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Bellus, P.A., and Eckerman, J. 1994. Airborne or Spaceborne Surveillance Radar Detection of WIPP Site. Westinghouse Electric Corporation, 10950, Minnetonka, MN.

2. Radar Reflectors, p. 1;

" A radar retroreflector fabricated from intersecting plates of metal provides a high radar cross section. The trihedral formed by the right-angle placement of adjacent plates gives a high reflection coefficient independent of angle. These devices have been used for many radar enhancement applications. Figure 1 shows such a device, sold under the trade name RADARK, for use as a boat radar signature enhancement navigational aid.

If the reflector is sized for 100MHz, the wavelength is 3 meters and the dimension of the trihedral facet should be 3 wavelengths on a side, for a length of 9 meters. Since there is a facet on either side of the center plane, the overall size of the reflector is 18 meters across. To get the maximum reflectivity, the accuracy of the right angle (the deviation of the surface of the plate from the plane) and the flatness of metal plates must be controlled to much less than a wavelength. Of course, the degree of control in absolute terms depends on wavelength, making for tighter tolerances as frequency increases. By providing a gradient of accuracy in towards the center, a smaller portion of the center could provide a high RCS for a high frequency radar, with more of the reflector area contributing to the RCS for lower frequency radar. Further, since the stresses on the plates increase with increasing distance from the center, as does the area of the plates, precision is easier to come by at the center, where it is most needed, at lower cost.

Will this corner reflector provide a sufficient signal? Consider the radar backscatter coefficient of a trihedral reflector. The peak RCS per unit area of trihedral reflector (dBsm/sm) is given by:

$$10\log(4\pi\ A/\lambda^2)$$

where A is the area of the reflector and λ is the wavelength of the radar.

For a triangular corner that is half a square 9 meters by 9 meters the area is 40 m^2. For 100 MHz radar λ is 3 meters, thus the RCS per unit area is:

$$10\log(4\pi\ (40)/3^2))=17\text{dBsm/sm}$$

Consider that the radar cross section of terrain at relatively oblique incidence is on the order of -15 dBsm/sm for many terrain types over a variety of frequencies and polarizations, a target with a backscatter coefficient of +17 dBsm/sm will be highly visible.

For L-band radars (1000 MHz, λ=0.3 m), the wavelength is 1/10th as large as for 100 MHz, so the trihedral sides can be 1/10 as large. The triangular corner is half of a square 0.9 x 0.9 m or 0.4 square meters. Thus the RCS per unit area is:

$$10\log(4\pi\ (0.4)/0.3^2))=17\text{dBsm/sm}$$

If the larger 9 m x 9 m target had the tolerances and surface finish required for the higher L-band frequency, its RCS per unit area would be:

$10\log(4\pi\ (40)/0.3^2))=37\text{dBsm/sm}$

while the smaller 0.9 m x 0.9 m target at 100 MHz will have an RCS per unit area of only:

$10\log(4\pi\ (0.4)/3^2))=2.5\text{dBsm/sm}$

Thus the larger target will be adequate at 100 MHz and 1 GHz, but the smaller target, while adequate at 1 GHz, will be clutter limited at 100 MHz, especially if buried under lossy material."

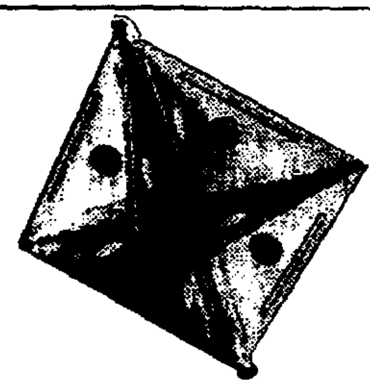

Figure 1 - RADARK Radar Reflector

DOE (U.S. Department of Energy), 1980. Final Environmental Impact Statement, Waste Isolation Pilot Plant, DOE/EIS-0026, Volumes 1 and 2, Department of Energy Office of Environmental Restoration and Waste Management, Washington, D.C.

p 1-2, Section 1.2.1 1980 WIPP FEIS

" The 1980 WIPP Final Environmental Impact statement (FEIS) and the associated public review and comment period provided environmental input for the DOE's initial decision to proceed with the WIPP (DOE, 1980). The significance of impacts associated with the various alternatives was assessed. For the selected alternative, a two-phased approach to development was proposed: 1) a site and preliminary design validation (SPDV) program, as discussed in Subsection 8.2.1 of the FEIS, and 2) full construction, as discussed in FEIS Subsection 8.2.2. The durations of key WIPP activities are shown in Figure 1.1.

The 1980 FEIS presented an analysis of the environmental impacts of a number of alternatives for demonstrating the safe disposal of TRU waste. The alternatives considered include:

- Alternative 1. No action. A research and development facility to demonstrate safe disposal of TRU waste would not be developed and post-1970 TRU waste would continue to be retrievably stored.

- Alternative 2. Developing the WIPP at the Los Medanos site in southeastern New Mexico.

- Alternative 3. Disposing of stored TRU waste in the first available repository for high-level radioactive waste.

- Alternative 4. Delaying a decision on the site for a WIPP until at least 1984 to allow for investigation of alternative sites.

Alternative methods and geologic media for TRU waste disposal were also considered but rejected in the FEIS. The alternative methods included burial in deep ocean sediments, emplacement in deep drillholes, transmutation, and ejection into space. The alternative geologic media included igneous, volcanic, and argillaceous rocks.

The DOE's Record of Decision, published January 28, 1981 (46 FR 9162), announced the DOE's selection of Alternative 2: to proceed with the phased development of the WIPP at the Los Medanos site in southeastern New Mexico. . . ."

7.3.7 Energy and Mineral Resources, page 7-64, para 6;

"<u>Methods used to determine potash reserves at the WIPP site</u>

Two separate studies were conducted for the DOE by the U.S. Bureau of Mines (USBM, 1977) and Agricultural and Industrial Minerals, Inc. (AIM, 1979) to determine what portion of the potash resources at the WIPP site is economic and may be considered to be reserves. Both studies started with the basic grade and thickness data provided by the USGS, and the USBM study was available for use by AIM. However, the two studies used different concepts for the development of the potash reserves and evaluated processing difficulties independently. The AIM approach, which may more nearly resemble the perspective of a potash operator, results in lower reserve estimates. However, because estimates of reserves and the associated economics are subject to uncertainty and because the USBM report gives a higher estimate of reserves, most table presented here will use USBM reserve estimates. The AIM report also estimated potash resources in the Carlsbad district and in the United States to allow comparison with the WIPP-site resources, and their values will be used in these comparisons. It should also be noted that local potash operators question the economic feasibility of mining the WIPP reserves.*

The USBM method of determining to what extent the deposits could be profitably mined and thus considered reserves consisted of designing conceptual models for exploiting the deposits. Models ranged from new mines and refineries to mines that merely send the new ore to existing refineries. Shaft locations were selected to minimize underground development and allow the richest ore beds to be mined first. The latter is important to the quick recovery of invested capital.

Costs were either estimated or, when available, matched to known cost experience at nearby mines. All costs, including construction, were used in discounted cash-flow analysis to determine the market price for refined products guaranteeing a 15% rate of return on invested capital. Federal, State, and local taxes and royalties were taken into account.

In all, the USBM prepared 12 different conceptual plans (which it has termed mining units) for exploiting the potash deposits in the WIPP site. Of these, eight were fully evaluated and four discarded because of complex problems related to the enrichment of raw ore.

Results of the potash-reserve determination

The full findings of the reserve evaluation have been reported (USBM, 1977; AIM, 1979), and the USBM estimates are summarized in Table 7-8. The eight mining units that were conceived and then costed are listed in the approximate order in which they would rank as potentially minable. Only the 48.46 million tons in mining units B-1 (Figure 7-25) within the site were classified as reserves by the USBM study. This is much less than would be classified as reserves by the USGS. The USGS used the potash grade and thickness parameters of the most efficient producers in the district. These minimum ore standards, excluding all other minability parameters, include all material in the WIPP site with a minimum cutoff grade of 4% K_2O as langbeinite or 10% K_2O as sylvite in a thickness of 4 feet.

The USBM used criteria consistent with industry practice in preparing economic-feasibility studies. In calculating potash-ore reserves, it used a method based on engineering design and economic-analysis procedures, including discounted cash flow, to determine the tonnage of minable potash ore that will yield a 15% rate of return on the total capital investment. Only economically recoverable ore is included in the USBM reserve estimates.

