drilling is continued below

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[6-5]Rabideau, S. W., M. J. Bradley and H. D. Cowan. 1959. *Alpha-Particle Oxidation and Reduction in Aqueous Plutonium Solutions.* Los Alamos, NM: Los Alamos National Laboratory, LA-MS-2236.

the conductor pipe, to 300-600 feet to top of the salt section using a large diameter (17-26 inches diameter) drill bit and another steel casing is set.[6-6]

A similar statement appears in the DCCA.

> . . . oil wells normally have a standard 0.413 m drilled hole to the top salt to accommodate 0.340 m steel casing, and gas wells normally have a standard 0.4445 m drilled hole to accommodate 0.356 m casing. (Appendix PAR, P. 223, DCCA, vol. 1).[6-1]

Thus, in order for radionuclide contaminated brine to flow into the Culebra, the fluid must flow through the pipe casing. In the 1992 performance assessment there was a nondegraded plug that forced discharge into the Culebra. Now the DOE assumes 100% failure of the casing!

The contaminated brine would not naturally flow into the Culebra and that is reinforced by the fact that the DOE set the permeability of other hydrostratigraphic units to zero to prevent brine from entering those units and to maximize the flow to the Culebra. The Unnamed Lower Member (p. 6-78), the Tamarisk (p. 6-85), and the Forty-Niner (p. 6-86) are all assigned zero permeability, and the Magenta (p. 6-85) and the Dewey Lake Redbeds (p. 6-86) are assigned low permeabilities.

There is a clear need to analyze two different scenarios: One with casing and the other without, and assign appropriate probabilities of occurrence for the two.

Retardation Mechanisms

In the postulated transport of radionuclides in the Culebra, three retardation mechanisms are used (DCCA, p. 6-80).[6-1]

[6-6]Butcher, B. M. et al. 1995. Disposal Room and Cuttings Models, Position Paper.

- Equilibrium Sorption;
- Matrix Diffusion;
- Corrensite Clay Sorption.

Our review raises questions about postulating each of these retardation mechanisms.

Equilibrium Sorption: During the advective-diffusive transport of contaminants, dissolved solute can adsorb onto solid surfaces or precipitate. The suite of processes that lead to contaminants traveling slower than the average pore velocity of ground-water flow is generally referred to as sorption. For many contaminants, many ground-water compositions, and many rock types, a linear isotherm results with

$$\frac{dS}{dC}=K_d \tag{1}$$

where S is the mass of solute adsorbed or precipitated per unit dry bulk mass of rock, C is the solute concentration, and K_d is known as the distribution coefficient. Using the distribution coefficient, one can compute the velocity v_i at which the particular contaminant will travel

$$\frac{v_i}{v}=\frac{1}{1+\rho_b K_d\left(\frac{1-\epsilon}{\epsilon}\right)} \tag{2}$$

where v is the average ground-water velocity, ρ_b is the bulk density of the rock, and ε is the matrix porosity.

Over the years there have been attempts to measure distribution coefficients relevant to the WIPP. However, these distribution coefficients do not represent anticipated conditions in the Culebra. First, because the chemistry of the water has a significant influence on sorption behavior. The isotherm experiments used unrepresentative chemistry for Culebra water, making the resultant distribution coefficients values invalid. Secondly, the distribution coefficients are from single measurements on powdered samples. Powdered samples have a different surface area to volume ratio and experiments with powdered samples are likely to overstate sorption in the field. As can be seen in eq. (1), it is difficult to obtain a proper K_d from a single measurement. Thirdly, review of the experimental conditions did not provide assurances that equilibrium conditions were reached in the isotherm experiments. Thus we conclude that experimental data valid for use in performance assessments of the WIPP are not currently available on partitioning coefficients for the Culebra Dolomite.

The problem is compounded because performance assessment did not use the flawed experimental data, but subjectively elicited probability distributions of distribution coefficients from Sandia National Laboratories employees. Clearly, additional data are needed.

The DOE is currently conducting a multi-well tracer test at the WIPP site. This test is designed to provide information on flow mechanism, as well as partition coefficients for actinides. In April 1995 the DOE dropped plans for a sorbing tracer test, while keeping the non-sorbing tracer test. Can one use a non-sorbing tracer test to obtain K_d for sorbing species?

For a nonsorbing species, the residence time t_n in a fracture of half-aperture δf is

$$t_n = (\phi_f + \phi_m)\ V_r/Q$$

where V_r is the volume of pores in the rock, Q is the water-flow rate, and ϕ_f and ϕ_m are the fracture and matrix porosities respectively.

For a sorbing species, the residence time in the same system is

$$t_s=(\delta_f+K_s)S_s V_r/Q$$

where K_d is a surface distribution coefficient, and S_s is the specific surface area.

It is apparent that the two residence times are different, and a non-sorbing tracer test cannot be used to obtain K_d for actinides.

Matrix Diffusion: Matrix diffusion has been shown to be an important mechanism in radionuclide retardation.[6-7] Water and contaminants in fracture flow result in transport of the contaminants from the fracture into the microfissures of the rock by diffusion. This diffusion of contaminants into the rock matrix and subsequent sorption onto the surfaces of the microfissures and dead-end pores is a significant retardation mechanism. This diffusive flux of contaminants from the fracture to the rock matrix (z direction) can be represented by

$$q = -\epsilon\tau\left(D'\frac{\partial C'_l}{\partial_z}\right)_{z=0} \tag{3}$$

where D' is the free-water molecular diffusion coefficient in the matrix (L^2/t),

ε is the rock porosity,

C'_l is the concentration of the lth solute in the matrix (M/L^3),

τ is the tortuosity correction (-).

Note the predominance of diffusive parameters.

The WIPP performance assessment takes credit for matrix diffusion, but offers no direct experimental evidence for its extent. The only related experiment was a diffusion test with a non-reactive tracer.[6-8] A series of multi-well, field scale, tracer tests has been planned but it is unclear how the results of these tests would provide unequivocal evidence for matrix

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[6-7]Neretnieks, I. 1980. Diffusion in the Rock Matrix: An Important Factor in Radionuclide Retardation? *J. Geophy. Res.* 85B:4379.

[6-8]Dykhuizen, R. C. and W. H. Casey. 1989. An Analysis of Solute Diffusion in Rocks. *Geochim. et Cosmo. Acta* 53:2797.

diffusion. Lee and Chaturvedi[6-9] have suggested some laboratory experiments to give direct evidence of matrix diffusion.

Corrensite Clay: The DOE identifies sorption on clay fracture-linings as one of three retardation mechanisms for radionuclide transport through the Culebra. The EEG was verbally informed that the assumption of corrensite clay as asorptive clay lining was dropped from future performance assessments. However, the definition sketch for SECOTP2D still shows corrensite clay lining (p. SECOTP2D-3).[6-1] The DOE is also funding basic studies on corrensite sorption mechanism. We will repeat the following comments on the lack of corrensite clay evidence in the Culebra fractures.

The concept of corrensite sorption is based on x-ray diffraction and analytical electron microscopy analysis of cores samples from clay-rich layers of the Rustler Formation, from wells drilled primarily in the Nash Draw, a topographic depression several miles west of the WIPP site and in a known Karst region. This concept originates from the work of Sewards and others.

Sewards, Glenn and Keil[6-10] presented mineralogical analysis of core samples from a single well, WIPP-19, and made no claim for clay-filled fracture linings in the Culebra.

Sewards[6-11] gave data on "whole rock" as well as "fracture surface" compositions of core samples collected from six wells in the Nash Draw, one borehole (WIPP-33) just outside the WIPP site, and three boreholes in the northern part of the WIPP site. Clays are expected to

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[6-9]Lee, W. W-L. and L. Chaturvedi. 1995. Radionuclide Retardation Mechanisms in the Culebra Aquifer at the Waste Isolation Pilot Plant. In *Proceedings of the Conference on Radioactive Waste Management and Environmental Remediation, ICEM "95, held in Berlin, Germany, September 3-7, 1995*, edited by S. Slate, F. Feizollahi, and J. Creer. New York, NY: American Society of Mechanical Engineers, 877-881.

[6-10]Sewards, T.R., R. Glenn and K. Keil. 1991. *Mineralogy of the Rustler Formation in the WIPP-19 Core.* Albuquerque, NM: Sandia National Laboratories, SAND87-7036.

[6-11]Sewards, T. 1991. *Characterization of Fracture Surfaces in Dolomite Rock, Culebra Dolomite Member, Rustler Formation.* Albuquerque, NM: Sandia National Laboratories, SAND90-7019.

be present in the Nash Draw cores because of extensive dissolution, weathering, and erosion in that area. WIPP-33 is located in a sink hole and dissolution, weathering, and erosion are expected. The other boreholes are located north of the WIPP repository and upstream from the expected direction of flow of water in the Culebra. Furthermore, cores from these wells are from sections with known clay seams.

Sewards, Williams and Keil[6-12] presented mineralogy of 107 core samples from eight wells, three of which are located in the WIPP site. X-ray diffraction analysis and an electron microscope were used to identify clays. However, electron microscopy raised doubt about the results of the x-ray diffraction results. When imaging was attempted on the electron microscope, it was extremely difficult to find any corrensite at all. However, Sewards, Williams and Keil[6-12] proceeded to conclude "that corrensite is the dominant phase in the Culebra."

Sewards *et al.*,[6-13] presented mineralogical analysis from 47 samples. Of these, 17 samples were taken from the Culebra, and of these only nine are from the WIPP site: six from the Air Intake Shaft and three from WIPP-12. The report (p. 28) states:

> Only small amounts of clay can be sampled from the Culebra fracture coatings; therefore, initial technique and model development for adsorption studies on WIPP clays (Park, et al., in review) were carried out with material from a black shale layer in the unnamed member. This material, so-called CorWIPP, is 94% corrensite and is described as Sample AIS-15 in this report. Corrensite has a high cation exchange capacity and affinity for the uranyl ion in dilute solution (Park, et al., in review) and could provide significant radionuclide retardation in fractures in the Culebra.[6-13]

[6-12]Sewards, T., M. L. Williams, and K. Keil. 1991. *Mineralogy of the Culebra Dolomite Member of the Rustler Formation.* Albuquerque, NM: Sandia National Laboratories, SAND90-7008.

[6-13]Sewards et al. 1992. *Nature and Genesis of Clay Minerals of the Rustler Formation in the Vicinity of the Waste Isolation Pilot Plant in Southeastern New Mexico.* Albuquerque, NM: Sandia National Laboratories, SAND90-2569.

The suggestion that corrensite clay-lined fractures in the Culebra may provide retardation for radionuclide migration is based on a single sample from a "black shale layer" obtained from the lower part of the Rustler Formation, below the Culebra, because not much clay could be sampled from Culebra fracture coatings. And yet, information from this sample is used to conjecture that "significant radionuclide retardation in fractures in the Culebra" could be present! Moreover, clay in fractures can act either as an additional sorption agent, or serve to block mass transfer between the fracture and the matrix. The *1992 Performance Assessment*[6-14] has eliminated the latter role. This is double counting for a mechanism which may not exist. Credit for corrensite sorption should not be taken in WIPP performance assessment unless demonstrated by additional evidence.

Colloids

Colloidal transport, a newly identified concern for the WIPP, has two components. The first concern is hydrodynamic chromatography, where colloidal particles might travel at the maximum velocity in a fracture rather than the average or retarded velocity. The second concern is that actinides might attach themselves to natural colloid particles, resulting in the same acceleration process. In the DCCA, colloids are not allowed to travel faster than the solute. This misses the essence of the concern for colloids in transport. The formation rate of colloids can be measured or calculated, but in the DCCA the initial colloid concentration is arbitrarily set by analysts.

Additional work is underway to delineate the role of colloids as a concern. We await the results.

[6-14]WIPP PA (Performance Assessment) Department. 1992. *Preliminary Performance Assessment for the Waste Isolation Pilot Plant, December 1992*, 3 vols. Albuquerque, NM: Sandia National Laboratories, SAND922-0700.

Conceptualization of Risk
Section 6.1.1, Page 6-3

Kaplan and Garrick[6-15] are cited as the basis for the ordered triple form of representing risk. Kaplan and Garrick recognize that it is impossible to identify all possible scenarios. In section 3.5 of the cited paper, they recommend the use of an N+1 scenario to represent all unidentified scenarios. Equation 2 is thus a deviation from Kaplan and Garrick that at least needs to be explained. A much better solution is to accommodate the N+1 scenario in the definition of risk and incorporate it as a modifier to the CCDF.

FEP Cutoff of 10^4 Years
Page 6-22, line 20

The 10,000 year cutoff may eliminate scenarios with significant impact. The DOE[6-16] noted that the time of maximum risk occurred at 1.6×10^6 years. The new NAS guidance to EPA for HLW disposal urges the calculation of risks for periods up to 1 million years. It is recognized that the EPA standard only requires 10,000 years in calculations but DOE should extend the time for their assessment.

Criteria for Screening of FEPs
Page 6-20, line 22; Section 6.2; Appendix SCR

By introducing an intermediate step, the draft application departs very sharply from the procedure proposed by Cranwell[6-17] and inappropriately eliminates viable features, events, and processes. A new elimination criteria is inserted as the second "sieve" (Regulations — DOE

[6-15]Kaplan, S. and B. J. Garrick. 1981. On the Quantitative Definition of Risk. *Risk Analysis* 1(1):11-27.

[6-16]U. S. Department of Energy. 1980. *Final Environmental Impact Statement, Waste Isolation Pilot Plant,* 2 vols. DOE/EIS-0026.

[6-17]Cranwell, R. M., R. V. Guzowski, J. E. Campbell, and N. R. Ortiz. 1990. *Risk Methodology for Geologic Disposal of Radioactive Waste: Scenario Selection Procedure.* NUREG/CR-1667. Sandia National Laboratories, Albuquerque, NM, SAND80-1429.

Interpretation) as shown in the figure below. Further, the procedure is such that the DOE determines which scenarios can be eliminated based on the DOE interpretation of the EPA regulations.

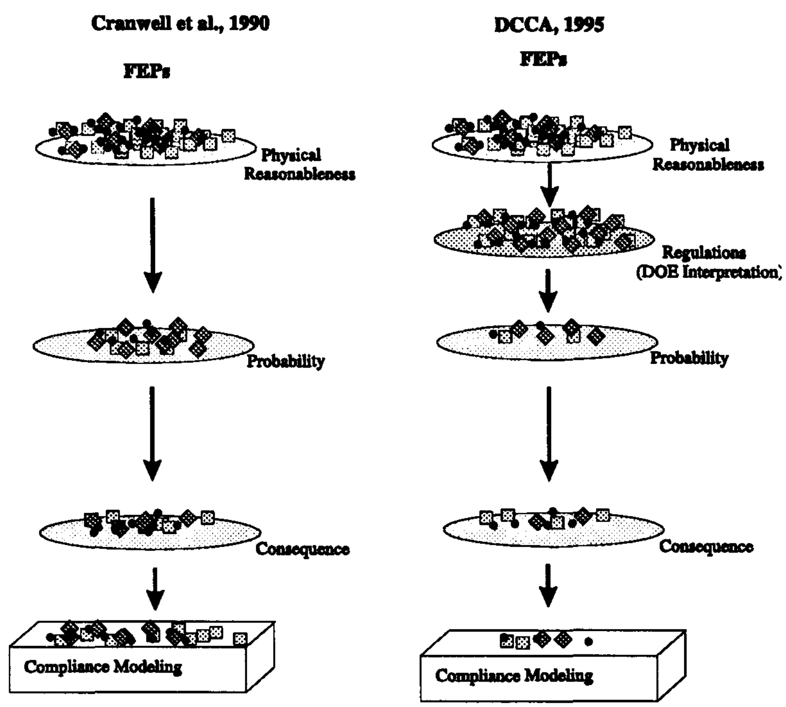

Figure 7. Comparison of Cranwell and DCCA Elimination Criteria.

Page 6-22, lines 18 through 21

Delete as a criteria for elimination of FEPs the new category, "*<u>Regulation</u> or, more broadly, scope and purpose of the assessment...*" The category is entirely subjective as applied and ignores valid technical considerations.

Page 6-23, lines 20 through 27

The paragraph describing FEPs requiring additional documentation appears to be prejudging a yet to be completed study. The statement is made, "the DOE has modeling or experimental work underway to increase understanding of the potential importance of some of these FEPs, but all are considered of low consequence.... The basis for eliminating these is not yet fully documented." Why are these considered to be of low consequence while the investigations are still underway?

Page 6-24, lines 5 through 8

The paragraph describing FEPs elimination on the basis that they represent a design modification notes that the use of backfill has been eliminated. Yet the DOE has a formal agreement with the State of New Mexico to include backfill in the design of the repository.

Page 6-24, lines 22 through 31

The paragraph describes the category of FEPs that have been eliminated citing the non-binding guidance which was intended for a generic site. Further, the paragraph suggests that the non-binding guidance on FEP elimination reflects screening decisions made by the EPA. Our recommendation is to delete the paragraph and the entire SO-R category.

Page 6-25, line 16 through page 6-26, line 16

It is stated that the "regulatory screening arguments are used largely to limit consideration of future disruptive human-initiated events and processes as discussed in Section 6.4.2." Future disruptive human-initiated events and processes should be evaluated for viability on the basis of probability and consequence. It is unreasonable to present circuitous arguments and a very selective interpretation of non-binding guidance as the basis for eliminating very plausible scenarios such as those associated with resource extraction in a resource rich area. The EEG recommendation is to delete this entire section as well as Section 6.4.2.

Page 6-27, Figure 6-6

Delete the category SO-R to reflect a technical evaluation of the performance of the repository.

Page 6-31, Line 15

Replace the phrase "form the engineered barrier system" with the verb "are." For compliance with 40 CFR 191, the seals in the drifts, shafts, and boreholes are not considered to be engineered barriers.[6-18]

Page 6-31, Line 22

The text mentions a "current set of engineered barriers" without identifying these barriers and without citing a reference for more discussion in the draft application. Identify the barriers.

Page 6-36, Table 6-5a

The comments on this table require a review of the relevant portions of the appendix SCR, which is given below.

Page SCR-64, Line 16 - 22

The paragraph appears to take the position that activities initiated outside the controlled area subsequent to the time of submission of the final application will not be accommodated in the application. Rather, the DOE will rely on periodic reappraisals. However, it seems shortsighted to postpone evaluating the impact of the activities surrounding the WIPP given the following observations.

- Mining, drilling, salt water disposal by injection, enhanced oil recovery, and well abandonment are human activities.
- The WIPP is located in the Potash Enclave.[6-19]

[6-18] Meyers, S. 1987. May 22 letter from S. Meyers, Director, Office of Radiation Protection, EPA, to G.A. Smithwick, Principal Deputy Assistant Secretary, Environmental Safety & Health, DOE.

[6-19] Olsen, J. A. 1993. *Federal Management of the Potash Area in Southeastern New Mexico.* In New Mexico Geological Society Forty-Fourth Annual Field Conference, October 6-9, 1993: Carlsbad Region, New Mexico and West Texas. Socorro, NM: New Mexico Geological Society, 39-41.

- The Potash Enclave represents 80% of the nation's domestic production and 57% of the nation's reserves[6-20] — a scarce resource not widely available elsewhere.
- Commercial mining in the Potash Enclave has been ongoing for more than 60 years[6-20] — an area with long history of mining.
- The WIPP Land Withdrawal Area contains economically minable potash reserves[6-20] — an attractive target for future production.
- The WIPP Land Withdrawal Area is surrounded by potash reserves and active potash leases.[6-21,6-20]
- Potash is obtained by mining[6,20] — a potentially disruptive activity.
- Subsidence occurs over potash mines propagates fractures through overlying aquifers to the land surface[6-22] and poses a hazard to petroleum well casings.[6-19]
- Water level rises in WIPP monitoring wells to the north potentially correlate with brine disposal from the potash industry — a direct impact on the hydrology of the area.
- The EPA has identified the absence of mining scenarios in WIPP performance assessment as a critical omission.[6-23]
- The resource evaluation by the NMBM&MR/Westinghouse[6-20] clearly demonstrates that there are proven and/or probable oil and gas resources under each and every section
    1) within the WIPP Land Withdrawal Area
    2) and surrounding the WIPP.

[6-20]Broadhead, R. F., F. Luo, and S. W. Speer. 1995. *Evaluation of Mineral Resources at the Waste Isolation Pilot Plant Site.* New Bureau of Mines and Mineral Resources. Carlsbad, NM: Westinghouse Electric Corporation.

[6-21]Silva, M. K. 1994. *Implications of the Presence of Petroleum Resources on the Integrity of the WIPP.* Albuquerque, NM: Environmental Evaluation Group. EEG-55.

[6-22]Sanchez, P. 1995. September 19 memorandum to Mel Marietta, Sandia National Laboratories on Subsidence Crack at WIPP 28.

[6-23]Oge, M. T. and M. Shapiro. 1994. October 18 letter from the U. S. Environmental Protection Agency to G. E. Dials, Manager, DOE Carlsbad Area Office. 4 pages + attachments.

- Oil and gas reserves are obtained by drilling through the Salado Formation and into the underlying oil and gas bearing formations.
- The oil producing formations in the vicinity of the WIPP also produce high volumes of mobile water.[6-20] Salt water disposal wells surround the WIPP Site and are injecting up to a million barrels of water per year per well into a formation underlying the salt formations.
- In 1988, WIPP monitoring wells experienced sharp water level rises which were strongly correlated with a nearby salt water disposal well operated by the oil and gas industry.[6-24,6-25] The observation strongly suggested leaking salt water disposal is influencing the regional hydrology in an aquifer considered to be a potential pathway for radionuclides.
- Southeast New Mexico has a history of waterflood problems with injected water migrating from adjacent properties through the Salado Formation.[6-26, 6-24, 6-25, 6-27, 6-21]
- The BLM recently denied an application for permit to drill wells within the WIPP Site Boundary citing concerns including the unknown effects of water injection on the repository,[6-28]

The WIPP is undeniably located in a resource rich area as shown in the Figure 8.

[6-24]Bailey, J. 1990. August 13 Memorandum from Certified Professional Geologist #7521, Petroleum Engineer at New Mexico State Land Office to Marsh La Venue, Intera Consulting Company, Contractor to Sandia National Laboratories on Water Level Rises in Culebra Dolomite Monitor Wells.

[6-25]LaVenue, M. 1991. January 28 Sandia National Laboratories Memorandum to distribution on the Anomalous Culebra Water-Level Rises Near the WIPP Site.

[6-26]Ramey, J.D. 1976. May 5 memorandum from the Director of the New Mexico Oil Conservation Division to John F. O'Leary on Water Flows in and near Waterflood Projects in Lea County.

[6-27]Hartman, D. 1993. November 22 letter to Sandia National Laboratories transmitting a copy of a Complaint of Trespass, Nuisance, and Waste filed in the Federal Court for the district of New Mexico, CIV93 1349M.

[6-28]Calkins, W.C. 1994. August 22 letter from W. C. Calkins, State Director, Bureau of Land Management, to the attention of Keith E. Bucy, Bass Enterprises Production Co.

Page SCR-66, Table SCR-3b

The draft application identifies 42 plausible scenarios and then eliminates 37 citing the DOE category SO-R. Among those eliminated by this DOE interpretation include:

Fluid injection:
- Salt water disposal
- Enhanced oil and gas recovery
- Hydrocarbon storage

Potash Mining
- (including solution mining)

Flow through abandoned boreholes.

Page SCR-64, line 23 through page SCR-67, line 29

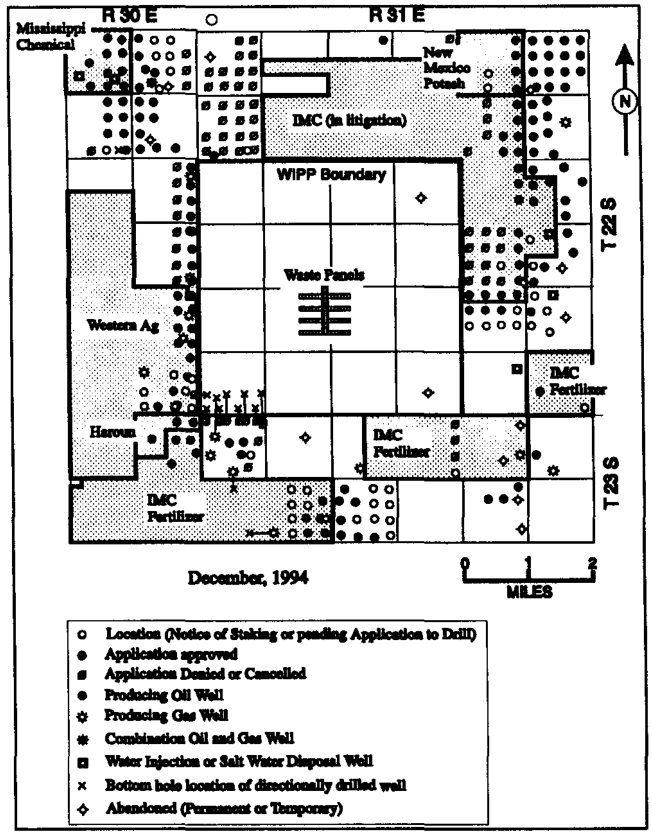

Figure 8. Natural Resources around WIPP site.

