A-98-49
II-B3-19

Department of Energy
Carlsbad Field Office
P. O. Box 3090
Carlsbad, New Mexico 88221

APR 26 2001

Mr. Frank Marcinowski
Office of Radiation and Indoor Air
U.S. Environmental Protection Agency
401 M. Street, S. W.
Washington, DC 20460

Dear Mr. Marcinowski:

This purpose of this letter is to request approval from the Environmental Protection Agency (EPA) regarding a proposed change in the utilization of Panel 1 at the Waste Isolation Pilot Plant (WIPP). The proposed change will allow the DOE to determine the optimum waste configuration in each room at the time of emplacement based on considerations of worker safety, operational efficiency and cost. We previously briefed your agency regarding this subject on June 28 and December 13, 2000.

As part of on-going operational evaluations, the flexibility to vary the utilization of Panel 1 was identified as important from both a worker safety and an operational efficiency perspective. The rooms of Panel 1 are over 12 years old and the natural process of room closure has reduced the vertical clearance to the extent that re-mining would be necessary to provide sufficient headroom and acceptable floor conditions for waste to be emplaced as described in the CCA, i.e., three waste containers high. Adding the flexibility included in the proposed change will allow the DOE to minimize the worker risk associated with re-mining and maintaining the back (roof) and ribs (sides) of the older excavations and will also improve operational efficiency.

The proposed changes include the flexibility to do the following:

- Place CH-TRU waste containers in either 1-, 2- or 3-high stacks. MgO backfill will be emplaced with the waste so that the ratio of backfill to waste remains consistent with ratios described in the CCA.
- Use all or only a part of the space in each of the seven Panel 1 rooms for waste disposal. Some rooms could be bypassed and left void of waste.
- Close Panel 1 without emplacing any RH-TRU waste.

:DM:VW:01-0762:UFC:5486

The enclosed package contains a description of the requested changes and an analysis of their effects. Our analysis demonstrates that these proposed changes are non-significant, i.e., that the changes will not significantly change the certified baseline or compromise repository performance.

If you have any questions, please contact Daryl Mercer at 505-234-7452.

Sincerely,

Lawrence D. Bailey Jr. for

Dr. Inés R. Triay
Manager

Enclosure

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PANEL 1 UTILIZATION ANALYSIS FOR THE WASTE ISOLATION PILOT PLANT

REVISION 0

April 26, 2001

Sandia National Laboratories

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EXECUTIVE SUMMARY

The Department of Energy (DOE) is requesting a change to allow the flexibility to alter the waste emplacement configuration in Panel 1 of the Waste Isolation Pilot Plant (WIPP) repository. This flexibility of waste emplacement in Panel 1 will allow the DOE to determine the specific waste configuration in each room based upon operational considerations at the time of emplacement, primarily ground control and waste receipt rate. Ground control is extremely important to the continued safe and efficient operation of WIPP. Because of the age of Panel 1 excavations (over 12 years), closure of the rooms has reduced the headroom required to meet the Compliance Certification Application (CCA) design configuration, while floor heave has in some cases made access by waste handling equipment difficult. The proposed change will allow the DOE to minimize the worker risk associated with re-mining of the floor in these rooms, as well as the increased refurbishing and maintenance of the back (roof) and ribs (sides) which would be required for safe disposal operations. The proposed change will also allow the DOE to maximize the efficiency of waste disposal operations, while fully complying with the regulatory requirements. The DOE also proposes to dispose of only contact-handled transuranic (CH-TRU) wastes in Panel 1 because it is projected that this panel will be closed prior to first receipt of remote-handled transuranic (RH-TRU) waste.

In the CCA, it was assumed that all disposal rooms, including those in Panel 1, would be filled with waste to design capacity. In this configuration, CH-TRU waste drums are stacked three-high and magnesium oxide (MgO) is used as a backfill material. In the CCA design, remote-handled transuranic (RH-TRU) canisters are placed in the walls of the rooms.

The proposed alternatives for Panel 1 utilization include the flexibility to:

1. Place CH-TRU waste containers in 1-, 2- or 3-high stacks. MgO backfill will always be emplaced with the waste so that the ratio of backfill to waste remains consistent with ratios described in the CCA.

2. Use all or only a part of the space in each of the seven Panel 1 rooms for waste disposal. Some rooms could be bypassed and left void of waste altogether.

3. Close Panel 1 without emplacing any RH-TRU waste.

The DOE technical review of this proposed change includes an analysis of the related performance assessment (PA) components such as features, events and processes (FEPs). These related PA components have been compared to the certified baseline to determine if any conflicts or inconsistencies with key assumptions result from the proposed change. Additionally, this review includes an evaluation of the proposed change and its expected effect(s) on drilling releases. These analyses demonstrate that any or all of the proposed alternatives discussed above are insignificant to repository performance and represent minor changes to the certified baseline.

CONTENTS

ACRONYMS AND ABBREVIATIONS

CCA	Compliance Certification Application
CCDF	Complementary Cumulative Distribution Function
CH-TRU	Contact-handled Transuranic
DOE	U.S. Department of Energy
DP	Disturbed Performance
EPA	U.S. Environmental Protection Agency
FEPs	Features, Events, and Processes
MgO	Magnesium Oxide
PA	Performance Assessment
RH-TRU	Remote-handled Transuranic
SNL	Sandia National Laboratories
SO-C	Screened Out by Consequence
SO-P	Screened Out by Probability
SO-R	Screened Out by Regulatory exclusions
TRU	Transuranic Waste
UP	Undisturbed Performance
WIPP	Waste Isolation Pilot Plant

1. INTRODUCTION

The Waste Isolation Pilot Plant (WIPP) in southeastern New Mexico is being operated for the disposal of transuranic (TRU) radioactive waste from Department of Energy (DOE) defense programs. In October 1996, the DOE submitted its Compliance Certification Application (CCA; DOE 1996) to the U.S. Environmental Protection Agency (EPA). In May 1998, the EPA certified (EPA, 1998) that the WIPP will comply with the radioactive waste disposal regulations of 40 CFR Part 191 (EPA, 1993).

It was always anticipated that changes would be made to the WIPP facilities and operations. These changes were expected to be the result of compliance activities, advances in technology, advances in scientific understanding, and identification of better and more cost effective operational alternatives.

In the WIPP CCA, it was assumed that all disposal rooms in Panel 1 would be filled with waste to design capacity. Waste drums would be stacked three high, and magnesium oxide (MgO) would be used as a backfill material above and around the waste. Because of the age of Panel 1 and the natural creep closure of the rooms, following this plan would require extensive re-mining. In order to avoid this, and to allow flexibility in utilization of the Panel 1 rooms based on their individual ground control conditions, the DOE is proposing a change in its utilization of Panel 1. This document provides an analysis of these proposed changes in Panel 1 utilization and the impact of these changes on repository performance.

This document has been developed with the understanding that when seeking approval for changes, the DOE must provide information to the EPA sufficient to support a determination of insignificance. As such, and consistent with EPA's recent guidance, this document includes: 1) a description of the proposed change (Section 2); 2) the rationale for the proposed change (Section 2); and 3) an assessment of the expected impact(s) of the change (Section 3 and Attachment IV). The DOE believes that the information presented in this document demonstrates that the proposed changes in the utilization of Panel 1 will have insignificant impacts on repository performance and represent insignificant changes to the certification baseline.

2. PROPOSED CHANGE TO UTILIZATION OF PANEL 1

2.1 BACKGROUND

The WIPP consists of 8 panels to be mined sequentially over a period of 35 years (the two access drifts comprise two additional "equivalent" panels, resulting in a storage capacity for the WIPP of 10 panels). Panel 1 of the WIPP, consisting of 7 disposal rooms (each 300 feet long, 33 feet wide and 13 feet high), was mined between 1986 and 1988. Mining of Panel 2, also consisting of 7 disposal rooms, was completed and certified in September 2000. Mining has not commenced on any other panels.

Time-dependant (creep) closure is a natural process in salt and has always been expected and incorporated into the design for the WIPP repository. However, due to the age of Panel 1, considerable creep closure has occurred in many of the Panel 1 disposal rooms, reducing the working height in these rooms. Room closure consists of both roof and floor convergence, so that as well as loss of room height, floor heave can lead to conditions which may make the operation of waste handling equipment difficult. Thus, the delayed opening of WIPP and a slower than expected waste receipt rate mean that waste disposal as originally planned in Panel 1 would require a substantial amount of re-mining in the disposal rooms. The only practicable means to restore adequate working height, and to maintain ease of access for equipment, is to remove material from the floor. In advance of receipt of first waste, approximately one-meter of material was removed from the floor of Panel 1, Room 7. The remaining rooms in Panel 1 will require at least a similar level of re-mining before waste can be placed in the rooms as originally envisioned.

To avoid this extensive re-mining, the DOE proposes to utilize Panel 1 for disposal of CH-TRU wastes, but with the specifics of the utilization being dictated by operational considerations at the time of emplacement. Operational considerations will primarily concern ground control which, because of the age of Panel 1, is extremely important to the continued safe and efficient operation of WIPP. In addition, it is probable that no RH-TRU waste will be received prior to the closure of Panel 1. Proposed Panel 1 utilization alternatives therefore include (as dictated by the conditions of the rooms and waste receipt rate at the time):

1. Placing waste containers in 1-, 2- or 3-high stacks.

2. Using all or part of the space in each of the seven Panel 1 rooms for waste disposal. Some rooms could be bypassed and left void of waste.

3. Closing Panel 1 without emplacing any RH-TRU waste.

A significant benefit of a more flexible approach to waste disposal in Panel 1 is that it minimizes risk to workers due to additional mining operations in Panel 1. Increased maintenance and refurbishing of the floors, backs (roof) and ribs (sides) of the older excavations involves risks to workers because the re-mining operations are performed on host rock that has been deformed from its initial state, and may be fractured. The flexible approach that is proposed will also maximize WIPP efficiency and cost-effectiveness:

1. when it is determined that a room cannot be reasonably maintained for the time required to fill the room; or,

2. when extensive re-mining of the floor would be required to return a room to full dimensions.

In these cases, the use of 1- or 2-high stacks or the use of only part of a room would allow the DOE to emplace waste in rooms that otherwise would have to be abandoned.

It is important to note that the proposed utilization of Panel 1 will not change the ratio of MgO to waste in Panel 1 or throughout the repository.