Under the USBM criteria, only mining unit B-1 meets the 1977 market prices current at the time of the study: $42 per ton of muriate, $84 per ton of "sulfate" (K_2SO_4), and $48 per ton of langbeinite. This particular reserve consists of langbeinite, mostly in ore bed 4 in the northern portion of the site. (Restriction of mining within the WIPP site would not render uneconomic the remainder of mining unit B-1 outside the site.)

Unit A-1 does not meet the market-price requirements; however, the market price of muriate has exceeded $52 per ton in the recent past, at which point the A-1 deposit would be considered a marginal, or "nearly economic," deposit. (Average market prices for October 1979 were $58.37 per ton of muriate, $42-44 per ton of langbeinite, and $56.14 per ton of all sulfate products: USGS Conservation Division, Monthly Mining Report, Roswell, New Mexico.) The A-1 deposit consists of sylvite contained in ore bed 10 and located on the west side of the site.

Methods used to determine the hydrocarbon resources at the WIPP site

The New Mexico Bureau of Mines and Mineral Resources (NMBM&MR) conducted hydrocarbon-resource study in southeastern New Mexico under contract to the Oak Ridge National Laboratory (Foster, 1974). The study included an area of 1512 square miles (Figure 7-26). At the time of that study, the proposed repository site was about 5 miles northeast of the current site. The NMBM&MR evaluation included a more detailed study of a four-township area centered on the old site; the present site is in the southwest quadrant of that area (Figure 7-26).

The resource evaluation was based both on the known reserves of crude oil and natural gas in the region and on the probability of discovering new reservoirs in areas where past unsuccessful wildcat drilling was either too widely spread or too shallow to have allowed discovery. All potentially productive zones were considered in the evaluation; therefore, the findings may be used for determining the total hydrocarbon resources at the site. A fundamental assumption in this study is that the WIPP area has the same potential for containing hydrocarbons as the much larger region in which the study was conducted and for which exploration data are available. Whether such resources actually exist can be satisfactorily established only by drilling at spacings close enough to give a high probability of discovery.

Results of the hydrocarbon-resource evaluation

Table 7-9 summarizes the findings of the NMBM&MR hydrocarbon evaluation as the potential resource of hydrocarbons that probably exist under a square mile (640 acres) with the typical geologic and stratigraphic section of that region. The New Mexico Bureau of Mines and Mineral Resources examined an area of 967,680 acres (1512 square miles). The hydrocarbon resources under the site are then estimated as the proportion of the total in the 29.625 square miles of the site (Table 7-10).

The hydrocarbon-resource quantities given in Table 7-10 are equivalent to potash-resource-quantity estimates in that both relate to the quantity of what is present, and not to its economic value or recoverability. Because the hydrocarbon-resource evaluation relies on statistical probability, it is not as accurate as the potash-resource evaluation. The potash resources were actually drilled and assayed, while the hydrocarbon resources were estimated by projecting historical drilling success into an untested area. Site-selection requirements dictated that the inner zones be free of deep holes (i.e., oil and gas test holes)."

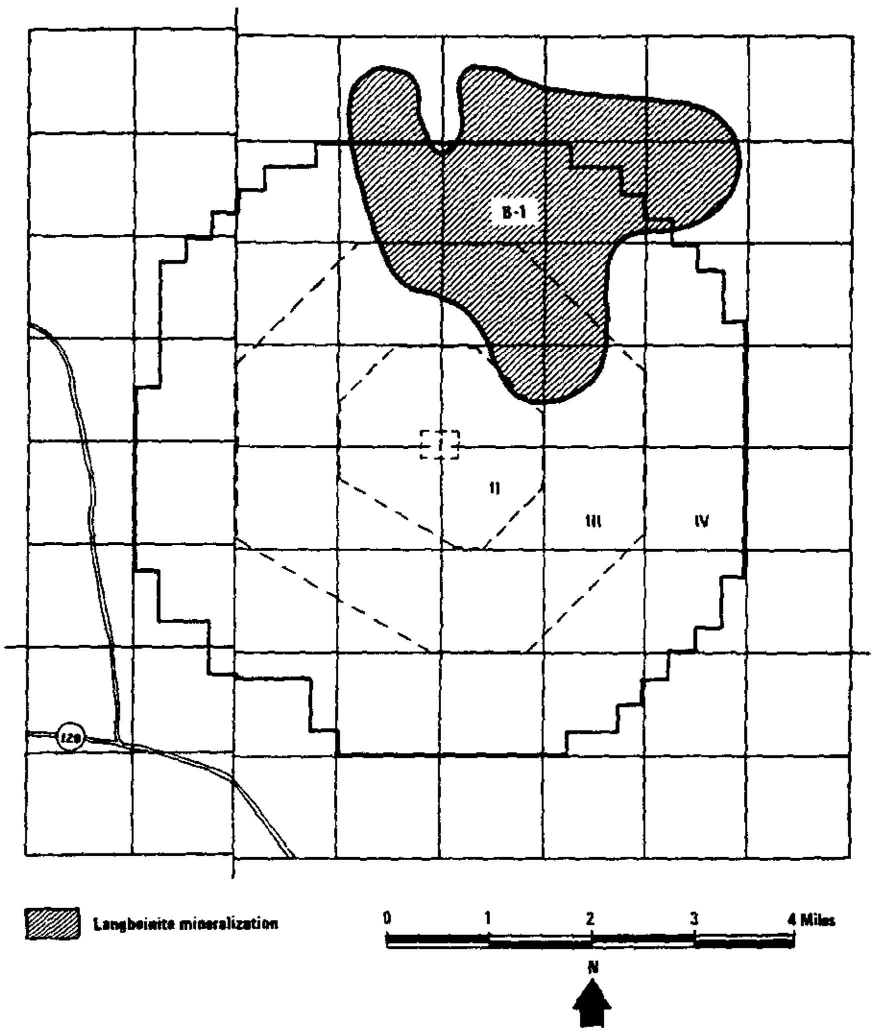

Figure 7-25. ***Economic langbeinite mineralization in mining unit B-1. (After USBM, 1977).***

DOE (U.S. Department of Energy), 1990. Final Safety Analysis Report; Waste Isolation Pilot Plant, WP02-9, Revision 0, Westinghouse Electric Corporation, Waste Isolation Division, Carlsbad, New Mexico.

PREFACE

"**Background**

This Final Safety Analysis Report (FSAR) has been prepared for the Waste Isolation Pilot Plant (WIPP) in order to satisfy the commitments made in the Working Agreement for Consultation and Cooperation(Article III, Section C and Article IV, Section K, known as the Working Agreement) between the State of New Mexico and the U.S. department of energy (DOE) and the requirements of Order DOE 5481.1B,Safety Analysis and Review System.

The objectives of the Safety Analysis Preparation and Review process, as specified in Order DOE 5481.1B, ensure that:

1. Potential hazards are systematically identified;

2. Potential consequences are analyzed;

3. Reasonable measures to eliminate, control or mitigate the hazards have been taken, including, where applicable, compliance with commitments made in environmental assessments and impact statements;

4. There is documented management authorization of the DOE operation based upon an objective assessment of the safety analysis.

Specific hazards that are analyzed include credible natural hazards such as flood, weather (tornado, wind, etc.) and earthquake; and credible man made hazards such as fire, explosion, radiation, and mining hazards. Mitigating measures include facility design and construction, operational controls, and administrative limits.

This FSAR represents a statement and commitment by the DOE that the WIPP facility can be operated safely and at minimum risk, if operated in accordance with this FSAR. Consequently, this FSAR has been prepared to document that a systematic analysis of the potential hazards associated with operating the WIPP facility has been performed (objective 1 of Order DOE 5481.1B); that potential consequences have been analyzed (objective 2 of Order DOE 5481.1B); and that reasonable measures have been taken to eliminate, control, or mitigate the hazards (objective 3 of Order DOE 5481.1B). In addition, this FSAR documents the implementation of commitments made in the environmental impact statement regarding the mitigation of adverse impacts to the environment (objective 3 of Order DOE 5481.1B)."

Section 1.1 INTRODUCTION; p 1.1-1. para 3;

"   In addition, this FSAR has been prepared in accordance with Article III of the 1981 Consultation and Cooperation Agreement (C&C Agreement) between the DOE and the State of New Mexico and, as such, represents the most comprehensive document concerning the WIPP facility both in general terms and specifically as related to public health and safety."