This paragraph acknowledges that the analyses of ongoing human initiated events and processes is underway and may be relevant when considering future initiated events and processes. But then the paragraph states that the extension of such analyses to anytime beyond October 1996 is speculative - an inconsistent position for an application that purports to calculate the behavior of a repository for the next 10,000 years.

Seals

Page 6-31, line 15

The statement, "Seals in drifts, shafts and boreholes form the engineered barrier system..." is wrong. The plugs and seals are not engineered barriers (see our comment on Section 3.3). The Panel Closure System shown in Fig. 3-1[6-1] has not been described. The vertical boreholes in the mine that extend upward and downward up to 100′ in the northern part of the WIPP excavations (abandoned in 1995) have not been plugged, and the DOE's WIPP

Experimental Area Mine Management Plan Phase I[6-29] justifies the decision on the basis that the boreholes will close by salt creep.

Salado Interbeds
Page 6-77, line 10

Discussion of the development of the simple interbed brine storage model from a literature search is referred to in Appendix PAR. While the model is described in the Appendix, the literature search is never mentioned.

Drum-Scale Variability in Spallings
Page 6-89 lines 1-9

It is stated that a sufficiently large volume of waste would be transported to the surface through spallings and that drum-scale variability can be neglected. Waste containers vary by several orders of magnitude in the activity of radionuclides they contain. The variation in the abundance of the relatively few activity level 4 or activity level 5 drums of Table 6-23 could dominate the activity of the spallings material. It needs to be demonstrated that the volume of waste entrained through spallings will be large enough to ensure average densities of radionuclides will reach the surface.

APPENDIX HYDRO

This appendix is a poor copy of the USGS Water-Resources Investigations Report 83-4016[6-30] and portions such as Figures 11, 12 and 16 are indecipherable. Originals of this report, that have not been marked up, do exist. If it is necessary to include this report as an appendix, reproductions from a better copy should be made,

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[6-29]U. S. Department of Energy. 1995. *Experimental Area Management Plan Phase I.*

[6-30]Mercer, J. W. 1983. *Geohydrology of the Proposed Waste Isolation Pilot Plant Site, Los Medanos Area, Southeastern New Mexico.* Washington, DC: U.S. Geological Survey. Water Resources Investigations 83-4016.

APPENDIX PAR

The formalized structure of Appendix PAR is very helpful. A specification of the equation number that first introduces the parameter in the description of the computational codes would increase the usefulness of the PAR appendix. Is the fracture spacing in the Culebra a SECOFL2D variable? Additional comments on this appendix are provided under the Appendix PAR heading.

APPENDIX BRAGFLO

The following criticism of the BRAGFLO code description may also be used as the EEG comments on code documentation in general. Appendix BRAGFLO presents a detailed and well developed description of the conceptual models implemented in the BRAGFLO code. The level of detail is, however, variable. For example, gas compressibility, Equation 31, is defined by a reference to a document that is not included in the DCCA. Without the referenced document, Equation 31 does not describe the model of gas compressibility.

BRAGFLO is apparently an isothermal code. This is never explicitly stated in the code description. More importantly, there is no defense given for an isothermal treatment of two-phase flow in WIPP. A discussion needs to be included to support such basic approximations. In addition, some assessment of the errors induced by approximations needs to be presented.

A reader friendly approach to identifying approximations is to 1) begin with the most general description of the phenomena to be modeled and then 2) introduce approximations that reduce the general description to the conceptual model implemented in the code. A section listing assumptions and limitations, such as NUTS.11, would also be very helpful.

Page BRAGFLO-21

BRAGFLO uses a user defined parameter to control the update frequency of the Jacobian matrix linearization. What assurances are there that the errors introduced by user control of code mechanics are acceptable? In general, assurances built into the codes are preferable to administrative controls.

Page BRAGFLO-48 Equation 128

Equation 128 is presented with almost no defense. If parameter n is an important parameter then Equation 128 must also be important and must be defendable. At the least, it must be shown that variance in parameter n is great enough to also cover conceptual model uncertainty. To aid in pursuing such issues, it would be helpful if the Appendix PAR variable name and page number were supplied when a new variable is introduced in a code description. In addition, when the variable is presented in the Appendix PAR it would help if the relevant equation number in the code description were listed as well as the code names.

APPENDIX CUTTINGS

The particular model used for calculations presented in the DCCA was not contained in Berglund (1992) and has not been documented in the DCCA. We understand that the experimental results did not support this model and it is now being discarded in favor of another model. We look forward to the complete documentation of the new model to be used for the final application (CCA).

Page CUTTINGS-10

The blowout calculation is limited to a five minute duration. The five minute limit is an important parameter. While the use of this parameter is justified in the text, it does not seem reasonable to have a fixed five minute time limit. Using a sampled parameter to represent this time limit is more justified. At least some runs should consider the situation of the blowout being allowed to run its course without intervention.

Page CUTTINGS-14

The list of sampled variables is helpful. It would also be helpful if the Appendix PAR variable names were listed along with the appropriate page number in Appendix PAR.

APPENDIX NUTS

This appendix contains material that seems to be in conflict with the usage of the code described on pages 6-97 and 6-98, *e.g.* Radionuclide decay. It is unclear whether the dual porosity and dual permeability features of the code will be used. Code descriptions should focus on those features that are used in the performance assessment modeling.

APPENDICES SECOFL2D and SECOTP2D

The code descriptions for SECOFL2D and SECOTP2D presented in the DCCA are insufficient to adequately defend the use of these codes for performance assessment. The conceptual models behind these codes are never discussed. Parameters are listed without any discussion of reasonable values. The lack of discussion of the use of a dispersion tensor for flow through a single fracture makes the use of Equation 1 questionable.

If the hydraulic transmissivity field of the Culebra Member is an important parameter as indicated on page PAR-230 then the conceptual models of flow and transport through the Culebra are also important. What is the basis for a parallel fracture model? What support is there for clay linings on the fracture walls? What is the influence of this assumption? If channeling is recognized as a possible important feature in anhydrite beds of the Salado Formation, why is it not considered as a possibly significant phenomena in the Culebra?

CHAPTER 7. ASSURANCE REQUIREMENTS

Purpose of Assurance Requirements

Page 7-1, lines 3-13

The document fails to state that the purpose of the assurance requirements in 40 CFR 191.14 is to provide the confidence needed for long-term compliance with the containment requirements of 40 CFR 191.13. The application should state the purpose and then show how the material that follows shows compliance.

The EPA, in 40 CFR 191.14, also notes that the Nuclear Regulatory Commission (NRC) has issued comparable provisions (10 CFR 60) applicable to facilities regulated by the Commission.

Page 7-1, line 36

After ".... effectiveness of those controls" add "in preventing or reducing radionuclide releases." Otherwise the reader is unaware of the reason for the controls.

Useful and Practical Active Institutional Controls

Page 7-2, line 3

The DOE interpretation is that active institutional controls (AICs) should be implemented as long as controls are useful and practical. DOE needs to specify how long they believe AICs are useful and practical.

Oversight Organizations

Page 7-2, line 23

Add EEG to the list of oversight agencies of AIC activities.

WIPP Active Institutional Control Program

Page 7-3, line 28

The steps identified for the WIPP AIC programs are so general and lacking in substance that it is difficult to comment meaningfully. The program should be clearly identified and defended for its projected effectiveness and duration.

Hot Cell as Post-Decommissioning Marker

Page 7-4, line 15

The text indicates that the concrete Hot Cell structure will be left in place. What are the plans for decontamination of that structure and disposal of radioactive material?

Uncontrolled Access to Site

Page 7-4, line 31 and Vol. II, page 13

While the site has 10,240 acres, the surface projection of the waste is only 120 acres. The text suggests that slant drilling is unlikely to occur in the remaining 10,120 acres into the repository. No explanation is offered for this assumption; particularly since the current experience in the Delaware Basin is contrary to the assertion. No restrictions on regular drilling in the site area outside the fenced area are identified which would be contrary to the requirements of active institutional control.

Description of Active and Passive Controls

Page 7-5, lines 30-33

A detailed description of the planned active and passive controls should be provided as a part of the Compliance Application and not "by October 30, 1997".

Monitoring Period

Page 7-7, line 18

Specify the length of time that monitoring would continue. DOE should have some estimate of the length of time that is realistic.

Monitoring

Page 7-7, line 20

Specify any other parameters to be monitored. Subsidence and groundwater in the Rustler are the only ones mentioned.

Groundwater Sampling

Page 7-7, line 21

How and when would the boreholes from the surface to the Rustler dolomite aquifers be plugged? Would the markers include this information?

Disposal System Monitoring

Page 7-8, line 25

How will the geochemical performance be assessed to substantiate assumptions regarding the characterization of brine and waste?

Page 7-8, line 27

What plans are there to monitor the efficacy of borehole plugs as a function of time?

Subsidence
Page 7-9, line 22

In view of the decision not to backfill the experimental area to the north immediately adjacent to the repository, how will one determine the effects of subsidence from the backfilled repository versus subsidence resulting from the experimental area?

Subsidence Measurements
Page 7-9, line 31

The subsidence studies should also predict Culebra settlement now as a result of potash mining. Data exist of the extent of Culebra settling where high potash extraction rates have occurred in the Basin. Such measurements can be made now in areas where potash has been mined to determine whether fracturing has been induced in the Culebra elsewhere in the Basin which could affect performance assessment calculations.

Environmental Radiation Surveillance
Page 7-11, line 1, Baseline Database

The environmental measurements obtained and published by EEG should be included. The EEG measurements cover a longer period of time than DOE's, contain specific radiochemical analyses which DOE has yet to implement, and the EEG Laboratory has participated in the EPA Quality Control programs with excellent results.

Preoperational Data
Page 7-12, lines 10-13

Preoperational data do not include the Aerial Radiological Survey of the Waste Isolation Pilot Plant and Surrounding Area[7-1] which identified ^{137}Cs within a few miles of the WIPP boundary.

[7-1]Berry, H.A., 1989. *An Aerial Radiological Survey of the Waste Isolation Pilot Plant and Surrounding Area, Carlsbad, New Mexico.* EG&G Energy Measurements. AMO-8809.

Future aerial radiological surveys listed on line 4 should include the Gnome site where measurable levels of fission products are on the ground surface. The location and movement of this contamination which contains radionuclides common to elements in the WIPP waste should be closely monitored so as not to be mistaken for WIPP related radioactive materials by future investigators.

Passive Institutional Controls
Page 7-13, line 26

Again, the purpose of PICs is to help provide confidence that the containment limits in 191.13 are met.

Perpetual Care
Page 7-13, line 44

DOE states that they will preserve knowledge of the site in perpetuity. That is much longer than the required 10^4 years.

Existing TRU Waste Markers
Page 7-14, line 7

DOE plans a number of elaborate markers and records. Please describe and reference markers and records currently used at TRU waste disposal sites in Nevada, LANL and ORNL for wastes buried prior to 1970.

Credit for PICs
Page 7-16, line 1

"The DOE believes that PICs will render human intrusion sufficiently unlikely so that the possibility need not be included in the CCDF." What is the basis for this statement? EEG believes it does not make sense to take <u>any</u> credit for a reduced future drilling frequency based on PICs, beyond 100 years.

Status of Passive Institutional Controls to Date

Page 7-16, line 19

The statement that DOE has been successful in gaining control of the subsurface to 6000 feet including the acquisition of oil, gas and potash leases is misleading since there are valid leases for slant drilling of 16 boreholes under the site. Please add a sentence to that effect to insure no confusion.

Buried Markers

Page 7-16, line 44

There is an excellent opportunity to place records in the SPDV experimental area adjacent to the repository now. Why not place messages there before it becomes unsafe to enter?

Missing Radiation Protection Standards

Page 7-22, line 27

The list of documents to be archived does not include a copy of the radiation protection standards used to protect the public health and the environment and the basis for them. There is no reason to believe that standards in place today will be the same in the long term future. Indeed, the allowable dose to the Nevada off-site community from weapons testing in the atmosphere in the 1950's was 3900 mrem per test series. Today, the allowable annual exposures being considered for waste disposal are 10 to 30 mrem. To deter future human intrusion, it is vital that future generations know what the acceptable risks were at the time of disposal.

Notification of Agencies

Page 7-23, line 1

After repeated requests by DOE, in 1992 Congress assigned the 4 mile x 4 mile BLM, DOI site to DOE in perpetuity. To date DOE has not delegated or assigned their authorities back to BLM, Dept. of Interior or to the State of New Mexico to establish a system to prevent drilling permits to be issued. Indeed, elsewhere in the text (Vol. II, Page 13) DOE states there is zero probability that slant drilling from a site within the 4 mile x 4 mile zone would intersect the repository. Hence, DOE would rely on their interpretation of current slant drilling practices in the Delaware Basin.

Archives
Page 7-23, line 14

DOE would rely on the local office of BLM, DOI to archive information. Local offices are consistently closing and reconsolidating. The information should be sent to all offices of BLM.

Monuments
Page 7-25, line 38

The plans call for expensive monuments. Consideration should be given to leaving the Hot Cell with 3 foot thick walls in place and using it as a monument to store records. This would save the cost of dismantling the Hot Cell and erecting a structure with thick walls to insure longevity.

Additional Study
Page 7-26, lines 1-8

Please add an additional study to evaluate the confusion to future generations where elaborate markers are placed at WIPP with TRU waste at 2150' depth and none are placed at pre-1970 TRU waste disposal sites at depths of a few feet.

Engineered Barriers
Page 7-26, line 35

DOE states that the proposed 40 CFR 194.44 imposes additional requirements. We disagree. The proposed criteria provide a basis to select or reject various proposed engineered barriers.

Page 7-26, line 43

DOE defines the "repository" as an engineered barrier. This is inconsistent with other regulatory agency definitions.

Commitment/Non-Commitment to Backfill

Page 7-27, line 1

DOE states that they will use backfill if appropriate. Line 43 acknowledges the Department has committed to include properly designed backfill in the repository. Which is the correct statement?

Need for Backfill

Page 7-27, line 2

DOE states that using backfill to fill voids or mitigate fires is not needed. That is not the primary purpose of using backfill, and the statement is irrelevant. Backfill can reduce the amount of brine that reaches the waste, reduce the amount of gas being generated, allow earlier room closure and minimize settlement in the overlying strata and reduce the probability of fracturing in the Culebra dolomite. Last but not least, it provides a use for some of the 10 million cu ft. of salt left over on the surface.

Evaluation of Engineered Alternatives

Page 7-27, line 11

The DOE Engineered Alternative Task Force only looked at engineered alternatives from the standpoint of changing the rate of gas generation or the total amount of gas that could be generated. It did not consider any other merits of engineered alternatives.

Defense in Depth Using Engineered Alternatives

Page 7-27, line 14

The DOE/EPA study is a cost-benefit analysis of engineered alternatives. As such it is not meaningful to assign a financial value to improved confidence in predicting that the probability is less than 1/1000 of releasing more than 10 x the Table 1 (40 CFR 191) limits to the accessible environment over 10,000 years. The purpose of the engineered barriers is to improve confidence in our ability to confine the wastes. It was never intended to be quantified.

Page 7-27, line 38

The DOE interpretation that only those engineered barriers and waste form modifications that are necessary to meet the calculated behavior of the transuranic wastes for 10,000 years is, EEG believes, a minimal approach. Relying on the calculations almost exclusively is contrary to the concept of multiple barriers and defense in depth adopted by virtually all organizations engaged in radioactive waste disposal. Also, the Assurance Requirements (40 CFR 191.14) require engineered barriers, irrespective of and in addition, to the ability to demonstrate compliance with the containment requirements (40 CFR 191.13).

Multiple Engineered Barriers

Page 7-28, line 6

Although DOE repeatedly states they use multiple engineered barriers, the only ones planned are shaft seals. It is interesting to note that NRC will not give DOE any credit for shaft seals as an engineered barrier for HLW disposal in Nevada and DOE has accepted that position. Also, the EPA definition of Barrier (40 CFR 191-12) and the EPA stated position does not allow seals to be an engineered barrier (see our comment on Section 3.3).

Meeting 40 CFR 191.14(e) Requirements

Page 7-28, line 28

DOE states that the intent of this requirement was met during site screening and selection. EEG disagrees. Site screening and selection occurred prior to the 1985 promulgation of 40 CFR 191. Additionally, EEG raised a number of issues in correspondence with DOE in our attached letters of February 13, 1990, August 10, 1990, and December 27, 1991 that were not addressed in the 1993 DOE report "Implications of the Resource Disincentive in 40 CFR 191.14(e) at WIPP."

Page 7-28, line 36 and line 41

The statement that EPA discourages the location of repositories in areas in which valuable material resources are present is misleading in that it omits two other requirements specified in the 40 CFR 191.14(e). They include places where there has been mining for resources, expectations for exploration for scarce resources or a significant concentration of rare material. If a site fails the 3 mineral requirements, the standard requires the applicant to identify the potentially favorable characteristics of the site that outweigh the risks. That has not been done.

Presence of Resources

Page 7-29, line 40

See EEG's Comments on Appendix IRD.

CHAPTER 8. INDIVIDUAL AND GROUNDWATER PROTECTION REQUIREMENTS

To show compliance with the individual protection requirements, a dose calculation needs to be done. To show compliance with the groundwater protection requirements, a concentration calculation has to be made. The DOE has not done either calculation and has not performed the assessments required by 40 CFR 194.55. Hence, it is not possible to provide meaningful comments.

EEG COMMENTS
on the
DCCA APPENDICES

PARAMETERS
(VOLUME I. APPENDIX PAR)

It is disappointing that the DOE has postponed providing specific information on the following 23 of the 53 parameters sampled in the analysis presented in Appendix PAR. The information will not be available until the final CCA is issued.

Page	Parameter
46	Residual Brine Saturation of Halite
56	Threshold Pressure in Halite
60	Intrinsic Permeability of Anhydrite Layers and Marker Beds
82	Threshold Pressure of Anhydrite Layers and Marker Beds
84	Residual Brine Saturation of Anhydrite Layers and Marker Beds
87	Residual Gas Saturation of Anhydrite Layers and Marker Beds
108	Brine Storage Model for Unfractured Interbeds
113	Brine Storage Model for Altered Interbeds
214	Intrinsic Permeability of the Shaft Seals
226	Shear Strength of Waste in the Panel
240	Uranium Oxide State
243	Plutonium Oxide State
247	Neptunium Oxide State
249	Solubility of Aqueous Radionuclides in Oxidation State III
252	Solubility of Aqueous Radionuclides in Oxidation State IV
255	Solubility of Aqueous Radionuclides in Oxidation State V
258	Solubility of Aqueous Radionuclides in Oxidation State VI
261	Fracture Spacing in the Culebra
265	Partition Function for Americium in the matrix of the Culebra
269	Partition Function for Neptunium in the matrix of the Culebra
273	Partition Function for Plutonium in the matrix of the Culebra
275	Partition Function for Thorium in the matrix of the Culebra
279	Partition Function for Uranium in the matrix of the Culebra

Halite Permeability
Page 1

The permeability of the halite blocks in the BRAGFLO model represents the permeability of "impure halite" which is based on extensive testing. It needs to be demonstrated that this representation bound the influences of interbeds of other materials such as polyhalite and anhydrite. Such calculations should include consideration of enhanced anhydrite permeability due to high gas pressures.

Halite Specific Storage
Page 17

The BRAGFLO model represents regions of Salado halite that includes numerous interbeds of varying mineralogy. If halite specific storage is used to represent these regions, it should be demonstrated that the specific storage contribution of these marker beds can be neglected.

Gas Storage Model for Interbeds Altered by Interbed Fracture
Page 105

The range values (1/3 to 10^{-3}) of C_g given in the equations do not agree with the values (1/10 to 10^{-6}) given in the text. The values for other parameters in the equation should be given in the discussion. These are: h_g, e_g and r.

Brine Storage Model for Unfractured Interbeds
Page 109

The discussion for this parameter is identical to the discussion for the brine storage in altered interbeds and applies to that parameter rather than the unfractured interbeds.

Initial Liquid Saturation of Panel and Repository
Page 206

The initial liquid saturation of the panel and the repository is based on an EG&G INEL memorandum on waste from the Rocky Flats facility. The memorandum presents the data as pints per drum of waste. A recommendation is given in the memorandum that a poisson distribution should be used to characterize the per drum liquid content. The conversion of this data to initial liquid saturation of the panel and the repository is not presented nor is any reference made to a conversion. The cumulative distribution function used in the performance analysis is linear corresponding to a uniform distribution function. No mention is made of whether the recommended poisson distribution has been ignored or whether the uniform distribution is a result of the conversion of the per drum data to panel averages.

The data is from a single source. No discussion is presented about how representative this sample is to the waste to be stored in WIPP. The lack of a description of the data conversion process prevents an evaluation of whether the data used in the performance analysis adequately bounds saturation induced from waste from all potential sites.

SCREENING CRITERIA
(VOLUME I. APPENDIX SCR)

Major Concerns

1. Although various phenomena have been screened out on the basis of low probabilities of occurrence or insignificant consequences, we are concerned about synergistic effects of these independent events occurring which could have a substantial impact on the repository's predicted behavior.

2. There are no calculations or evidence provided to support the conclusions that various FEPs can be assumed to have little if any impact on probabilities or consequences, except for meteorite impact.

3. The impact of potash mining on subsidence and fracturing in the Culebra has not been addressed.

4. EEG does not believe that it is reasonable to automatically exclude human initiated events on the basis that the regulations do not require such analyses. This applies to the impact of potash mining on the geohydrological characteristics of the Culebra, fracturing in the Salado at the repository horizon from brine injection, or other man-made activities. DOE has the authority to self-regulate in other areas and the position taken by the Department to only address failure modes that are *required* by EPA to be addressed will undermine public confidence in the assertion that it is a world-class design.

5. What are the definitions and quantitative thresholds of "low probability" and "lower consequence" used to screen out various phenomena for consideration?

Regional Tectonics

SCR-8, line 19

Please provide an analysis to justify the deletion of regional tectonics on the basis of low consequence to the repository system performance.

Fracture Development

SCR-13, line 29

Naturally induced fractures affecting groundwater flow have been ruled out, but there does not appear to be a discussion of fracture development due to human initiated events.

Deep Dissolution

SCR-17, line 18

While deep dissolution has been ruled out on the basis of a low probability of occurrence, what is the calculated probability over 10^4 years?

SCR-18, line 11

The text states that deep dissolution is not a problem but that dissolution at depth is still taking place. Can this effect be bound?

SCR-19, line 2

Include a discussion on the age and mechanism of collapse breccias.

Flooding

SCR-23, line 2

Include a discussion on the evidence for and against downward percolation of water.

SCR-28, line 12

The position taken by DOE that assessments of the individual dose and impact on ground water are not required by EPA for the disturbed case is not particularly comforting. DOE should undertake such analyses.

Waste and Container Characterization as Described in Chapter 4
SCR-28, line 25

Contrary to the text, the container characteristics are not described in Chapter 4.

Nuclear Criticality
Section 2.3.2, Page SCR-38

EEG looks forward to a detailed analysis of the potential for nuclear criticality and the resultant heat generation. The EEG was actively involved in studying this issue in the 1981-85 period and sent two reports to the DOE. The issue should be reexamined in light of the current design of the repository, Waste Acceptance Criteria, Characteristics of the WIPP mine shafts, and the retardation characteristics of the Rustler aquifers. Both RH and CH-TRU Waste should be considered in such a study.

Copies of three letter reports, dated September 1981; December 30, 1993; and January 18, 1984, from Sanford Cohen and Associates are attached as Supplements 2, 3, and 4 to this report to help DOE prepare an up-to-date report on this subject.

Backfill Commitment
SCR-39, line 21

The text indicates that the repository will not be backfilled. This is contrary to the C&C Agreement between New Mexico and DOE.

Roof Falls
SCR 39, line 29

Add a discussion on the experience in the WIPP mine with roof falls.

Thermally Induced Stress
SCR 40, line 6

What is the basis of the assumption that the effects of thermally induced stress in the repository can be eliminated from performance assessment on the basis of low consequence and the documentation will be available in the final CCA?

The text notes that thermally induced stress could result in pathways for ground water flow in the DRZ, in the anhydrite layers and member beds, and through seals or enhance existing pathways. Please include the analyses to support the assumption of no consequence.

SCR-40, line 24

See EEG comment on SCR-38, line 5

SCR-41, line 3

Flow through sealed investigation boreholes has been eliminated on the basis of low consequence to P.A. An analysis of the impact of the 100 foot boreholes extending upward and downward from the repository horizon should be presented.

Thermal Convection
SCR-42, line 4

Although the statement is made that the extent of thermal convection arising from heat generation has yet to be done, DOE has eliminated thermal convection on the basis of low consequence. The conclusion appears premature.

Backfill
SCR 60, line 16

The DOE conclusion that backfill is not warranted on the basis of little impact on subsidence does not address other more relevant advantages from backfill such as the ability to restore the near field characteristics to the undisturbed rock quicker, to minimize the effects of roof fall in completed panels during the 35 year waste emplacement, to minimize gas generation by brine inflow, and others.

Human Initiated Events

SCR-60, line 34

EEG disagrees with the position taken by DOE not to evaluate the individual dose or the impact on groundwater because the regulations do not *require* them for human initiated events.

EEG disagrees with the DOE contention that human initiated events that might occur after 1996 should not be addressed.

SCR-61, line 5

EEG disagrees with DOE's contention that the effects of human actions after 1996 which may disrupt the disposal system do not have to be considered.