3. FEP ANALYSIS

The CCA is based on an assessment of the probabilities and consequences of future occurrences involving the WIPP that begins with the determination of scenarios to be analyzed and ends with an assessment of the consequences for relevant scenarios. Scenarios are determined through a formal process that has four steps:

1. FEPs potentially relevant to the WIPP are identified and classified.

2. Certain FEPs are eliminated according to well-defined screening criteria as not important or not relevant to the performance of WIPP.

3. Scenarios are formed from the remaining FEPs in the context of the regulatory performance criteria.

4. Scenarios are specified for consequence analysis.

Consequence analysis for the selected scenarios involves quantitative modeling with a linked system of computer codes, Monte Carlo analysis of uncertainties, and production of a Complementary Cumulative Distribution Function (CCDF) for the probability of release that is compared to the containment requirement from 40 CFR 191.

Because a change in the utilization of Panel 1 of the WIPP has been proposed, the processes of scenario determination and consequence analysis must be revisited to determine what, if any, relevance the proposed change may have on the compliance CCDF. The analysis reported here parallels the approach used to develop scenarios and analyze consequences in the CCA. First, all WIPP-related FEPs identified in the CCA are examined to determine:

1. Is the FEP still meaningful given the proposed change to Panel 1 utilization?

2. Is the screening argument applied in the CCA still valid given the proposed change?

3. Does the proposed change affect modeling for FEPs that were included ("screened-in" FEPs) in the CCA?

Second, the CCA models that were used to simulate the FEPs are identified. Each of these models has specific model parameters that may be affected by the proposed change. The third step is identification of the model parameters for which a value change is indicated if the proposed change is implemented. Finally, the potential impact, if any, of model parameter value changes on the compliance CCDF is considered.

3.1 RELEVANCE OF PROPOSED CHANGE ON CCA FEPS

In the CCA, the DOE identifies all significant processes and events that may affect the disposal system. There were over 1000 FEPs originally considered for the WIPP. The DOE determined that 240 of these related to WIPP. The 240 FEPs were evaluated (screened) to identify those FEPs that should be accounted for in performance assessment calculations and those FEPs that need not be considered further. Sections 6.1 and 6.2 of the CCA contain a discussion of the development of a comprehensive initial set of FEPs, the methodology and criteria used for screening, and a summary of the FEPs retained for scenario development. Detailed discussion of the basis for eliminating or retaining particular FEPs is provided in Appendix SCR of the CCA.

The DOE's process of removing FEPs from consideration in performance assessment calculations involved the structured application of explicit screening criteria. The criteria used to screen out FEPs are explicit regulatory exclusions (SO-R), and probability (SO-P), or consequence (SO-C) considerations. FEPs not screened as SO-R, SO-P, or SO-C were retained for inclusion in performance assessment calculations and were classified as undisturbed performance (UP) or disturbed performance (DP) FEPs. In the analysis discussed below, the FEPs are further divided into "Natural FEPs," "Waste and Repository-Induced FEPs," and "Human-Induced FEPs."

3.2 NATURAL FEPS

Natural FEPs are defined as those that deal with natural processes in the WIPP environment, mostly of geologic origin, not directly relating to the existence of the repository. The WIPP-related, "Natural FEPs" identified by the DOE are shown in Attachment I. If the DOE implements the proposed changes in utilization of Panel 1, all of the 72 FEPs listed in Attachment I will still be relevant to the WIPP. In addition, none of the screening arguments for the FEPs listed in Attachment I will change. Categorically, the natural FEPs can be eliminated from further consideration because DOE's proposed changes in utilization of Panel 1 have no bearing on natural processes as they are described in Attachment I.

3.3 WASTE- AND REPOSITORY-INDUCED FEPS

The waste- and repository-induced FEPs are those that relate specifically to the waste material, waste containers, shaft seals, MgO backfill, panel closures, repository structures, and investigation boreholes. All FEPs related to radionuclide chemistry and radionuclide migration are included in this category. FEPs related to radionuclide transport resulting from future borehole intersections of the WIPP are also defined as waste- and repository-induced FEPs.

The WIPP-related "Waste- and Repository-Induced FEPs" identified by the DOE are shown in Attachment II of this document. The proposed changes in utilization of Panel 1 have no effect on the relevance or the screening arguments for the FEPs listed in Attachment II. Further, CCA assumptions, models, parameters, and documentation are unchanged for all but four of the FEPs listed in Attachment II. The four FEPs that have associated CCA assumptions, models, parameters, and documentation that might be affected by DOE's proposed change are W32 (consolidation of waste), W84 (cuttings), W85 (cavings), and W86 (spallings). These four FEPs are discussed in Sections 3.5 and 3.6.

The Waste- and Repository-Induced FEPs can be broken down into a number of natural groupings, which are used in the following discussion.

3.3.1 Repository Scale FEPs

For many of the FEPs listed in Attachment II, proposed changes in the utilization of Panel 1 would not have an effect because these FEPs address repository characteristics or repository-scale processes. Any process that occurs throughout the repository due to repository-scale phenomena will not be affected by the changes that the DOE is proposing.

This group of FEPs includes all those related to gas generation either from corrosion of waste container metals or from microbial degradation of cellulosic, plastic, and rubber materials contained in the waste. While gas production is a molecular process and will vary from room to room depending on the quantity of gas-generating material in the room, gas equilibrates relatively quickly throughout the repository as modeled in the CCA. Therefore, CCA models look at gas production not on a room-by-room basis, but on a repository scale. The DOE proposal may lower the quantity of gas generating material in a given room(s), but it does not lower the total quantity of gas generating material in the repository.

Similarly, changes in the utilization of Panel 1 would not have an effect on FEPs related to changing repository temperatures. CCA models consider global temperature changes, not temperature gradients within the repository. Therefore, any variation in heat generation due to changing quantities of waste in a given room would not be significant in the CCA models.

3.3.2 Seal Process FEPs

The changes that DOE is proposing for Panel 1 utilization would also have no effect on seal processes or those FEPs listed in Attachment II that address seal processes. Therefore, seal processes do not change, and seal FEPs are eliminated from further consideration. This group of FEPs would include processes such as "Seal Geometry (W6)" and "Seal Physical Properties (W7)."

3.3.3 Container Scale FEPs

The nature of the waste containers (characteristics) and those FEPs listed in Attachment II that address container characteristics or container-scale processes will also not change as a result of the changes that DOE is proposing for Panel 1 utilization. Therefore, container-scale processes and container-scale FEPs are eliminated from further consideration. This group of FEPs would include "Container Form (W5)" and "Container Integrity (W34)."

3.3.4 Waste Scale FEPs

For most of the FEPs listed in Attachment II, proposed changes in the utilization of Panel 1 would not have an effect because those FEPs address waste characteristics or waste-scale processes. The nature and characteristics of the waste disposed will not change as a result of the changes that DOE is proposing for Panel 1 utilization and waste-scale processes and waste-scale FEPs are therefore eliminated from further consideration. This group of FEPs include "Radionuclide Decay and In-growth (W14)" and "Helium Gas Production (W54)."

3.3.5 Molecular Scale FEPs

The changes that DOE is proposing for Panel 1 utilization have no effect on molecular phenomena or on those FEPs listed in Attachment II that address molecular phenomena. Therefore, molecular-scale processes and molecular-scale FEPs are eliminated from further consideration. This group of FEPs would include processes such as "Diffusion (W91)", "Osmotic Processes (W98)", and "Actinide Sorption (W61)."

3.3.6 Biosphere Process FEPs

For the FEPs listed in Attachment II that address biosphere processes, the changes that DOE is proposing for Panel 1 utilization have no effect. Since biosphere processes do not change, biosphere FEPs are eliminated from further consideration. This group of FEPs would include processes such as "Accumulation in Soils (W102)" and "Plant Uptake (W101)."

3.3.7 Conservative Assumption FEPs

There are also three FEPs in Attachment II that were eliminated from further consideration because their exclusion was (in the CCA) and is still considered to be conservative. These are W9, "Backfill Physical Properties," W35, "Mechanical Effects of Backfill," and W75, "Chemical Degradation of Backfill." These FEPs involve physical characteristics of the backfill material. The models used in the CCA do not take any credit for this backfill. As a result, W9, W35, and W75 were screened out of the CCA based on consequence.

3.4 HUMAN-INITIATED EVENTS AND PROCESSES

The WIPP-related "Human-Initiated Events and Processes" identified by the DOE for the CCA are shown in Attachment III. If the DOE implements the proposed changes in utilization of Panel 1, all of the FEPs listed in Attachment III will still be relevant to the WIPP. However, none of the screening arguments for the FEPs listed in Attachment III will change. Most human-initiated FEPs can be eliminated from further consideration because DOE's proposed changes in utilization of Panel 1 have no bearing on human-initiated processes as they are described in Attachment III. The two exceptions to this statement are H21, "Drilling Fluid Flow", and H22, "Drilling Fluid Loss".

H21 states that "drilling within the controlled area could result in releases of radionuclides into the drilling fluid." This is true, and the release of radionuclides to drilling fluid will increase as the quantity of waste impacted increases. Therefore, the number of waste containers in a stack will have bearing on the release of radionuclides to drilling fluid. However, this is very similar to W84, W85, and W86 (see Section 3.6) and is covered under the discussion of those FEPs.

H22 addresses the issue of drilling fluid loss to thief zones during drilling. The potential for thief zones in Panel 1 will increase as a result of the DOE's proposed utilization of the panel especially at early times in rooms that may be left vacant (no waste, no MgO). As time passes, all of the rooms will close. Because the first drilling intrusion in the CCA does not occur until after 300 years, the potential increased incidence in thief zones at early times has no effect.

3.5 RELEVANCE OF PROPOSED CHANGE ON THE CCA BASELINE FOR CONSOLIDATION OF THE WASTE (FEP W32)

Salt creep occurs naturally in the Salado halite resulting in creep closure of the excavated regions. If the rooms were empty, creep closure would eventually close the rooms. In the waste disposal region, creep closure leads to waste consolidation, which will continue until the waste provides sufficient support to stop any further closure. The amount of waste consolidation that occurs and the time it takes to consolidate are governed by properties of the waste (waste strength, modulus, etc.), properties of the surrounding rock, the dimensions and location of the room, and the quantities of materials present in the room.