Section 1A.1.1.1 Earthquakes, p 1A.1-2;

"   Seismic risk analysis has defined a conservative DBE for the WIPP facility with a maximum ground acceleration of 3.2 in/s^2 (0.1g) horizontally and vertically, with 10 maximum stress cycles, and based on a 1000-year recurrence interval. This maximum acceleration is used in analysis and design of surface confinement facilities and equipment. Response spectrum analysis was contacted using structural mode shapes and frequencies for two principal horizontal directions, and modal responses (shear, moments,stresses, deflection, accelerations) were combined to assess the contribution to loading from seismic sources. Seismic overturning moment was used to compute foundation reactions and account for vertical earthquake effects. . . . "

Section 2.2.1 INDUSTRIAL AND COMMERCIAL FACILITIES, p 2.2-1, line 4;

"   There are three potash mines and two chemical processing plants (adjacent to the mines) between five and 10 miles of the WIPP facility."

Section **5.1 CH TRU WASTE HANDLING SYSTEM**, para 3;

"   The average CH TRU waste throughput is shown in Table 5.1-2. This table is based on handling only drums. This assumption produces an upper bound for the WIPP facility on handling processes. The design basis throughput for CH TRU is 500,000 ft^3 per year at 250 days per year. The anticipated average throughput is 250,000 ft^3 per year."

Section **3.1.3.1 RH TRU Waste Quantities and Storage**, Paragraph 2;

"   The RH TRU waste design throughput capacity is two canisters per shift or a maximum of 250 canisters per year (7500 ft^3 per year)."

throughput   7500 ft^3 per year
facility design life x 25 years
                     187,500 ft^3

25 year throughput 187,500 ft^3
design capacity   ÷250,000 ft^3
                    0.79   or 79 percent of design capacity

Table 5.1-2

AVERAGE CH TRU WASTE VEHICLE, CONTAINER, AND DRUM THROUGHPUT

Vehicle	No. of TRUPACT II's Per Vehicle	Vehicles per day	TRUPACT II per day	Drums* per day	Vehicles per year	Volume per year ft^3
Truck Trailer	3	3.2	9.7	136	810	250,000

*Assumes 14 drums/TRUPACT II

Introduction

" The DOE's plan for monitoring VOCs emitted from the WIPP during the test phase is described in this document.

The monitoring program is designed to demonstrate that there will be no migration of hazardous chemicals from the WIPP in concentrations exceeding health-based criteria. The monitoring plan included an overview of the WIPP test program, a description of waste sources, the monitoring design, and justification of the design. The plan also includes a description of sampling and analysis procedures, QA objectives, and reporting activities.

Possible migration pathways from the unit, both during the active life of the facility and through the postclosure phase."

Section 6.1.7.2.1 Migration Pathways, p 6.1-34;

"Hazardous chemicals available for release are predominantly volatile organic gases. The only pathway of concern for exposure and risk from such releases is airborne diffusion and inhalation. The highest air concentration at the WIPP Site boundary was approximately four orders of magnitude below the minimum detection limit using EPA standard methods (EPA, 1984). Due to the low air concentrations, the relative insolubility of these chemicals and their tendency to break down in the atmosphere, ingestion exposure from scavenging and deposition of contaminated particles is considered very minor and without significant risks. This pathway is not evaluated. There is little probability that liquids will be released, as only residual liquids are allowed in the waste, and potential pathways for liquids released in groundwater or surface water are nonexistent."

Summary

" The results of the experiments conducted during the test phase will be used, in part, to refine the monitoring programs that will be established for the planned operational phase, during which full-scale waste emplacement activities will occur. Environmental monitoring currently anticipated during both the operational and postclosure phase is described in Volume 1 of the petition (DOE, 1990a)."

Section 2.6.4.5.3 Regional Warping, p 2.6-24;

" In 1977 the DOE commissioned the National Geodetic Survey to put in a first order line across the WIPP facility area. This line extends from Carlsbad to San Simon Sink. It runs through both Nash Draw and the WIPP facility. In 1981, this line was resurveyed and showed subsidence in the WIPP facility at less than 0.04 in. [106]"

DOE (U.S. Department of Energy), 1991. Draft Report: Evaluation of the Effectiveness and Feasibility of the Waste Isolation Pilot Plant Engineered Alternatives: Final Report of the Engineered Alternatives Task Force, DOE/WIPP 91-007, Rev. 0, Westinghouse Electric Corporation, Carlsbad, NM.

EXECUTIVE SUMMARY, p ES-i;

" The Engineered Alternatives Task Force (EATF) was established by the United States Department of Energy (DOE) WIPP Project Office (WPO) in September, 1989 (Hunt, A., 1990), to evaluate the relative effectiveness and feasibility of implementation of selected design enhancements (referred to as 'engineered alternatives') for the Waste Isolation Pilot Plant (WIPP). These enhancements consist of modifications of existing waste forms and/or the WIPP facility, and other design variations such as passive marker systems. The purpose of this report is to summarize the methodologies and results of evaluation of the effectiveness of selected engineered alternatives relative to the existing repository design, and to discuss the feasibility of implementing these alternatives with respect to availability of technology, cost, schedule, and regulatory concerns.

Preliminary analyses of the long-term performance of the WIPP disposal system performed by Sandia National Laboratories (SNL) (referred to as 'performance assessment') have identified two potential problems in demonstrating compliance with the applicable regulation 40 CFR Part 191 (EPA, 1985) that governs the disposal of transuranic radioactive waste. The first potential problem relates to gas generation. Lappin et al. (1989) discuss the possibility that up to 1,500 moles of gas can be generated per drum (or drum equivalent) of waste from anoxic corrosion, microbial degradation, and radiolysis, at rates that may be as high as 2.55 moles/drum/year. Although processes exist to dissipate excess gas pressure, these processes are currently believed to be slow relative to the current estimates of gas generation rates, resulting in gas pressures in storage rooms that may temporarily exceed lithostatic pressure. The consequences of exceeding lithostatic pressure are currently being evaluated by SNL (Lappin et al., 1989). Unless these evaluations demonstrate that either excess pressures will not occur, or that excess pressures will not degrade the performance of the disposal system, some type of waste form or facility modification may be required to either eliminate gas generation or reduce the rate of gas generation. For example, if the organics in the waste are incinerated and vitrified, then microbial gas generation can be eliminated.

A second potential problem in demonstrating compliance with 40 CFR Part 191 relates to the consequences predicted from future inadvertent human intrusion events. Preliminary evaluations of compliance with the containment requirement of 40 CFR Part 191 performed by SNL suggest that some of the current waste forms (under current interpretations of human intrusion provisions) may eventually be found to be unacceptable for disposal at the WIPP (Marietta et al., 1989). This may be due to uncertainties in key performance parameters of the waste forms. Key parameters that control the release of radionuclides during human intrusion scenarios are permeability of the waste storage rooms, radionuclide solubilities, and the availability of brine. Permeability of the storage rooms can be effectively reduced by the use of a grout backfill and/or shredding and cementation of the waste. Solubilities can be reduced by the use of grout backfill or the addition of lime to raise the pH of any brine that may come in contact with the waste."

Section 1.0 INTRODUCTION, p 1-1;

" The Engineered Alternatives Task Force (EATF) was formed by the Department of Energy (DOE) WIPP Project Office (WPO) to evaluate the feasibility and relative effectiveness of selected enhancements to the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico (Hunt, A. 1990). These enhancements (referred to as engineered alternatives) include modifications to existing waste forms and/or the WIPP facility, and other design variations such as passive marker systems. Recommendations of the EATF will be forwarded by DOE to Sandia National Laboratories (SNL) for input into their experimental and Performance Assessment (PA) programs, as appropriate. Subsequent sections of this report describe the methodology used by the EATF to evaluate the relative effectiveness, the results of this evaluation, and the feasibility of implementing various engineered alternatives. An overview of the WIPP project in reference to the EATF effort, and the framework of the EATF, are described in this section."

Section **7.0 FEASIBILITY OF IMPLEMENTING BACKFILL ALTERNATIVES**,
7.1 STATUS OF DEVELOPMENT, p 7-1;

" Three backfill modification alternatives have been recommended for inclusion in the WIPP Experimental Program (DOE, 1990b):

- Salt with Brine Absorbent - Addition of an absorbent, such as bentonite, introduces brine absorbing capability to reduce the potential for brine penetration into the waste. . . ."

7.1.1 Salt with Brine Absorbent, p 7-2;

" Mining of the WIPP facility produces bulk salt, which is stored above ground at the WIPP site. Granulation of this salt to a consistency required for efficient emplacement and the addition of a brine sorbent such as bentonite clay will not require a research and development program. Bentonite is expected to possess the beneficial characteristics of radionuclide sorption, and brine sorption (Butcher, 1990b)."

DOE (U.S. Department of Energy), 1994. Permanent Marker Conceptual Design Report, Draft. Rev 2, November 1994. U.S. Department of Energy, Carlsbad, New Mexico.

NOTE: The above listed document was not available for inclusion in the Reference Expansion as of the printing date. Page changes will be provided as the above document becomes available for inclusion.