Deleting Potential Failure Modes

SCR-63, line 31

The logic presented by DOE for not considering various failure modes is to hold EPA responsible for the exclusion. This appears inconsistent with the stated aim of DOE to insure the full protection of the public health and environment.

SCR-64, line 6

DOE's position on post CCA submission is to only consider the effects of potentially disruptive events that occur prior to the 1996 Final Application. EEG does not agree with this and believes potentially disruptive events in the future such as brine injection to enhance oil recovery and potash mining effects should be considered.

Fluid Injection

SCR-72, line 11

DOE concludes that the effects of recent and ongoing fluid injection through boreholes outside the controlled area can be eliminated on the basis of low consequence to P.A. What is the basis for this conclusion?

Events More Severe than Bounding Events

SCR-73, line 11

Eliminating fluid injection from P.A. calculations since it is more severe than the bounding limit (inadvertent intrusion) defies common sense.

WIPP ACTIVE ACCESS CONTROLS AFTER DISPOSAL
DESIGN CONCEPT DESCRIPTION DRAFT
(VOLUME II)

Summary

While a considerable amount of detailed information is presented, this section does not identify specific active institutional controls and how they will help fulfill the assurance requirements of 40 CFR 191.14(a) active institutional controls.

Nowhere in this section is the purpose of active institutional controls (AICs) listed. 40 CFR 191.14 states that it is to provide the confidence needed for long-term compliance with the requirements of 191.13 (40 CFR 191.13 containing the Containment Requirements).

The section also addresses passive institutional controls (PICs) without including a definition or explaining their purpose. There is no explanation of how and when the DOE will delegate or assign authorities obtained under the 1992 LWA to the Department of the Interior or to New Mexico to implement a system to prevent issuing a license or permit to drill or mine.

The title of this section does not match the EPA requirement. "Active Institutional Controls" has been changed to "Active Access Controls". Why?

Detailed Comments follow:

Paraphrasing the Regulations
Page 1, Section 1A

The language of the Regulations should not be paraphrased. Example: The text states that Title 40 CFR 191.12 defines Active Institutional Control as.... The exact language is, "Active Institutional Control means...."

Purpose of Active Institutional Controls

Page 1

The text correctly quotes 40 CFR 191. 14(a) but it should include the full 40 CFR 191.14 citation which states that the purpose is to provide confidence that the containment requirements in 191.13 will be met. It is not merely to control access to the site.

Passive Institutional Controls

Page 2

References to Permanent Markers should either be deleted or rewrite this section to clearly indicate that Passive Institutional Controls (PICs) are included as well as AICs. Permanent markers do not constitute active institutional control.

Documentation in Application

Page 2, Paragraph 2

Two other reports, Conceptual Decontamination and Decommissioning Plan and Long Term Monitoring Design are cited. Are they a part of the package to demonstrate compliance with 40 CFR 191.14(a) assurance requirements?

Long-Term Effects of Mining

Page 2

DOE is to be commended for acknowledging potential problems associated with mining.

Incorrect WIPP Mission

Page 3

Change the R&D mission of WIPP to one of disposal.

WIPP Waste Limits
Page 3, Paragraph 4

Since the limit on waste volume is specified, add limits of 5.1 million curies for RH-TRU and 1000 R/hour for 12,500 Cu ft of RH-TRU.

Design of Repository
Page 4

Where are panels 9 and 10?

Site Access
Page 5, Paragraph 2

Explain the term "occasional access to the site". It is unclear whether it means to intrude into the waste or have access to the surface.

Panel Seals
Page 8, Figure I-3

Also show a diagram of proposed panel seals.

Underground Markers
Page 11

Decide now whether to place markers underground in the non-backfilled experimental area adjacent to the repository. The opportunity will soon be lost since access will be too hazardous.

Page 13, Paragraph 2

"The salt formations do not support slant drilling due to insufficient consolidation of the salt material." What is the basis for this statement? The following sentence in the text concludes that it is not necessary to have a system to prevent slant drilling in the 4 mile x 4 mile area because it is unlikely. Can one assume that there are no plans by DOE to actively prevent vertical drilling in the remaining 10,120 acres of the WIPP site during the first 100 years? This appears to violate the EPA standard and the P.A. has not addressed this scenario of unrestricted mining during the first one hundred years.

Paraphrasing the Standards

Page 16

Top of page. Paraphrasing the exact language in the regulations can lead to confusion. For example, "Title 40 CFR.12 defines Active Institutional Control to include four elements." The verb "include" suggests that one is not necessarily limited to the following list whereas EPA intended it to be limited to <u>only</u> those items that follow.

Misinterpretation of the WIPP Land Withdrawal Act

Page 16, IV, Paragraph 2

Assuming that the mere existence of the 1992 WIPP law will insure the requirements are met without any enforcement for the next 100 years by implementing low technology barriers may be unduly optimistic.

Drilling Probabilities

Page 17, Paragraph 1

"The risk of drilling at a location outside the disposal area surface footprint and inadvertently intruding into the disposal area is essentially zero."

A. Do you mean "risk" or "probability"?
B. Where are the calculations to substantiate this statement?
C. On what basis is the writer confident that the current practice will apply for 100 years?
D. If slant drilling is not practical (as allowed) why has there been extensive slant drilling in salt formations?

Long-Term Monitoring

Page 22

The only long-term monitoring planned by DOE are measurements of subsidence. Other monitoring should be planned as well.

Page 27

The material to be archived should also include a copy of the standards since the allowable risks may be substantially different in the future and future generations may have a different threshold of an acceptable risk. This is much more important than many of the other reports.

Since the EPA standards urge the reader to see comparable provisions issued by the NRC for high level waste, include a comparison of items not being done at WIPP and add 10 CFR 60 to the list of references.

What are the plans for markers, records and active institutional control for TRU waste that has been buried to date? List those plans in the references since those PICs may not all survive. Include an explanation why we have markers for TRU waste buried at 2150 feet and none for TRU waste buried in shallow formations so that future generations can understand our logic.

BIENNIAL ENVIRONMENTAL COMPLIANCE REPORT (BECR)
(VOLUME II)

Background

While DOE is a regulatory agency and DOE Orders are applicable to this project, DOE is not identified as such in the list of regulatory agencies. It is essential that public accountability of compliance with DOE requirements be included. The BECR report provides detailed information on the status of compliance with laws, regulations and standards by a number of regulatory agencies. Unfortunately, the report omits any information on the status of compliance with regulations issued by a key regulatory agency, namely the U.S. Department of Energy. An analysis of the DOE Orders, and the reviews and approvals by the Office of Environment Safety and Health (ES&H) and the Defense Nuclear Facilities Safety Board (DNFSB) should be included.

It should be made clear that the Administrator of EPA or the State, as appropriate, shall determine whether DOE is in compliance with all the regulations and permits listed in Sect. 9(a)(1). Use the full, exact citation in the Land Withdrawal Act.

The cutoff date of a year prior to reporting is needlessly long. It should be six months.

WIPP LWA Requirement
Page 1.2

Provide the specific citation, Section 9(a)(2), in the 1992 LWA that this section shows compliance with.

Codification of Regulations
Page 1-3, 1.3.2

The description of the mechanism for promulgating regulations by federal regulatory agencies is good. It should be noted that DOE, as a regulatory agency, has not published proposed regulations in the Federal Register nor codified them in the Code of Federal Regulations.

DOE has issued regulations as DOE Orders without a public review process. The text on page 13-2 acknowledges that the DOE Orders are not considered to be at the same levels as those in the Code of Federal Regulations. DOE is now beginning to codify regulations in the CFR.

Page 2-8

40 CFR 268.10-12 requires waste for treatment to be evaluated. If the DOE treats mixed TRU waste, additional documentation should be provided.

CRCLA Requirements

Page 3-4

While DOE was required to submit a preliminary assessment for WIPP to EPA by August 5, 1994, the March 31, 1995, DCCA indicates that the brief preliminary assessment is still in preparation. What is the status?

Page 3-4

The March 31, 1995 DCCA states, "An official Local Emergency Planning Committee will be established in 1994." What is the status?

NRC Standards

Page 5-1, Paragraph 3

The statement is made that "NRC standards and requirements are incorporated into DOE Orders." Generally this is not true.

NRC and DOT

Page 5-1

"The NRC's requirements pertain to WIPP only in the transportation of TRU waste from the generator sites to WIPP."

Transportation regulations are established by the U.S. Department of Transportation (DOT). The design of the Type B shipping containers is licensed by NRC under 10 CFR 71.

NESHAPS Limits
Page 6-12, 6.2.2

While EEG agrees that the NESHAPS limit of an effective dose equivalent of 10 mrem/year will not be exceeded, the use of CAP-88 in the 1990 FSAR calculations was applied incorrectly. See EEG-52

Mission of DOE
Page 13-1, Paragraph 2

Contrary to the assertion, the U.S. DOE is not solely involved in national defense activities.

DOE Regulatory Authorities
Page 13-1

An analysis of the DOE system of Orders, notices, and directives to protect the public, the environment and workers from adverse consequences from DOE operations should be included in this section.

RH-TRU Waste Transportation
Page 15-1

There are two types of transuranic wastes to be shipped to WIPP. CH-TRU and RH-TRU waste. The 28 pages of Chapter 15 only describe the shipping container for the CH-TRU waste. Nothing is included on the RH-TRU container which may have 1/3 of the total radioactivity. Revise this section to include the status of the design, and schedule for the RH-TRU container submission to NRC with the expected date of certification.

Compliance
Page 16-1

While DOE is not required to do so, the Department might request the U.S. Department of Transportation to make an evaluation of DOE's determination of compliance with the materials outlined in this section. The same applies to all regulatory agencies in the BECR.

Federal Land Policy and Management Act

Section 18 should provide specific information on the plans to remove the 10 million Cu ft of salt that will be left over at the completion of the project.

BOREHOLE DATA OF SOUTHEASTERN NEW MEXICO
(VOLUME II)

The compilation on borehole data for southeastern New Mexico is incomplete and does not include all oil and gas wells. While there is a reference in Volume I (page 2-114) to a report being prepared on Delaware Basin boreholes, the compilation should be available now, particularly since DOE states that the report being prepared is associated with the prediction of future drilling rates.

Other wells that appear missing from the inventory include:

Engle
USGS 4
USGS 1
USGS 8
LRL 7
DD1
Hudson Federal
Culbertson-Erwin
Bootlegger Ridge
Gulf 1-A
Pogo
Union
Danford
Belco
Culbertson
Covington
Masho 1
Masho 2
Shell
Tidewater
Bilbrey
Barclay State #1
James Ranch
James E.
Martha
Dolores
Federal
Federal
Phillips
Wright
David
Dunes
State
I-P.G.-4
Barclay Federal #1
Medano State Comm #1
Forty-niner Ridge Unit #3
Getty "24" Federal #5WD, #'s
Neff "13" Federal #'s 2,3,4,5,6,7,8

None of the boreholes listed in Subsurface Exploration Borehole Data Base have drilling records prior to 1978. Were there none or are the records unavailable?

BASELINE INVENTORY REPORT (BIR)
VOLUMES III AND IV

The projected quantities of TRU waste have changed substantially from the February 1995 Baseline Inventory Report (BIR) Rev. 1 estimates used in the DCCA to the December 1995 BIR Rev. 2. An explanation is needed, particularly since DOE is considering a redefinition of defense TRU waste. Additionally, the existing design of 7080 m^3 for RH-TRU waste will not accommodate the 27,000 m^3 of RH-TRU waste to be emplaced in the walls of the rooms.

	REV. 1 2/95 (m^3)	REV. 2 12/95 (m^3)
RH-TRU Waste	4800	27000
CH-TRU Waste	120,000	110,000
Total	125,000	140,000

Commercial TRU Waste
ES-1

Why is commercial transuranic waste included in the inventory since it is specifically precluded both by the NM/DOE C&C Agreement as well as Public Law 102-579?

Disposal Inventory
Page 1-4

The volume shown for CH-TRU waste is high by a factor of 100,000.

Particulate waste
Page 1-5
The text states that all particulate wastes will usually be immobilized prior to shipment to WIPP. This form is not identified as a Waste Matrix Code Group nor is it defined in the Glossary. How will it be immobilized?

RH-TRU Waste Inventory

Page 4-2

The allowable projected volume has an unwarranted multiplier in the expression of 10^5.

CH-TRU Waste Quantities Incorrect

Page 4-2

"The total volume of projected CH-TRU waste from the IDB in Table 4-1, if added to the stored waste volumes from the IDB, exceeds the capacity of WIPP (176,000 m^3)." No, it does not. The sum of the existing and projected volumes from Table 4-1 is less than 176,000 m^3. The whole purpose of the scaling equation on this page is to note that there will be unused space for 30.5% of the design volume or 1.9 x 10^6 cu ft.

Estimating the Total CH-TRU Waste at Each Site

While an elaborate description is provided of the method to calculate the CH-TRU waste at each site the results of the calculations are not provided in either Chapter 4, Volume I, or in Volume III or Volume IV. They should be shown.

The origin of the 0.65 factor is not shown. The text should note that it is

$$\frac{72{,}000}{64{,}600 - 14{,}600 + 62{,}000}$$

The 14,600m^3 is a correction for low-level waste.
The 62,000 M^3 is a correction for the Savannah River (SR) TRU waste.

Estimating the Total RH-TRU waste at Each Site

Page 4-3

The result of the calculations are not shown.

It would be simpler to show

Existing Waste + Projected Future Waste + Vacant Space = Design Capacity

Vacant Space = 5182 m^3 or 73% of the RH-TRU waste capacity.

The opposite conclusion is presented on page 4-4 which states that the volume of RH-TRU waste identified by the sites exceeds the capacity of the repository.

Low-Level Waste

Page 4-5

It appears that half the waste that has been characterized as TRU may be Low-Level Waste. More information is needed on this.

DECONTAMINATION AND DECOMMISSIONING PLAN
(VOLUME V)

As the title implies, the plan is conceptual in nature and does not provide specific details of the decommissioning process, but it is appropriate that the plan be conceptual and general in nature. It should be expected that regulatory requirements for decommissioning and decontamination and technical capabilities will change prior to facility closure. Appropriate commitments are present and the plan is reasonable.

- Estimates of the amounts of metal to be emplaced in the repository following D&D should be provided.

- What are the plans for TRU and LLW generated during decommissioning?

Specific comments follow:

Page 1, paragraph 3

The reference for the waste acceptance criteria for decontamination and decommissioning (DD-WAC) should be provided for review.

Page 2, paragraph 1

"Mined salt remaining after closure and berm construction will be disposed under Section 2 and 3 of the Minerals Act of 1947."

The requirements of the Act should be discussed in the plan rather than just making reference to the applicable Sections. There will be about 10 million Cu ft of salt left over at the end of the project and a commitment needs to be made to remove it.

Page 2, paragraph 3
Regarding stakeholder involvement.

The actual commitments of NEPA should be specified in the plan, rather than making general references to the Act.

Page 3, paragraph 7

The hot cell may remain as part of a permanent marker.

There is no explanation why the Hot Cell would be allowed to remain as a marker. Plans to decontaminate the Hot Cell should be included.

Page 26, paragraph 1

Reference to shaft seals.

What is an acceptable sealing technique? The basis for establishing such criteria should be provided.

Page 27, paragraph 1

Radiation survey techniques.

Reference the criteria for radiation surveys.

Page 27, paragraph 2

Environmental monitoring.

The criteria for environmental monitoring should be provided.

GEOLOGICAL CHARACTERIZATION REPORT
VOLUMES VI AND VII

Considerable site characterization work has occurred since the publication of the GCR. New Issues have arisen, some of which have been resolved and the others remain unresolved.

In August 1979, the EEG published EEG-2 (App. III to EEG-3), titled Review Comments on Geological Characterization Report, Waste Isolation Pilot Plant (WIPP) Site, Southeastern New Mexico SAND 78-1596, Volumes I and II, December 1978. A number of EEG reports and papers have since been published (see the list of EEG reports at the end of this report) that relate to the geological characterization issues. The EEG Comments on Chapter 2 of the DCCA reflect the EEG's up-to-date position on many of these issues.

STATISTICAL SUMMARY OF THE RADIOLOGICAL BASELINE PROGRAM FOR THE WASTE ISOLATION PILOT PLANT (VOLUME VIII. APPENDIX RBP)

Project Gnome Environmental Radioactivity

Page 1-3

The paragraph about project Gnome states that the surface radioactivity has been reduced to approximately background levels. EEG has conducted a radiological survey of the area and found significant levels of Pu-238, Pu-239+240, and Am-241. The results were published in EEG-58, Radionuclide Baseline in Soil near Project Gnome and the Waste Isolation Pilot Plant, Jim W. Kenney, Paula S. Downes, Donald H. Gray, Sally C. Ballard, July 1995.

The paragraph about the Test Phase should be deleted since these plans are no longer in effect.

Fission Products in Groundwater Samples

Pages 5-7

The reported presence of the fission product Sr-90 in groundwater samples does not appear correct.

Long Lived Radionuclides

Page 6-1

Contrary to the assertion, ^{90}Sr and ^{137}Cs are generally not considered to be long-lived radionuclides as are transuranics.

References

Page 9-1

Add the following EEG publications:

EEG-47, Kenney, Jim W., and Sally C. Ballard, Preoperational Radiation Surveillance of the WIPP Project by EEG During 1989, December 1990.

EEG-49, Kenney, Jim W., Preoperational Radiation Surveillance of the WIPP Project by EEG During 1990, November 1991.

EEG-51, Kenney, Jim W., Preoperational Radiation Surveillance of the WIPP Project by EEG During 1991, October, 1992.

EEG-54, Kenney, Jim W., Preoperational Radiation Surveillance of the WIPP Project by EEG During 1992, February 1994.

EEG-58, Kenney, Jim W., Paula S. Downes, Donald H. Gray, and Sally C. Ballard, Radionuclide Baseline in Soil Near Project Gnome and the Waste Isolation Pilot Plant, July 1995.

Illegible Graphs

Pages A-1 through A-52

The graphs in the appendix, Date Histograms and Probability Distribution Models are not legible.

QUALITY ASSURANCE PROGRAM DESCRIPTION
(VOLUME VIII. APPENDIX QAPD)

The "QAPD" Appendix, consisting of the June 1994 CAO Quality Assurance program Description (QAPD) revision 0, does not specifically address QA as related to any of the 40 CFR 191 requirements, and became effective well after the bulk of the work described in the rest of the DCCA was completed.

The "Draft Compliance Application Guidance (CAG) Document for 40 CFR Part 194 Federal Register Draft" of September 1995 (EPA 402-R-95-014) which postdates the DCCA, provides guidance to the proposed 40 CFR 194.22 for "...submission of information...demonstrating the establishment and execution of Quality Assurance programs..." (p. 22-23). It should be noted, however, that the DCCA states specifically that the requirements of 40 CFR 194.22 are not addressed (p. 5-1, lines 15-17).

The "QAPD" appendix was addressed in several of our comments on Chapter 5 of the DCCA. The bulk of these comments compare the requirements in the proposed 40 CFR 194.22 concerning NQA-1, NQA-2 (part 2.7), and NQA-3 against both the CAO QAPD revision 0 (the "QAPD" appendix) and the draft revision 1 currently under review by CAO. The conclusion is that neither version requires adherence to all of the NQA standards as proposed in 40 CFR 194.

IMPLEMENTATION OF THE RESOURCE DISINCENTIVE IN 40 CFR PART 191.14(e) AT THE WIPP
(VOLUME VIII. APPENDIX IRD)

EEG does not believe the report "Implementation of the Resource Disincentive in 40 CFR Part 191.14(e) at the Waste Isolation Pilot Plant DOE/WIPP 91-029 Revision 1, June 1993" satisfies the Assurance Requirement 40 CFR 191.14(e), which states the following,

> "Places where there has been mining for resources, or where there is a reasonable expectation of exploration for scarce or easily accessible resources, or where there is a significant concentration of any material that is not widely available from other sources, should be avoided in selecting disposal sites. Resources to be considered shall include minerals, petroleum or natural gas, valuable geologic formations, and ground waters that are either irreplaceable because there is no reasonable alternative source of drinking water available for substantial populations or that are vital to the preservation of unique and sensitive eco-systems. Such places shall not be used for disposal of the wastes covered by this part unless the favorable characteristics of such places compensate for their greater likelihood of being disturbed in the future."

Since WIPP fails all three Criteria (previous mining for resources, reasonable expectation of future exploration, and significant concentration of a rare material) DOE needs to provide documentation on the favorable characteristics. It is important to note that the purpose of the Assurance Requirements is to provide <u>confidence needed for long-term compliance with the Containment Requirements</u> of 40 CFR 191.13.

EEG reviewed the August 1991 draft of the report and provided detailed comments in our December 27, 1991 letter to the WIPP Project Director (Supplement 5). Also attached are copies of the EEG's February 13, 1990 (Supplement 6) and August 10, 1990 letter (Supplement 7) on this subject. There was no response to questions raised in our three letters (see Supplement 8).

Page 12

The DOE concludes from the Natural Resources Study: "The conclusion of this study is that activities related to potash and hydrocarbon resource extraction and solution mining from within (and outside of) Control Zone IV, using currently available and applicable technology, will not compromise the integrity of the WIPP waste emplacement facility and increase the likelihood of a breaching event." This statement may not be justified in the light of the extensive oil, gas, and potash extraction activities in recent years and the case of Hartman vs. Texaco (see the comments on Chapter 6).

DOE Natural Resources Study

Page 13, paragraph 2 & 3

The specific conclusions reached from the natural resource study need to be reconsidered on the basis of the Hartman vs. Texaco case and the expected waterflooding activities in the vicinity of the WIPP site.

Probability of Resource Extraction in Zone IV

Page 13, and page 16

The summary paragraph states "...any resource recovery operation will be reviewed by the Bureau of Land Management (BLM) (for surface claims) and the Minerals Management Service (for underground claims) prior to its implementation." (page 13) and "the DOE did commit to working out arrangements with the BLM to assure that the DOE receives notification of resource development proposals in the vicinity of the WIPP site." (page 16).

A number of examples were cited in EEG-55 to indicate problems with the assumptions.

Basis of 1980 Site Selection

Page 27

"... the Eastern New Mexico area is not very productive, and has not been subjected to a lot of drilling."

This is a false statement.

Page 30

At the end of section 4.2.1, Table 4-1 should be table 4-2.

Page 32

Table 4-3 should be table 4-4.

SEPTEMBER 1994 WIPP SITE ENVIRONMENTAL REPORT FOR CY 1993
(VOLUME IX. APPENDIX SER)

Preface

"All activities pertaining to the Test Phase will now be conducted at the INEL." The alcove tests would have accounted for most of the waste to be used in the Test Phase. These tests are not being conducted at INEL nor anywhere else.

Additionally, bins that had been characterized at great expense at INEL to measure gas generation have not been used for that purpose at INEL.

The report does not include measurements obtained by EEG over the past decade and published eight reports. There is surface radioactivity caused by the Plowshare atomic weapons test in 1963, six miles southwest of the WIPP site. The document should also reference the EEG work in this area.

Prerequisite to Shipping Waste to WIPP

Page 2-2

Contrary to the statement, the shipment of wastes to WIPP are not predicated on the completion of bench-scale tests at INEL.

"Subsequent to a successful completion of the test phase, the WIPP will be designated as an operational facility and TRU waste will be transported... to the WIPP site." The test phase has been cancelled.

Radioactive Waste at WIPP

Page 3-2

"Most of the waste slated to be sent to the WIPP site is TRU waste." It is <u>all</u> TRU waste.

Potentiometric Surface of Culebra

Page 7-19

The potentiometric surface of the Culebra dolomite in Figure 7-3 is different from that shown in Chapter 2.

Environmental Data from 1989 thru 1993

DOE did not report radiochemical data from environmental samples between 1989 and 1993. Most radiochemical results reported before and after this time were reported as "less than detectable". Such reporting does not allow for determination of a numerical radionuclide baseline.

Concentrations of Gases

Page 6-3

Annual average concentrations for the five gases identified are not provided.

Page 6-3

The air quality monitoring section states, "initial indications show H_2S, SO_2, and NO_x, data values at or below the lower level of detection for these analyzers." The lower limits of detection should be specified for these instruments.

SUPPLEMENT 1
(Chapter 2, DCCA)

EEG COMMENTS ON THE COMPLIANCE STATUS REPORT FOR THE WIPP
(DOE/WIPP 94-019, Rev. 0)
GENERAL REMARKS

The Compliance Status Report (DOE/WIPP 94-019, Rev. 0) for the WIPP project contains descriptions and status of resolution of issues related to the WIPP's compliance with the applicable standards and regulations of the Environmental Protection Agency (EPA). The Environmental Evaluation Group (EEG) has been studying these issues for many years and has a different perspective from DOE on their status of resolution and importance. The differences can perhaps be resolved through further discussion or may require additional field and/or laboratory investigations.

These comments are arranged according to the chapters in the Compliance Status Report (CSR). When a topic is discussed in more than one chapter in the report, the comments are consolidated for the chapter where the topic is first discussed. Specific suggestions for the compliance application are provided, when appropriate. These comments are a part of our continuous review of the compliance issues.

The Compliance Status Report appears to have been prepared by a number of authors, and portions have been apparently taken from other documents. The quality is therefore highly variable. This review addresses only the significant errors or omissions. It is hoped that other more formal WIPP documents, such as the compliance application, will be more carefully prepared.