Three major material-response models are required to describe and analyze the closure/consolidation process. The first model describes how the halite creeps as a function of time and stress. The second model describes the state of consolidation of the waste as a function of applied stress. A third constitutive model is used to model the mechanical behavior of anhydrite marker beds. For the CCA, these models were numerically implemented in the SANTOS computer code, which is used to calculate the change in porosity in the disposal rooms, which is input to the fluid-flow code, BRAGFLO. This is done through the use of a porosity surface, which is a look-up table relating porosity (void volume) to (1) time after sealing and (2) gas pressure.

The alternatives suggested for Panel 1 utilization have no effect on this SANTOS implementation since the geomechanics of salt creep and anhydrite marker bed behavior are unchanged from the fundamental models used for the CCA (Stone, 1997). Variation in the inventory, or of room utilization, would yield a range of porosity and permeability for individual rooms within Panel 1. The normal configuration of 3-high stacks of waste is included in the CCA (Appendix PORSURF). Alternatives with 1-high or 2-high stacks would reduce the thickness of the compacted waste, but the intrinsic properties of the stack would not be changed. That means permeability would be unchanged from the CCA (1.7×10^{-13} m^2) and the porosity of the compacted drum(s) would be unchanged. If rooms are left open, they will close to a condition equivalent to unmined salt. The permeability of these rooms will be much less than the assumed permeability of waste for the CCA (1.7×10^{-13} m^2). In effect, the very low permeability of the closed rooms, and the lack of radionuclides, imply that these rooms can be ignored in the performance assessment.

The small variations in overall porosity of the rooms in Panel 1, which might result from using a more flexible approach to disposal, must also be viewed in terms of the natural uncertainties in the calculation of mechanical response of the excavated and filled rooms. Approximations in the SANTOS analyses include ignoring the details of the near room stratigraphy, the choice of boundary locations and conditions, and choices over mesh refinement. All of these approximations lead to some uncertainty in the calculated response of the rooms and the waste, and these uncertainties will mask any small influence on the porosity surface of changing the inventory in a few rooms in Panel 1. It is also worth noting that the overriding influence on room closure and waste consolidation in the CCA is the influence of gas generation in developing pressures to offset closure. This effect will be unchanged due to the proposed changes in utilization in Panel 1. For all of these reasons it is apparent that the proposed changes will not effect the estimation of waste consolation or the calculation of repository wide porosity development.

3.6 RELEVANCE OF PROPOSED CHANGE ON THE CCA BASELINE FOR CUTTINGS (FEP W84), CAVINGS (FEP W85), AND SPALLINGS (W86)

The CCA and its supporting analyses indicate that direct releases associated with intrusion events are the dominant contributors to total release from the WIPP. Total release and waste removal due to drilling events are directly correlated. If the volume and associated activity of waste released to the surface increases, the compliance CCDF will shift to the right, closer to the release limits of 40 CFR 191. If the volume and associated activity of waste released to the surface decreases, the CCDF will shift to the left, farther from the release limits of 40 CFR 191. If the volume of waste released to the surface remains essentially the same, the compliance CCDF will essentially be unchanged. The primary mechanisms for direct releases to the surface are cuttings, cavings, and spallings. Releases due to direct brine release (DBR) are a relatively minor contributor to the total release from the repository.

Cuttings are materials removed to the surface through drilling mud by the direct mechanical action of the drill bit. The activity of waste removed to the surface as cuttings for an individual drilling event is the product of the area of the drill bit and the areal activity density of the waste, typically expressed as Curies/m^2 or EPA Units/m^2. This product is a function of the drill bit area, but is independent of conditions in the repository such as pressure, porosity or saturation. The drill bit area is not affected by the proposed change in utilization of Panel 1.

Cavings are materials introduced into the drilling mud by the erosive action of circulating drilling fluid on the waste in the walls of the borehole annulus. Erosion is driven solely by the shearing action of the drilling fluid (or mud) as it moves up the borehole annulus. The principal parameters in the cavings model are the properties of the drilling mud, drilling rates, and the shear strength of the waste. These parameters are not affected by the proposed changes for Panel 1 utilization.

Spallings are the particulate material introduced into drilling mud by the movement of gas from the waste into the borehole annulus. The principal parameters in the spallings model are the gas pressure in the repository when it is penetrated and properties of the waste such as particle diameter and erosive properties. None of these parameters are affected by the potential changes proposed in Panel 1 utilization. In addition, the properties of the waste disposed in the repository are not changed even if the number of containers in a stack is changed.

Direct brine release from a drilling intrusion can also transport contaminated brine to the surface. Direct brine release is a minor release mechanism for the CCA; it is a function of repository pressure, repository saturation, borehole properties, and the solubility limits for radionuclides. These quantities are not expected to change significantly due to alternatives for Panel 1 utilization. The changes in direct brine release due to the proposed alternatives for Panel 1 utilization are therefore expected to be insignificant.

The release from the repository by any of these mechanisms also depends on the activity of the waste and its distribution within the repository. The analysis in Attachment IV can be used to demonstrate that the expected total release from the repository is independent of the actual waste loading scheme, such as stacking drums 0-, 1-, 2- or 3-high and/or excluding RH-TRU waste from Panel 1. The reasoned argument is as follows:

1. The specific analysis in Attachment IV shows that the expected releases of CH-TRU and RH-TRU waste through cuttings/cavings are independent of the actual waste-loading scheme in individual rooms.

2. The analysis in Attachment IV also applies to the expected releases of CH-TRU through spallings, assuming that the spall volume is unchanged by the waste loading scheme and that the activity of the released material varies linearly with the fraction of waste emplaced in each room. These are reasonable assumptions.

3. The expected releases from cuttings/cavings and spallings are the main components of the total expected release (see Figure 13.2.3, Helton et al. 1998)

It follows that the total expected release will also be independent of the actual waste-loading scheme.

4. CONCLUSIONS

Because of the age of Panel 1, natural and expected creep closure of the rooms has occurred which would require re-mining of the floor to provide adequate headroom to meet the CCA design capacity in these rooms. Operational considerations, including the need for re-mining and overall ground control, have prompted the DOE to propose alternative utilization of the remaining rooms of this panel. These alternatives, which will enhance the safe and efficient operation of the WIPP, include:

1. Placing waste containers in 1-, 2- or 3-high stacks. MgO backfill will be emplaced with the waste in all of these configurations;

2. Using all or only part of the space in each of the seven Panel 1 rooms for waste disposal (some rooms could be bypassed and left void of waste); and,

3. Closing Panel 1 without emplacing any RH-TRU waste.

This analysis shows that a significant departure from the original design is not being sought, and that aspects of the repository system important to waste containment will not be affected or changed. Key assumptions and components used in PA are not affected significantly, and the analysis in Attachment IV shows that alterations in repository waste loading will have an insignificant impact on expected releases from the repository.

Additionally, the DOE has conducted an analysis to assure that screening arguments for features, events, and processes (FEPs) remain unaffected by this proposed change. This FEP analysis has concluded that the screening arguments for natural, and for most waste and repository induced FEPs and human-initiated events and processes are unaffected by the proposed changes. For those waste and repository induced FEPs and human-initiated events and processes, which might be affected by the proposed changes, a more detailed analysis has shown that the impact of these changes on the FEPs is insignificant.

The DOE believes that the information presented in this document, which is based on the analyses of information in the certified baseline, demonstrates that the proposed alternatives for Panel 1 will have insignificant impacts on repository performance relative to the CCA.

5. REFERENCES

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ATTACHMENT I: SUMMARY OF WIPP-RELATED NATURAL FEPS[1]

EPA FEP No.	FEP Name	Issue	Screening Classification (see legend)
N1	Stratigraphy	Disposition and properties of geological formations control system performance	UP
N2	Brine reservoirs	Pressurized brine reservoirs may be present in the Castile beneath the controlled area	DP
N3	Changes in regional stress	Tectonic activity on a regional scale may change levels of stress	SO-C
N4	Regional tectonics	Tectonic setting of the region governs current level of stress	SO-C
N5	Regional uplift and subsidence	Tectonic activity on a regional scale could cause uplift and subsidence	SO-C
N6	Salt deformation	Salt formations may deform under gravity or other forces	SO-P
N7	Diapirism	Buoyancy forces may cause salt to rise through denser rocks	SO-P
N8	Formation of fractures	Changes in stress may cause new fracture sets to form	SO-P
N9	Changes in fracture properties	Changes in the local stress field may change fracture properties such as aperture and asperity	SO-C
N10	Formation of new faults	Tectonic activity on a regional scale could cause new faults to form	SO-P
N11	Fault movement	Movement along faults in the Rustler or in units below the Salado could affect the hydrogeology	SO-P
N12	Seismic activity	Groundshaking may give rise to cracking at free surfaces such as the roof of the repository	UP
N13	Volcanic activity	Igneous material feeding volcanoes or surface flows could affect disposal system performance	SO-P
N14	Magmatic activity	Subsurface intrusion of igneous rocks could affect disposal system performance	SO-C
N15	Metamorphic activity	High pressures and/or temperatures could cause solid state recrystallisation changes	SO-P
N16	Shallow dissolution	Percolation of groundwater and dissolution in the Rustler may increase transmissivity	UP
N17	Lateral dissolution	Dissolution at the Rustler - Salado contact may create pathways and/or increase transmissivity	SO-C
N18	Deep dissolution	Dissolution in the Castile or at the base of the Salado may create pathways	SO-P

[1] Changes in waste loading in Panel 1 have no impact on Natural FEPs.