EPA (U.S. Environmental Protection Agency), 1985. "40 CFR 191:Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste; Final Rule." Federal Register, Volume 50, No. 182, pp.38066-38089, September 19, 1985, Office of Radiation and Air, Washington, D.C. WPO 39132.

SUMMARY, p. 38066, col. 1;

" The Environmental Protection Agency (EPA) is promulgating generally applicable environmental standards for the management and disposal of spent nuclear fuel and high-level and transuranic wastes. The standards apply to management and disposal of such materials generated by activities regulated by the Nuclear Regulatory Commission (NRC) and to disposal of similar materials generated by atomic energy defense activities under the jurisdiction of the Department of Energy (DOE). These standards have been developed pursuant to the Agency's authorities and responsibilities under the Atomic Energy Act of 1954, as amended; Reorganization Plan No. 3 of 1970; and the Nuclear Waste Policy Act of 1982.

Subpart A of these standards limits the radiation exposure of members of the public from the management and storage of spent fuel or high-level or transuranic wastes prior to disposal at waste management and disposal facilities regulated by the NRC. Subpart A also limits the radiation exposures to members of the public from waste emplacement and storage operations at DOE disposal facilities that are not regulated by the NRC.

Subpart B establishes several different types of requirements for disposal of these materials. The primary standards for disposal are long-term containment requirements that limit projected releases of radioactivity to the accessible environment for 10,000 years after disposal. These release limits should insure that risks to future generations from disposal of these wastes will be no greater than the risks that would have existed if the uranium ore used to create the wastes had not been mined to begin with. A set of six qualitative assurance requirements is an equally important element of Subpart B designed to provide adequate confidence that all containment requirements will be met. The third set of requirements are limitations on exposures to individual members of the public for 1,000 years after disposal. Finally, a set of ground water protection requirements limits radionuclide concentrations for 1,000 years after disposal in water withdrawn from most Class I ground waters to the concentrations allowed by the Agency's interim drinking water standards (unless concentrations in the Class I ground waters already exceed limits in 40 CFR Part 141, in which case this set of requirements would limit the increases in the radionuclide concentrations to those specified in 40 CFR Part 141). Subpart B also contains informational guidance for implementation of the disposal standards to clarify the Agency's intended application of these standards, which address a time frame without precedent in environmental regulations. Although disposal of these materials in mined geologic repositories has received the most attention, the disposal standards apply to disposal by any method, except disposal directly into the oceans or ocean sediments.

This notice describes the final rule that the Agency developed after considering the

public comments received on the proposed rule published on December 29, 1982, and the recommendations of a technical review conducted by the Agency's Science Advisory Board (SAB). The major comments received on the proposed standards are summarized together with the Agency's responses to them. Detailed responses to all the comments received are discussed in the Response to Comments Document prepared for this final rule.
DATE: These standards shall be promulgated for purposes of judicial review at 1:00 p.m. eastern time on October 3, 1985. These standards shall become effective on November 18, 1985."

Long-Term Monitoring; p. 38081, col. 2;

" The proposed rule addressed active institutional controls over a disposal site only in a negative sense-to prohibit reliance upon them for more than a few hundred years after disposal. The Agency's intent was to be sure that long-term protection of the environment did not depend upon positive actions by future generations. Almost all commenters agreed with this intent, although many suggested a shorter period of reliance was appropriate (see the preceding discussion under "Approach Towards Institutional Controls").

However, several commenters (including most of the States) also urged addition of a requirement for long-term monitoring of a repository after disposal. This view did not deny the need to select and design disposal systems without depending upon active controls in the future. However, it broadened this perspective by arguing that a disposal system so designed should still be monitored for a long time after disposal to guard against unexpected failures.

The Agency had not considered this viewpoint in developing the proposed rule. Accordingly, further information on this idea was sought during the "second round" of public comment, and the Agency surveyed the capabilities and expectations of long-term monitoring approaches. Evaluating this information led the Agency to several conclusions:

(1) Perhaps most importantly, the techniques used for monitoring after disposal must not jeopardize the long-term isolation capabilities of the disposal system. Furthermore, plans to conduct monitoring after disposal should never become an excuse to relax the care with which systems to isolate these wastes must be selected, designed, constructed, and operated.

(2) Monitoring for radionuclide releases to the accessible environment is not likely to be productive. Even a poorly performing geologic repository is very unlikely to allow measurable releases to the accessible environment for several hundreds of years of more, particularly in view of the engineered controls needed to comply with 10 CFR Part 60. A monitoring system based only on detecting radionuclide releases-a system which would almost certainly not be detecting anything for several times the history of the United States-is not likely to be maintained for long enough to be of much use.

(3) Within the above constraints, however, there are likely to be monitoring approaches which may, in a relatively short time, significantly improve confidence that a repository is performing as intended. Two examples are of particular interest. One involves the concept of monitoring ground water sources at a variety of distances for benign tracers intentionally released to the ground water in the repository; this approach can evaluate the delay involved in ground water movement from the repository to the environment and can

serve to validate expectations of the performance expected from the system's natural barriers. Another concept involves monitoring the small uplift of the land surface over the repository in order to validate predictions of the system's thermal behavior. Both of these approaches can be carried out without enhancing pathways for the wastes to escape from the repository.

Based on these conclusions and the public comments on this question, the Agency has included a provision for long-term monitoring after disposal in the assurance requirements of the final rule: "Disposal systems shall be monitored after disposal to detect substantial and detrimental deviations from expected performance. This monitoring shall be done with techniques that do not jeopardize the isolation of the wastes and shall be conducted until there are no significant concerns to be addressed by further monitoring." This new provision is consistent with the overall intent of the assurance requirements: To take prudent and cautious steps necessary to minimize the risks posed by the inherent uncertainties in expectations of the future. Beyond this broad mandate, however, the Agency has not specified the details of a monitoring program. That is properly left to the implementing agencies. Furthermore, the precise objectives of an appropriate monitoring program probably should not be spelled out until much more information is gathered about the characteristics and expected behavior of specific sites and designs.

Ability To Recover Wastes After Disposal

The proposed rule included an assurance requirement that recovery of these wastes be feasible for "a reasonable period of time" after disposal. The agency specifically sought comment on whether this was a desirable provision, since it would rule out certain disposal concepts, such as deep-well injection of liquid wastes. The comments received were split about evenly between those who thought the provision should be retained and those who thought it was detrimental to the overall rule. Many of those who opposed the requirement argued that it would encourage designing a geologic repository to make retrieving waste relatively easy-which might compromise the isolation capabilities of the repository or which might encourage recovery of the waste to make use of some intrinsic value it might retain (the potential energy content of spent nuclear fuel, for example).

The intent of this provision was not to make recovery of waste easy or cheap, but merely possible in case some future discovery or insight made is clear that the wastes needed to be relocated. EPA reiterates the statement in the preamble to the proposal that any current concept for a mined geologic repository meets this requirement without any additional procedures or design features. For example, there is no intent to require that a repository shaft be kept open to allow future recovery. To meet this assurance requirement, it only need be technologically feasible (assuming current technology levels) to be able to mine the sealed repository and recover the waste-albeit at substantial cost and occupational risk. The Commission's requirements for multiple engineered barriers within a repository (10 CFR Part 60) adequately address any concerns about the feasibility of recovering wastes from a repository.

Therefore, this provision should not have any effect upon plans for mined geologic repositories. Rather, it is intended to call into question any other disposal concept that might not be so reversible-because the Agency believes that future generations should have options to correct any mistakes that this generation might unintentionally make. Almost all of the commenters agreed with the validity of the objective. Accordingly, the Agency has decided to retain this assurance requirement in the final rule as proposed."

EPA (U.S. Environmental Protection Agency). 1988. Test Methods for Evaluating Solid Waste. Volume 1A through 1C and Volume 2. Field Manual Physical Chemical Methods (3rd Edition). Report EPA/SW-846, September 1988, National Technical Information Service, Springfield, VA.

ABSTRACT, p i;

" The manual provides test procedures which may be used to evaluate those properties of a solid waste which determine whether the waste is a hazardous waste within the definition of Section 3001 of the Resource Conservation and Recovery Act (PL 94-580). These methods are approved for obtaining data to satisfy the requirement of 40 CFR Part 261, Identification and Listing of Hazardous Waste. Volume IA deals with quality control, selection of appropriate test methods, and analytical methods for metallic species. Volume IB consists of methods for organic analytes. Volume IC includes a variety of test methods for miscellaneous analytes and properties for use in evaluating the waste characteristics. Volume II deals with sample acquisition and includes quality control, sampling plan design and implementation, and field sampling methods."