The EEG recommends that the scientific issues be resolved through scientific arguments and additional analytical or experimental work where necessary. When an issue is very difficult to resolve, it may be acceptable to leave it unresolved on the basis of low probability or low consequence. However, if many significant issues remain unresolved, it may result in loss of credibility of the scientific effort spent on the project. Subject the issues to the SPM process only after the best scientific data and arguments have been analyzed and debated. Moreover, certain issues, such as the knowledge of the hydrologic recharge and discharge areas and the position of the water table, may not directly affect the input parameters for the performance assessment calculations but are nonetheless important for demonstrating confidence in a basic understanding of the site characteristics.

EXECUTIVE SUMMARY

The Purpose of WIPP

The description of the purpose of the WIPP project continues to remain confused in the DOE documents. "Research and development facility to demonstrate the safe disposal of radioactive waste..." has never adequately described the purpose of WIPP, even though it is the language in the 1979 Act authorizing WIPP. The first sentence in the Executive Summary of the CSR, "WIPP...has been sited and constructed to meet the criteria established by the scientific and regulatory community...", is also unnecessarily convoluted. The following straightforward statement is suggested to describe the purpose of the WIPP project for use in all the WIPP project documents: "The Waste Isolation Pilot Plant is planned to be a permanent geologic repository for transuranic waste generated by the defense activities of the United States."

As appropriate, additional statements about the DOE being the manager of the waste and the repository, the EPA being the certifier of compliance with the environmental regulations, etc., can be added.

CHAPTER 1 - INTRODUCTION

Project Overview

Only through a full description of the checkered history of the WIPP project can the inconsistencies and contradictions in the project be fully explained. For example, the WIPP facility has not been constructed to "determine the efficacy of an underground repository for disposal of TRU waste" (CSR, p. 1-1, second paragraph). Study of the in situ geomechanical and geohydrological behavior of the repository did not require excavation of the full-fledged repository and waste handling facilities, or the heated room experiments. The WIPP facility was constructed in the 1980s because the DOE had planned to emplace underground all the then existing (200,000 drums) transuranic contact-handled (CH-TRU) waste, and limited quantities of high level waste for experiments, before assessing the WIPP's suitability as a permanent repository. Similarly, for those who may not be familiar with the DOE desire to conduct a "test phase" involving emplacement of waste in the Panel 1 rooms and in the alcoves, the provisions of the Land Withdrawal Act are hard to explain. This section should describe the plans prior to October 1993, the reasons for the DOE decision to abandon the idea of testing with the waste at WIPP, and the effect of that decision on the requirements of the Land Withdrawal Act.

The DOE Energy Systems Acqisition Advisory Board (ESAAB) decision (p. 1-2, last paragraph) was made specifically to start the test phase, so the characterization of this decision to mark "the end of the construction phase" is curious. Since only one-eighth of the planned repository has been excavated, how could the construction phase have ended, anyway? Also, since the CSR and the Experimental Program Plan describe a number of site characterization activities yet to be conducted at WIPP, how could Lappin (1988) have "brought to termination the WIPP site characterization phase" (p. 1-2, third paragraph)? Similarly, it is misleading to state that "The Final Safety Analysis Report (FSAR) was then published." (p. 1-2, last sentence). The 1990 FSAR did not even evaluate the safety of conducting the bin and alcove experiments, that had been planned for WIPP. An Addendum to the FSAR was published in 1991, but it addressed only a small part of the planned tests. A new FSAR is needed to assess the safety of the disposal operations.

Past efforts to represent a very checkered history of the project as a tidy phased development have not succeeded and have only confused successive newcomers on the project. For example, the DOE first announced the end of the Site Characterization phase in 1981, then in 1983, and now it is 1988, but the site characterization is not yet complete because the DOE has not, until now, given a high priority to assessing the facility as a permanent repository. It is not necessary to rewrite history. The project is finally on the right track. Only an awareness of the past mistakes and disassociation with the past short-sighted approaches will keep it there.

The Project Overview should include an assessment of the potential difficulties in carrying out the disposal and decommissioning activities because of the age of the facility. The facility was constructed for a 25 year operation starting in 1988. Since the earliest date to start disposal now is 1998, what is the effect of this 10 year delay on the stability of the excavations and safety of operations?

Site Selection Process

1957 NAS Report: Frequent references to the 1957 National Academy of Sciences (NAS) report (The Disposal of Radioactive Waste on Land, A Report of the Committee on Waste Disposal of the Division of Earth Sciences, NAS-NRC Publication 519, April, 1957) in the WIPP project publications necessitates pointing out some recommendations of that committee which would be useful for the WIPP project to follow:

> "The Committee has in no sense done the research so that such expressions of opinion as are contained herein are predicated on the assumption that the research will be done before any final conclusion is reached on any type of waste disposal." (p. 2 of the report).
>
> "We stress that the necessary geologic investigation of any proposed site must be completed and the decision as to a safe disposal means established before authorization for construction is given. Unfortunately such an investigation might take several years and cause embarrassing delays in the issuing of permits for construction." (p. 4 of the report, underlining added).

It should also be pointed out that the report was written for disposal of high level liquid waste in salt cavities and as such has very little relevance to WIPP.

Omissions in the History of the WIPP Site Selection: Any history of the WIPP site selection process should include the following important milestones.

- The original WIPP site was abandoned after the borehole ERDA-6 was drilled at that location in 1975 and encountered extreme geologic deformation and a pressurized brine reservoir at a depth of 2708 ft. Testing in 1981 indicated that the brine reservoir encountered by ERDA-6 contains 100 million liters of brine.

• The two mile criterion was changed to one mile, since a new suitable site could not be found that would be two miles away from any existing drill holes through salt. The new site was selected so that there were no boreholes through salt within one mile of zone II within the WIPP site. The repository was designed to be in the northern part of zone II (see Fig. 8-9, p. 8-17, WIPP Final Environmental Impact Statement, Vol. 1).

• Borehole WIPP-12, located in Section 17, T22S, R31E, within the present WIPP site, 1 mile north of the center of the site and just north of the Zone II, was drilled between November 9 and December 7, 1978, to a depth of 2785.8 ft, 48.3 ft in to the Castile Formation. The original purpose was primarily to investigate an anticlinal structure inferred from seismic reflection profiling. Following a suggestion by the EEG, DOE deepened the well in October-November, 1981, to the base of the Castile Formation, to a total depth of 3925 ft, and in the process encountered pressurized brine at a depth of 3016 ft. Brine started flowing out of the well at a rate of 350 gallons per minute and 1.14 million gallons of brine flowed out of the borehole before the well was controlled.

Based on the results of an extensive series of flow tests conducted in 1981-82, the brine reservoir penetrated by WIPP-12 is estimated to contain 17 million barrels (2.7 billion liters) of brine. The different pressure potentials and some differences in geochemistry between ERDA-6 and WIPP-12 encounters were interpreted to suggest a lack of communication between the two. There was no consensus on the origin and age of the reservoirs. Following a suggestion from the EEG, the WIPP repository was relocated in 1982 to be in the southern part of the WIPP site.

• The WIPP site is much richer in natural resources than was assumed at the time of site selection. The site now is surrounded by more than 100 oil and gas wells within 2 miles of the WIPP site boundary (Silva, 1994).

Regulatory Framework

Section 1.3 should state that the Environmental Protection Agency (EPA) has the authority to approve or disapprove the DOE's determination of compliance with the EPA standards.

Also, add at the top of page 1-9 that the State of New Mexico entered into an agreement with the DOE, soon after the EPA Standards (40 CFR 191) were vacated, to continue the performance assessment work as though the provisions of those Standards remained applicable (C & C Agreement, 2nd Modification, August 4, 1987).

Compliance with RCRA

There may be similarities between the No Migration Variance Petition (NMVP) process for the now-defunct test phase, and the same process for the disposal phase, but there were no procedural precedents set, as the CSR claims (p. 1-8). The NMVP granted by EPA for the test phase incorporated dilution with ventilating air, and that will clearly not happen during the disposal phase. Moreover, the statement about "no migration" on page 1-8 is simplistic. In fact, EPA applies the Draft of Subpart S of 40 CFR 264 (55 FR 30798 *et seq*, 1990) as "standards" that should not be exceeded. EPA has agreed to apply the soil standards for the relevant chlorinated hydrocarbons to the WIPP.

CHAPTER 2 - SITE DESCRIPTION/SITE CHARACTERIZATION

Drilling for Oil and Gas Around WIPP

Oil is being produced from the Delaware Mountain Group Sandstones just outside the WIPP site on all sides, and gas is produced from a well drilled directionally beneath the WIPP site. It is misleading to suggest that these sandstones have been "targets for hydrocarbon exploration elsewhere in the Delaware Basin." (p. 2-9). Furthermore, there is no mention of the deeper stratigraphic units like the Atoka Formation, from which gas is being produced through a directionally drilled gas well located beneath the WIPP site.

Breccia Pipes

Any discussion of Breccia Pipes in the Delaware Basin (e.g. Sec. 2.1.2.2) should address Roger Anderson's hypothesis of formation of the Castiles in the Delaware Basin and other suspected Breccia Pipes in the Basin cited by Anderson and Kirkland (1980) and Anderson (1980). The WIPP project has also not addressed Davies (1984) criticism of the Snyder and Gard (1982) conceptual model of the formation of breccia pipes. Without addressing these alternate conceptual models, the project should not claim that the breccia pipes are confined to the Capitan Reef.

Alternative Conceptual Models for the Culebra

Geological descriptions and interpretations of the observations of the Culebra Member (Sec. 2.1.2.6.2) present only one set of ideas. In many instances, alternative conceptual models exist which should be included. For example, only by ignoring a lot of existing data can it be stated that "density of open fractures in the Culebra decreases to the east". The pattern of fracture distribution and corresponding transmissivity values distribution is too complex to be explained away in a simple statement like that and as expected, has become more complex with additional data acquisition.

Lowenstein (1987) presented an alternative explanation to the Holt and Powers (1988) and Powers and Holt (1990) interpretation of the distribution of halite in the Rustler Formation. Based on a detailed sedimentological study of the Culebra cores from a number of wells at the WIPP site, Lowenstein (1987) interpreted four distinct dissolution zones in the Rustler Formation.

The respective thicknesses of the Rustler and the upper Salado (Chaturvedi and Channell, 1985, Fig. 8, p. 23) call into question the Beauheim and Holt (1990) proposition that dissolution of the upper portion of the Salado Formation may have caused subsidence and fracturing in the Culebra (p. 2-17). The Rustler Formation is 450 ft thick four miles east of the center of the WIPP site and only 300 ft thick from the center of the site westward. The upper Salado (from the top of the Salado to Marker Bed 103), on the other hand, maintains a uniform thickness of about 190 ft over the WIPP site and only decreases in thickness west of the Salado dissolution front that coincides with the western margin of the WIPP site. It would be more logical to postulate the gradational removal of salt from the Rustler Formation itself to have caused fracturing in the Culebra over the WIPP site. West of the Salado dissolution front (west of the WIPP site), both the Salado and the Rustler have been affected grading into total collapse in the Nash Draw.

If the high transmissivity zone in the southeastern part of the WIPP site is related to the dissolution of gypsum fillings in the Culebra fractures, then the high T zone may extend to the south-central part of the WIPP site (p. 2-21 and Fig. 2-12).

<u>Retardation Through Clays in the Culebra</u>

This section (page 2-21) asserts:

> "--- clay fracture-linings may play an important role in the chemical retardation of radionuclides transport through the Culebra---."

This conclusion is based on the X-Ray Diffraction and Analytical Electron Microscopy analysis of samples collected primarily from clay rich layers of the Rustler Formation from cores of wells drilled primarily in the Nash Draw. Four reports are cited to support this conclusion. These reports are based on the work of Terry Sewards and others at the University of New Mexico under contract to the Sandia National Laboratories.

Sewards, et al, 1991 (a) contains mineralogical analysis of core samples from a single well, WIPP-19, and presents no claim for clay filled fracture linings in the Culebra.

Sewards (1991) presents data on the "whole rock" as well as the "fracture surface" compositions of samples of cores collected from 6 wells (WIPP-26, 27, 28, 29, 30, 32) in the Nash Draw, one borehole (WIPP-33) between the Nash Draw and the WIPP site, and three boreholes (WIPP-12, 13, and 34) in the northern part of the WIPP site. Clays are expected to be present in the Nash Draw cores because of extensive dissolution, weathering, and erosion in that area. WIPP-33 is located in a sink hole and processes similar to Nash Draw have operated there as well. Boreholes 12, 13 and 34 are located north of the WIPP repository and upstream from the direction of flow of water in the Culebra. Furthermore, the cores from these wells were selected from known clay seams. For example, the only sample from WIPP-12 (CS-1) came from the zone 838.5 to 838.7 ft below the surface. The Basic Data Report for WIPP-12 (Sandia National Laboratories, 1982) identifies mud seams at 837.7 and 840.7 ft depths.

Three Sandia National Laboratory scientists (WIPP Performance Assessment Department, 1992, pp. A-127 to A- 131) correctly evaluated the Sewards (1991) report and stated the following:

> "Sewards (1991) measured and reported clay abundance for eighteen Culebra samples; thirteen from locations to the north and/or west of the WIPP site, and five from the north end of the WIPP site. None of these samples was from wells along fast transport paths. Because Sewards (1991) was focusing on clay abundance and compositional analyses, it is likely that samples were selected for analysis based on visual appearance of clays. Thus, these data may not be representative of clay abundance on fracture surfaces in the area of interest for transport modeling." (WIPP Performance Assessment Department, 1992, Memo from Craig F. Novak, et al to Martin S. Tierney, p. A-127 to A-131).

Having made this statement, it is surprising that the authors of the memo, Messrs. Craig F. Novak, Fred Gelbard and Hans Papenguth, nevertheless recommended assuming the probability of the existence of relative thickness of clay linings in the Culebra fractures to be as high as 0.5.

Sewards et al., 1991 (b) presents mineralogy of 107 samples collected from the cores of 8 wells, 3 of which are located within the WIPP site. However, clay fraction separates (<2 microns) were obtained for only three samples: "WIPP-12 #3, a clay-poor dolomite; WIPP-12 #16, a clay-rich dolomite; and H6B #3, a shale." X-Ray Diffraction analysis was performed on the clay fractions from these three samples, and one sample (H6B #3) was analyzed under the electron microscope. The electron microscopy on this one sample casts doubt on the accuracy of the X-Ray Diffraction technique used:

> "There is, however, a discrepancy between the results of the quantitative XRD analysis and the results of the AEM investigation of sample H6B #3. In that sample, the XRD results show that the sample contains approximately 50% corrensite. When imaging was attempted on the AEM, it was extremely difficult to find any corrensite at all; the dominant phases appeared to be serpentine, illite, and chlorite." (Sewards et al 1991 b, p. VII-19).

The conclusion of this report, quoted below, clearly demonstrates how very limited information has been used to make important interpretations:

> "The fact that corrensite is the dominant phase in the Culebra samples is important. Corrensite has a high CEC and high surface area, thus it is able to sorb radionuclides very efficiently in the event of a low pressure breach in the WIPP facility. Although the clay minerals of only three samples were investigated, the results of Sewards et al., 1991 show that mixed-layer chlorite/smectite is the dominant clay phase throughout the Rustler Formation, so it is reasonable to suggest that the same is true in the Culebra unit." (Sewards et al, 1991 b, p. VII-19).

Sewards et al., 1991, mentioned in the above quotation, is Sewards et al., 1991 a of this review (Sewards et al, 1991 b of CSR), i.e., "Mineralogy of the Rustler Formation in the WIPP-19 core". As stated earlier, that report makes no claim for clays lining the Culebra fractures. Corrensite is only interpreted to be present in some of the samples, as one mineral among many, when powdered bulk samples were analyzed through X-Ray Diffraction. How can this observation lead to the statement cited above?

The final report by Sewards (Sewards et al, 1992), cited in the CSR, presents mineralogical analysis from 47 samples. Of these, 17 samples were taken from the Culebra, and of these only 9 are from the WIPP site - 6 from the Air Intake Shaft and 3 from WIPP-12. The report states the following with respect to the existence of clay in the fractures of the Culebra Samples:

> "Only small amounts of clay can be sampled from the Culebra fracture coatings; therefore, initial technique and model development for adsorption studies on WIPP clays (Park et al., in review) were carried out with material from a black shale layer in the unnamed member. This material, so-called CorWIPP, is 94% corrensite and is described as Sample AIS-15 in this report. Corrensite has a high cation exchange capacity and affinity for the uranyl ion in dilute solution (Park et al., in review) and could provide significant radionuclide retardation in fractures in the Culebra." (SAND90-2569, p. 28).

The above quotation clearly identifies the problem with using Terry Sewards' work to conclude that corrensite clay lined fractures in the Culebra may provide retardation for radionuclide migration through the Culebra. The argument is based on a sample from a "black shale layer" obtained from the lower part of the Rustler Formation, below the Culebra, because not much clay could be sampled from the Culebra fracture coatings! And yet, this information is used to argue that "significant radionuclide retardation in fractures in the Culebra" could be present. It is also the basis for continuing research on the adsorption properties of Corrensite, model development for retardation properties of the Culebra, and the credit for radionuclide retardation taken in the performance assessment work to date.

Any reference to the existence of corrensite or other clay minerals lining the fractures in the Culebra Dolomite member of the Rustler Formation at the WIPP site should be deleted from the project documents because there is no basis for this assumption.

Supra-Rustler Hydrology

The hydrology of the strata overlying the Rustler Formation is poorly understood and serious effort to understand it has not been made (Sec. 2.1.2.7). Basic hydrological parameters such as the location of the water-table and the recharge and discharge areas must be known as clearly as possible, if only to establish the credibility of site characterization. EEG has made specific suggestions for field work in this area since 1985. As long as the position of the water table is not known, it is not possible to say that "Most of the Dewey Lake Red Beds Formation is unsaturated." (p. 2-26, first sentence).

Conceptual Model of Contaminant Transport in the Culebra

The discussion of this topic on page 2-30 is incomplete and presents a single conceptual model while the DOE has decided to perform an important series of field tests to resolve the issue. At this stage, a full discussion of the status of understanding of the mechanism of contaminant transport would include single versus double porosity flow, the role of matrix diffusion and the channeling model.

The estimated flow times in the Culebra, when integrated over the general flow path from the storage panel area to the compliance boundary, range from 100 to 1000 years. The performance assessment has assumed matrix diffusion to retard the radionuclide transport, but the degree of matrix diffusion affecting the transport is not clear. The INTRAVAL participants have pointed out that a conceptual flow-model based entirely on channeling also fits the current hydrological field data, but the current modeling utilizes a dual porosity concept instead. With the channeling model, there would be no matrix diffusion. Sandia National Laboratory plans to start a 7-well tracer test to address these questions. Unless and until these issues are resolved, there is no basis to favor a particular conceptual model.

Culebra Hydrochemical Facies

Section 2.2.2.1 should be revised to assign proper credit for the issues discussed in this section. The EEG has raised the issue of the inconsistency between the inferred direction of flow in the Culebra aquifer and the chemistry of water since the early 1980s and has published three reports on the subject. The issue was first raised by the EEG in 1983 as follows:

> "The unexplained decrease in TDS and a change in the general chemical nature of the Culebra water from sodium and chloride at the site to magnesium, calcium, and sulfate south of the site indicates that insufficient data are presently available to adequately characterize the flow system south of the site." (Neill, et al, 1983, p. 79).

Ramey (1985, Fig. 7) elaborated on this issue and presented the concept of geochemical zonation of the Culebra water. Chapman (1988) further explored the problem and provided a hypothesis to account for the decreasing total dissolved solids in the direction of flow, as follows:

> "As groundwater moves from north to south across the area, the Total Dissolved Solids (TDS) decrease by an order of magnitude and the major hydrochemical facies change from Na-Cl to $Ca\text{-}SO_4$. The only plausible mechanism to effect this change is the influx of a large quantity of low TDS water. The possibility of recharge in the southern area is enhanced by the presence of solution and fill features such as the gypsum caves in the Forty-Niner Member of the Rustler near the Gnome site. These features could behave as conduits supplying fresher water to deeper Rustler units." (Chapman, 1988, p. iv).

The Siegal et al. (1991) report was prepared following a suggestion by the EEG which was incorporated as a requirement of the DOE/State of New Mexico Agreement for Consultation and Cooperation. The EEG considers this issue to remain unresolved, and unless it is resolved, an adequate understanding of the hydrology of the Rustler Formation cannot be claimed.

Hydrogen and Oxygen Isotopes in Groundwater

The EEG (Chapman, 1986) compiled stable isotope data from throughout southeastern New Mexico and compared them to data from the WIPP area. The stable isotopic compositions of most samples of groundwater from the Rustler Formation were found to be similar to the composition of other, verifiably young, groundwater in the area. Though the stable isotope data cannot indicate ages for water in the various aquifers, neither did the data show any distinction between most Rustler groundwater and verifiably young groundwater. A small number of samples, primarily from the Rustler/Salado contact east of Nash Draw, had isotopic compositions that are not characteristic of recently recharged meteoric water. These waters' enrichment in heavy isotopes may be due to mixing with deeper groundwater (supported by the stable isotopic composition of Salado fluid inclusions and Castile brine) or to exchange between the groundwater and hydrous minerals.

A comparison of the heavy isotope enrichment observed in evaporating waters and the composition of the water at WIPP-29 and Surprise Spring showed that the isotopic composition of these Nash Draw waters could be derived by evaporating Rustler groundwater. Based on stable isotopes, both WIPP-29 and Surprise Spring could be discharge areas for Rustler groundwater moving from elsewhere in Nash Draw and the east.

The enrichment in heavy isotopes found in the water from pools in the Carlsbad Caverns was used by Lambert (1986) as evidence that the relatively depleted Rustler water was recharged during a past, more pluvial, time. However, the uniqueness of the isotopic composition of water in the Caverns' pools suggests that rather than representing the composition of recent recharge, the heavy isotopes are enriched by evaporation and equilibrium isotope exchange in the humid cave environment. Recharge in the extreme karst environment near the cavern may also favor isotopically heavy precipitation.

Radiocarbon Ages of Groundwater

The discussion in section 2.2.2.3 is based on Lambert (1986), although the report is not identified. This report was reviewed for EEG by Dr. Fred Phillips of the New Mexico Institute of Mining and Technology in 1987 who found the conclusions of the report, now presented in the CSR, to be unacceptable. Reasons for our position, based on the review by Dr. Phillips, are discussed below.

While it is true that all of the samples (excluding H-5C, which may possibly be contaminated) are probably in the age range 10,000 to 16,500 years B.P., the ages of the water samples vary in a systematic fashion from youngest (10,000 years) in the north to oldest (16,500 years) in the south (with the exception of H-5, which is clearly on a different flow path than the other ^{14}C sampling wells). This corresponds to the pattern expected from the north-to-south flow direction inferred from the physical hydrology. Thus a more reasonable interpretation of the ^{14}C age distribution is that only a segment has been sampled in the middle of a large-scale flow system. Additional ^{14}C samples to the north and/or east might well yield Holocene ^{14}C ages. Also, well H-5, although it may be contaminated, may also indicate active recharge.

The major conclusion of the report (Lambert, 1986, p. 5-10 and 81) was, "Because of the questionable validity of the assumptions necessary in applying radiocarbon and radiochlorine dating methods in the evaporite environment of southeastern New Mexico, and because of the previously demonstrated susceptibility of these components to contamination in this groundwater system, these methods will not be pursued beyond this feasibility study." The EEG finds this conclusion to be unnecessary because good results have been obtained from uncontaminated wells. Ground-water systems are fundamentally not amenable to intensive sampling and thus in all ground-water investigations (whether physical or geochemical) assumptions regarding the system are necessary. Useful results can be obtained, even given a wide range in parameters assumed for the ^{14}C dating model. With a properly conducted field study of the system, the parameters could undoubtedly be constrained much more closely and much better refined dates obtained. Because interpreting WIPP site flow patterns by physical hydrology alone is very difficult and uncertain, and because ^{14}C tracing may hold the best hope of elucidating the flow system, the very negative viewpoint expressed by Lambert (1986) is considered by the EEG to be totally unwarranted.

The contamination issue is even more clearcut. Certainly, it is true that a majority of the wells sampled during this study did not yield useful results due to contamination. One does not need to be an expert in ^{14}C to predict that wells crammed with "shredded paper, cottonseed hulls, peanut shells, and various proprietary organic additives" (Lambert, 1986, Section 4.2.6) will not yield meaningful ^{14}C dates! There is very little logic in arguing that because wells deliberately injected with organic material were contaminated, all other wells must also be. Contrary to the statement by Lambert (1986, p.23), contamination during drilling is not "inescapable". The best evidence of this is that four of the wells drilled without organic circulation-loss additives did not show any sign of contamination. There is no evidence that this groundwater system is unusually "susceptible" to contamination. Any system is susceptible to inappropriate drilling practices, and appropriate practices should yield acceptable results at the WIPP site.