EPA FEP No.	FEP Name	Issue	Screening Classification (see legend)
N19	Solution chimneys	Dissolution cavities in the Castile or at the base of the Salado may propagate towards the surface	SO-P
N20	Breccia pipes	Formations above deep dissolution cavities may fracture	SO-P
N21	Collapse breccias	Dissolution may result in collapse of overlying units	SO-P
N22	Fracture infills	Precipitation of minerals as fracture infills can reduce hydraulic conductivities	SO-C
N23	Saturated groundwater flow	Groundwater flow beneath the water table is important to disposal system performance	UP
N24	Unsaturated groundwater flow	The presence of air or other gas phases may influence groundwater flow	UP
N25	Fracture flow	Groundwater may flow along fractures as well as through interconnected pore space	UP
N26	Density effects on groundwater flow	Spatial variability of groundwater density could affect flow directions	SO-C
N27	Effects of preferential pathways	Groundwater flow may not be uniform, and may occur along particular pathways	UP
N28	Thermal effects on groundwater flow	Natural temperature variability could cause convection or otherwise affect groundwater flow	SO-C
N29	Saline intrusion [hydrogeological effects]	The introduction of more saline water into the Rustler could affect groundwater flow	SO-P
N30	Freshwater intrusion [hydrogeological effects]	The introduction of freshwater into the Rustler could affect groundwater flow	SO-P
N31	Hydrological response to earthquakes	Fault movement can affect groundwater flow directions and pressure changes can affect groundwater levels and movement	SO-C
N32	Natural gas intrusion	The introduction of natural gas from formations beneath the repository could affect groundwater flow	SO-P
N33	Groundwater geochemistry	Groundwater geochemistry influences actinide retardation and colloid stability	UP
N34	Saline intrusion [geochemical effects]	The introduction of more saline water into the Rustler could affect actinide retardation and colloid stability	SO-C
N35	Freshwater intrusion [geochemical effects]	The introduction of freshwater into the Rustler could affect actinide retardation and colloid stability	SO-C
N36	Changes in groundwater Eh	Changes in oxidation potentials could affect radionuclide mobilization	SO-C
N37	Changes in groundwater pH	Changes in pH could affect colloid stability and the mobility of radionuclides	SO-C
N38	Effects of dissolution	Dissolution could affect groundwater chemistry and hence radionuclide transport	SO-C

EPA FEP No.	FEP Name	Issue	Screening Classification (see legend)
N39	Physiography	The physiography of the area is a control on the surface water hydrology	UP
N40	Impact of a large meteorite	A large meteorite could fracture the rocks above the repository	SO-P
N41	Mechanical weathering	Processes such as freeze -thaw affect the rate of erosion	SO-C
N42	Chemical weathering	Breakdown of minerals in the surface environment affects the rate of erosion	SO-C
N43	Aeolian erosion	The wind can erode poorly consolidated surface deposits	SO-C
N44	Fluvial erosion	Erosion by rivers and streams could affect surface drainage	SO-C
N45	Mass wasting [erosion]	Gravitational processes can erode material on steep slopes	SO-C
N46	Aeolian deposition	Sand dunes and sheet sands may be deposited by the wind and affect surface drainage	SO-C
N47	Fluvial deposition	Rivers and streams can deposit material and affect surface drainage	SO-C
N48	Lacustrine deposition	Lakes may be infilled by sediment and change the drainage pattern	SO-C
N49	Mass wasting [deposition]	Land slides could block valleys and change the drainage pattern	SO-C
N50	Soil development	Vegetation and surface water movement is affected by the types of soil present	SO-C
N51	Stream and river flow	The amount of flow in streams and rivers affects erosion and deposition	SO-C
N52	Surface water bodies	The disposition of lakes is a control on the surface hydrology	SO-C
N53	Groundwater discharge	The amount of water leaving the groundwater system to rivers, springs and seeps affects the groundwater hydrology	UP
N54	Groundwater recharge	The amount of water passing into the saturated zone affects the groundwater hydrology	UP
N55	Infiltration	The amount of water entering the unsaturated zone controls groundwater recharge	UP
N56	Changes in groundwater recharge and discharge	Changes in climate and drainage pattern may affect the amount of water entering and leaving the groundwater system	UP
N57	Lake formation	Formation of new lakes will affect the surface hydrology	SO-C
N58	River flooding	Flooding will affect the area over which infiltration takes place	SO-C
N59	Precipitation [e.g. rainfall]	Rainfall is the source of water for infiltration and stream flow	UP

N60	Temperature	The temperature influences how much precipitation evaporates before it reaches streams or enters the ground	UP
N61	Climate change	Temperature and precipitation will vary as natural changes in the climate take place	UP
N62	Glaciation	Natural climate change could lead to the growth of glaciers and ice sheets	SO-P
N63	Permafrost	The regions in front of advancing ice sheets will be subject to frozen ground preventing infiltration	SO-P
N64	Seas and oceans	The volume and circulation patterns in seas and oceans would affect the distribution of radionuclides	SO-C
N65	Estuaries	Water movement in estuaries would affect the distribution of radionuclides	SO-C
N66	Coastal erosion	Coastal erosion could affect the local groundwater system	SO-C
N67	Marine sediment transport and deposition	Transport and deposition could affect the distribution of radionuclides	SO-C
N68	Sea level changes	Sea level change would affect coastal aquifers	SO-C
N69	Plants	Plants play a role in the hydrological cycle by taking up water	SO-C
N70	Animals	Burrowing animals can affect the structure of surface sediments	SO-C
N71	Microbes	Microbes can be important in soil development. Microbes in groundwater may sorb radionuclides	SO-C
N72	Natural ecological development	Changes in climate may cause changes in the types of vegetation and animals present	SO-C

ATTACHMENT II: SUMMARY OF WIPP-RELATED WASTE- AND REPOSITORY-INDUCED FEPS

EPA FEP No.	FEP Name	Issue	Screening Classification (see legend)	Impact from Proposed Change
W1	Disposal geometry	WIPP repository disposal geometry will influence flow and transport patterns	UP	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W2	Waste inventory	The quantity and type of radionuclides emplaced in the repository will dictate performance requirements	UP	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W3	Heterogeneity of waste forms	The distribution of radionuclides within the different waste types could affect release patterns	DP	This FEP addresses a waste scale process or waste characteristic. The DOE's proposed change does not affect waste characteristics and therefore does not affect this FEP.
W4	Container form	The type and shape of waste container will affect heat dissipation and container strength	SO-C	This FEP addresses a container scale process or container characteristic. The DOE's proposed change does not affect containers characteristics and therefore does not affect this FEP.
W5	Container material inventory	Steel and other materials will corrode and affect the amount of gas generated	UP	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W6	Seal geometry	Size, location, and materials of shaft seals, and panel and drift closures will affect flow patterns and transport pathways	UP	This FEP addresses a seal process. The DOE's proposed change does not affect any seal processes and therefore does not affect this FEP.
W7	Seal physical properties	Porosity and permeability of seals will control flow rates	UP	This FEP addresses a seal process. The DOE's proposed change does not affect any seal processes and therefore does not affect this FEP.
W8	Seal chemical composition	The chemistry of seal materials could affect actinide speciation and mobility	SO-C	This FEP addresses a seal process. The DOE's proposed change does not affect any seal processes and therefore does not affect this FEP.

W9	Backfill physical properties	The amount and distribution of backfill could affect porosity and permeability in disposal rooms	SO-C	The DOE's proposed change does not affect this FEP because a waste stack that is 1- or 2-drums high is expected to compress to the same porosity and permeability as the 3-drum high stack for the CCA (see section 3.5).
W10	Backfill chemical composition	The chemical behavior of the backfill will affect actinide speciation and mobility	UP	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP. Ratios between MgO backfill and waste will stay the same, or increase
W11	Postclosure monitoring	Inappropriate monitoring after closure could affect performance	SO-C	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W12	Radionuclide decay and in growth	Radioactive decay of waste will change and decrease the inventory with time	UP	This FEP addresses a waste scale process or waste characteristic. The DOE's proposed change does not affect waste characteristics and therefore does not affect this FEP.
W13	Heat from radioactive decay	Radioactive decay of waste will generate heat in the repository	SO-C	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W14	Nuclear criticality: heat	A sustained fission reaction would generate heat	SO-P	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W15	Radiological effects on waste	Radiation can change the physical properties of many materials	SO-C	This FEP addresses a waste scale process or waste characteristic. The DOE's proposed change does not affect waste characteristics and therefore does not affect this FEP.
W16	Radiological effects on containers	Radiation can change the physical properties of many materials	SO-C	This FEP addresses a container scale process or container characteristic. The DOE's proposed change does not affect containers characteristics and therefore does not affect this FEP.
W17	Radiological effects on seals	Radiation can change the physical properties of many materials	SO-C	This FEP addresses a seal process. The DOE's proposed change does not affect any seal processes and therefore does not affect this FEP.

W18	Disturbed rock zone	Repository construction has led to fracturing of rock around the opening	UP	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W19	Excavation-induced changes in stress	Repository construction has led to changes in stress around the opening	UP	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W20	Salt creep	Salt creep will consolidate seal components and close the disposal rooms, thereby compacting the waste	UP	This FEP addresses a seal process, room closure and waste consolidation. The DOE's proposed change does not affect any seal processes. Effects on room closure and waste consolidation are discussed under FEP W32
W21	Changes in the stress field	Salt creep will affect the stress field around the repository opening	UP	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W22	Roof falls	Instability of the DRZ could lead to roof falls	UP	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W23	Subsidence	Salt creep and roof falls could lead to subsidence of horizons above the repository	SO-C	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W24	Large scale rock fracturing	Salt creep and roof falls could lead to fracturing between the repository and higher units or the surface	SO-P	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W25	Disruption due to gas effects	Increased gas pressures may lead to fracturing of Salado interbreeds	UP	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W26	Pressurization	Increased gas pressures may slow the rate of salt creep	UP	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W27	Gas explosions	Explosion of gas mixtures in the repository could affect the DRZ	UP	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W28	Nuclear explosions	A critical mass of plutonium in the repository could explode if rapidly compressed	SO-P	This FEP addresses a waste scale process or waste characteristic. The DOE's proposed change does not affect waste characteristics and therefore does not affect this FEP.

W29	Thermal effects on material properties	Temperature rises could lead to changes in porosity and permeability	SO-C	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W30	Thermally-induced stress changes	Elevated temperatures could change the local stress field and alter the rate of salt creep	SO-C	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W31	Differing thermal expansion of repository components	Stress distribution and strain changes can depend on differing rates of thermal expansion between adjacent materials	SO-C	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W32	Consolidation of waste	Salt creep and room closure will change waste permeability	UP	This FEP is affected by DOE's proposed utilization of Panel 1 (see Section 3)
W33	Movement of containers	Density differences or temperature rises could lead to movement of containers within the salt	SO-C	This FEP addresses a container scale process or container characteristic. The DOE's proposed change does not affect containers characteristics and therefore does not affect this FEP.
W34	Container integrity	Long-lived containers could delay dissolution of waste	SO-C	This FEP addresses a container scale process or container characteristic. The DOE's proposed change does not affect containers characteristics and therefore does not affect this FEP.
W35	Mechanical effects of backfill	Backfill in disposal rooms will act to resist creep closure	SO-C	The DOE's proposed change does not affect this FEP because of conservative assumptions in the CCA.
W36	Consolidation of seals	Salt creep will consolidate long-term seal components, reducing porosity and permeability	UP	This FEP addresses a seal process. The DOE's proposed change does not affect any seal processes and therefore does not affect this FEP.
W37	Mechanical degradation of seals	Gas pressurization, clay swelling, and cracking of concrete could affect seal properties	UP	This FEP addresses a seal process. The DOE's proposed change does not affect any seal processes and therefore does not affect this FEP.
W38	Investigation boreholes	Improperly sealed investigation boreholes near the repository could act as release pathways	SO-C	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W39	Underground boreholes	Improperly sealed boreholes drilled from the repository could provide pathways to the interbreeds	UP	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.