EPA (U.S. Environmental Protection Agency), 1996a. 40 CFR Part 194: Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations. Final Rule, Federal Register, Vol. 61, No. 28, pp. 5224-5245, February 9, 1996. Office of Radiation and Indoor Air, Washington, D.C.

SUMMARY, p. 5224, col. 1;

" The Environmental Protection Agency (EPA) is promulgating criteria for determining if the Waste Isolation Pilot Plant (WIPP) will comply with EPA's environmental radiation protection standards for the disposal of radioactive waste. If the Administrator of the EPA determines that the WIPP will comply with the standards for disposal, then the Administrator will issue to the Secretary of Energy a certification of compliance which will allow the emplacement of transuranic waste in the WIPP to begin, provided that all other statutory requirements have been met. If a certification is issued, EPA will also use this final rule to determine if the WIPP has remained in compliance with EPA's environmental radiation protection standards, once every five years after the initial receipt of waste for disposal at the WIPP. This rulemaking was mandated by the WIPP Land Withdrawal Act of 1992. EFFECTIVE DATE: These regulations are effective April 9, 1996."

p. 5238, col. 2;

" §194.14. Content of compliance certification application.

Any compliance application shall include:

(a) A current description of the natural and engineered features that may affect the performance of the disposal system. The description of the disposal system shall include, at a minimum, the following information:

(1) The location of the disposal system and the controlled area;

(2) A description of the geology, geophysics, hydrogeology, hydrology and geochemistry of the disposal system and its vicinity and how these conditions are expected to change and interact over the regulatory time frame. Such description shall include, at a minimum:

(i) Existing fluids and fluid hydraulic potential, including brine pockets, in and near the disposal system; and

(ii) Existing higher permeability anhydrite interbeds located at or near the horizon of the waste.

(3) The presence and characteristics of potential pathways for transport of waste from the disposal system to the accessible environment including, but not limited to: Existing boreholes, solution features, breccia pipes, and other potentially permeable features, such as interbeds.

(4) The projected geophysical, hydrogeologic, and geochemical conditions of the disposal system due to the presence of waste including, but not limited to, the effects of production of heat or gases from the waste."

p. 5240, col. 2;

"   §194.24 Waste characterization.

(a) Any compliance application shall describe the chemical, radiological and physical composition of all existing waste proposed for disposal in the disposal system. To the extent practicable, any compliance application shall also describe the chemical, radiological and physical composition of to-be-generated waste proposed for disposal in the disposal system. These descriptions shall include a list of waste components and their approximate quantities in the waste. This list may be derived from process knowledge, current non-destructive examination/assay, or other information and methods."

p. 5243, Assurance Requirements, col. 3;

"   §194.44 Engineered barriers.

(a) Disposal systems shall incorporate engineered barrier(s) designed to prevent or substantially delay movement of water or radionuclides toward the accessible environment."

EPA (U.S. Environmental Protection Agency) 1996b. Compliance Application Guidance for 40 CFR 194, EPA 402-R-95-014, March 29, 1996. Washington, D.C. WPO 39159.

INTRODUCTION, p. 1;

" The Compliance Application Guidance (CAG) is a companion to the final rule published at 61 FR 5224, February 9, 1996, 'Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's (WIPP) Compliance With the 40 CFR Part 191 Disposal Regulations' (to be codified at 40 CFR Part 194).

The CAG summarizes and explains the February 9, 1996 final rule. The United States Environmental Protection Agency (EPA) developed this guidance to assist the United States Department of Energy (DOE) with the preparation of any Compliance Certification Application (CCA) for the WIPP and, in turn, to assist in EPA's review of the CCA for completeness and generally to enhance the readability and accessibility of the CCA for EPA and public scrutiny. It is EPA's intent that this guidance will facilitate the understanding that DOE and the public have of the specific information that is expected to be included in a *complete* application for certification of compliance. Examples used for clarification purposes in this guidance should not be considered exhaustive or definitive, since they are provided merely to facilitate DOE's understanding of the types of information EPA is expecting. . . ."

p. 2, para. 2;

" The CAG summarizes and explains EPA's expectations of the format and content of the CCA, based on the February 9, 1996 final rule (hereafter referred to as '40 CFR Part 194'). The technical and legal requirements pertaining to the CCA are addressed by 40 CFR Parts 191 and 194. The CAG's format follows that of 40 CFR Part 194, restating the rule language in *italics*, followed by the specific guidance for that section in standard type. Only those portions of 40 CFR Part 194 (and, by reference, applicable portions of 40 CFR Part 191) for which DOE is required to submit specific information to EPA, are addressed. Portions of 40 CFR Part 194 which are applicable only to EPA, such as Subpart D, were excluded from this guidance.

The information DOE presents in any compliance application must conform to the requirements of 40 CFR Part 194."

Hora, S.C., D. von Winterfeldt, and K.M. Trauth, 1991. Expert Judgment on Inadvertent Human Intrusion into the Waste Isolation Pilot Plant, SAND90-3063, Albuquerque, NM, Sandia National Laboratories.

ABSTRACT, p i;

" Four expert-judgement teams have developed analyses delineating possible future societies in the next 10,000 years in the vicinity of the Waste Isolation Pilot Plant (WIPP). Expert-judgement analysis was used to address the question of future societies because neither experimentation, observation, nor modeling can resolve such uncertainties. Each of the four, four-member teams, comprised of individuals with expertise in the physical, social, or political sciences, developed detailed qualitative assessments of possible future societies. These assessments include detailed discussions of the underlying physical and societal factors that would influence society and the likely modes of human-intrusion at the WIPP, as well as the probabilities of intrusion. Technological development, population growth, economic development, conservation of information, persistence of government control, and mitigation of danger from nuclear waste were the factors the teams believed to be most important. Likely modes of human-intrusion were categorized as excavation, disposal/storage, tunneling, drilling, and offsite activities. Each team also developed quantitative assessments by providing probabilities of various alternative futures, of inadvertent human intrusion, and in some cases, of particular modes of intrusion. The information created throughout this study will be used in conjunction with other types of information, including experimental data, calculations from physical principles and computer models, and perhaps other judgements, as input to a 'performance assessment.' The more qualitative results of this study will be used as input to another expert panel considering markers to deter inadvertent human intrusion at the WIPP."

Murphy, John N. and H.F. Parkinson. 1978. "Underground Mine Communications," Proceedings of the IEEE, Vol. 66, No. 1, pp. 26-50.

Seismic Trapped Miner Signaling:, p. 42, col. 1, para. 2;

" In the seismic system, the trapped miner signals on the mine floor with a timber or sledge hammer, and multiple geophone arrays on the surface can detect signals in the majority of areas in overburden less than 150 m deep. Various signal-processing techniques enhance the signal-to-noise ratio; the predominant noise sources during a rescue operation are surface-generated noises from moving equipment, people walking, and power lines. A variety of processing schemes have been tried [77]; the computation of the location of the trapped miner by using the differences in the arrival time of the signals at various geophone arrays has been quite successful when the leading edge of the miner-generated pulses is of adequate clarity to accurately obtain arrival times. A seismic location system has the advantage that the miners do not have any special equipment and need only to be trained in how and when to signal. The disadvantage is that discontinuities in the overburden can significantly affect rescue signal propagation relative to both detection and computation of location of the signal. Additionally, in a rescue and recovery operation, the time required to deploy and relocate, if necessary, a massive geophone array may hamper the progress desired. However, until a suitable alternative is available, the seismic scheme does provide the miner with an additional degree of protection. The Mining Enforcement and Safety Administration (MESA) does maintain a seismic rescue system as part of its Mine Emergency Operations group [78]. Additional work is nearing completion in terms of optimizing the hardware.

The advantages and disadvantages of the seismic approach have been identified above. Also in the work described above, the propagation of VF signals through the overburden has been thoroughly analyzed. The advantages of an electromagnetic scheme for the detection and location of trapped miners are that it would not require the time-consuming deployment of geophone arrays--in fact, the site could be scanned by helicopter--and that the propagation of a VF signal through the overburden would not be so susceptible to typical overburden anomalies as is the seismic approach. The disadvantage is that a piece of special equipment (a transmitter) is required underground. Considerable efforts have been directed toward development of suitable hardware and evaluation of same in operating mines [79]. The present configurations consist of a transmitter [80] with dimensions 6.25 X 3.2 X 1.5 cm, which, when connected to an external loop of wire 25 m long, generates a peak magnetic moment of 1000 A • m^2. The transmitter and the antenna have been packaged two ways, on the left as an attachment to the top of the cap-lamp battery, and on the right as a self-contained unit to be worn on the miner's belt.