Based on the data contained in the report, the EEG came to a different conclusion. In all cases, where ^{14}C could reasonably be expected to give useful results, it did so. Although there were only a limited number of uncontaminated samples, the geographic distribution of the resultant ages is hydrogeologically reasonable. A carefully designed program should be undertaken to expand the number of useful ^{14}C samples and to constrain their interpretation. The EEG advised the DOE not to abandon this potentially very informative avenue of investigation in 1987 and the EEG recommendation was incorporated in the 1988 modification to the DOE/State of New Mexico Consultation and Cooperation Agreement, as follows:

> "Conduct additional radiocarbon studies on Rustler groundwater. The study will consist of two parts. At least 6 wells will be samples to investigate further questions of contamination and system stability raised in SAND86-1054; completion of this study may require resampling of one or two wells known to be contaminated at the time of earlier sampling. In addition, several (approximately 10) new radiocarbon samples will be collected during sampling as part of the Water-Quality Sampling Program (WQSP), in the hope of obtaining direct evidence of groundwater residence times. Samples from the WQSP will be restricted to the near-WIPP environment (not including Nash Draw), and will include reasonable numbers of samples from both high- and low-transmissivity holes. Serious consideration will be given to conducting limited investigations of the metabolic pathways of modern vegetation at the WIPP, and to carbon analysis of both soil gas and soil carbonate, if evaluation indicates these studies would improve the confidence in modeling of WIPP release scenarios."

The target date for completion of this study was September, 1989.

The EEG recommends initiating this study without further delay using the following guidelines:

(1) avoid sampling all wells known to have organic circulation-loss prevention agents added;
(2) sample existing wells at larger distances from the WIPP site that may yield information on

recharge areas, in addition to unsampled wells near the site; (3) collect data on the metabolic pathway characteristics (and thus $\delta^{13}C$) of present vegetation and the $\delta^{13}C$ of modern soil gas and soil carbonates, and (4) use quantitative geochemical modeling to investigate the chemical and isotopic evolution of carbonate species in Rustler groundwater.

Given this approach to a ^{14}C groundwater investigation, there is a high probability of greatly enhancing our understanding of the groundwater flow system at the WIPP site.

Uranium-isotope Disequilibrium Data

The Lambert and Carter (1987) report was reviewed for the EEG by Dr. John Osmond in 1987. Dr. Osmond is the co-inventor of the Uranium-isotope Disequilibrium technique applied to the study of groundwater flow, as acknowledged in the first sentence of Section 2.2.2.6 of CSR. Based on Dr. Osmond's review, the EEG provided comments on the Lambert and Carter (1987) report to the DOE through a letter dated 12/2/1987. The following is a summary of those comments.

The limitations of the application of uranium systematics to groundwater interpretations should be kept in mind:

1) one usually cannot deduce from the uranium data alone the direction of groundwater flow,
2) one usually cannot determine the flow rate of groundwater itself by the use of U-234 decay rates.

The same isotopic data can be used to model water flow in more than one direction. This is because changes in isotopic ratio can be caused either by true ageing (decay or growth of U-234) or by water-rock or water-water interactions. Researchers in this field usually have independently derived information as to flow directions, which they can use to deduce the possibility of uranium leaching or the mixing of two or more groundwater sources.

Investigators can sometimes determine, in deep confined aquifers, the rate of movement of uranium in the system. The rate of flow of the water itself, however, must be inferred from one's estimate of the retardation factor for uranium in that particular aquifer.

That an aquifer is "confined" is usually an assumption of the modelling of slow-moving systems. Mixing with undefined waters, whether from recharge or other aquifers, negates any evolutionary conclusions. The authors of this report recognize the potential problem, but argue against leakage, perhaps too readily.

Finally, when uranium leaching or adsorption is inferred, it should be remembered that only the grain or fracture surfaces of the host rock are involved. The concentration of uranium on these surfaces can be much different than the concentration values of the whole rock.

Therefore, the principal conclusions of the report must be regarded as possibly overstated: 1) it is possible, but not proven, that the Rustler system can be modelled as a confined aquifer, 2) it is plausible that the flow regime has changed direction, but alternative interpretations based on a more steady-state model are readily visualized, and 3) although the inferred rate of movement of uranium through the aquifer near the site is probably about right, the flow rate of the water itself could be appreciably faster.

The basic pattern of occurrence of uranium isotopes in the Rustler ground water in the western half of the study area, as pointed out by the authors, is consistent with a two-source mixing model. These two end members could be water masses represented by H4 and W29 (Fig. 10), or by a water with very little U-238, but considerable excess U-234, that has leached to varying degrees uranium from the aquifer rock. The regression line on Fig. 15 implies that these two end members are leached uranium (infinite concentration) with an atomic ratio (A.R.) of 1.55 and water of zero concentration of U-238 but carrying 13.4 ppb (U-238 equivalent) of U-234.

The authors make use of this pattern to make three different interpretations. Each interpretation is plausible to some degree, but taken together they are somewhat inconsistent.

The most logical has to do with a possible westward flow direction of water from the site toward Nash Draw. Low concentration water (with respect to U) gradually dissolves uranium with lower A.R. values. No information regarding flow rate derives from this model.

The least plausible interpretation assumes that the decrease in A.R. westward is the result of U-234 decay, which leads to deductions regarding low U movement rates (not necessarily low water flow rates). It is recognized by the investigators that such a model is suspect where uranium concentration values are increasing; leaching, if ignored, produces inferred flow rates which are too low.

The third interpretation is inconsistent with the first, so the authors postulate an earlier flow regime and ask as to why the A.R.'s are so high to the East. Such values depend on fractionation processes that often require time periods commensurate with the half-life of U-234, and therefore are nearly always down-flow. In this case, argue the investigators, the estimates of time are apt to be conservative because leaching would hold the A.R. values down.

In all of their modeling, the authors of this report display considerable knowledge and insight; they do not flagrantly misinterpret the data. Their assumptions are made clear. Nevertheless, one aspect of uranium isotope systematics in groundwater is neglected, and could affect their models. In any ancient system, uranium has been moving for much longer than the period of time being modeled. The distribution factor between dissolved and adsorbed uranium (related to retardation) means that any interactions between water and rock are probably independent of whole-rock uranium concentration values. It is the concentration of uranium on adsorption surfaces, rather than that inside the rock particles, which determines how much fractionation occurs, and how fast relative to water movement. The concept of "reducing barrier" is often cited to explain concomitant decreases in U concentration and increases in A.R. over short distances.

The potentiometric contours of the Culebra suggest two flow lines in the study area: to the west, flow is more or less directly south; in the general area of the site, however, there appears to be an easterly flow in the north, a southeasterly flow at the site, and a southerly and westerly flow to the South.

If we postulate a general source area anywhere to the North, with the usual reducing barrier not far from the point of recharge, then all of the water would enter the area with a high A.R. and a low concentration. Water flowing southward in the west would dissolve uranium and take on the higher U and lower A.R. fingerprint. Water flowing in the east would move slower, dissolve less uranium, and have its A.R. altered only gradually with time. When the flow looped west, dissolving and "mixing" with rock-derived uranium would occur.

This scenario combines the three models proposed by Lambert and Carter: mixing in the west and southwest, increasing A.R. due to recoil-type fractionation in the north, and decay of excess U-234 in the general area of the site. If this model has merit, we can deduce uranium movement rates in the aquifer near the site which are consistent with those values proposed by the investigators. Because of the retardation factor, the water flow rate could be higher.

All of these remarks concern the Culebra unit of the Rustler. There are not enough data from the other units to do any regional modelling. However, the fact that none of the A.R. values from above and below are as high as some from the Culebra suggests that the latter is the "tightest" with respect to uranium mobility.

Apparently the data regarding oxidation potential of the Culebra waters is inconclusive; and the same might be said about the other hydrologic and geochemical information that might be used to demonstrate that the Culebra is truly confined. Uranium isotopic data has often been used as evidence in such interpretations. Most deep confined aquifer waters carry uranium at very low concentration levels, on the order of .1 to .001 ppb., and with quite high A.R. values, anywhere from 2 to 20 or more. The Culebra waters have higher uranium concentration than do truly reducing aquifers suggesting the possibility of leakage from shallower horizons. However, the fact that the isotopic data can be used to model flow in systematic ways suggests that such invasions are not the predominant process. Any such oxidative tendencies would favor interactive models (uranium leaching) over the fractionation and time-related models emphasized by Lambert and Carter (1987).

Regarding flow rates and groundwater residence time, Lambert and Carter (1987) consistently confuse <u>uranium</u> residence time with <u>groundwater</u> residence time. The data presented in the report do not allow for the calculation of groundwater ages. Even when the appropriate retardation factors and grain and fracture surface characteristics are known, there are still serious questions about applying uranium isotopic data to determine basic groundwater flow characteristics. Davis and Murphy (1987), Simpson et al (1985), and Hussain and Krishnaswami (1980) all express serious reservations about the reliability of uranium-disequilibrium dating because of the many difficult-to-substantiate assumptions involved.

The amount and reliability of the data are also questionable. Outside of Nash Draw, the authors have only four wells on which to base conclusions of changes in flow direction. It is important to consider the dual-porosity nature of the Culebra, indicated by the recent hydrologic testing. The very high activity ratios at H-4 and H-5 may be related to the low-transmissivity, matrix flow found at those wells. Conversely, the lower activity ratios at H-6 may be the result of rapid groundwater flow through fractures. More data east of Livingston Ridge, and from fracture-flow areas such as near H-11 and DOE-1 must be collected before any confidence can be placed in conclusions about flow paths.

Considering the serious questions of groundwater contamination in Nash Draw raised by Lambert (1987), there should be an in-depth discussion of the reliability of the presented analyses of a trace constituent like uranium. If contamination with organics is as pervasive in the Nash Draw wells as reported in SAND86-1054, this would very likely alter redox conditions near the wells. Oxidation-reduction potential is an important control on uranium content. Though the authors state on page 6 that the uranium values and isotope ratios have been perturbed at W-29 by wastewater dumping, they then proceed to use this value throughout the report, for instance as an important part of their argument for recharge in southwest Nash Draw.

As previously mentioned, redox conditions are an important factor in modeling uranium behavior. Field evidence (Eh values as reported in Uhland and Randall, 1986 and Uhland et al, 1987) and the relatively high uranium values both argue against reducing conditions in the Culebra. There is no evidence for the "reducing barrier" required by Lambert and Carter's model. The authors should provide some discussion of the physical requirements of the model relative to known aquifer characteristics.

The section on "Implications" for recharge, karst flow, and climate change presents insufficient discussion for reaching the presented conclusions on this broad topic. For instance, if no recharge is supposed to be occurring, there should be some discussion of what happens to rainfall. There is no integrated surface drainage, there are numerous gaps in the Mescalero caliche, and 20 inches of annual rainfall has been common the last few years. The role of southwestern Nash Draw (SWND) is another point requiring additional discussion. The authors present contradictory hypotheses in this section. Lambert and Carter's item number 2 on page 45 says SWND is a recharge area, while item number 4 on page 46 calls for discharge in that area.

Contradictory statements are also made regarding the degree of vertical interconnection in Nash Draw. Item 5 on pages 46 and 47 (Lambert and Carter, 1987) argues that the Magenta and Culebra are freely connected at W-25 and W-27 (as previously discussed in Chaturvedi and Channell, 1985, though overlooked in Lambert and Carter's references). However, item 4 on page 46 argues that recharge to sinkholes in the Tamarisk member cannot be interpreted as providing recharge to the Magenta or Culebra. Are the authors proposing that the Magenta and Culebra are well-interconnected, but <u>not</u> the intervening Tamarisk? Some discussion of this extraordinary hypothesis is warranted. Likewise, more discussion must also be provided of the author's assertion that the dominant process at W-33 is alluvial infilling. The continued presence of this large depression, even after the springs have ceased to flow, argues against infilling at the surface. We are not aware of any evidence or studies that support the author's statement.

In light of the above comments on the Lambert and Carter (1987) report, all the assumptions arising from the conclusions of that report should be reexamined.

<u>Physical Hydrogeology of the Bell Canyon/Capitan Flow Regime</u>

This section (2.2.5) presents contradictory interpretations of the postulated flow between the Culebra and the Bell Canyon aquifers if a connection was made between the two. Mercer (1983) concluded that the flow would be downward, and Beauheim (1986) concluded it would be upward. What is the project's latest position on this issue?

Resources

The estimates of resources reported in the 1980 Final Environmental Impact Statement (FEIS) and all other DOE reports have been shown to be wrong by current exploitation in the field (Silva, 1994). We understand that the DOE has recently contracted with the New Mexico Bureau of Mines and Mineral Resources to prepare new estimates based on current data and look forward to the results of that study.

Background Environmental Conditions

The statement (Section 2.4, p. 2-44), "The effort to establish environmental baseline conditions at the WIPP facility was initiated in 1975.", is wrong.

The earliest environmental data reported by WIPP was collected in 1985. The first report which contained the 1985 data was the Annual Site Environmental Monitoring Report for the Waste Isolation Pilot Plant CY 1985, (DOE-WIPP 86-002).

The WIPP facility is designed to handle and dispose of several million curries of transuranic elements. The environmental baseline has not established a range of specific transuranic elements. The Compliance Status Report only reports gross alpha and gross beta ranges which are several orders of magnitude greater than the fall-out levels of transuranic elements reported for New Mexico by EPA and LANL. This very important portion of the baseline has not been adequately determined by WIPP's Environmental Radiological Surveillance Program.

Climatology and Meteorology

Geological effects of climate change, i.e., dissolution, subsidence, change in hydrological properties of the subsurface strata, etc., should also be considered in scenario screening, in addition to varying the hydraulic head.

Gas Generation

There is considerable discussion (Sec. 2.7.1) of the gas generation model and its development. However, here is a system that can be validated in the laboratory to some extent. What is needed now is not refinement or simplification of the gas generation model, but some laboratory experimentation to see if the right chemical reactions are being modeled. If the model persists in including hydrogen as a product, while actually methane is produced (as is commonly produced in the anaerobic parts of landfills), the model will lead to erroneous conclusions. Testing the gas generation model assumptions in the laboratory is most important.

Salado Formation

The project position on the preferred conceptual model for brine flow from the Salado Formation into the repository should be developed and justified. If it cannot be done without additional analytical or experimental work, then that work should be identified. The EEG does not agree with the strategy of treating various conceptual models to be of equal importance when overwhelming evidence exists that a particular model is far superior than others in explaining the observed phenomena. The EEG recommends that the brine inflow into the repository from the Salado Formation be modeled by assuming Darcy flow in salt, impure salt and fractured anhydrite of the marker beds, and using the in situ measured permeability values for these layers.

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SUPPLEMENT 2
(Appendix SCR, DCCA)

CRITICALITY REVIEW

FOR THE

WASTE ISOLATION PILOT PLANT

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September, 1981

Prepared for the Environmental Evaluation Group, State of New Mexico, under a Task Order

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1.0 INTRODUCTION

This report discusses the potential for accidental criticality in the Waste Isolation Pilot Plant. Accidental criticality is defined as the inadvertent assemblage of a critical configuration during the processing, storage, or transportation of fissionable materials. A critical configuration occurs when fissionable materials are brought together in such a way that the number of neutrons produced by fission are exactly equal to the number lost by non-fission absorption and leakage--a so-called "chain reaction" occurs. In a "safe," or subcritical configuration, non-fission absorption and leakage predominate.

Inadvertent criticality is of concern because a self-sustaining nuclear chain reaction releases instantaneous radiation--which is hazardous to the health of workers in the vicinity--and creates fission products--which present a hazard to the environment if they are not contained. Thus it is standard practice to conduct detailed analyses of potential criticality prior to the handling of fissionable materials, and to design processes and procedures such that "at least two unlikely, independent, and concurrent changes in process conditions (are required) before a nuclear incident is possible."[1]

The Waste Isolation Pilot Plant (WIPP) is a facility planned to store transuranic (TRU) waste in a mined bedded salt medium well below grade.[2] TRU waste is defined as waste contaminated with certain alpha-emitting radionuclides, including plutonium, transplutonium nuclides, and uranium-233--all fissionable. These wastes are categorized into two classes: contact-handled (CH) and remotely handled (RH), which are separated on the basis of the surface-dose rate.

The wastes originate in a number of DOE laboratories and facilities, and thus are packaged in a variety of containers of differing compositions, geometries, and sizes. Moreover, both the radioisotopic and the inert (defined here as non-radioactive) composition of the packages vary considerably. Thus it has become necessary to define certain bounding conditions for the wastes in order to address several issues in the design and operation of the repository. This is particularly important in addressing the issue of criticality.

This work does not include the performance of any new, detailed physics calculations. Rather, we have reviewed existing criticality analyses as they apply to the current design of WIPP. The objective is to determine if existing analyses are adequate in demonstrating criticality safety. If they are not, a secondary objective is to determine, from the extrapolation of existing analyses, if inadvertent criticality is likely to pose a serious problem.

We are concerned with the emplacement configuration of TRU wastes. Spent fuel, experimental configurations, and transportation are considered outside of the scope of this review. This exclusion also applies to long-term alterations of the emplacement configuration, potentially involving dissolution, transport, and reconcentration of radioisotopes.

The following Section (2.0) describes briefly the characteristics of the TRU wastes and their containers planned for emplacement within WIPP, and the currently envisioned storage configuration. Summaries are then given of the existing analyses which examine the potential for criticality in WIPP. Section 3.0 discusses the validity of the existing analyses in demonstrating criticality safety in WIPP, and extrapolates to determine if criticality is a serious problem. Finally, Section 4.0 provides conclusions and recommendations.

2.0 BACKGROUND

2.1 Waste Description and WIPP Storage Configuration

Waste compositions and package descriptions are given in the FEIS[2] and the SAR.[3] However, a supporting document[4] provides the best summary description of the salient information, and this is reproduced here in Tables 1 through 3.

The CH storage rooms are about 13 ft. high by 33 ft. wide by 300 ft. long, separated by 100 ft. wide pillars of salt. When the waste material has been emplaced in the storage room, it will be covered with crushed salt backfill at the end of each shift or as required.

According to existing drawings,[5] if a storage room is devoted exclusively to 55-gallon drums, these will be stacked 3 tiers high, 15 drums wide, and an unspecified number of drums long. A storage room could contain as many as 144 drums along the 300 ft. dimension.

If the storage room is devoted exclusively to 83 gallon overpacks these would be stacked 3 tiers high, 10 drums wide, and as many as 135 drums long. Boxes would be stacked 2 tiers high, 6 boxes wide, and as many as 37 boxes long. Other configurations might consist of 83 gallon drums on top of M-3 Bins.

The RH storage area utilizes the walls of the CH waste storage rooms and entries. The RH wastes are contained in Schedule 20, carbon steel pipes, 10 ft. long and 24 in. in outside diameter. These pipes are emplaced horizontally in the pillars of the waste storage area. Current designs envision that the RH waste canisters will be placed on 8 ft. centers. The canisters will be stored in horizontal sleeved holes 6 ft. deeper than the canister lengths.

Table 1
(From Reference 4)

CONTACT HANDLED WASTE CONTAINERS

Package Description	Dimensions	Maximum Fissile Content (grams)
DOT-7A Boxes†		
a. FRP-coated plywood	4' x 4' x 7'	350*
b. Cleated plywood	Random	*
c. Steel boxes (M3-Bins)	50" x 58" x 72"	*
Drums		
a. 55-gallon, 17C	24" dia. x 35" length	200
b. 30-gallon, 17H	19" dia. x 29" length	100
c. 55-gallon, DOT 6M	24" dia. x 35" length	500
d. 83-gallon**	26" dia. x 43" length	200

† Packaged in steel overpack for storage.
* Limited to 5 grams in any cubic foot.
**Used as overpacks for 55-gallon drums.

Table 2

(From Reference 4)

ISOTOPIC CONTENT OF CONTACT HANDLED WASTE DRUMS AND BOXES

Isotope	Total Mass Per Drum, grams	Total Mass Per Box, grams
Pu-238	2.5×10^{-3}	4.0×10^{-3}
Pu-239	7.5	12.0
Pu-240	0.5	0.81
Pu-241	2.7×10^{-2}	4.4×10^{-2}
Pu-242	2.4×10^{-3}	3.9×10^{-3}
Am-241	1.5×10^{-3}	2.5×10^{-3}
Total	8.03	12.86
Typical Fissile Content, grams	7.5	12.0
Typical Plutonium Content, grams	8.0	12.8
Maximum Allowable Fissile Content, grams	200.0	350.0

Table 3

(From Reference 4)

REMOTE HANDLED WASTE ISOTOPIC CONTENT

Isotopes	Mass in Waste, grams
Co-60	0.093
Sr-90/Y-90	59.3
Ru-106/Rh-106	2.0×10^{-8}
Cs-137/Ba-137m	0.5
Eu-152	0.1
Eu-154	3.1×10^{-2}
Pu-238	0.042
Pu-239	126.7
Pu-240	8.7
Pu-241	0.46
Am-241	2.5×10^{-2}
Total	195.95

2.2 Classical Criticality Considerations

The minimum critical mass of a Pu^{239} sphere, moderated and reflected by H_2O, is 520 gms.[6] The ratio of hydrogen to plutonium in the minimum mass sphere is approximately 800. Measurements with polyethylene-moderated systems revealed a minimum Pu^{239} critical mass of 370 gms.[7]

The critical loading of an infinite slab is dependent only on the areal density of fissile material. For slabs consisting of homogeneous mixtures of plutonium and water, the limiting areal density of Pu^{239} is 0.25 gm/cm².[8]

2.3 The SAR Criticality Analysis

The SAR criticality safety analysis is contained in a supplementary document.[4] The calculations were performed using the multi-group, discrete-ordinates, transport theory code, ANISN, in the P_1-S_4 approximation. 27-group cross sections, generated by the AMPX code system, were used in the analysis. The methods were validated by analyzing two critical assemblies.

The RH wastes were modeled as an infinite slab of plutonium, conservatively omitting the steel canister and the other parasitic neutron absorbers. Mixtures of Pu/concrete/water, Pu/glass/water, and Pu/steel/water were considered, in an attempt to simulate both fixed and non-fixed waste forms. The highest calculated k_∞ was 0.11, for the 100% concrete/Pu mixture. The calculated k_∞ of the 100% water/Pu mixture was 0.045.

The 17C 55-gallon drum was selected as the typical CH waste container. It was assumed that the drum is <u>uniformly</u> filled with a homogeneous mixture of Pu^{239} and hydrogen. It was further assumed that 25% of the waste is comprised of combustible material (hydrocarbons), at a packing fraction of 0.5, and at a density of 0.5 gms/cm³. This defined a <u>minimum</u> hydrogen to Pu^{239} ratio of approximately <u>2000</u>. The calculations were performed for higher ratios of H to Pu^{239}. A 90-mil polyethylene liner was assumed to be present on the inside of the 16 gauge steel drum wall.

The results of the calculations, for the three drum loadings considered, are reproduced in Figure 1. The average drum loading was determined by assuming that 3% of the drums contain the maximum 200 gm plutonium, and the remainder contain the typical 7.5 gm. These k_{∞} results are for an infinite array of drums, presumably modeled by using a reflecting boundary condition in cylindrical geometry.

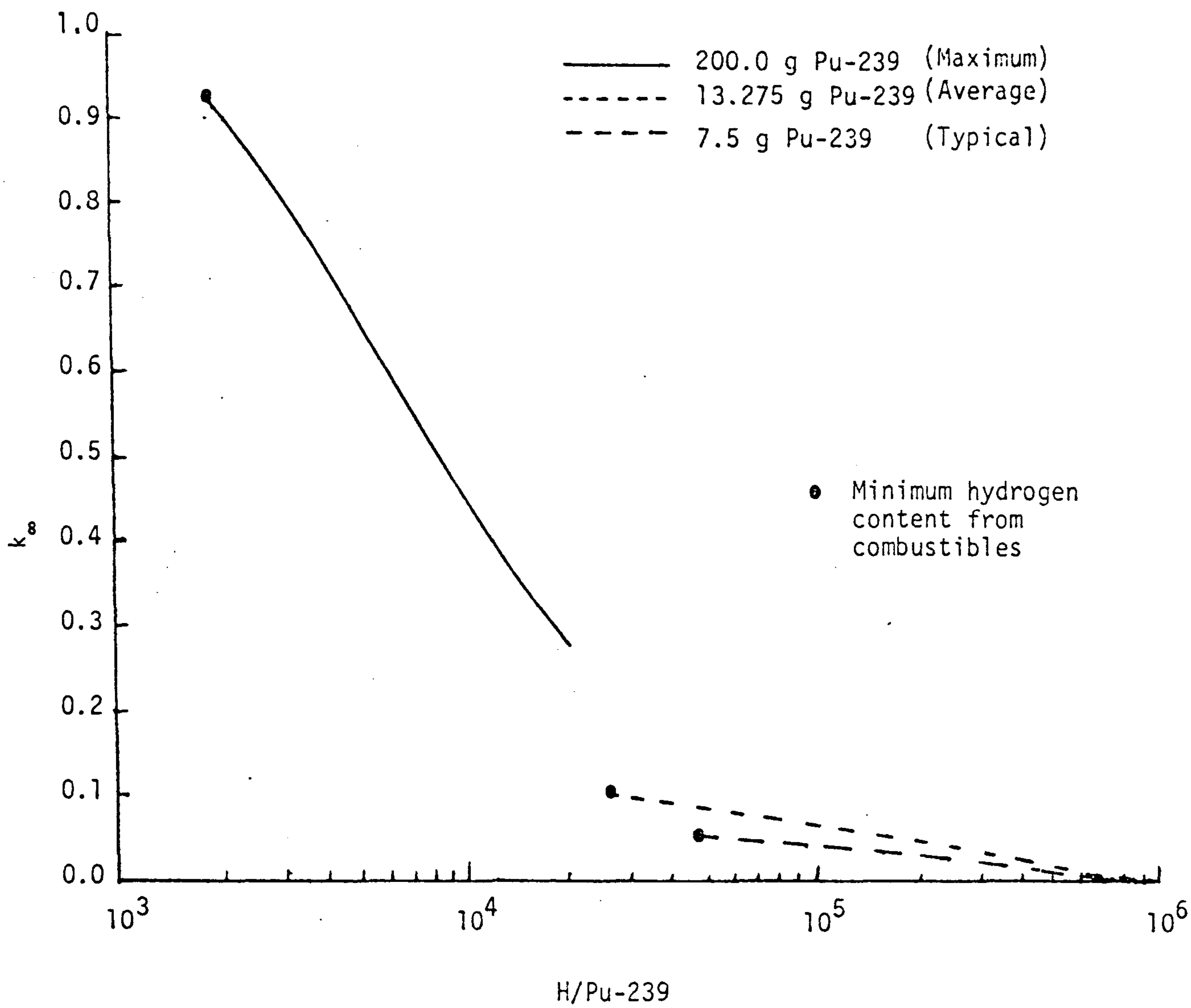
2.4 The Rockwell Hanford Operations Calculations

An extensive series of criticality calculations on arrays of 55-gallon drums containing plutonium was performed at Rockwell Hanford Operations.[9] KENO-III and KENO-IV Monte Carlo codes were used, with 18 energy group cross sections generated by the GAMTEC II code. The drum arrays were assumed to be square, however, the somewhat higher fissile densities in triangular arrays were simulated by using a slightly reduced radius. A reflecting boundary condition was used to simulate infinite arrays. For finite vertical dimensions, the actual number of tiers of drums was simulated.