W40	Brine inflow	Brine will enter the disposal rooms through the interbreeds, impure halite and clay layers	UP	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W41	Wicking	Capillary rise is a mechanism for brine flow in unsaturated zones in the repository	UP	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W42	Fluid flow due to gas production	Increases in gas pressure could affect the rate of brine inflow	UP	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W43	Convection	Temperature differentials in the repository could lead to convection cells	SO-C	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W44	Degradation of organic material	Microbial breakdown of cellulose material in the waste will generate gas	UP	This FEP addresses a waste scale process or waste characteristic. The DOE's proposed change does not affect waste characteristics and therefore does not affect this FEP.
W45	Effects of temperature on microbial gas generation	Temperature rises could affect the rate of microbial gas generation	UP	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W46	Effects of pressure on microbial gas generation	Increases in gas pressure could affect microbial populations and gas generation rates	SO-C	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W47	Effects of radiation on microbial gas generation	Radiation could affect microbial populations and, therefore, gas generation rates	SO-C	This FEP addresses a waste scale process or waste characteristic. The DOE's proposed change does not affect waste characteristics and therefore does not affect this FEP.
W48	Effects of bio films on microbial gas generation	Bio films serve to maintain optimum conditions for microbial populations and affect gas generation rates	UP	This FEP addresses a waste scale process or waste characteristic. The DOE's proposed change does not affect waste characteristics and therefore does not affect this FEP.
W49	Gases from metal corrosion	Anoxic corrosion of steel will produce hydrogen	UP	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.

W50	Galvanic coupling	Potential gradients between metals could affect corrosion rates	SO-P	This FEP addresses a container scale process or container characteristic. The DOE's proposed change does not affect containers characteristics and therefore does not affect this FEP.
W51	Chemical effects of corrosion	Corrosion reactions will lower the oxidation state of brines and affect gas generation rates	UP	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W52	Radiolysis of brine	Alpha particles from decay of plutonium can split water molecules to form hydrogen and oxygen	SO-C	This FEP addresses a waste scale process or waste characteristic. The DOE's proposed change does not affect waste characteristics and therefore does not affect this FEP.
W53	Radiolysis of cellulose	Alpha particles from decay of plutonium can split cellulose molecules and affect gas generation rates	SO-C	This FEP addresses a waste scale process or waste characteristic. The DOE's proposed change does not affect waste characteristics and therefore does not affect this FEP.
W54	Helium gas production	Reduction of alpha particles emitted from the waste will form helium	SO-C	This FEP addresses a waste scale process or waste characteristic. The DOE's proposed change does not affect waste characteristics and therefore does not affect this FEP.
W55	Radioactive gases	Radon will form from decay of plutonium. Carbon dioxide and methane may contain radioactive ^{14}C	SO-C	This FEP addresses a waste scale process or waste characteristic. The DOE's proposed change does not affect waste characteristics and therefore does not affect this FEP.
W56	Speciation	Speciation is the form in which elements occur under particular conditions. This form controls mobility and the reactions that are likely to occur	UP	This FEP addresses a waste scale process or waste characteristic. The DOE's proposed change does not affect waste characteristics and therefore does not affect this FEP.
W57	Kinetics of speciation	Reaction kinetics control the rate at which particular reactions occur thereby dictating which reactions are prevalent in non-equilibrium systems	SO-C	This FEP addresses a waste scale process or waste characteristic. The DOE's proposed change does not affect waste characteristics and therefore does not affect this FEP.

W58	Dissolution of waste	Dissolution of waste controls the concentrations of radionuclides in brines and groundwaters	UP	This FEP addresses a waste scale process or waste characteristic. The DOE's proposed change does not affect waste characteristics and therefore does not affect this FEP.
W59	Precipitation [secondary minerals]	Precipitation of secondary minerals could affect the concentrations of radionuclides in brines and groundwaters	SO-C	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W60	Kinetics of precipitation and dissolution	The rates of dissolution and precipitation reactions could affect radionuclide concentrations	SO-C	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W61	Actinide sorption	Actinides may accumulate at the interface between a solid and a solution. This affects the rate of transport of actinides in brines and groundwaters	UP	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W62	Kinetics of sorption	The rate at which actinides are sorbed can affect radionuclide concentrations	UP	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W63	Changes in sorptive surfaces	Changes in mineralogy along fracture walls could change the extent of sorption	UP	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W64	Effect of metal corrosion	Metal corrosion will have an effect on chemical conditions in the repository by absorbing oxygen	UP	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W65	Reduction-oxidation fronts	Redox fronts may affect the speciation and hence migration of radionuclides	SO-P	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W66	Reduction-oxidation kinetics	Reduction-oxidation reactions may not be in thermodynamic equilibrium thereby affecting speciation	UP	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W67	Localized reducing zones	Localized reducing zones, bounded by reduction-oxidation fronts, may develop on metals undergoing corrosion	SO-C	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.

W68	Organic complexation	Aqueous complexes between radionuclides and organic materials may enhance the total dissolved radionuclide load	SO-C	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W69	Organic ligands	Increased concentrations of organic ligands favour the formation of complexes	SO-C	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W70	Humic and fulvic acids	High molecular weight organic ligands, including humic and fulvic acids may be present in soil waste	UP	This FEP addresses a waste scale process or waste characteristic. The DOE's proposed change does not affect waste characteristics and therefore does not affect this FEP.
W71	Kinetics of organic complexation	The rates of complex dissociation may affect radionuclide uptake and other reactions	SO-C	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W72	Exothermic reactions	Exothermic reactions, including concrete and backfill hydration, and aluminium corrosion, may raise the temperature of the disposal system	SO-C	This FEP addresses a repository scale process. The DOE's proposed change does not affect repository scale processes and therefore does not affect this FEP.
W73	Concrete hydration	Hydration of concrete in seals will enhance rates of salt creep and may induce thermal cracking	SO-C	This FEP addresses a seal process. The DOE's proposed change does not affect any seal processes and therefore does not affect this FEP.
W74	Chemical degradation of seals	Reaction of cement with brine and groundwater may affect seal permeability	UP	This FEP addresses a seal process. The DOE's proposed change does not affect any seal processes and therefore does not affect this FEP.
W75	Chemical degradation of backfill	Reaction of the MgO backfill with CO_2 and brine may affect disposal room permeabilities	SO-C	The DOE's proposed change does not affect this FEP because of conservative assumptions in the CCA.
W76	Microbial growth on concrete	Acids produced by microbes could accelerate concrete seal degradation	UP	This FEP addresses a seal process. The DOE's proposed change does not affect any seal processes and therefore does not affect this FEP.
W77	Solute transport	Radionuclides may be transported as dissolved species or solutes	UP	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W78	Colloid transport	Colloid transport, with associated radionuclides, may occur at a different rate to dissolved species	UP	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.

W79	Colloid formation and stability	The formation and stability of colloids is dependent upon chemical conditions such as salinity	UP	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W80	Colloid filtration	Colloids with associated radionuclides may be too large to pass through pore throats in some media	UP	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W81	Colloid sorption	Colloids with associated radionuclides may be physically or chemically sorbed to the host rock	UP	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W82	Suspensions of particles	Rapid brine flow could transport active particles in suspension	DP	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W83	Rinse	Rapid brine flow could wash active particulates from waste surfaces	SO-C	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W84	Cuttings	Waste material intersected by a drill bit could be transported to the ground surface	DP	This FEP is affected by DOE's proposed utilization of Panel 1 (see Section 3.6)
W85	Cavings	Waste material eroded from a borehole wall by drilling fluid could be transported to the ground surface	DP	This FEP is affected by DOE's proposed utilization of Panel 1 (see Section 3.6)
W86	Spallings	Waste material entering a borehole through repository depressurization could be transported to the ground surface	DP	This FEP is affected by DOE's proposed utilization of Panel 1 (see Section 3.6)
W87	Microbial transport	Radionuclides may be bound to or contained in microbes transported in groundwaters	UP	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W88	Biofilms	Biofilms may retard microbes and affect transport of radionuclides	SO-C	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.

W89	Transport of radioactive gases	Gas phase flow could transport radioactive gases	SO-C	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W90	Advection	Dissolved and solid material can be transported by a flowing fluid	UP	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W91	Diffusion	Dissolved and solid material can be transported in response to Brownian forces	UP	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W92	Matrix diffusion	Dissolved and solid material may be transported transverse to the direction of advection in a fracture and into the rock matrix	UP	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W93	Soret effect	There will be a solute flux proportional to any temperature gradient	SO-C	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W94	Electrochemical effects	Potential gradients may exist as a result of electrochemical reactions and groundwater flow and affect radionuclide transport	SO-C	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W95	Galvanic coupling	Potential gradients may be established between metal components of the waste and containers and affect radionuclide transport	SO-P	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W96	Electrophoresis	Charged particles and colloids can be transported along electrical potential gradients	SO-C	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W97	Chemical gradients	Chemical gradients will exist at interfaces between different parts of the disposal system and may cause enhanced diffusion	SO-C	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W98	Osmotic processes	Osmosis may allow diffusion of solutes across a salinity interface	SO-C	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.