A recent modification to the system has been to incorporate an inductive voice receiver into the transmitting package so that, via a longwire or loop antenna on the surface, voice messages can be sent to the miner; he responds via code with his beacon transmitter. To support there transmitters, surface equipment has been developed--a receiver for handheld or helicopter-borne use."

NMBMMR (New Mexico Bureau of Mines and Mineral Resources). 1995. Final Report Evaluation of Mineral Resources at the Waste Isolation Pilot Plant (WIPP) Site. Vol. I, Ch. I-III, December 22, 1994.

EXECUTIVE SUMMARY, p E-1;

" The Waste Isolation Pilot Plant (WIPP) land withdrawal area occupies 16 mi^2, on the southeastern edge of the Known Potash Leasing Area (administered by BLM), about 30 miles southeast of Carlsbad, Eddy County, New Mexico. It is four miles on a side and is located in secs. 15 to 22 and 27 to 34 of T22S R31E. This study includes an additional study area about one mile wide surrounding and containing an additional 20 mi^2. The combined study area comprises about 36 mi^2.

The amount and value of natural resources under the WIPP land withdrawal area have not been calculated for more than ten years. This report performs this calculation using current and projected prices, production, geologic data, and conditions. The need for recalculating the volume and value of mineral resources within the boundaries of the WIPP land withdrawal area stems from the discovery of oil and associated natural gas in adjacent lease tracts during the late 1980s and 1990s, and the approach of potash mining.

During the late 1980s and early 1990s oil was discovered in the lower parts of the Delaware Mountain Group (Permian: Cherry Canyon and Brushy Canyon Formations) along the eastern, southern, and western boundaries of the land withdrawal area. In the Delaware Basin as a whole, these formations were not generally recognized as exploratory and development targets until the late 1980s. Prior to that time, they were usually bypassed during drilling with little or no thought that they might contain economically recoverable oil resources. Although these two formations had been penetrated by thousands of wells throughout the Delaware Basin, few attempts were made to adequately test them.

The main reason for bypassing these formations during drilling was a lack of understanding of their production characteristics. Water saturations calculated from analysis of electric logs were often high and did not differentiate oil-productive sandstones from sandstones that would yield mostly water upon completion. However, recent developments in log analysis (Asquith and Thomerson, 1994) have made it possible to differentiate Delaware sandstones with a high percentage of movable hydrocarbons from those with a low percentage of movable hydrocarbons. This type of analysis, in conjunction with the discovery of several commercial oil pools in the Brushy Canyon Formations, set off an oil drilling boom throughout the Delaware Basin that continues to the present. The Delaware play is currently the primary exploration and development play in the Permian Basin and is one of the most active oil plays in the United States. Of special note in the vicinity of WIPP was the discovery and development of commercial oil accumulations in the Brushy Canyon Formation at Cabin Lake; Livingston Ridge, Lost Tank, and Los Medaños pools.

During the last decade or so, potash mining has continued and the mining front is now much closer to the WIPP boundary. Mining by IMC has reached the edge of the additional study area on the southwest side of the WIPP. Future mining may occur mainly there or on the north.

The value of potash (sylvite and langbeinite) and petroleum (oil and gas) were calculated using iterative economic models commencing in 1996 and lasting until 2031 (potash), 2026 (petroleum), and 2038 (natural gas plus associated oil). The potash and petroleum resources produced over this time frame were calculated from estimates based on drill hole data and projections of data and geology as needed. The value calculation used these resource data and projections of historical cost, price, and other economic data.

Potash Reserves

The results of the potash resources and reserve calculation are:

Resources and reserves of the 4th langbeinite ore zone (short tons in millions).

Area, Type of Lease, and Scenario	Tons	Avg % K_2O
Entire study area		
In-place resource (>4% K_2O & actual thickness)	168.7	8.02
BLM Lease Grade reserve (>4% K_2O & 4 ft mining height)	166.5	7.22
Minable reserve (>6.25% K^2O & 6 ft mining height	72.4	7.95
Inside WIPP boundary		
In-place resource (>4% K_2O & actual thickness)	47.0	7.21
BLM Lease Grade reserve (>4% K_2O & 4 ft mining height)	40.5	6.99
Minable reserve (>6.25% K^2O & 6 ft mining height	18.0	7.59
Outside of the WIPP boundary (about one mile)		
In-place resource (>4% K_2O & actual thickness)	121.7	8.33
BLM Lease Grade reserve (>4% K_2O & 4 ft mining height)	126.0	7.30
Minable reserve (>6.25% K^2O & 6 ft mining height	54.4	8.07

Resources and reserves of the 10th sylvite ore zone (short tons in millions).

Area, Type of Lease, and Scenario	*Tons*	*Avg % K_2O*
Combined Area		
In-place resource (>10% K_2O & actual thickness)	168.2	14.61
BLM Lease Grade reserve (>10% K_2O & 4 ft mining height)	157.3	14.64
Minable reserve (>12.25% K^2O & 4.5 ft mining height	107.8	15.33
WIPP Area		
In-place resource (>10% K_2O & actual thickness)	53.7	14.26
BLM Lease Grade reserve (>10% K_2O & 4 ft mining height)	52.3	13.99
Minable reserve (>12.25% K^2O & 4.5 ft mining height	30.6	15.00
Additional Area (~1 mile around WIPP)		
In-place resource (>10% K_2O & actual thickness)	114.5	14.77
BLM Lease Grade reserve (>10% K_2O & 4 ft mining height)	105.0	14.96
Minable reserve (>12.25% K^2O & 4.5 ft mining height	77.2	15.46

p. E-4;

"Petroleum Reserves

The Results of the calculation of probable petroleum resources are:

Oil and gas resources (probable)

	Combined Area	WIPP Area	Additional Area
Primary Oil (million bbls)	35.2	12.3	22.9
Secondary Oil (million bbls)	20.2	6.4	13.8
Oil Subtotals (million bbls)	55.4	18.7	36.7
Gas Subtotals (MCF)	354	186	168

NOTE: In addition, there is an unknown but significant amount of possible oil and gas resources beneath the WIPP land withdrawal area and surrounding one-mile-wide additional area."

p. VII-1, METHOD OF POTASH RESERVE EVALUATION;

" Evaluation of potash reserves was based solely on subsurface information from 40 core holes previously drilled within and around the WIPP Site. The nearest underground mine operations are currently no closer than one mile from the outer boundary of WIPP. All 40 holes were drilled using brine (containing potassium as well as sodium chloride) to inhibit dissolution of potassium minerals. The results of chemical analyses of the ore-bearing intervals were adjusted to calculate the percentage equivalent as individual natural mineral species. Only the K_2O percentages as either sylvite or langbeinite were used to compute ore reserves."

p. XI-1, OIL AND GAS RESOURCE ESTIMATES

Ronald F. Broadhead, Fang Luo, and Stephen W. Speer

SUMMARY OF OIL AND GAS RESOURCES;

" Rigorous, quantitative estimates were made of oil, natural gas, and natural gas condensate resources that exist beneath the 16 mi^2 area of the WIPP land withdrawal area and an additional one-mile wide study area around the WIPP site. Calculations were made for resources that are extensions of known, currently producible oil and gas resources thought to extend underneath the WIPP land withdrawal area with reasonable certainty (*probable resources*). Qualitative estimates were also made of oil and gas that may be present in undiscovered pools and fields beneath the WIPP land withdrawal area (*possible resources*). Possible resources were not quantified."

p. XI-2, INTRODUCTION;

" Oil and gas resources are typically divided into several categories (Potential Gas Committee, 1993; Energy Information Administration, 1994; **Figs. 1a, 1b**). For purposes of this report, five categories of resources are referred to: 1)cumulative production; 2) proved reserves; 3) probable resources (extensions of known pools); 4) undiscovered recoverable resources; and 5) unrecoverable resources. *Cumulative production* is the total volume of crude oil, natural gas condensate, and natural gas that have been withdrawn (produced) from a pool or well. *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 from 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 (Potential Gas Committee, 1993), that is by drilling. This report restricts the definition of proved reserves to those producible resources identified as producible by existing wells (whether currently producing or abandoned). *Ultimate recovery* is the sum of cumulative production and proved reserves or probable resources for a pool or individual well.