An infinite soil reflector, found to be more effective than water, was used outside of the drums for calculations of finite dimensions. Most of the calculations were performed for fissile loadings of 200 gm Pu^{239} per drum; a few calculations examined higher fissile loadings. Water was used as moderator in most calculations; some calculations explored the effect of polyethylene and cellulose as moderator.

Figure 1

(From Reference 4)



Infinite Multiplication Factor as a Function of H/Pu-239 for Contact Handled Wastes in 17C 55-Gallon Drums

A large number of parameters were studied in this work. These include:

- The hydrogen to Pu^{239} ratios
  $\sim$ 100 to $\sim$ 2500

- Fissile mass
  200 to 400 gm Pu^{239}/drum

- Iron mass in the drum
  0 to 29 Kg

- Reflectors
  1 to 3 ft of soil
  1 ft of water

- Pu^{239} - H_2O mixture density
  Full drum volume down to full theoretical density

- Pu^{239} - H_2O mixture shape
  Full radius, flattened
  Height to diameter ratio = 1.5

- Array shape
  Infinity by infinity by one to seven tiers high
  Three-dimensional arrays

- Effect of polyethylene drum liner

- Effect of substituting polyethylene and cellulose for water

- Effect of array collapse

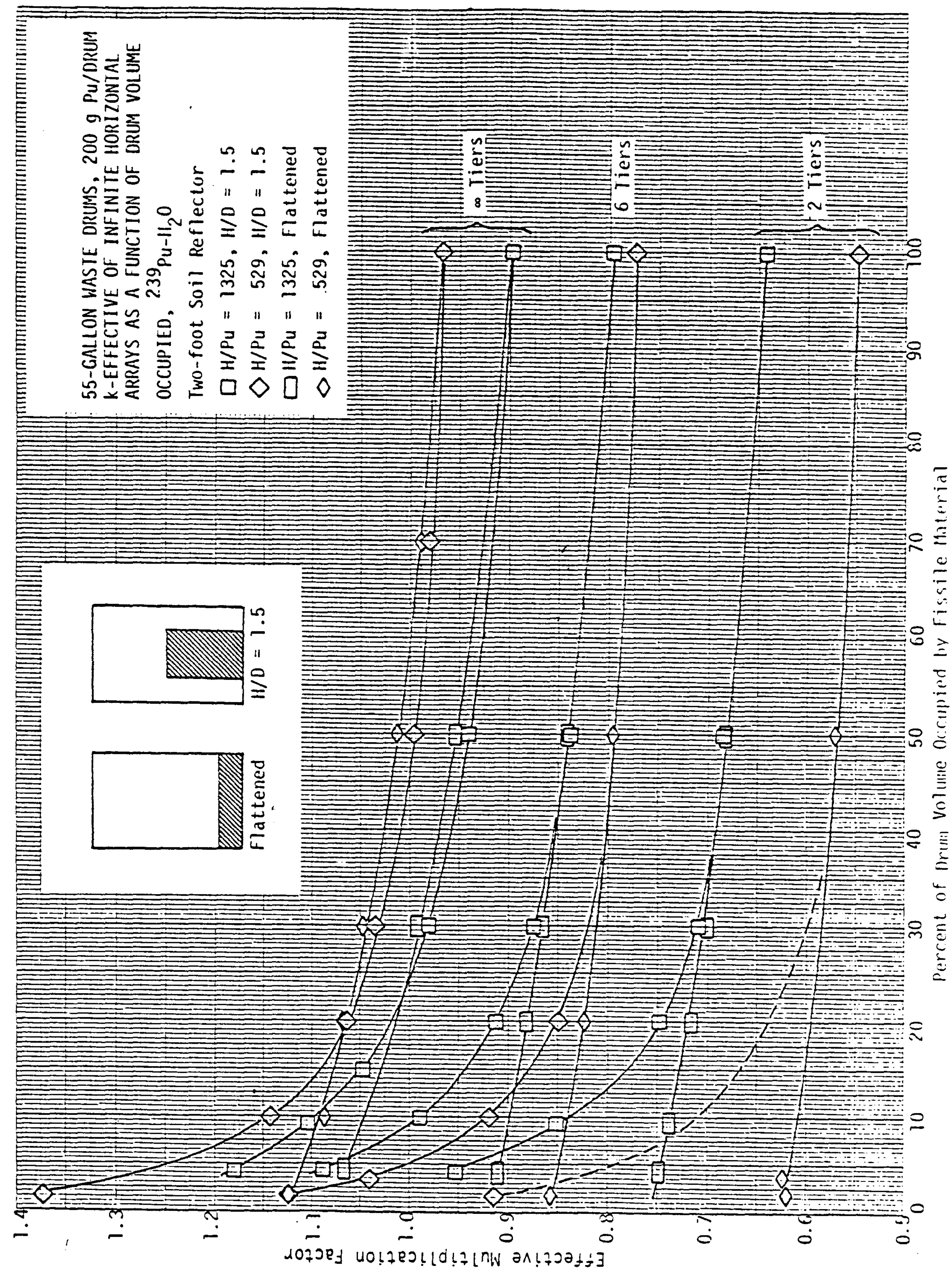
No attempt will be made to summarize all of the results here (approximately 200 separate calculations were performed). However, the most significant contribution of this work is the clear demonstration of the important effect that shape and density of the fissile material in the drum have on the results. The results demonstrate that modeling the plutonium-moderator mixture as uniformly distributed throughout the drum is not a conservative assumption. This is most clearly demonstrated in Figure 2, reproduced from Reference 9.

Figure 2 contains 3 sets of curves--corresponding to three heights of the array--an infinite number of tiers, 6 tiers, and 2 tiers. Each set of curves is displayed for two hydrogen to plutonium ratios, 1325 and 529. (Note that for the finite number of tiers, the higher H/Pu leads to higher k_{eff} values; this direction is reversed for the infinite number of tiers.) For any one of the curves, the point at the right (100% of drum volume occupied by fissile material) corresponds to the Pu^{239} - H_2O mixture smeared uniformly over the entire drum volume. As we move to the left, the mixture is compressed, either by flattening (denoted by ▭ and ⬭) or by "scrunching" into a cylinder with H/D = 1.5 (denoted by □ and ◇). The mode of volume reduction does not appear to affect the results down to roughly 35-40% reduction in volume for the 2 and 6 tier calculations. At this point the H/D = 1.5 results depart significantly from the flattening results.*

These results demonstrate the significant positive effect on k_{eff} of reductions in volume occupied by the fissile-moderator mixture--as much as +0.40 for the H/D = 1.5 compression. For flattening alone, the effect is smaller--a maximum of +0.17. This effect is derived from the smaller fractional leakage for the compressed shapes, which results in a smaller fractional neutron absorption in the iron drum walls. For the full volume,

*There is separation between the two results for all percent reductions in drum volume for the infinite tiers. The author points out the crossover in the curves, but pleads ignorant as to its physical explanation.

Figure 2
(From Reference 9)



smeared material, the fractional absorption in the drum walls compared to total absorptions plus leakage is 34% (for $\infty \times \infty \times 6$ arrays). This is reduced to 27% for the full density, flattened shape, and further reduced to 17% for the full density, H/D = 1.5 shape.

2.5 Other Analyses

Criticality analyses on storage arrays have also been performed at EG&G Idaho. The first set of calculations examined arrays of 17C 55-gallon drums containing 200 gm of Pu^{239}.[10] The analysis was performed using the KENO-IV Monte Carlo Code with 16-group Hansen and Roach cross sections. Parameters varied were the hydrogen to plutonium ratio, the array height, and density and shape of the fissile material within the drum.

For an array five drums high, a maximum k_{eff} of 0.68 was obtained at H/Pu $\cong$ 1200. This is lower than the six tier result of Reference 9, but only by approximately .01 to .05 when the effects of the iron content, height difference, and polyethylene liner are taken into account. The effects of density reduction, both by flattening and reduction in radius, are roughly comparable in magnitude to the results presented in Reference 9, although the radial compression was not accomplished in exactly the same way. Similarly, the effects of height reduction are roughly comparable to the results given in Reference 9, although the magnitude of the effect is not quite as large.

In another set of calculations, EG&G analyzed arrays of DOT-7A, FRP-coated plywood boxes containing a maximum of 350 gm plutonium. The analyses were accomplished using the one-dimensional discrete ordinates code, SCAMP, with 16-group Hansen and Roach cross sections. For array heights of 16 ft., the maximum calculated multiplication factor is approximately 0.64 for H-Pu systems. For a graphite-Pu mixture containing only the additional container wood, the maximum k_{eff} is 0.88 for a 16-ft. high array at optimum C/Pu ratio.

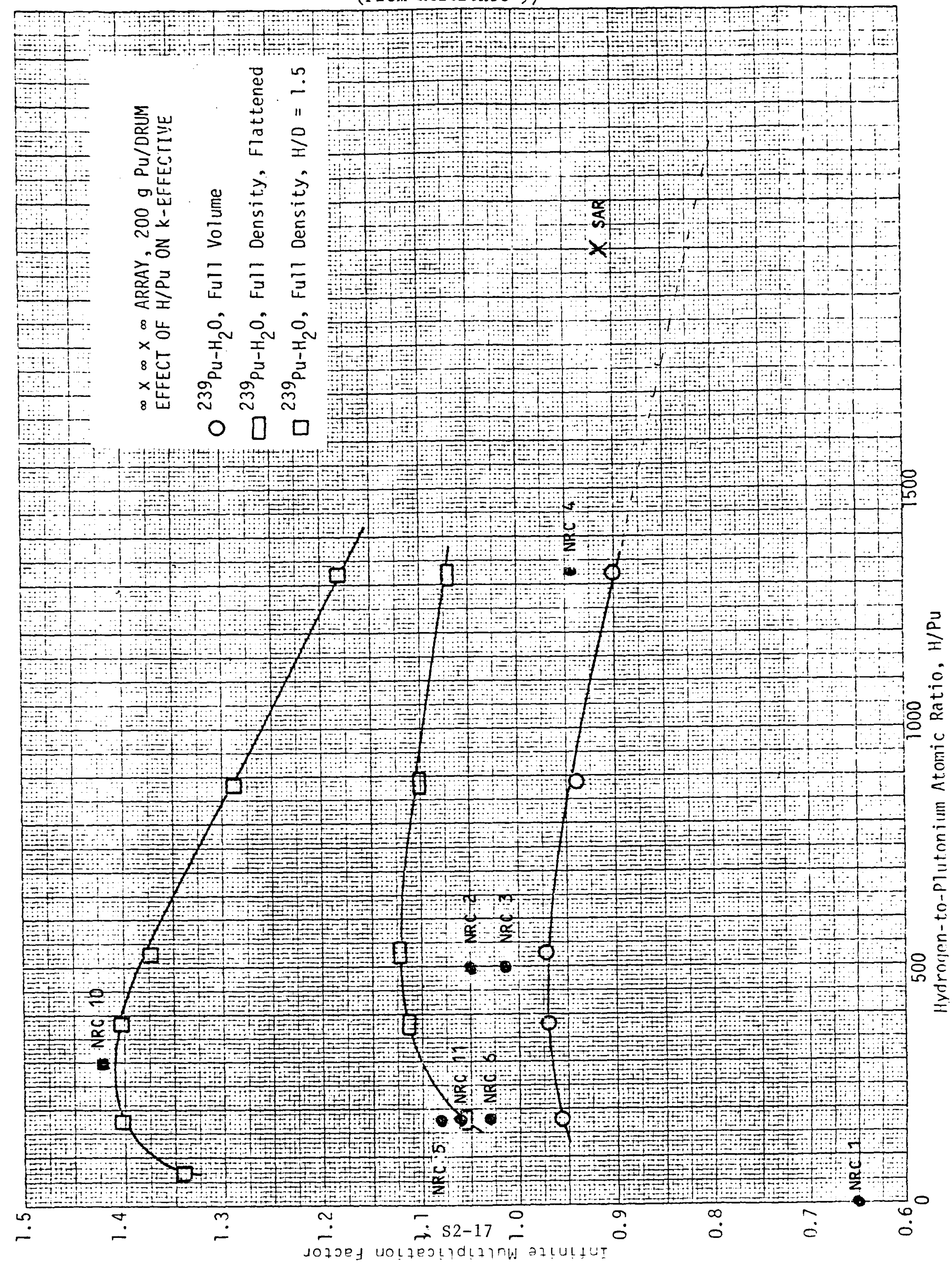
Two sets of relevant criticality calculations were also performed in Silver Spring, using 27-gp. cross sections (generated from the GAM-THERMOS Library using the SCALE program) in the KENO-IV Monte Carlo Code. The first set, for 17C 55-gallon drums, was designed to provide an independent check of the Rockwell Hanford Operations calculations for infinite arrays. We have reproduced these results alongside the appropriate Rockwell Hanford Operations curves in Figure 3. Most of the Silver Spring calculations were designed to simulate the full volume, uniformly smeared configuration (lower curve). Only one calculation was performed for the full density, H/D = 1.5 configuration (top curve). Note that all of the Silver Spring calculations predict higher k values, ranging from +0.01 to +0.14 (the iron density was too low by approximately 2 Kg in the most widely discrepant calculation.), than the comparable Rockwell Hanford Operations calculations. For completeness, the WIPP SAR result for the lowest ratio of hydrogen to plutonium examined is also shown. This result is to be compared against the full volume, uniformly smeared curve (extrapolated).

A few calculations were also performed in Silver Spring for 6M drums containing 500 gm of Pu. The results indicated that infinite arrays of 6M containers <u>without</u> wood between the inner and outer containers may be substantially supercritical.* The infinite arrays <u>containing</u> wood between the inner and outer containers appear to be safely subcritical (highest calculated k_{eff} = 0.46).

---

*For an infinite array of 6M containers (no wood) with 500 gm of unmoderated Pu^{239}, the calculated multiplication factor was 1.06. For the same configuration with moderator added to the plutonium (H/Pu ≅ 63), the calculated multiplication factor was 1.62.

Figure 3
(From Reference 9)



S2-17

3.0 DISCUSSION

3.1 Validity of the Existing Analyses

The SAR Criticality Analysis

The RH waste analysis appears conservative and the results indicate that the storage configurations are far subcritical for either fixed or non-fixed waste forms, and in the event of complete flooding by water.

Moreover, the safe neglect of all configurations of CH waste except the 17C 55-gallon drums also appears justified. The FRP-coated plywood boxes are shown to be safely subcritical in Reference 11; in fact, classical criticality considerations dictate their safety.*

According to Reference 4, the 83-gallon drums are used only as overpacks on the 55-gallon drums. The ratio of iron to allowable fissile content in the 30 gallon drum is higher than that of a 55-gallon drum,** so a 30-gallon drum array should be subcritical if a comparable array consisting of 55-gallon drums is subcritical. Finally, as long as the wood reinforcement is present, an infinite array of DOT 6M drums was shown to be safe by the calculations performed in Silver Spring.

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*For the 13 ft height limitation in WIPP, the areal density of Pu^{239} is a factor of six below the 0.25 gm/cm² critical areal concentration for H-Pu^{239} systems.[8]

**This is true for most 30- and 55-gallon drums. However, at least two 17H 30-gallon drums weigh less than one-half (27.2 lbs. and 31.4 lbs.) of at least one 17H 55-gallon drum (66.2 lbs).[12] These drums are, however, greater than one-half of the weight assumed in the Rockwell Hanford Operations 55-drum calculations.[9]

The SAR analysis of the 17C 55-gallon drums considers an infinite array in three dimensions. This is conservative because the drums in WIPP will be stacked three tiers high by 15 drums wide. Although three different plutonium contents were modeled, only the 200 gm loading is conservative unless the actual plutonium content will be measured for each drum.

Two assumptions are made in the analysis which are not conservative. The first is the assumed lower limit in the ratio of hydrogen to plutonium (roughly 2000). This assumption is apparently related to a statement in the SAR regarding the combustible content of the wastes. However, the use of the combustible content as a constraint on the range considered for the hydrogen to plutonium ratio does not appear justified. According to the analysis presented in Reference 9 (reproduced in Fig. 3), the difference in the infinite multiplication factor between an optimally moderated array (H/Pu ≅ 300) and one in which H/Pu ≅ 2000 (extrapolated from the curve given in Reference 8) is approximately 0.4.* It is noteworthy that the 200 g Pu curve in Figure 1 is climbing steeply toward $k_\infty=1$ at the assumed maximum H/Pu.

The second unconservative assumption is that the plutonium-moderator mixture is spread uniformly throughout the drum. As demonstrated in References 9 and 10, the least reactive configuration is the one in which the fissile material occupies 100% of the drum volume (see Figure 2). In fact, as discussed in Section 2.4, the effective multiplication factor of the full density configuration (with H/D=1.5) is higher than that of the uniform configuration by as much as 0.40.

Although the combined effects of these two unconservative assumptions are not additive, they may in fact exceed the opposing conservative effect of the infinite array approximation. Therefore, the SAR criticality analysis

*However, the range is not nearly as great for heterogeneous and/or finite arrays.

does not demonstrate criticality safety for the WIPP storage configuration.*

The Rockwell Hanford Operations Analyses

As discussed in Section 2.4, the Rockwell Hanford Operations analyses explored a wide variety of parameters. Certain approximations and assumptions applied consistently throughout the analysis are conservative, tending to bias the calculated multiplication factors on the high side. The most obvious of these are:

1. The ninety-mil polyethylene liners** for 55-gallon drums were omitted from most of the calculations. Incorporation of these liners in the calculations was found to decrease k_{eff} by about 0.03 (at minimum densities) to approximately 0.1 (at maximum densities).

2. Most of the calculations assumed 23 kilograms of iron in the drum, less than the 29 Kg of iron in 17C 55 gallon drums.*** Increasing the iron content by 6 kilograms in the calculations decreases k_{eff} by about 0.015 (at maximum densities) to approximately 0.08 (at minimum densities).

---

*Reference 4 rightly points out that the analysis conservatively omitted parasitic neutron absorption in miscellaneous materials admixed with the plutonium. Although this is undoubtedly true, the waste materials admixed with the fissile material are too variable and poorly defined to rely upon for criticality safety.

**These are available on the Hanford plant drums[9] and were incorporated in the SAR criticality analysis.[10] However, some of the drums at EG&G Idaho have 10-mil polyethylene liners; the extent to which liners are applied to drums from other facilities is not known.

***Some care must be exercised in pinning down the amount of iron in 55-gallon drums. According to one source,[12] the drums range in weight from 55.6 lbs to 66.2 lbs.

3. The existence of the poison, Pu^{240}, was neglected. It is estimated that approximately 7% of the plutonium consists of this isotope.[4] The poisoning effect of this isotope is not negligible, but the magnitude has not been determined.

4. A reduced drum radius was used in the calculations to simulate the higher average fissile density found in triangular arrays. Since square drum arrays are planned for WIPP,[5] this assumption is also conservative. The magnitude of this effect is also not known.

The calculations performed in Silver Spring, however, revealed some discrepancies which are not in the conservative direction (see Figure 3). Most of these calculations provided an independent check on the full volume infinite array analysis of Rockwell Hanford Operations. Eliminating the results which are not comparable on the basis of iron densities (Nos. 2 and 5 in Fig. 3) or cross section structure (No. 11 in Fig. 3), the multiplication factors calculated in Silver Spring are higher than those of Rockwell Hanford Operations by approximately +0.01 to +0.08. The single result for the full density array implies that the discrepancy is significant only for the full volume cases.

The source of this discrepancy, the multi-group iron cross sections, appears to have been identified at Rockwell Hanford Operations.[13] Most of the calculations have been redone, and a revised report is in draft form. However, the revised calculations presumably do not demonstrate changes in the results for arrays with 6 tiers or less.

One additional aspect of the Rockwell Hanford Operations results is worthy of note. This is the analysis of array collapse. Array collapse is credible in the underground repository through waste containment or structural failures. Although waste containment failure is essentially assured over the long-term, this review concentrates on the short-term, operational phase of the repository, for which structural failure, at a minimum, should be considered.

The results given in Reference 9 indicate that the increase in multiplication factor brought about by 1-dimensional (i.e., vertical) collapse is negligible. 3-dimensional collapse, however, can lead to an increase in k_{eff} of +0.25 for initially flattened, full density 12 x ∞ x 5 drum arrays.

3.2 Criticality Safety in WIPP

As discussed in the previous section, the criticality analysis in support of the SAR does not demonstrate the safety of 17C 55-gallon waste drum storage arrays in WIPP. None of the many configurations analyzed in Reference 9 is identical to the proposed storage configuration in WIPP. Nevertheless, the safety of the WIPP storage configuration can be inferred from the Rockwell Hanford Operations results.*

The most reactive, physically realistic configuration analyzed in Reference 9 is the ∞ x ∞ x 6 array of drums containing 200 gm of Pu^{239} in a full density, flattened configuration. The fissile material is optimally moderated (H/Pu $\cong$ 1100) and the vertical dimension of the array is infinitely reflected with soil. The predicted effective multiplication factor is approximately 0.92.

Other results presented in Reference 9 permit an estimate of the effect of additional leakage to be expected from the actual storage configuration. The effect of reducing the vertical dimension from 6 to 3 tiers is estimated to change the multiplication factor by roughly -0.08. The effect of reducing the width of the array from infinity to 15 drums is estimated to be approximately -0.04 in k_{eff}.

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*This statement and the subsequent remarks are predicated on the assumption that the revised analysis (yet to be released) does not result in higher predicted values of k_{eff} for arrays of 6 tiers or less.

Moreover, several additional conservative approximations and assumptions inherent in all of the calculations were pointed out in Section 3.1. The combined effect of these additional conservative assumptions, although not explicitly analyzed, could easily amount to -0.05 to -0.10 in k_{eff}.

Although these negative contributions to the effective multiplication factor are not additive, the combined effect is to provide an additional cushion of conservatism to the analysis. Therefore, it can be concluded that the 55-gallon drum storage array in WIPP will be safely subcritical ($k_{eff} < 0.95$).

In arriving at this conclusion, two very reactive configurations analyzed in Reference 9 have been ignored. The first is the H/D=1.5 shape in the drum, shown to be higher by as much as +0.2 in k_{eff} than that of the flattened shape. That the fissile moderator mixture could assume such a shape in a significant number of drums is considered to be physically unrealistic. The second is the three-dimensional collapse of the array, shown to result in an increase in k_{eff} by as much as +0.25. Although a one-dimensional collapse is considered to be possible (and, according to Reference 9, of negligible consequence), a complete three-dimensional collapse is difficult to envision.*

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*Of course, over the long-term, such an effect is fair game. The long-term, however, is outside of the scope of this review.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Criticality safety in WIPP has not been demonstrated in the SAR. However, a review of independent analyses suggests that criticality safety is assured in the planned configuration for TRU waste storage.*

Criticality safety is dependent on the assumption that no mechanism exists to radially compact the wastes in individual drums or to compress the entire array in all three dimensions. Although this assumption appears reasonable, some thought should be given to potential failure modes that could conceivably undermine its validity. Moreover, a reliable assay method must be specified to assure that the content of plutonium in the drums is less than the prescribed limit (200 gm, for 55-gallon drums).

Other configurations for waste storage in WIPP would require additional analysis before criticality safety can be assured. For example, a configuration in which the drums were to be stacked on their sides has not been shown to be safe. Moreover, if 6M drums containing 500 gm of plutonium are to be stored in WIPP, assurances must be given that each drum will contain the specified wood reinforcement.

Finally, thought should be given to long-term effects that could assemble a critical mass through dissolution, transport, and reconcentration of the fissile material.

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*This conclusion must be regarded as tentative until the revised results of the Rockwell Hanford Operations analyses are released.