W99	Alpha recoil	Recoil of the daughter nuclide upon emission of an alpha-particle during radioactive decay at the surface of a solid may eject the daughter into groundwater	SO-C	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W100	Enhanced diffusion	Chemical gradients may locally enhance rates of diffusion	SO-C	This FEP addresses a molecular scale process. The DOE's proposed change does not affect any molecular scale processes and therefore does not affect this FEP.
W101	Plant uptake	Radionuclides released into the biosphere may be absorbed by plants	SO-R	This FEP addresses a biosphere process. The DOE's proposed change does not affect any biosphere processes and therefore does not affect this FEP.
W102	Animal uptake	Animals may eat or drink radionuclides released into the biosphere	SO-R	This FEP addresses a biosphere process. The DOE's proposed change does not affect any biosphere processes and therefore does not affect this FEP.
W103	Accumulation in soils	Radionuclides released into the biosphere may accumulate in soil	SO-C	This FEP addresses a biosphere process. The DOE's proposed change does not affect any biosphere processes and therefore does not affect this FEP.
W104	Ingestion	Humans may receive a radiation dose from radionuclides in food or drink	SO-R	This FEP addresses a biosphere process. The DOE's proposed change does not affect any biosphere processes and therefore does not affect this FEP.
W105	Inhalation	Humans may receive a radiation dose from air taken into the lungs	SO-R	This FEP addresses a biosphere process. The DOE's proposed change does not affect any biosphere processes and therefore does not affect this FEP.
W106	Irradiation	Humans may receive a radiation dose from radionuclides external to the body	SO-R	This FEP addresses a biosphere process. The DOE's proposed change does not affect any biosphere processes and therefore does not affect this FEP.
W107	Dermal sorption	Humans may receive a radiation dose from radionuclides absorbed through the skin	SO-R	This FEP addresses a biosphere process. The DOE's proposed change does not affect any biosphere processes and therefore does not affect this FEP.
W108	Injection	Humans may receive a radiation dose from radionuclides injected beneath the skin	SO-R	This FEP addresses a biosphere process. The DOE's proposed change does not affect any biosphere processes and therefore does not affect this FEP.

ATTACHMENT III: SUMMARY OF WIPP-RELATED HUMAN FEPS[1]

EPA FEP No.	FEP Name	Issue	Screening Classification (see legend)	Comments on Classification
H1	Oil and gas exploration	Oil and gas exploration is a reason for drilling in the Delaware Basin	SO-C (HCN) DP (Future)	DP for boreholes that penetrate the waste and boreholes that penetrate Castile brine underlying the waste disposal region. SO-C for other future drilling.
H2	Potash exploration	Potash exploration is a reason for drilling in the Delaware Basin	SO-C (HCN) DP (Future)	DP for boreholes that penetrate the waste and boreholes that penetrate Castile brine underlying the waste disposal region. SO-C for other future drilling.
H3	Water resources exploration	Water resources exploration is a reason for drilling in the Delaware Basin	SO-C (HCN) SO-C (Future)	

[1] Changes in waste loading in Panel 1 have no impact on Human FEPs.

H4	Oil and gas exploitation	Oil and gas exploitation is a reason for drilling in the Delaware Basin	SO-C (HCN) DP (Future)	DP for boreholes that penetrate the waste and boreholes that penetrate Castile brine underlying the waste disposal region. SO-C for other future drilling.
H5	Groundwater exploitation	Groundwater exploitation is a reason for drilling in the Delaware Basin	SO-C (HCN) SO-C (Future)	
H6	Archaeological investigations	Archaeological investigations could be a reason for drilling	SO-R (HCN) SO-R (Future)	
H7	Geothermal	Geothermal energy could be a reason for drilling	SO-R (HCN) SO-R (Future)	
H8	Other resources	Exploration for other resources could be a reason for drilling	SO-C (HCN) DP (Future)	DP for boreholes that penetrate the waste and boreholes that penetrate Castile brine underlying the waste disposal region. SO-C for other future drilling.
H9	Enhanced oil and gas recovery	Enhanced oil and gas recovery is a reason for drilling in the Delaware Basin	SO-C (HCN) DP (Future)	DP for boreholes that penetrate the waste and boreholes that penetrate Castile brine underlying the waste disposal region. SO-C for other future drilling.
H10	Liquid waste disposal	Liquid waste disposal could be a reason for drilling	SO-R (HCN) SO-R (Future)	

H11	Hydrocarbon storage	Hydrocarbon storage could be a reason for drilling	SO-R (HCN) SO-R (Future)	
H12	Deliberate drilling intrusion	Deliberate investigation of the repository could be a reason for drilling	SO-R (HCN) SO-R (Future)	
H13	Potash mining	Potash mining is a reason for excavations in the region around WIPP	UP (HCN) DP (Future)	UP for mining outside the controlled area. DP for mining inside the controlled area.
H14	Other resources	Mining of other resources could be a reason for excavations	SO-C (HCN) SO-R (Future)	
H15	Tunnelling	Tunnelling could be a reason for excavations	SO-R (HCN) SO-R (Future)	
H16	Construction of underground facilities (for example storage, disposal, accommodation)	Construction of underground facilities could be a reason for excavations	SO-R (HCN) SO-R (Future)	
H17	Archeological excavations	Archeological investigations could be a reason for excavations	SO-C (HCN) SO-R (Future)	
H18	Deliberate mining intrusion	Deliberate investigation of the repository could be a reason for excavations	SO-R (HCN) SO-R (Future)	
H19	Explosions for resource recovery	Underground explosions could affect the geological characteristics of surrounding units	SO-C (HCN) SO-R (Future)	
H20	Underground nuclear device testing	Underground nuclear device testing could affect the geological characteristics of surrounding units	SO-C (HCN) SO-R (Future)	

H21	Drilling fluid flow	Drilling within the controlled area could result in releases of radionuclides into the drilling fluid.	SO-C (HCN) DP (Future)	DP for boreholes that penetrate the waste. SO-C for other future drilling. Impacts of the proposed changes to this FEP are considered under W84, W85 and W86
H22	Drilling fluid loss	Borehole circulation fluid could be lost to thief zones encountered during drilling	SO-C (HCN) DP (Future)	DP for boreholes that penetrate the waste. SO-C for other future drilling.
H23	Blowouts	Fluid could flow from pressurized zones through the borehole to the land surface	SO-C (HCN) DP (Future)	DP for boreholes that penetrate the waste and boreholes that penetrate Castile brine underlying the waste disposal region. SO-C for other future drilling.
H24	Drilling-induced geochemical changes	Movement of brine from a pressurized zone, through a borehole, into potential thief zones such as the Salado interbeds or the Culebra, could result in geochemical changes	UP (HCN) DP (Future)	SO-C for units other than the Culebra.
H25	Oil and gas extraction	Extraction of oil and gas could alter fluid-flow patterns in the target horizons, or in overlying units as a result of a failed borehole casing. Removal of confined fluids from oil- or gas-bearing units can cause compaction, potentially resulting in subvertical fracturing and surface subsidence	SO-C (HCN) SO-R (Future)	
H26	Groundwater extraction	Groundwater extraction from formations above the Salado could affect groundwater flow	SO-C (HCN) SO-R (Future)	
H27	Liquid waste disposal	Injection of fluids could alter fluid flow patterns in the target horizons or, if there is accidental leakage through a borehole casing, in any other intersected hydraulically conductive zone	SO-C (HCN) SO-R (Future)	

H28	Enhanced oil and gas production	Injection of fluids could alter fluid flow patterns in the target horizons or, if there is accidental leakage through a borehole casing, in any other intersected hydraulically conductive zone	SO-C (HCN) SO-R (Future)	
H29	Hydrocarbon storage	Injection of fluids could alter fluid flow patterns in the target horizons or, if there is accidental leakage through a borehole casing, in any other intersected hydraulically conductive zone	SO-C (HCN) SO-R (Future)	
H30	Fluid-injection induced geochemical changes	Injection of fluids through a leaking borehole could affect geochemical conditions in thief zones, such as the Culebra or the Salado interbeds	UP (HCN) SO-R (Future)	SO-C for units other than the Culebra
H31	Natural borehole fluid flow	Natural borehole flow through abandoned boreholes could alter fluid pressure distributions	SO-C (HCN) DP (Future)	DP for boreholes that penetrate Castile brine underlying the waste disposal region. SO-C for other future boreholes.
H32	Waste-induced borehole flow	Abandoned boreholes that intersect a waste panel could provide a connection for transport away from the repository horizon	SO-R (HCN) DP (Future)	DP for boreholes that penetrate the waste. SO-C for other future boreholes.
H33	Flow through undetected boreholes	Undetected boreholes that are inadequately sealed could provide pathways for radionuclide transport	SO-P (HCN) NA (Future)	
H34	Borehole-induced solution and subsidence	Boreholes could provide pathways for surface-derived water or groundwater to percolate into formations containing soluble minerals. Large-scale dissolution through this mechanism could lead to subsidence and to changes in groundwater flow patterns	SO-C (HCN) SO-C (Future)	
H35	Borehole-induced mineralization	Fluid flow through a borehole between hydraulically conductive horizons could cause mineral precipitation to change permeabilities	SO-C (HCN) SO-C (Future)	
H36	Borehole-induced geochemical changes	Movement of fluids through abandoned boreholes could change the geochemistry of units such as the Salado interbeds or Culebra	UP (HCN) DP (Future)	SO-C for units other than the Culebra

H37	Changes in groundwater flow due to mining	Fracturing and subsidence associated with excavations may affect groundwater flow patterns through increased hydraulic conductivity within and between units	UP (HCN) DP (Future)	UP for mining outside the controlled area. DP for mining inside the controlled area.
H38	Changes in geochemistry due to mining	Fluid flow and dissolution associated with mining may change brine densities and geochemistry	SO-C (HCN) SO-R (Future)	
H39	Changes in groundwater flow due to explosions	Fracturing associated with explosions could affect groundwater flow patterns through increased hydraulic conductivity within and between units	SO-C (HCN) SO-R (Future)	
H40	Land use changes	Land use changes could have an effect upon the surface hydrology	SO-R (HCN) SO-R (Future)	
H41	Surface disruptions	Surface disruptions could have an effect upon the surface hydrology	SO-C (HCN) SO-R (Future)	
H42	Damming of streams or rivers	Damming of streams or rivers could have an effect upon the surface hydrology	SO-C (HCN) SO-R (Future)	
H43	Reservoirs	Reservoirs could have an effect upon the surface hydrology	SO-C (HCN) SO-R (Future)	
H44	Irrigation	Irrigation could have an effect upon the surface hydrology	SO-C (HCN) SO-R (Future)	
H45	Lake usage	Lake usage could have an effect upon the surface hydrology	SO-R (HCN) SO-R (Future)	
H46	Altered soil or surface water chemistry by human activities	Surface activities associated with potash mining and oil fields could affect the movement of radionuclides in the surface environment	SO-C (HCN) SO-R (Future)	
H47	Greenhouse gas effects	Changes in climate resulting from increase in greenhouse gases could change the temperature and the amount of rainfall	SO-R (HCN) SO-R (Future)	
H48	Acid rain	Acid rain could change the behaviour of radionuclides in the surface environment	SO-R (HCN) SO-R (Future)	
H49	Damage to the ozone layer	Damage to the ozone layer could affect the flora and fauna and their response to radioactivity	SO-R (HCN) SO-R (Future)	