The remainder of the resource base consists of *potential resources*. These can be summarized as hydrocarbons that can be inferred to exist, but have not yet been proven by drilling to exist. These can be grouped into: 1)*probable resources (extensions of known pools*; 2) *probable resources (new pools)*; 3) *possible resources*; and 4) *speculative resources*. These subdivisions of potential resources are differentiated on the basis of available geologic, geophysical, and engineering data and studies. *Probable resources (extensions)* consist of oil and gas in pools that have been discovered but have not yet been developed by drilling; their presence and distribution can generally be surmised with a high degree of confidence. *Probable resources (new pools)* consist of oil and gas that are surmised to exist in undiscovered pools within existing fields. *Possible resources* are less assured; they are postulated to exist outside of known fields but within productive stratigraphic units in a productive basin or geologic province. *Speculative resources* are expected to be found in stratigraphic units, basins, or geologic provinces that have not yet been proved productive; estimates of speculative resources are the least assured of all resource estimates. *Unrecoverable resources* are dispersed in such minute accumulations or under such conditions that they can not be extracted with existing or foreseeable technology."

p. XI-11, DELAWARE MOUNTAIN GROUP;

"   The Delaware Mountain Group (Guadalupian) is the major oil producing unit near the WIPP site (Fig. 14). It is subdivided into three formations (descending): Bell Canyon, Cherry Canyon, and Brushy Canyon. It was deposited basinward of the Getaway, Goat Seep, and Capitan shelf-margin and reef complexes (Fig. 15). The Delaware Mountain Group consists of sandstone, siltstone, shale, and minor (<5%) limestone, dolostone, and conglomerate (Harms and Williamson, 1988). IN areas adjacent to the WIPP site, production is obtained from the Cherry Canyon and Brushy Canyon Formations with most production coming from the Brushy Canyon.

The Bell Canyon Formation, at a depth of approximately 4500 ft, has been penetrated by most wells in the study area (Fig. 2). Most oil and gas exploratory wells drilled in the WIPP area prior to 1965 reached total depth in the upper or middle part of the Bell Canyon. Objectives were upper Bell Canyon sandstones. . . ."

p. XI-28, para 1;

"   . . . stratigraphic traps and stratigraphic trends have not been fully defined and the Bone Spring remains inadequately explored and developed in the area. It is highly likely that numerous significant commercial accumulations of oil and associated gas (possible resources) remain to be found, especially in stratigraphic traps in off-structure areas. The Potash Area, in particular, has been poorly explored because of restrictions on drilling (see Ramey, this report, for a discussion of drilling restrictions in the potash area)."

p. XI-32, ATOKA GROUP;

"   The Atoka Group is found within the WIPP site area at depths of 12,700 to more than 13,700 ft. The Atoka is composed of interbedded limestone, sandstone, and shale and generally mimics the Strawn Group in structural configuration. It ranges from 210 ft to more than 270 ft in thickness.

Although prolific production has been established within the nine-township study area from this unit in both limestone and sandstone reservoirs, all of the productive wells found within or adjacent to the WIPP land withdrawal area produce primarily from one narrow and thin (5 to 15+ ft) lenticular sandstone channel deposit. . . . Estimated ultimate recoveries push the per well average to over 8 BCF and 70 KBC. . . ."

p. XI-33, para 2;

"   Based on subsurface mapping of this particular reservoir, it appears that there is excellent potential for similar Atoka production within the confines of the WIPP land withdrawal area. . . ."

Powell, J.A. 1976. *An Electromagnetic System for Detecting and Locating Trapped Miners*, U.S. Bureau of Mines Report of Investigations, RI 8159, U.S.B.M, Pittsburgh, PA.

ABSTRACT, p. 1;

" The theory of electromagnetic fields indicates such fields could be used to detect and locate trapped miners. To be useful, the hardware of the system must meet a number of requirements, including small size, intrinsic safety, and rugged construction. Such hardware has been built, and the system has been tested by the Bureau of Mines and its contractors. These tests indicate that the electromagnetic method provides a practical means to locate miners in emergencies."

Trauth, K.M., S.C. Hora, and R.V. Guzowski, 1993. Expert Judgment on Markers to Deter Inadvertent Human Intrusion into the Waste Isolation Pilot Plant, SAND92-1382, Albuquerque, NM, Sandia National Laboratories. WPO 23389.

ABSTRACT, p i, para 2;

" The expert panel identified the basic principles to guide current and future marker development efforts: (1) the site must be marked, (2) message(s) must be truthful and informative, (3) multiple components within a marker system, (4) multiple means of communication (e.g., language, pictographs, scientific diagrams), (5) multiple levels of complexity within individual messages on individual marker system elements, (6) use of materials with little recycle value, and (7) international effort to maintain knowledge of the locations and contents of nuclear waste repositories. The efficacy of the markers in deterring inadvertent human intrusion was estimated to decrease with time, with the probability function varying with the mode of intrusion (who is intruding and for what purpose) and the level of technological development of the society. The development of a permanent, passive marker system capable of surviving and remaining interpretable for 10,000 years will require further study prior to implementation."

APPENDIX F, 3.4.2.1 *Linguistic Demography of the WIPP Site*, p. F-44;

" The language in daily use by the majority of the residents of Eddy County (in which both WIPP and the city of Carlsbad are located) is English. The county has a sizable Hispanic population (although not as large as in other parts of New Mexico) with Spanish spoken by a minority of residents, most of whom are bilingual in English. The Mexican border, however, is only 150 miles away, and parts of west texas and New Mexico in which Spanish predominates are even closer. All projections agree that the percentage of Spanish speakers in this area will increase steadily in the foreseeable future.

Eddy County is less than 1% Indian and does not contain a community of speakers of an Indian language. There is a Mescalero Apache reservation about 120 miles to the northwest, with about 1,800 speakers out of a population of 2,000. There is no actively used written language, however, and even the spoken language is severely threatened, as children are not learning it or are learning it imperfectly. The huge Navajo reservation occupies the opposite corner of the state from WIPP site and extends into northeast Arizona. The Navajo language has 130,000 speakers out of a population of 170,000, many of whom live in Albuquerque and other towns outside the reservation. The written language is in the healthiest condition of any indigenous to North America; newspapers and books are published in it. Given current trends, Navajo should last well into the next century; as only about a third of the children are becoming fluent speakers, however, it too must be considered threatened.

3.4.2.2 *The Choice of Languages*

Which languages should the messages be in? English and Spanish are obvious choices, by virtue of their being spoken in the area of WIPP and also being two of the most widely spoken languages in the world. Our feeling is that if the scholars of future millennia cannot read current English or Spanish, they won't be able to read any language of today. However, because there are good reasons to mark every radioactive waste site in the world identically, more languages should be represented. Those of the United Nations are obvious choices: Arabic, Chinese, French, and Russian, in addition to English and Spanish.

Markers in countries where none of the above is the local language (say, Japan) will also have to be marked in that language. This means that (assuming that at least some markers will have all languages represented) there will have to be space on the markers for a seventh language. We suggest that the seventh language on the WIPP site markers be Navajo. While the immediate area contains few if any Navajo speakers, marking in Navajo grants recognition to the fact that Native American peoples predominated in the area for many thousands of years. Also, Mescalero Apache, which is spoken relatively close to WIPP, is very closely related to Navajo.

It will be important to consult with the Navajos themselves to ensure that they feel that including a message in their language is appropriate. After all, they may see it as a patronizing attempt to appease them as one more desecration of what was once Indian land is carried out. That Native peoples might not have an automatic revulsion at the idea of marking the WIPP site in an indigenous language, however, is suggested by the fact that the President of the Mescalero Apache Tribal Council, Wendell Chino, has recently received a Department of Energy grant to investigate the possibility of storing radioactive waste on their reservation.

There exists today a number of artificially constructed 'international' languages, the most notable of which is Esperanto. Millions of people in dozens of countries have had some connection with this language, but the number of effective speakers is under 50,000. Study and use of Esperanto has had its ups and downs. It peaked between the two world wars, and was especially popular in the smaller European countries. Its effective death knell was sounded when the U.S. and the Soviet Union joined forces to prevent it from becoming a working language of the United Nations. We see no prospect of a widespread adoption of Esperanto, and do not recommend it as a language of the markers."

BIBLIOGRAPHY DOCUMENTS

DOE (U.S. Department of Energy). 1990. *Radionuclide Emission Data Package for the Waste Isolation Pilot Plant*. U.S. Department of Energy, Carlsbad, NM.

SUMMARY, p 5-1;
" The EPA has established regulations (40 CFR 61, Subpart H) limiting airborne radionuclide emissions from DOE facilities to releases that would not cause any member of the public to receive, in any year, an effective dose equivalent equal to or exceeding 10 mrem/yr. The total dose to a member of the public at maximum risk from projected annual radioactive releases from the WIPP facility during the Test Phase is established to be 0.00257 mrem/yr. This value represents 0.025 percent of the EPA airborne radionuclide emission standard. Increased chances of contracting a fatal cancer for this individual at maximum risk are less than 1 in 70,000,000 (1.43×10^{-08})."