5.0 REFERENCES

1. ERDA Manual Chapter 0530, Nuclear Criticality Safety; Approved December 21, 1976 (recently cancelled).

2. Final Environmental Impact Statement, Waste Isolation Pilot Plant, U.S. Department of Energy, October 1980.

3. Safety Analysis Report, Waste Isolation Pilot Plant, U.S. Department of Energy, revised in January 1981.

4. M.H. Lipner and J.M. Ravets, "Nuclear Criticality Safety Analyses for the Waste Isolation Pilot Plant Project," Westinghouse Advanced Energy Systems Division, WAES-TME-3025, April 1980.

5. Repository Level Waste Stacking and Configuration Plan and Sections, Bechtel Drawing No. 51-U-001, Revision E.

6. H.C. Paxton, J.T. Thomas, D. Callihan, and E.B. Johnson, Eds., "Critical Dimensions of Systems Containing U^{235}, Pu^{239}, and U^{233}, USAEC Report TID-7028 (1964).

7. L.C. Davenport and J.K. Thompson, "Survey of Criticality Parameters for Pu^{239} in Organic Media," Trans. Am. Nucl. Soc. 77, p. 419, 1977.

8. J. T. Thomas, Ed., Nuclear Safety Guide, TID-7016, Rev. 2, 1978.

9. W.A. Blyckert and R.D. Carter, "Criticality Parameters of 55-Gallon Waste Drum Arrays," Rockwell Hanford Operations, RHO-SA-183, November 7, 1980.

10. R.R. Jones, Independent Criticality Analysis of 17C Drum Storage at RWMC, EG&G Idaho, Inc., RE-P-81-033, May 1981.

11. R.R. Jones & G.E. Putnam, Independent Criticality Analysis of RWMC Storage and Disposal of Waste with 177 g/m^3 Fissile Material Limit, EG&G Idaho, Inc., RE-P-81-050, May 1981.

12. R. Odegaarden, U.S. Nuclear Regulatory Commission, Private Communication, September 4, 1981.

13. R.D. Carter, Rockwell Hanford Operations, private communication, August 31, 1981.

SUPPLEMENT 3
(Appendix SCR, DCCA)

S&C&A Inc.
S. COHEN AND ASSOCIATES

RECEIVED
JAN 3, 1984
ENVIRONMENTAL
EVALUATION GROUP

December 30, 1983

Mr. Robert H. Neill
Director
Environmental Evaluation Group
State of New Mexico
320 E. Marcy Street
P.O. Box 968
Santa Fe, New Mexico 87503

Subject: Reviews of WAESD-TR-83-0015 and TME-3025 Rev.1

Dear Bob:

I have reviewed the subject documents (References 1 and 2 in the attached list) and offer the following comments for your consideration.

In its original WIPP criticality safety analyses,[3] DOE addressed both remote-handled (RH) and contact-handled (CH) wastes. The revised WIPP criticality safety analysis[2] addresses only CH waste. The WAESD report[1] considers the criticality safety of RH waste.

The new RH waste criticality analysis[1] has a different orientation than the original analysis.[3] The original analysis estimated k_∞ for one nominal amount of Pu-239 (126.7 gm), assumed to be uniformly distributed in various solid-water mixtures. The assumed compositions were estimated to be substantially subcritical ($k_\infty \leq 0.109$).

The new analysis <u>determines</u> criticality <u>limits</u> for an array of RH waste containers under <u>double accident conditions</u>. A subcritical margin of 5% Δk is the objective, modified to a value of 8% Δk to account for calculational methods and cross section data uncertainties (at 3σ). The study resulted in two types of limits -- a concentration limit and a mass limit. For those cases in which uniformity of fissile concentration can be assured (the criterion is a maximum of 50% void averaged over any 5 liter volume within the container), a fissile concentration limit of 1.9 gm/liter was derived.* In all other cases, a mass limit of 240 gms obtains (190 gms and 160 gms for fissile assay errors of 25% and 50%, respectively).

Although we do not have the resources to attest to the validity of the results, the RH waste criticality analysis appears to have been professionally executed. The array of containers was modeled using a three-dimensional Monte Carlo code

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*Note that this concentration is equivalent to a fissile content of approximately 3 kg in an RH container, roughly a factor of 24 higher than the nominal amount of Pu-239 assumed in the original criticality analysis.[3]

(KENO-IV). Sensitivity to variations in parameters was checked using a one-dimensional transport code (XSDRNPM), which also generates an appropriate neutron spectrum. ENDF/B-4 cross sections were used, with resonance self-shielding accomplished with the NITAWL code. Methods were benchmarked against seven plutonium critical experiments. The calculations considered a number of constituents in the waste matrix, various reflectors surrounding the array, a full range of moderation (H/Pu-239), and compaction/settling of the waste pieces. Additionally, several accident configurations were examined, and double accident conditions were assumed in establishing the limits. In summary, the methods are state-of-the-art and the investigators explored the sensitivity of the results to a very wide range of parameters.

We turn now to the revised CH waste criticality analysis.[2] In my 1981 review of the original CH waste criticality analysis,[3] I pointed out two assumptions which were not conservative.[4] The first was the assumed lower limit on the ratio of hydrogen to plutonium (roughly 2000). The second was the assumed homogeneous distribution of the plutonium throughout the waste.

In the revised CH waste criticality analysis, the former assumption was relaxed, and k_∞ was calculated over the entire range of hydrogen to plutonium ratios. For the maximum fissile content of 200 gm Pu-239, the 17C 55-gallon drum infinite array is critical over the range of $40 < H/Pu\text{-}239 < 1500$. The maximum calculated k_∞ is approximately 1.2 at a hydrogen to plutonium ratio of approximately 400. However, DOE dismisses these results by stating that "the simultaneous occurrence of a very large array of drums all containing the maximum allowable fissile loading combined with uniform interspersed moderation is considered incredible."

In a February 1982 letter from the WIPP Project Office to the EEG,[5] DOE argues persuasively against the possibility of a significant fraction of the drums being at maximum density. The letter states that "the data package to be provided with every container of waste to be shipped to WIPP will contain the results of an assay of the fissile content in accordance with the WIPP Waste Acceptance Criteria. This assay will be sufficiently accurate to alert the WIPP operator to any trend toward increased fissile loadings."

In its revised criticality analysis, DOE did <u>not</u> relax the second assumption, that the plutonium is admixed homogeneously throughout the waste. In fact, the original erroneous language was not changed, namely that "modeling the plutonium as homogeneously distributed throughout the waste is very conservative since this ignores geometric self-shielding." As demonstrated in Reference 6 and discussed in my 1981 review,[4] compressing the fissile-moderator mixture leads to significant increases in reactivity because it results in a smaller fractional leakage and less parasitic absorption in the drum walls.

In the February 1982 letter from the WIPP Project Office to the EEG,[5] DOE correctly points out that "reactivity is not significantly affected by settling of the drum's content until the total drum content reaches approximately 30% of the total drum volume." However, DOE further contends that "this settling must occur independent of crushing of the drum, a situation we believe incredible in view of the nature of the drum contents and the limited handling activity involved." I do not agree. This configuration could simply be realized with partially filled drums (with the 70% remainder of the drum empty) or material which has settled to the bottom of the drums.

However, the DOE analysis, coupled with administrative limits on drum loading, would assure subcriticality. The average drum loading (13.275 gm Pu-239) would surely remain subcritical (k_∞ of the homogeneous, infinite array at optimum moderation is less than 0.4), even under conditions of partially filled or settled material in the drums (although this was not explicitly demonstrated by the DOE analysis).

Although I don't suggest that any more resources be expended on this issue, I am still perplexed by DOE's analytical approach to this problem. As discussed in my 1981 review, it is possible to demonstrate subcriticality of a finite array of maximally loaded drums in a flattened configuration.* Relying on this most conservative analysis, DOE would not have to impose administrative limits on drum loading or configuration.

I hope that the foregoing comments are useful to you in your review of these recent DOE documents. Please feel free to contact me if you should have any questions concerning my comments.

Sincerely,

Sanford Cohen

Attachment

SC/gh

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*In fact, the Rockwell Hanford analyses[6] have already done this. At the time of my 1981 review, the Rockwell Hanford calculations were being revised because of changes in the iron cross sections. The revised analyses did not result in higher predicted values of k_{eff} for arrays of 6 tiers or less.[7]

SUPPLEMENT 4
(Appendix SCR, DCCA)

S. COHEN AND ASSOCIATES

RECEIVED

JAN 20

ENVIRONMENTAL
EVALUATION GROUP

January 18, 1984

Mr. Robert H. Neill
Director
Environmental Evaluation Group
320 E. Marcy Street
P.O. Box 968
Santa Fe, New Mexico 87503

Dear Bob:

We have completed our analysis of the postulated WIPP reconcentration criticality, and discuss our results in this letter. In summary, we learned that for the material concentrations that you have postulated, a criticality is indeed likely if the high fissile concentration obtains and the dimension of the aquifer is greater than roughly one-half meter. For such a high fissile concentration, the multiplication factor is not affected significantly by the postulated range of carbon adsorption, non-TRU brine composition, or low iron adsorption. High iron adsorption does significantly reduce the multiplication factor, but the thick aquifer is probably still critical. On the other hand, a criticality does not appear achievable if the low fissile concentration obtains for any combination of the other parameters.

The input material concentrations, based on your letter of July 20, 1983*, modified by telephone conversations with Jim Channell on December 19, 1983, are given in Attachment I. The resulting homogeneous atom densities used in the computer analyses are given in Attachment II. A number of the elements contained in Attachment I have been omitted from the calculations. The reasons for these omissions and other assumptions used in computing the atom densities are as follows:

- The calculated atom density of U-233 is three orders of magnitude lower than that of Pu-239, given a uranium distribution coefficient (K_D) of 10; thus U-233 was omitted from the calculation.

- The macroscopic thermal absorption cross sections and potential cross sections of several elements were calculated to be at least three orders of magnitude lower

*Attachment to letter from Robert H. Neill to Sanford Cohen, entitled "Inputs to Criticality Calculation."

than the corresponding macroscopic cross sections for hydrogen, and thus these elements were omitted from the calculations. These omitted elements are barium, cesium, strontium, bromine, flourine, iodine, phosphorus, aluminum, copper, manganese, silicon, and zinc.

- Cross sections for the element chlorine were not available on the master data tape. Chlorine could not be disregarded in the calculations because of its relatively large absorption cross section. Therefore, chlorine was replaced by an equivalent amount of boron, based on the relative thermal neutron (0.025 ev) absorption cross sections of the two elements, i.e.:

  $$N_B = \frac{(33.6 \text{ barns}) N_{Cl}}{755 \text{ barns}},$$

  where N_B and N_{Cl} are the atom densities of boron and chlorine, respectively.

- The element lithium was replaced by the appropriate atom density of lithium-6. The predominant isotope, lithium-7, is relatively transparent and can be safely neglected.

- The "Miscellaneous" material in Case 1 brine is assumed to be nitrogen.

- The hydrogen and oxygen atom densities for Case 2 brine are derived by assuming that the difference between the specific gravity (1.215 gm/cc) and the total dissolved solids (0.328 gm/cc) represents the density of water in the brine.

The computer calculations were performed using the NITAWL and XSDRNPM computer codes installed on the CDC Cybernet system.* NITAWL extracts 123-group cross sections from the master cross

*The codes are summarily described and the input data specified in the AMPX-II manual, "AMPX: A Modular Code System for Generating Coupled Multigroup Neutron-Gamma Libraries from ENDF/B," ORNL/TM-3706, March 1976 (December 1978, Revised).

section library* and prepares them as input to XSDRNPM. It additionally performs any required resonance calculations (only for Pu-240 in our calculation) using the Nordheim Integral Method. XSDRNPM calculates the neutron spectrum and the eigenvalue for a one-dimensional system, accepting fine-group cross sections from NITAWL. It additionally collapses the weighted fine-group cross sections to any specified multi-group set, for input to a multi-dimensional code. For all but one of our calculations (to be described later) we used XSDRNPM in the homogeneous approximation (infinite medium), thus computing the infinite multiplication factor (k_∞).

In all of our calculations, we collapsed cross sections to calculate the diffusion area:

$$L^2 = \frac{D}{\Sigma_a} = \frac{1}{3\Sigma_a \Sigma_{tr}} ,$$

where D is the diffusion coefficient and Σ_a and Σ_{tr} are the macroscopic absorption and transport cross sections, respectively. We also computed the buckling using the following relationship**:

$$B^2 = \left(\frac{\pi}{700 + \frac{1.42}{\Sigma_{tr}}}\right)^2 + \left(\frac{\pi}{d + \frac{1.42}{\Sigma_{tr}}}\right)^2 ,$$

where the first quantity accounts for leakage from the depth (7m) of the slab and the second quantity from the width (d=0.5m or 5.0m) of the slab. (Leakage from the 7m depth is, in all cases examined, negligible.) Then, the effect of leakage on the multiplying system is computed using the one-group, diffusion approximation:

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*The master library is taken from GAM-II (fast cross sections) and THERMOS (thermal cross sections) cross section sets prepared in the 1960s, and is poorly documented. According to representatives of Oak Ridge National Laboratory, it will be documented in the SCALE manual, which is yet to be published.

**This assumes an unreflected configuration. In actuality, our assemblies are probably reflected by rock. We have neglected the effect of this reflection in our analyses, rendering the results conservative. (The effect of reflection would be to increase slightly the k_{eff} of the assemblies.)

$$k_{eff} = \frac{k_\infty}{1 + L^2B^2} .$$

We examined the accuracy of the above approximation by mocking up the actual geometry (0.5m wide, unreflected slab) in a P_1, S_4*, XSDRNPM spatial transport calculation. We used Case A (HI fissile, brine 1, no adsorbed Fe, no adsorbed C) for the calculation. The spatial transport calculation resulted in a k_{eff} of approximately 0.83. This is to be compared with an estimated k_{eff} of 0.97 obtained in the one-group, diffusion approximation. Thus the one-group, diffusion approximation appears to underestimate the effect of leakage for the thin slab and thus overestimates the effective multiplication factor. The overestimation in k_{eff} is approximately 0.14 for the 50cm thick slab. Such an error does not significantly affect the results of the study, because it translates into less than 20cm of additional thickness for an unreflected slab. Moreoever, we have assumed in our analysis an unreflected configuration, and the slab would most likely be reflected by unsaturated rock, thus reducing the critical slab thickness.

The final results of the criticality calculations are given in Attachment III. The actual computer output that these results are based on are being sent to you under separate cover. The calculated value of the infinite multiplication factor, k_∞, is tabulated in column 3. The effective multiplication factors, for each slab width, are given in columns 5 and 6. For the five cases identified as A through E, the infinite multiplication factors are also the eigenvalues calculated in corresponding XSDRNPM runs. For the cases denoted with primes, the infinite multiplication factors were obtained by weighting the microscopic fission and absorption cross sections over the unprimed spectra (A' and A" over the spectrum calculated in Case A; E' and E" over the spectrum calculated in Case E), and computing:

$$k = \frac{\nu\Sigma_f}{\Sigma_a} ,$$

using the appropriate number densities for the primed cases. This approximation should be quite accurate for the high fissile cases, since the perturbations are small. For the lo fissile

*The P_1 stands for first order quadrature of the scattering anisotropy; S_4 stands for four discrete angles represented in the spatial transport calculations.

cases, the approximation is less accurate, but sufficient for demonstrating trends for these assemblies, which are estimated to be far subcritical under any of our variations.

The results given in Attachment III demonstrate that an infinite configuration of the hi fissile concentration is far supercritical and roughly invariant under all of the modifications examined, with the exception of the hi adsorbed iron case. The insensitivity of the hi fissile case can be expained by the fact that, with the exception of the hi adsorbed iron case, approximately 75% of the absorptions are in the Pu-239.

Conversely, all of the lo fissile concentration cases are subcritical by a substantial margin. This is because only approximately 35% of the absorptions (only 18% for the hi adsorbed iron case) are in the Pu-239. For the lo fissile case with Brine 1, hi adsorbed carbon, and no adsorbed iron, 12% of the adsorptions are in the calcium, 8% in the hydrogen, 35% in the boron (simulated chlorine), 4% in the non-fissile plutonium, and the remaining 16% in the other nuclides.

Leakage from the 5 meter slabs is insignificant, so that k_{eff} is essentially equivalent to k_∞. Leakage from the 0.5 meter slabs is significant; the one-group diffusion analyses indicate that for hi fissile concentrations, with the exception of the hi adsorbed iron case, the configurations may be barely critical ($0.96<k_{eff}<1.07$). Transport calculations indicate that leakage is underestimated. However, we have neglected reflection by the surrounding rock. Therefore, it may be safely concluded that the thin slabs are critical in the thickness range of 0.5 to 1.0 meters.

Two additional perturbations, not tabulated in Attachment III, were examined. The first was the effect of the removal of Pu-238 from Case A.* This results in an increase in k_∞ of approximately 0.01, which is a negligible effect. The second was the effect of the removal of boron, used to simulate the chlorine, from Cases A and E. The results are increases in k_∞ of 0.10 for Cases A (hi fissile) and 0.36 for Case E (lo fissile). The results indicate that a 100% error in the simulation of chlorine by boron would not alter the major qualitative results for the high fissile cases, but might for the low fissile cases.

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*Pu-238 has a relatively short half-life, and is unlikely to be present to any significant degree in a repository several hundred years after waste emplacement.

The environmental consequences of a reconcentration criticality incident are highly uncertain. The release of fission products depends on the number of fissions, which in turn depends on the ability of the configuration to remain critical. Most historical criticality incidents result in modest bursts of approximately 10^{16} to 10^{18} fissions; however, as many as $\sim 10^{20}$ fissions have been recorded.* The historical incidents involving solutions generally proceed in a succession of bursts until the geometry is destroyed by the expulsion of the liquid from the confined configuration. This occurs from the heating and subsequent expansion of the liquid. (10^{20} fissions corresponds to approximately 10^4 Mw-sec, or approximately 10^7 BTU.)

The reconcentration criticality postulated here could have a different physical behavior. The fissile material is deposited on the rock and would presumably remain in place after the brine has been expelled from the generated heat. Moreover, the system would probably fill with fluid again because the source is a flowing aquifer. Thus, the most likely physical behavior is a continual "chugging" of the system, resulting in a continual series of bursts, each resulting in, say, approximately 10^{16} fissions, until the reaction is quenched by the poisoning effect of fission products. Possibly Oklo is the closest analogy.

The quantity of fission products produced can be estimated once the total energy release is determined. However, because of the location of the incident, the consequences to the accessible environment should not be very high. The noble gases may find their way to the atmosphere, but most of the radioiodine would probably be retained in the aquifer or the rock. If Oklo is indeed a reasonable analogy, most of the non-volatiles should be retained in the rock in close proximity to the site of the critical configuation.

I hope that this letter and the Attachments are useful to you in your assessment of the likelihood of a reconcentration criticality resulting from dissolved WIPP transuranic wastes. If you or your staff have any question relating to any of this information, please do not hesitate to call me. I am sending the computer output under separate cover.

Sincerely,

Sanford Cohen

Attachments

*William R. Stratton, "A Review of Criticality Accidents", LA-3611, September 1967.

Attachment I

MATERIAL CONCENTRATIONS

In Rock (with porosity = 10%)

Element	Density (gm/cc)
Calcium	0.435
Carbon	0.247
Magnesium	0.251
Oxygen	1.045
Hydrogen	0.00234
Sulfur	0.019

TRU Content of Brine

Nuclide	Concentration (mg/l) Hi Fissile	Low Fissile
U-233	1.1	0.11
Pu-238	0.17	0.017
Pu-239	6.6	0.66
Pu-240	0.32	0.032

Concentration factor for rock - 4000

Other Constituents of Brine

Element	Concentration (mg/l) Case 1	Case 2
Oxygen	644	See
Hydrogen	95	attached
Carbon	138	chemistry
Iron	222	for
Sodium	115	WIPP-12
Chlorine	175	brine
Misc. (assume Nitrogen)	55	

Adsorbed Carbon Concentration in Rock (mg/cc)

Low Adsorption	Hi Adsorption
50	500

Adsorbed Iron Concentration in Rock (mg/cc)

Low Adsorption	Hi Adsorption
100	1000

Attachment I (Cont.)

TABLE C.2

CHEMICAL COMPOSITION OF BRINES
SUMMARY OF STATISTICS
ERDA-6, WIPP-12, AND UNION WELLS(1)

SAMPLE TYPE: / LABORATORY: / LOCATION:		FLOW SAMPLE D'APPOLONIA ERDA-6					FLOW SAMPLE D'APPOLONIA WIPP-12					FLOW SAMPLE D'APPOLONIA UNION				
FIELD DETERMINATIONS:	UNITS	NO. OF ANALYSES	MINIMUM	MAXIMUM	AVERAGE(2)	CV(3)	NO. OF ANALYSES	MINIMUM	MAXIMUM	AVERAGE(2)	CV(3)	NO. OF ANALYSES	MINIMUM	MAXIMUM	AVERAGE(2)	CV(3)
Temperature	°C	40	21.0(4)	26.7	26.7(5)	0	39	24.2	28.2	26.7	3	—	—	—	—	—
pH	Standard Units	40	6.0	6.3	6.17	0.8	39	6.4	7.28	7.06	2	4	6.95	7.3	7.10	2
Eh	Millivolts	40	-160	-51	-132	8	39	-230	-195	-225	13	4	-239	-184	-233	14
Specific Gravity	—	39	1.216	1.232	1.218	0.2	39	1.210	1.220	1.215	0.2	4	1.210	1.220	1.216	4
Specific Conductance	µmhos/cm @ 25°C	39	351,000	623,000	473,000	3	39	420,000	599,000	546,000	5	4	499,000	542,000	526,000	0.4
Alkalinity(6)	mg/l	20	2245	2930	2600	5	35	2625	3040	2800	3	3	1935	2320	2100	9
Carbonate	mg/l	20	0	0	0	0	35	0	0	0	0	3	0	0	0	0
Hydroxide	mg/l	20	0	0	0	0	35	0	0	0	0	3	0	0	0	0
Chloride	mg/l	20	170,200	210,900	188,000	3	51	171,000	197,000	187,700	4	3	183,200	185,400	183,900	0.7
Sulfate	mg/l	20	15,700	26,400	19,100	9	48	16,200	21,300	18,900	6	3	18,600	20,100	19,300	4
Total Hardness (as $CaCO_3$)	mg/l	25	2235	4730	2640	6	25	5640	6515	6050	4	3	8950	9160	8970	2
Total Iron	mg/l	19	0.03	0.85	0.22	70	12	0.06	0.69	0.27	70	3	0.13	1.5	0.62	120
Hydrogen Sulfide	mg/l	20	172	837	380	30	39	682	1168	990	10	3	566	612	990	6
LABORATORY DETERMINATIONS:																
pH	Standard Units	10	6.29	6.73	6.42	2	13	7.16	7.80	7.40	3	3	7.3	7.34	7.31	0.6
Specific Conductance	µmhos/cm @ 25°C	10	400,000	510,000	490,000	7	13	480,000	810,000	637,000	16	3	500,000	500,000	500,000	0
Total Dissolved Solids	mg/l	10	320,000	340,000	330,000	3	13	310,000	340,000	318,000	2	3	300,000	510,000	390,000	27
Total Suspended Solids	mg/l	10	32	220	87	80	13	8	92	45	65	3	24	96	70	57
Cations																
Barium	mg/l	10	0.10	2.3	0.76	100	13	<0.1	0.99	<0.31	100	3	1.5	2.0	1.7	16
Calcium	mg/l	10	470	520	490	3	13	200	420	350	10	3	330	350	340	3
Cesium	mg/l	5	2.4	2.6	2.5	3	10	1.2	1.9	1.6	14	—	—	—	--	—
Lithium	mg/l	10	210	270	240	8	13	220	330	280	13	3	355	365	360	2
Magnesium	mg/l	10	330	540	450	19	13	1600	1700	1600	3	3	1900	2300	2100	10
Potassium	mg/l	10	2800	4400	3800	12	13	2500	3300	2900	8	3	3500	4600	3900	16
Sodium	mg/l	10	109,000	116,000	112,000	3	13	113,000	180,000	138,000	12	3	109,000	115,000	111,000	3
Strontium	mg/l	10	16	20	18	12	13	10	26	19	23	3	11	12	12	5
Anions																
Alkalinity(6)	mg/l	10	2600	2700	2600	2	13	2560	2800	2700	3	3	1500	1600	1500	4
Bromide	mg/l	10	750	990	880	9	13	300	600	510	14	3	430	580	480	17
Chloride	mg/l	10	160,000	180,000	170,000	6	13	160,000	220,000	178,000	8	3	160,000	180,000	170,000	6
Fluoride	mg/l	10	1.6	1.9	1.7	6	13	2.9	4.3	3.6	16	3	0.88	1.0	0.92	8
Iodide	mg/l	5	25	32	30	11	5	16	29	24	22	--	--	—	--	--
Sulfate	mg/l	10	14,000	18,000	16,000	7	13	16,000	20,000	18,000	7	3	20,000	24,000	22,000	10
Nutrients:																
Ammonia (as Nitrogen)	mg/l	10	840	920	870	2	13	320	430	370	11	3	300	340	310	7
Nitrate (as Nitrogen)	mg/l	10	570	680	620	15	13	360	1300	550	43	3	370	480	440	14
Phosphate (as Phosphorus)	mg/l	10	0.26	0.40	0.37	19	13	<0.10	0.8	<0.3	100	3	<0.1	<0.1	<0.1	0
Other Elements:																
Aluminum	mg/l	10	0.20	3.9	2.4	33	13	1.4	3.9	2.9	27	3	2.4	3.4	2.9	18
Boron	mg/l	10	570	890	680	15	13	790	1400	990	16	3	1000	1300	1100	16
Copper	mg/l	10	0.10	0.96	0.49	53	13	0.36	0.86	0.62	30	3	<0.1	0.6	0.3	60
Iron	mg/l	10	2.4	6.9	3.6	37	13	2.5	4.5	2.7	26	3	1.2	3.6	2.0	49
Manganese	mg/l	10	5.6	7.8	6.9	11	13	0.16	0.92	0.71	38	3	0.6	1.0	0.8	25
Silica (as SiO_2)	mg/l	5	36	51	45	17	10	41	73	57	23	—	—	—	—	—
Zinc	mg/l	10	0.38	0.64	0.55	20	13	0.27	0.51	0.37	20	3	<0.1	1.4	0.63	110

NOTES:

(1) Analyses performed by D'Appolonia. Samples containing drilling fluid contamination excluded from this table.