H50	Coastal water use	Coastal water usage could affect the uptake of radionuclides by animals and humans	SO-R (HCN) SO-R (Future)	
H51	Sea water use	Sea water usage could affect the uptake of radionuclides by animals and humans	SO-R (HCN) SO-R (Future)	
H52	Estuarine water use	Estuarine water usage could affect the uptake of radionuclides by animals and humans	SO-R (HCN) SO-R (Future)	
H53	Arable farming	Arable farming could have an effect upon the surface hydrology	SO-C (HCN) SO-R (Future)	
H54	Ranching	Ranching could have an effect upon the surface hydrology	SO-C (HCN) SO-R (Future)	
H55	Fish farming	Fish farming could affect the uptake of radionuclides by animals and humans	SO-R (HCN) SO-R (Future)	
H56	Demographic change and urban development	Demographic change and urban development could have an effect upon the surface hydrology	SO-R (HCN) SO-R (Future)	
H57	Loss of records	Loss of records could change the effectiveness of institutional controls	NA (HCN) DP (Future)	

ATTACHMENT IV: EFFECT OF CHANGED WASTE LOADING ON COMPLEMENTARY CUMULATIVE DISTRIBUTION FUNCTIONS (CCDFs) FOR DRILLING RELEASES TO THE ACCESSIBLE ENVIRONMENT

IV.1 INTRODUCTION

The purpose of this attachment is to evaluate the effects of changed CH- and RH-TRU waste loading at the WIPP on direct drilling releases to the accessible environment using a probabilistic approach. As stated in Section 6.5.3 of the CCA, releases from cuttings and cavings are shown to be the most important contributors to the location of the mean CCDF, with spallings also making a small contribution. Direct brine releases are less important, and have very little effect on the location of the mean CCDF. Each mean CCDF can be reduced to an expected value, defined as the average of the releases for each point on the CCDF. This Attachment demonstrates that changes that can be implemented within the geometry imposed by the waste forms and the design of the waste disposal areas will have very small effects on the expected value of the mean CCDF.

IV.2 EXPECTED VOLUME OF WASTE RELEASED

The expected volume of waste released to the surface due to drilling is independent of both the area over which the waste is emplaced and local variations in the density at which the waste is emplaced.

IV.2(a)

The expected volume of waste released to the surface due to drilling, under the assumption of uniform waste emplacement, is considered first. Here, uniform waste emplacement means that the volume concentration of emplaced waste (i.e., m^3 of waste per m^2 of emplacement area) is the same over the entire waste disposal area.

The following notation is introduced:

$\lambda(t)$ = drilling rate ($1/m^2yr$) at time t,

$V(a,b)$ = volume (m^3) of waste removed by a sequence of drilling intrusions occurring at rate $\lambda(t)$ over the time interval [a,b],

aWD = area (m^2) over which waste disposal takes place,

vW = volume (m^3) of disposed waste,

aBH = cross-sectional area (m^2) of cylinder passing through waste resulting from cuttings and cavings removal associated with a single borehole,

dWD = areal density ($m^3/m^2 = m$) of waste disposal

$= vW/aWD.$

The expected value of the volume of released waste, $E[V(a,b)]$, is given by

$$E[V(a,b)] = \int_a^b aBH\, dWD\, \lambda(t)\, aWD\, dt$$

$$= \int_a^b aBH\, (vW/aWD)\, \lambda(t)\, aWD\, dt$$

$$= aBH\, vW \int_a^b \lambda(t)\, dt. \qquad \text{(IV.1)}$$

Thus, $E[V(a,b)]$ depends only on aBH, vW, and $\lambda(t)$, and is independent of the area over which the waste is emplaced.

IV.2(b)

The expected volume of waste released to the surface due to cuttings and cavings, under the assumption of nonuniform waste emplacement, is considered next. Here, nonuniform waste emplacement means that the volume concentration of emplaced waste (i.e., m^3 of waste per m^2 of emplacement area) varies from location to location over the waste emplacement area.

The waste disposal area is assumed to be subdivided into $i = 1, 2, \ldots, nWD$ areas with a constant waste emplacement over each of these areas. The following additional notation is introduced:

aWD_i = area (m^2) of waste disposal area i, with $aWD_1 + aWD_2 + \ldots + aWD_{nWD} = aWD$,

fWD_i = fraction of total waste volume in area i, with $fWD_1 + fWD_2 + \ldots + fWD_{nWD} = 1$,

dWD_i = area density ($m^3/m^2 = m$) of waste in area i

$= fWD_i\, vW/aWD_i,$

$V_i(a,b)$ = volume of waste (m^3) removed by a sequence of drilling intrusions into area i occurring at rate $\lambda(t)$ over the time interval $[a,b]$.

The expected value of the volume of released waste, $E[V(a,b)]$, is given by

$$E[V(a,b)] = \sum_{i=1}^{nWD} E[V_i(a,b)]$$

$$= \sum_{i=1}^{nWD} \int_a^b aBH\, dWD_i\, \lambda(t)\, aWD_i\, dt$$

$$= \sum_{i=1}^{nWD} \int_a^b aBH(fWD_i\, vW/aWD_i)\, \lambda(t)\, aWD_i\, dt$$

$$= aBH\, vW \int_a^b \left(\sum_{i=1}^{nWD} fWD_i \right) \lambda(t)\, dt$$

$$= aBH\, vW \int_a^b \lambda(t)\, dt. \qquad \text{(IV.2)}$$

Thus, $E[V(a,b)]$ is the same for both uniform and nonuniform waste loading and is independent of the area over which the waste is emplaced. Further, this result is independent of the size of nWD, i.e., the number of individual areas of waste disposal, and whether or not these individual waste disposal areas are contiguous.

IV.2(c)

The expected volume of waste released to the surface due to cuttings and cavings, under the assumption of stacking drums 1-, 2- or 3-high, is a special case of the analysis in Section IV.2(b). In the context of waste disposal at the WIPP, the areas aWD_i, $i = 1,2,3$, could also represent waste drums stacked i drums high in area i. In this case,

$$dWD_2 = 2\, dWD_1,\ dWD_3 = 3\, dWD_1, \qquad \text{(IV.3)}$$

and so

$$vW = \sum_{i=1}^{3} dWD_i\, aWD_i$$

$$= \sum_{i=1}^{3} (i\, dWD_1)\, aWD_i. \qquad \text{(IV.4)}$$

Thus,

$$dWD_1 = vW / \left(\sum_{i=1}^{3} i\, aWD_i \right) \tag{IV.5}$$

$$fWD_1 = dWD_1\, aWD_1 / vW = aWD_1 / \left(\sum_{i=1}^{3} i\, aWD_i \right). \tag{IV.6}$$

As a result,

$$dWD_i = i\, vW / \left(\sum_{i=1}^{3} i\, aWD_i \right) \tag{IV.7}$$

and

$$fWD_i = i\, aWD_i / \left(\sum_{i=1}^{3} i\, aWD_i \right) \tag{IV.8}$$

for $i = 1,2,3$.

This special case, for waste stacked one-drum, two-drums or three-drums high in the repository, will have no impact on the expected volume of waste released to the surface due to cuttings/cavings because Equation (IV.2) is independent of fWD_i and dWD_i. A similar argument, based on Equation (IV.2), demonstrates that waste stacked 0-, 1-, 2-, or 3-drums high will have no impact on the expected volume of waste released to the surface.

IV.3 EXPECTED RADIONUCLIDE RELEASE

The expected release of an individual radionuclide due to cuttings and cavings is independent of the distribution of this radionuclide over the disposal area. For notational convenience, let

λ_d = decay constant (yr^{-1}) for radionuclide,

$R_i(a,b)$ = release (EPA units, Ci, or kg as desired) of radionuclide by a sequence of drilling intrusions into area i occurring at rate $\lambda(t)$ over the time interval $[a,b]$,

$R(a,b) = \sum_{i=1}^{nW} R_i(a,b)$,

aI = initial amount (e.g., EPA units) of radionuclide present at time t=0,

fR_i = fraction of total amount of radionuclide initially present in area i, with $fR_1 + fR_2 + \ldots + fR_{nWD} = 1$,

dR_i = initial areal density (e.g., EPA units/m^2) of radionuclide in area i $= fR_i \, aI/aWD_i$.

The expected value of radionuclide release, $E[R(a,b)]$, is given by

$$
\begin{aligned}
E[R(a,b)] &= \sum_{i=1}^{nWD} E[R_i(a,b)] \\
&= \sum_{i=1}^{nWD} \int_a^b aBH\, dR_i \exp(-\lambda_d t)\, \lambda(t)\, aWD_i \, dt \\
&= \sum_{i=1}^{nWD} \int_a^b aBH\, (fR_i \, aI/aWD_i) \exp(-\lambda_d t)\, \lambda(t)\, aWD_i \, dt \\
&= aBH\, aI \int_a^b \left(\sum_{i=1}^{nWD} fR_i \right) \exp(-\lambda_d t)\, \lambda(t)\, dt \\
&= aBH\, aI \int_a^b \exp(-\lambda_d t)\, \lambda(t)\, dt. \qquad \text{(IV.9)}
\end{aligned}
$$

Thus, $E[R(a,b)]$ is independent of the concentration at which a particular radionuclide is spread over the disposal area and also the size of the disposal area.

In a similar manner, the expected release of multiple radionuclides can be shown to be independent of both the exact manner in which the radionuclides are spread over the disposal area and the size of the disposal area. Specifically,

$$E[R_T(a,b)] = aBH \int_a^b \left[\sum_{j=1}^{nR} aI_j \exp(-\lambda_{dj} t) \right] \lambda(t)\, dt, \qquad \text{(IV.10)}$$

where

$R_T(a,b)$ = total release (e.g., EPA units) of radionuclides j=1,2,...,nR by a sequence of drilling intrusions occurring at rate $\lambda(t)$ over the time interval $[a,b]$

and the subscript j, j=1,2,...,nR, has been added to aI and λ_d to identify the initial inventory and decay constant associated with radionuclide j.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUN 22 ~~1999~~ 2001

OFFICE OF
AIR AND RADIATION

Dr. Inés R. Triay, Manager
Carlsbad Field Office
Department of Energy
P.O. Box 3090
Carlsbad, New Mexico 88221

Dear Dr. Triay:

The Environmental Protection Agency (EPA) is reviewing the Department of Energy's (DOE's) request, dated April 26, 2001, to approve changes in the utilization of Panel 1 of the Waste Isolation Pilot Plant (WIPP). EPA is examining the potential impacts of: (1) emplacing CH-TRU waste containers in 1-, 2- or 3-high stacks, (2) using all, part or none of the space in each of the rooms in Panel 1, and (3) closing Panel 1 without emplacing RH-TRU waste. We are aware of the safety issues that are developing in Panel 1 and we want to assist you in completing the work in Panel 1 as soon as possible. In order for us to make a determination on these changes, we are requesting additional information about analyses on the impact of roof falls on 1- and 2-drum high stacks, the assumption that the unused rooms will return to be equivalent to unmined conditions and other questions. Please see the enclosed list of questions.