DOE (U.S. Department of Energy), 1992. Statistical Summary of the Radiological Baseline Program for the Waste Isolation Pilot Plant, DOE/WIPP 92-037, U.S. Department of Energy, Carlsbad, NM.

Section 1.0 Introduction, p 1-1;

" The Waste Isolation Pilot Plant (WIPP) is a U. S. Department of Energy (DOE) research and development project to demonstrate the safe disposal of waste materials contaminated with transuranic (TRU) radionuclides from defense programs. From 1986 through 1989, the WIPP Radiological Baseline Program (RBP) was dedicated to characterizing the radiological environment in the vicinity of WIPP prior to the start of waste handling operations. The preoperational data collected during the RBP, along with operational data collected at control locations, will serve as a basis for evaluating the results of the WIPP Operational Environmental Monitoring Program (OEMP). This report presents statistical summaries of the RBP data bases in a form that will facilitate their use in the OEMP."

DOE (U.S. Department of Energy), 1993. Waste Isolation Pilot Plant Land Management Plan, DOE/WIPP 93-004, U.S. Department of Energy, Carlsbad Area Office, Carlsbad, NM.

Section 1.2 Management Goal, p 1-5;

"   The goal of this land management plan is to manage the surface of the withdrawal area under the traditional public land use concept of multiple use and to minimize, to the extent possible, land use restrictions. It is not the intent of the DOE to manage the surface of the withdrawal area as a WIPP exclusive-use area. The subsurface of the withdrawal area is restricted to exclusive use by the WIPP, except for two 320-acre tracts of land within the withdrawal area that are leased for oil and gas development below 6000 feet (Federal Oil and Gas Leases No. NMNM 02953 and No. NMNM 02953C). This restriction is needed to protect the long-term integrity of the WIPP repository. In addition, it is clearly the intent of DOE that during repository operations, facility safety and security shall be maintained."

DOE (U.S. Department of Energy). 1994. WIPP Active Access Controls After Disposal Design Concept Description (Draft). Revision 1, December 1994. U.S. Department of Energy, Carlsbad, NM.

SCOPE, p 2;

" The design description addresses a means of controlling access to the site of the repository's surface footprint (the repository area projected to the surface). It is anticipated that active control of access to the site will be exercised by the DOE or other federal government entity for at least 100 years. Control of access will preclude the inadvertent intrusion into the disposed waste by deep well drilling or mining of natural resources. The report also describes a process for scheduling activities required to meet the needs of the Long Term Monitoring of the repository performance. Many of these activities will be initiated during the disposal phase to establish data bases and are planned to continue beyond the time after removal of the site structures and return of the site to as near its original configuration as possible. Permanent Marker testing and Long Term Monitoring requirements will impact return of the site to its original condition."

U.S. Congress, 1992. Waste Isolation Pilot Plant Land Withdrawal Act, Public Law 102-579.

"An Act
To withdraw land for the Waste Isolation Pilot Plant, and for other purposes.
Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,"

SEC 2 (20) defines TRANSURANIC WASTE as follows: "The term 'transuranic waste' means waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for--

(A)high-level radioactive waste;

(B) waste that the Secretary has determined, with the concurrence of the Administrator, does not need the degree of isolation required by the disposal regulations; or

(C) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with part 61 of title 10, Code of Federal Regulations."

SEC.3.LAND WITHDRAWAL AND RESERVATION FOR WIPP.;

" (a)LAND WITHDRAWAL, JURISDICTION, AND RESERVATION.--

(1)LAND WITHDRAWAL.--Subject to valid existing rights, and except as otherwise provided in this Act, the lands described in subsection (c) are withdrawn from all forms of entry, appropriation, and disposal under the public land laws, including without limitation the mineral leasing laws, the geothermal leasing laws, the material sale laws (except as provided in section 4(b)(4) of this Act), and the mining laws.

(2)JURISDICTION.--Except as otherwise provided in this Act, jurisdiction over the Withdrawal is transferred from the Secretary of the Interior to the Secretary.

(3)RESERVATION.--Such lands are reserved for the use of the Secretary for the construction, experimentation, operation, repair and maintenance, disposal, shutdown, monitoring, decommissioning, and other authorized activities associated with the purposes of WIPP as set forth in section 213 of the Department of Energy National Security and Military Applications of Nuclear Energy Authorization Act of 1980 (Pub.L. 96-164; 93 Stat. 1259, 1265), and this Act.

(b) REVOCATION OF PUBLIC LAND ORDERS.--Public Land Order 6403 of June 29, 1983, as modified by Public Land Order 6826 of January 28, 1991, and any memoranda of understanding accompanying such land orders, are revoked.

(c)LAND DESCRIPTION.--

(1)BOUNDARIES.--The boundaries depicted on the map issued by the Bureau of Land Management of the Department of the Interior, entitled 'WIPP Withdrawal Site Map,' dated October 9, 1990, and on file with the Bureau of Land Management, New Mexico State Office, are established as the boundaries of the Withdrawal.

(2)LEGAL DESCRIPTION AND MAP.--Within 30 days after the date of the enactment of this Act, the Secretary of the Interior shall--

(A) publish in the Federal register a notice containing a legal description of the Withdrawal; and

(B) file copies of the map described in paragraph (1) and the legal description of the Withdrawal with the Congress, the Secretary, the Governor of the State, and the Archivist of the United States.

(d)TECHNICAL CORRECTIONS.--The map and legal description referred to in subsection (c) shall have the same force and effect as if they were included in this Act. The Secretary of the Interior may correct clerical and typographical errors in the map and legal description.

(e)WATER RIGHTS.--This Act does not establish, nor may any provision be construed to establish, a reservation to the United States with respect to any water or water rights. Nothing in this Act shall affect any water rights acquired by the United States prior to the date of enactment of this Act. The United States may apply for and obtain water rights for purposes associated with this Act only in accordance with the substantive and procedural requirements of the laws of the State."

"SEC.7.DISPOSAL OPERATIONS.

(a)TRANSURANIC WASTE LIMITATIONS.--

(1) REM LIMITS FOR REMOTE-HANDLED TRANSURANIC WASTE.--

(A) 1,000 REMS PER HOUR.--No transuranic waste received at WIPP may have a surface dose rate in excess of 1,000 rems per hour.

(B) 100 REMS PER HOUR.--No more than 5 percent by volume of the remote-handled transuranic waste received at WIPP may have a surface dose rate in excess of 100 rems per hour.

(2) CURIE LIMITS FOR REMOTE-HANDLED TRANSURANIC WASTE.--

(A) CURIES PER LITER.--Remote-handled transuranic waste received at WIPP shall not exceed 23 curies per liter maximum activity level (averaged over the volume of the canister).

(B) TOTAL CURIES.--The total curies of the remote-handled transuranic waste received at WIPP shall not exceed 5,100,000 curies."

(3) CAPACITY OF WIPP.--The total capacity of WIPP by volume is 6.2 million cubic feet of transuranic waste."

SEC. 8. ENVIRONMENTAL PROTECTION AGENCY DISPOSAL REGULATIONS.

(a) REINSTATEMENT.--

(1) IN GENERAL.--Except as provided in paragraph (2), the disposal regulations issued by the Administrator on September 19, 1985, and contained in subpart B of part 191 of title 40, Code of federal regulations, shall be in effect.

(2) EXCEPTIONS.--Paragraph (1) shall not apply to--

(A) the 3 aspects of sections 191.15 and 191.16 of such regulations that were the subject of the remand ordered in Natural Resources Defense Council, Inc. v. United States Environmental Protection Agency, 824 F.2d 1258(1st Cir., 1987); and

(B) the characterization, licensing, construction, operation, or closure of any site required to be characterized under section 113(a) of Public Law 97-425."

(d) DISPOSAL REGULATIONS.--

(A) IN GENERAL.--The Secretary shall comply at WIPP with the final disposal regulations. Within 7 years of the date of first receipt of transuranic waste at WIPP, the Secretary shall submit to the Administrator an application for certificatio of compliance with such regulations.

(B) CERTIFICATION BY ADMINISTRATOR.--Within 1 year of receipt of the application under subparagraph (A), the Administrator shall certify, by rule pursuant to section 553 of title 5, United Staes Code, whether the WIPP facility will comply with the final disposal regulations, and sections 556 and 557 of such title shall not apply.

(C) JUDICIAL REVIEW.--Judicial review of the certification of the Administrator under subparagraph (B) shall not be restricted by the provisions of section 221 c. of the Atomic Energy Act of 1954 (42 U.S.C. 2271(c)).

(D) LIMITATION.--Any certification of the Administrator under subparagraph (B) may only be made after the application is submitted to the Administrator under subparagraph (A)."

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