(2) Average = Arithmetic Mean.

(3) CV = Coefficient of Variance (%) = $\frac{\text{Standard Deviation}}{\text{Average}}$ x 100.

(4) Borehole temperature averaged 21.9°C during Activity ERDA-6.8 from 10/31/81 to 11/4/81 (measured at 405 feet below the surface).

(5) Borehole temperature averaged 26.7°C during Activity ERDA-6.9 (measured at approximately 2472 feet below the surface).

(6) Values are reported as mg/l HCO_3^-. However, analyses of inorganic carbon average only 340 mg/l HCO_3^- in WIPP-12 and 980 mg/l HCO_3^- in ERDA-6.

"—" = Parameter not analyzed.

Attachment II
HOMOGENIZED ATOM DENSITIES (atoms/cc X 10^{24})

Element/Nuclide	Case A Hi Fissile, Brine 1, No Ads.Fe, No Ads.C	Case B Hi Fissile, Brine 1, No Ads.Fe, Hi Ads.C	Case C Hi Fissile, Brine 1, Hi Ads.Fe, No Ads.C	Case D Hi Fissile, Brine 2, No Ads.Fe, No Ads.C	Case E Lo Fissile, Brine 1, No Ads.Fe, Hi Ads.C
Hydrogen	7.07×10^{-3}	7.07×10^{-3}	7.07×10^{-3}	7.33×10^{-3}	7.07×10^{-3}
Lithium-6	0.0	0.0	0.0	1.83×10^{-7}	0.0
Boron	1.32×10^{-5}	1.32×10^{-5}	1.32×10^{-5}	1.89×10^{-5}	1.32×10^{-5}
Carbon	1.31×10^{-2}	3.82×10^{-2}	1.31×10^{-2}	1.24×10^{-2}	3.82×10^{-2}
Nitrogen	2.36×10^{-4}	2.36×10^{-4}	2.36×10^{-4}	3.95×10^{-6}	2.36×10^{-4}
Oxygen	4.17×10^{-2}	4.17×10^{-2}	4.17×10^{-2}	4.23×10^{-2}	4.17×10^{-2}
Sodium	3.01×10^{-4}	3.01×10^{-4}	3.01×10^{-4}	3.61×10^{-4}	3.01×10^{-4}
Magnesium	6.21×10^{-3}	6.21×10^{-3}	6.21×10^{-3}	6.21×10^{-3}	6.21×10^{-3}
Sulfur	3.57×10^{-4}	3.57×10^{-4}	3.57×10^{-4}	3.68×10^{-4}	3.57×10^{-4}
Potassium	0.0	0.0	0.0	4.47×10^{-6}	0.0
Calcium	6.54×10^{-3}	6.54×10^{-3}	6.54×10^{-3}	6.54×10^{-3}	6.54×10^{-3}
Iron	2.39×10^{-4}	2.39×10^{-4}	1.10×10^{-2}	2.91×10^{-9}	2.39×10^{-4}
Pu-238	1.72×10^{-6}	1.72×10^{-6}	1.72×10^{-6}	1.72×10^{-6}	1.72×10^{-7}
Pu-239	6.65×10^{-5}	6.65×10^{-5}	6.65×10^{-5}	6.65×10^{-5}	6.65×10^{-6}
Pu-240	3.21×10^{-6}	3.21×10^{-6}	3.21×10^{-6}	3.21×10^{-6}	3.21×10^{-7}

Attachment III

RESULTS

Case	Description	k_∞	$L^2 (cm^2)$	k_{eff}	
				5.0m	0.5m
A	Hi Fissile, Brine 1, No Ads.Fe, No Ads.C	1.40	135.	1.39	0.97
A'	Hi Fissile, Brine 1, No Ads.Fe, Lo Ads.C	1.40	130.	1.39	0.97
A"	Hi Fissile, Brine 1, Lo Ads.Fe, No Ads.C	1.38	129.	1.37	0.96
B	Hi Fissile, Brine 1, No Ads.Fe, Hi Ads.C	1.41	92.4	1.41	1.07
C	Hi Fissile, Brine 1, Hi Ads.Fe, No Ads.C	1.18	101.	1.17	0.88
D	Hi Fissile, Brine 2, No Ads.Fe, No Ads.C	1.37	132.	1.36	0.95
E	Lo Fissile, Brine 1, No Ads.Fe, Hi Ads.C	0.68	134.	0.67	0.46
E'	Lo Fissile, Brine 1, Hi Ads.Fe, Hi Ads.C	0.35	56.9	0.35	0.29
E"	Lo Fissile, Brine 1, No Ads.Fe, No Ads.C	0.68	175.	0.67	0.43

SUPPLEMENT 5
(Appendix IRD, DCCA)

ENVIRONMENTAL EVALUATION GROUP

AN EQUAL OPPORTUNITY / AFFIRMATIVE ACTION EMPLOYER

7007 WYOMING BOULEVARD, N.E.
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December 27, 1991

Mr. W. John Arthur, III
Project Director
WIPP Project Integration Office
U.S. Department of Energy
P.O. Box 5400
Albuquerque, NM 87115

Dear Mr. Arthur:

EEG has reviewed DOE/WIPP 91-029, "Implementation of the Resource Disincentive in 40 CFR Part 191.14(e) at the Waste Isolation Pilot Plant," August 1991. We do not believe that the report accomplishes the objective of satisfying the requirement of 40 CFR 191.14(e) nor does it adequately address concerns expressed in our August 10, 1990 letter (attached). Also, it appears that DOE has not asked EPA's opinion about whether this report would satisfy the 191.14(e) requirement.

However, EEG wishes to be constructive and look to the future to compensate for the lack of this compliance. Because the site has not been shown to possess favorable characteristics to compensate for the handicap of a resource-rich site, its compliance with the containment requirements should be very conservative. Human intrusion into the site should be considered a high probability, engineered modifications of the waste should be seriously considered, and the reliance for long-term integrity should rest on engineered barriers in addition to the geology.

If you agree with this suggestion, it would be necessary to:

(1) abandon the DOE efforts to modify the Human Intrusion portion of the Standard. Suggested modifications would reduce or eliminate the only quantitative deterrent in the Standard against deliberately choosing a resource-rich site;
(2) make a commitment to include robust engineered barriers in the WIPP design similar to NRC and NWTRB recommendations for the high-level repository; and
(3) seriously examine the options for repository design and waste form modification to minimize the release from human intrusion.

We believe that this approach would be more productive than continuation of our six-year-old debate about whether compliance with 40 CFR 191.14(e) has been shown. If you do not agree with this constructive approach, we will have to insist on your publishing a report that shows compliance with the resource disincentive assurance requirement.

Our detailed comments on the report are enclosed.

Sincerely,

James K. Channell

Robert H. Neill
for Director

RHN:js
Enclosure

cc: James Bickel, DOE/ALO
Arlen Hunt, DOE/WPO
Mark Frei, WIPP Task Force
William Gunter, EPA

COMMENTS ON "IMPLEMENTATION OF THE RESOURCE DISINCENTIVE IN 40 CFR PART 191.14(e) AT THE WASTE ISOLATION PILOT PLANT (DOE/WIPP 91-029, August 1991)

General Comments

This report states that the "resource disincentive" assurance requirement (40 CFR 191.14(e) that was in the remanded 1985 40 CFR 191 Standard and expected to be in the repromulgated standard has been satisfied. We disagree. The report states "In addressing the natural resource provision of 40 CFR Part 191, the DOE does not propose to provide justification for the selection of the WIPP site." Rather, the report presents the history of how natural resource issues were evaluated during the site selection process. The contention is that the evaluation was extensive, with outside reviewers (including EEG), satisfied the NEPA process, and concluded that the use of the site for a TRU waste repository was of greater benefit than the possible development of the resources. The point was also made that the entire site selection process was completed prior to the issuance of the EPA Standards which contain the "resource disincentive" assurance requirement.

Our page-by-page comments follow. The comments recognize that much of the text is quotes from various documents and we believe it is historically accurate. However, some of these quotes give a misleading picture of the current situation and its applicability to the "resource disincentive."

Page-By-Page Comments

Page 1. The introduction fails to describe the event that prompted DOE to issue a strategy plan. It was a requirement specified in the 1987 modification to the C&C Agreement between DOE and the State of New Mexico.

Page 9, first paragraph, EEG is quoted (in a 1983 report) as suggesting that the loss of resources "is perhaps best handled by the NEPA process" and that health and safety issues from the attractiveness of the resource should be addressed by evaluating the increased probability of human intrusion.

This is still our position. The ultimate determination that a resource-rich site is acceptable can come only after evaluating it against a standard that adequately reflects the increased attractiveness of the site to human intrusion. However, it appears that DOE and SNL are engaging in activities designed to reduce or eliminate the effect that resources have on the human intrusion scenario in the 1985 EPA Standard.

Page 10, second paragraph. The EPA ESAB is quoted as saying that "it may be possible by suitable engineering technique to recover the resources without disturbing a nearby repository or to mitigate the effects of potential human intrusion. The site and engineered barriers should be seen as a system, ..."

EEG is uncomfortable with the concept of recovering resources on the WIPP site (currently permitted by DOE with the existing gas leases) and any general policy to permit this should be considered only after extensive discussions with non-DOE organizations. Also, there are still no commitments by DOE to any type of engineered barrier system to mitigate the effects of human intrusion.

Pages 12 and 61. EPA expects that sites with resources would be used only "if it is reasonably certain that they would provide better overall protection than the practical alternatives that are available." On page 61 the report says "The conclusion is that the favorable characteristics of the site uniquely qualify it for a repository for defense TRU wastes. These characteristics more than compensate for the likelihood of a future disturbance." What practical alternative to WIPP has been evaluated to determine if the repository provides better overall protection? Storage on the surface? Also, what are the favorable characteristics of the site that uniquely qualify it for a repository?

Pages 14 and 53. The report points out that "care has been taken to avoid such brine reservoirs within the site area." (page 14) and "when the Los Medanos site was initially screened for the WIPP project it was thought that the facility was positioned outside of the known Carlsbad Potash District, and would therefore have a minimal impact on potash resources." (page 53).

The presence of brine reservoirs and potash resources on the site were considered undesirable before site characterization. When it was found they existed on the site it was decided they were acceptable.

Page 13. "There is no indication that an alternative site for the demonstration would pose reduced risk."

Is there any indication that an alternative site would not pose reduced risk? Has the WIPP site been compared to any alternative site?

Pages 16-18. The statement is made three times on these pages that "the consequences of future events, including resource extraction, are acceptably small."

The determination that consequences are acceptably small cannot be made until compliance with the EPA standard is shown. Since compliance is not scheduled to be shown until about 1995 this statement is premature. Also, the standard requires that only the consequences of exploratory drilling be evaluated. Resource extraction does not need to be evaluated.

Page 24. Reference is made to the favorable hydrologic regime at the WIPP and quotes a 1983 report.

The Culebra model now being used is somewhat different than in 1983. Is this statement still correct?

Page 26. EEG-11 (Channell, 1982) is one of the references cited when claiming that "future human intrusion in search of mineral resources will not significantly impact public health and safety."

It is best not to generalize too much about what a report is saying. The EEG-11 scenarios resulted in maximum calculated doses to a nearby resident of >1 rem (committed effective dose equivalent) per year of inhalation and maximum quantities of radionuclides to the surface that were about 2.5 times that permitted by the 1985 EPA Standard. The report concluded that quantities brought to the surface were great enough compared to the 1981 draft of the EPA Standard to require a more detailed evaluation. Furthermore, the data have changed considerably since 1981. For example, the inventory is now believed to be about 10 times as great, the existence of a brine reservoir under the site about 12 times as great, and the amount of brine that might flow to the surface could be about 5 times as great.

Page 48. The following quote was made from the 1978 Geological Characterization Report: "The selection criteria used, however, was sufficient to establish that the site selected was adequate, safe, and acceptable."

We suggest that these words exaggerate the acceptability and safety of the site. The fact is that DOE does not expect to be able to show compliance with the 1985 EPA Standard before 1995. The site cannot be assumed to be safe and acceptable until it is shown to be in compliance with the EPA Standard.

Pages 49-58. It would have been helpful to have given in-place (gross) and net values of resources with 1991 market prices. Also, the efforts to minimize the impact of not mining langbeinite (pages 54, 56, 59) are not very convincing.

Page 60. The statement is again made that the consequences of an inadvertent intrusion into the repository are small. However, two sentences later the more accurate statement is made: "The final determination of the acceptability of the site will be based on compliance to the performance assessment requirements of 40 CFR 191 Subpart B."

Conclusions on Resource Disincentive

1. DOE did openly address the resource issue during site characterization and had interactions with appropriate State and public organizations. They appear to have satisfied the NEPA process. However, we are surprised there was not more public concern raised about the denial of resources, especially langbeinite.

2. Siting a repository in a resource-rich area has always been considered undesirable and DOE should have expected that when standards were finally enacted they would contain some penalty for such sites. DOE's siting approach was to try and find a site in a resource-rich area that contained lesser amounts of resources than surrounding areas. When the chosen site was found to contain more potash resources and Castile brine reservoirs than originally believed these features were considered acceptable.

3. The report suggests that DOE has compared this site against alternatives and shown that it is an overall superior

location. EEG is unaware that DOE has ever compared the WIPP site against alternatives or identified those favorable characteristics that compensate for choosing a resource-rich area. Thus, we conclude that DOE has not justified the choice of this resource-rich site over a resource-poor site.

4. DOE has incorporated no waste form modifications or engineered barriers in the repository design that would mitigate human intrusion effects.

5. Preliminary results by SNL suggest that the WIPP site might be able to meet the Containment Requirements of 40 CFR 191 despite the resource effect and no design modifications to mitigate the effects of human intrusion. However, since it is not certain the Containment Requirements could be met DOE is doing the following:
   (a) Recommending that the Standard be revised to separate the human intrusion scenario from the Complementary Cumulative Distribution Function. This would downgrade the importance of the human intrusion event and make it easier for WIPP to comply;
   (b) Recommending that the Standard be revised to permit alternatives to the generic radionuclide release limits allowed to reach the accessible environment. This could permit a site performance assessment to meet a lesser standard in some cases;
   (c) SNL is using expert panels on the future, site markers, and site barriers in an attempt to justify reduction in the maximum exploratory drilling rate specified in EPA Guidance. If successful this exercise would have the effect of reducing or eliminating any penalty for choosing a resource-rich site.

6. The probable form of the 1985 EPA Standard and the human intrusion guidance for resource-rich sites was reasonably

well known by mid-1983 when the Decision for Repository Construction was made.

7. EEG has always recognized that the WIPP site is in a resource-rich area and we have never contended that this should be grounds for automatically rejecting the site. However, we believe that since DOE picked a resource-rich site and was aware of the penalties likely to be in the 1985 Standard before they began construction of the repository, they should be prepared to show compliance of the WIPP site with those standards and not try to obtain compliance by getting this portion of the Standard modified.

The proof of the suitability of the site can only be determined by showing compliance with the Containment Requirements with Guidance for a resource-rich site and not by unverified claims that the site is superior to alternatives.

SUPPLEMENT 6
(Appendix IRD, DCCA)

ENVIRONMENTAL EVALUATION GROUP

AN EQUAL OPPORTUNITY / AFFIRMATIVE ACTION EMPLOYER

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(505) 828-1003

February 13, 1990

Mr. Arlen Hunt
Acting Project Manager
WIPP Project Office
U. S. Department of Energy
P. O. Box 3090
Carlsbad, New Mexico 88221

Dear Mr. Hunt:

The question has arisen on the Department's plans to demonstrate compliance with the natural resource Assurance requirement of the EPA Standard, 40 CFR 191.14(e). As you know, that particular requirement states that places where there has been mining for resources, a reasonable expectation of future exploration or a significant concentration of a scarce material should be avoided in selecting disposal sites. The requirement states,

> "Such places shall not be used for disposal of the wastes covered by this Part unless the favorable characteristics of such places compensate for their greater likelihood of being disturbed in the future."

A recently published Sandia National Laboratory report (SAND 88-1452, Bertram-Howery et al, p. VI-2) states the following with respect to compliance with the natural resources part of the Assurance Requirements (40 CFR 191.14.e):

> "The WIPP project met this requirement when the site was selected, and the Project will issue a finding to that effect."

The site was selected in the seventies and I don't believe that the Project has ever taken the position that the scientific evidence at that time provided any documentation for conclusions on the characteristics of the site--favorable or otherwise. In addition, our understanding was that the Department intended to publish an analysis similar to the October 20, 1988 document which was subsequently withdrawn.

Please advise whether the SAND 88-1452 statement reflects the DOE/WPO official position.

Sincerely,

Robert H. Neill
Director

RHN:LC/lsb/ct

cc: Mr. James E. Bickel, Asst. Mgr. for Projects and Energy Programs, DOE-ALO
Mr. Leo P. Duffy, Special Asst. to the Sec. for Coordination of DOE Waste Management, DOE-EH
Ms. Jill E. Lytle, Deputy Asst. Secretary for Nuclear Materials, DOE
Mr. Mark Frei, Chairman, WIPP Task Force

SUPPLEMENT 7
(Appendix IRD, DCCA)

ENVIRONMENTAL EVALUATION GROUP

AN EQUAL OPPORTUNITY / AFFIRMATIVE ACTION EMPLOYER

7007 WYOMING BOULEVARD, N.E.
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August 10, 1990

Mr. Arlen Hunt
Project Manager
WIPP Project Manager
U. S. Department of Energy
P. O. Box 3090
Carlsbad, New Mexico 88221

Dear Mr. Hunt:

On February 13, 1990, EEG asked your office how WPO would show compliance with the natural resource Assurance requirement of the EPA Standard 40 CFR 191.14(e). After 5.5 months, you wrote back on July 31, 1990 to say that the requirement was met when the site was selected, (presumably in 1980 when the WIPP FEIS compared different sites) and you reiterated the position stated in the Sandia December 1989 report that you expect to publish a short report at some unspecified future date that will cite the favorable characteristics.

Fundamental Concerns

This raises some very fundamental concerns on the manner in which DOE is regulating itself in demonstrating compliance with the EPA Standards for safe disposal of TRU wastes at WIPP.

1. Was this conclusion reached by DOE as the implementing agency entrusted with the responsibility of insuring that the EPA Standards are met, or as DOE, the regulated agency that must do the actual demonstration?

2. What other parts of the EPA Standards can DOE, as either the regulator or regulated merely say have been demonstrated at some time in the past? Would the Department as regulator be willing to provide a written list of those portions of the Standards which have been met? It is interesting to note that NRC, as the regulator for HLW disposal, is writing criteria to provide clear guidance to DOE on what they must do to show compliance with 40 CFR 191 as part of 10 CFR 60.

3. Have you asked EPA whether your approach to declare portions of the standards to have been met and then document it in the future is what they had in mind? The May 22, 1987 letter by the Director, Office of Radiation Programs, EPA to the Deputy Assistant Secretary DOE, indicates that your position would not be sufficient. Examples like this provide the basis for not allowing the same party to be both a regulator and the regulated.

4. Has DOE-OCRWM asked NRC if they would accept such logic that DOE had satisfied this requirement when they selected Yucca Flats some years ago for a high-level waste repository?

<u>DOE Progress in meeting Assurance Requirements over past 5 years</u>

You point out that EEG often states that DOE has made no progress with the Assurance Requirements (40 CFR 191.14) since they were promulgated 5 years ago and provided examples of progress.

It is important to remember that 3½ years ago DOE said the assurance requirements would be completed by October 1988. Specifically, EPA noted that DOE stated at a March 26, 1987 meeting, "i.e., that projected compliance with Subpart A and the assurance requirements of Subpart B will be shown <u>prior</u> to waste receipt, currently scheduled for October 1988." We are unaware of any published progress.

Active Institutional Controls

You cite the identification of soil preparation techniques and the selection of seed species as progress in active institutional controls. Since the purpose of active institutional controls as defined in the EPA Standards is to prevent radiation exposure and protect the public health in the post-decommissioning phase from radioactive materials located at a depth of 2150 feet in the repository, the examples of work cited by you will not be of any value in this regard. You appear to misunderstand "performing maintenance operations or remedial actions at a site" (40 CFR 191.12(f)(2)) to mean site reclamation when it actually refers to preventing radioactive releases. After 12 years of study and the expenditure of almost $1 billion, one would expect progress in active institutional controls to include specifying how long you intend to leave a fence around the property or keep a watchman on the payroll to prevent human intrusion.

NRC requires early warning monitoring systems to detect any changes in the HLW repository and DOE is designing the facility to handle this including underground sensors to measure any radionuclide migration. Is it not appropriate that WPO should do the same?

Passive Institutional Controls

Your letter states, ". . . through the administrative land withdrawal, the DOE is able to protect the lands from any entry that would compromise the integrity of the disposal system." There is only a request pending by DOE to the Department of the Interior for administrative land withdrawal which has not been acted upon and it is incorrect to imply that the action has occurred. Further, DOE must publish the design of permanent markers, etc. to prevent future generations from drilling into the repository.

Your Department has asked the Congress for exclusive authority to prevent mining without any power to redelegate such authority but has been silent on how it would be done. How can you claim credit for the ability to prevent intrusion (as well as the authority) without providing any plans to show how it will be done?

Your letter states that your contractors have been instructed to evaluate criteria for markers and provide warnings. What progress has been demonstrated through published or unpublished work since this requirement was established 5 years ago? You correctly point out that the DOE HLW commercial repository program has done a large amount of work in this area using WIPP as an example. Since we are not aware of any difference in the technology of markers in the past decade, why not use their work?

Multiple Barriers

You stated that WIPP depends on a combination of engineered and natural barriers. To date, DOE has not selected any engineered barriers as required by the Standards. The waste is soluble, respirable, and in a carbon steel drum and the only commitment to an engineered barrier is a getter of unspecified composition and thickness to be placed above the waste. Your letter only describes plugs and seals (which DOE is not allowed to take credit as an engineered barrier in the NRC regulated repository in Nevada nor did EPA include room and shaft seals as an engineered barrier for WIPP).

Although my impression may not be totally fair, the tenor of your response suggests a commitment to the absolute minimum as expressed in the philosophy that anything beyond plugs would only be included if it were proven to be necessary through performance assessment. The intent of the Assurance Requirements was clearly spelled out by EPA in the 1985 preamble that it is not necessary to quantify the amount of benefit obtained but was to be done as an assurance of repository integrity due to the inherant uncertainties in the calculations of travel times and leach rates.

Waste Removal

You state that mined geologic repositories such as the WIPP meet the requirement for waste disposal removal with no further action. As the regulator of TRU waste at WIPP, DOE has imposed far less stringent requirements on waste removal at WIPP than the regulator of HLW disposal (NRC) has placed on DOE. Note the requirements in 10 CFR 60 for the SAR which include plans for alternate storage should retrieval prove necessary.

Sincerely,

Robert H. Neill

Robert H. Neill
Director

RHN:lsb
Enclosures: 2/13/90 letter Neill, EEG to Hunt, DOE
7/31/90 letter Hunt, DOE to Neill, EEG

cc: Mr. J. Bickel, DOE-ALO
Mr. L. Duffy, DOE-Headquarters
Ms. J. Lytle, DOE-Headquarters
Mr. M. Frei, DOE-Headquarters

SUPPLEMENT 8
(Appendix IRD, DCCA)

Department of Energy
Field Office, Albuquerque
P.O. Box 5400
Albuquerque, New Mexico 87115

JUN 1 6 1992

Mr. Robert H. Neill, Director
Environmental Evaluation Group
7007 Wyoming, N. E., Suite F-2
Albuquerque, NM 87109

Dear Mr. Neill:

The Department of Energy has received your letter dated December 27, 1991, which provides the Environment Evaluation Group's review comments on DOE/WIPP 91-029, "Implementation of the Resource Disincentive in 40 CFR Part 191.14(e) at the Waste Isolation Pilot Plant" (August 1991). At the present time, we are reviewing a plan to address this complex issue. When we have completed the task of addressing this issue, we will provide you with a detailed response to your referenced letter and its accompanying "Comments."

If you have any questions regarding this transmittal, please call Tracy Loughead of my staff at 845-5977.

Sincerely,

W. John Arthur, III

W. John Arthur, III
Project Director
WIPP Project Integration Office

cc:
C&C File (ED9100184)
T. Loughead, WPIO
J. Kenney, EEG