Until we have an opportunity to examine the additional requested information, DOE is only authorized to stack CH-TRU 3 drums high. Once we receive the additional information we will review it and make a determination as quickly as possible. If you have any questions about the information we are requesting, please call Sharon White at (202)564-9457.

Sincerely,

Frank Marcinowski, Acting Director
Radiation Protection Division

Enclosure

cc: Cindy Zvonar, CBFO
Matthew Silva, EEG

Enclosure

Additional Information Needs on the Utilization of Panel 1

Roof Fall Analysis:

- The proposal does not include analysis of the potential impact of a roof fall on a one or two stack. Please submit documentation that shows how a roof fall on a 1- or 2-drum stack will influence Subpart A compliance. In addition you state, "Alternatives with 1-high or 2-high stacks would reduce the thickness of the compacted drum(s), but the intrinsic properties of the stack would not be changed." (Section 3.5) This conclusion may be correct for the long-term, but it is not clear from your documentation that this is true during the short-term. Submit analyses that support the conclusions that 1-high and 2-high stacks would not change the potential impact of roof falls during the operational phase.

Backfill:

- You state, in the Executive Summary, that, "MgO backfill will always be emplace with the waste so that the ratio of backfill to waste remains constant.".If only supersacks of MgO are available, how will the backfill to waste ratio be maintained?

Impact of Unused Rooms:

- You state that, "If rooms are left open, they will close to a condition equivalent to unmined salt." (Section 3.5) Justify this assumption. What evidence do you have to support this conclusion?

- It is clear that you assume that an unused Room will close to become equivalent to unmined salt. Has your evaluation also considered the possibility that an empty room may act as a preferential pathway for fluid to enter the repository in the event of a intrusion borehole? Please explain how this scenario for intrusion is or is not plausible.

Waste Loading:

- It appears that your conclusion that the expected total releases from the repository are independent of the waste loading scheme is predicated on the assumption that waste is uniformly emplaced. Under the proposed changes, waste will not be uniformly emplaced in Panel 1. Is this conclusion still appropriate? Please explain.

Department of Energy
Carlsbad Field Office
P. O. Box 3090
Carlsbad, New Mexico 88221

June 29, 2001

Mr. Frank Marcinowski
Office of Radiation and Indoor Air
U.S. Environmental Protection Agency
401 M. Street, S. W.
Washington, DC 20460

Dear Mr. Marcinowski:

This letter transmits additional information requested in your letter dated June 22, 2001 concerning a proposed change in the utilization of Panel 1 at the Waste Isolation Pilot Plant (WIPP).

Upon further consideration, we have determined that placement of CH-TRU waste containers in either 1- or 2-high stacks is not efficient because of floor conditions in the rooms. The floors are presently in such condition that they will have to be milled to a level condition to allow any waste emplacement. If a particular room is to be utilized, it is much more efficient to remove enough of the floor to stack 3-high as a part of the floor-leveling operation. Accordingly, we are no longer requesting the authority to stack CH-TRU waste containers 1- or 2-high and we have not supplied the additional information you requested to support approval of that request.

DOE is now requesting the flexibility to make only the following changes at WIPP:

- Use all, part or none of the space in each of the rooms in Panel 1 for CH-TRU waste disposal.
- Close Panel 1 without emplacing any RH-TRU waste.

The enclosure contains additional information requested regarding these two remaining changes. As discussed in our initial request dated April 26, 2001, the proposed change will allow the DOE to optimize the utilization of Panel 1 based on considerations of worker safety, operational efficiency and cost. Adding the flexibility included in the proposed change will allow the DOE to minimize the worker risk associated with re-mining and maintaining the back (roof) and ribs (sides) of the older excavations and will also improve operational efficiency. Finally, our analyses continue to demonstrate that these changes are non-significant, and that the proposed changes will not significantly change the certified baseline or compromise repository performance.

CBFO:ORC:DM:VW:01-0797:UFC:5822

At the present rate of waste receipt, DOE will have to cease waste disposal in Panel 1 to avoid blocking access to room 6 by July 31, 2001 if authorization to bypass room 6 is not granted by then. Under these circumstances, we request that you act separately on the request to bypass rooms in Panel 1, if necessary, to expedite action on that portion of our request.

If you have any questions, please contact Daryl Mercer at (505) 234-7452.

Sincerely,

Roger A Nelson for Dr. Inés Triay

Dr. Inés R. Triay
Manager

Enclosure

cc: w/enclosure
D. Huizenga, DOE EM
S. White, EPA-ORIA
C. Byrum, EPA, Region VI
N. Stone, EPA, Region VI
S. Zappe, NMED
M. Silva, EEG

cc: w/o enclosure
B. Lilly, CBFO
S. Hunt, CBFO
C. Zvonar, CBFO
D. Mercer, CBFO
J. Lee, WTS
P. Shoemaker, SNL

CBFO:ORC:DM:VW:01-0797:UFC:5822

1. **Roof Fall Analysis:**

This request for additional information specifically pertains to stacking CH-TRU waste containers 1- or 2-high. This information is no longer needed because DOE has withdrawn its request for the flexibility to stack 1- or 2-high.

2. **Backfill:**

This request for additional information also specifically pertains to stacking 1- or 2-high and is no longer needed because DOE has withdrawn its request for the flexibility to stack 1- or 2-high.

3. **Impact of Unused Rooms:**

"You state that, "If rooms are left open, they will close to a condition equivalent to unmined salt." (Section 3.5) Justify this assumption. What evidence do you have to support this conclusion?

It is clear that you assume that an unused Room will close to become equivalent to unmined salt. Has your evaluation also considered the possibility that an empty room may act as a preferential pathway for fluid to enter the repository in the event of an intrusion borehole? Please explain how this scenario for intrusion is or is not plausible.

Disposal rooms close rapidly. This was observed in the WIPP underground where approximately one meter of closure occurred in Panel 7 between 1988 and 1998. Closure calculations of several experiments conducted at WIPP have demonstrated that the magnitude of creep closure can be accurately modelled. These large-scale experimental results were used to validate geomechanical models. The technical community, including the NRC WIPP Panel (1996), concur that predicted closure rates have a relatively small uncertainty and the magnitude of deformation is captured adequately by the models. The expectation that room closure leads to waste entombment underlies the scientific foundation for disposal in salt.

There is a large body of empirical evidence that abandoned rooms in working salt and potash mines continue to close with time, and eventually close completely to a condition equivalent to that of the unmined rock. This is particularly evident in some of the deep potash mines in Saskatchewan where previously mined rooms close quickly. Mraz et. al (1996), for example, have published data on closure rates in rooms at the K2 mine of IMC showing rapid closure continuing several years after mining. Where rooms have been backfilled, the reconstitution to native salt conditions is even more rapid. During a recent workshop in Carlsbad, Dr. Peter Breidung of Kali und Salz GmbH (Germany) noted that their disposal operations and production mines commonly backfill rooms and shafts which reconsolidate to *in situ* conditions (Breidung, 2001). In fact, Kali und Salz operations have mined back through old workings and the backfilled zones are essentially indistinguishable for the native rock. Similar results are known from salt mines in German domes, including the Asse mine.

This evidence from working mines is compelling, although it may not be directly applicable to the WIPP since the extraction ratios at WIPP are much lower and closure rates correspondingly slower. Thus, while the total closure of WIPP rooms is expected, it will take longer to occur than closure in operating salt or potash mines. In order to estimate the times needed for complete closure under WIPP conditions, it is necessary to rely on model predictions. The modelling results are summarized in the following paragraphs. They include calculations on empty rooms, which were conducted as the WIPP underground was being constructed, as well as later calculations on the closure of rooms backfilled with materials such as salt or waste. Note that these latter calculations are relevant since collapse of material from the roof, floor and ribs will approximate the salt-backfill case.

Room closure can be quantified by geomechanical modeling. Response of the underground is conventionally modeled using the finite element method (FEM). Many pertinent analyses of waste rooms have been performed (e.g., Morgan, 1987, Callahan and DeVries, 1991 and Stone, 1997). Morgan's analysis of closure of an empty single room using SANCHO (a precursor of SANTOS) estimated total room closure in 195 years (Figure 1), without simulating the effects of roof collapse and floor heave. The analyses by Stone used the FEM code SANTOS. Figure 2 is a plot referenced by Stone, which illustrates room closure rates (although this particular calculation simulates the presence of WIPP waste in the room). Porosity is reduced to about 8% in approximately 100 years. As salt-backfilled rooms or empty rooms approach total closure, permeability will reduce asymptotically to values equivalent to those of intact salt ($K<10^{-19}$ m^2). This estimate of re-consolidated salt permeability (K) derives from a relationship between permeability and density, which was developed for the shaft seal system design (Sandia, 1996).

If disposal rooms are left open and unsupported or roof bolted, creep closure and structural response will include floor heave and roof fall. With creep closure the empty (no WIPP waste) room would close around disaggregated material derived from the damaged rock in the roof, floor and ribs. Halite consolidation would then be the primary mechanism of porosity reduction. Callahan and DeVries calculated the closure of backfilled rooms, which are equivalent in many ways to an empty room filled with debris. They calculated mean stress development for rooms containing various backfill materials, which usually exceeded 10 MPa in 200 years. Salt debris subjected to such stress conditions would be well consolidated. Evidence from many studies indicates re-consolidation is effective and rapid (Mellegard et al., 1998) under conditions of modest mean stress (of the order of 5 MPa). Thus, the closing room would provide ample stress to reconsolidate the salt aggregate.

This scenario holds when some of the debris in the formerly empty room includes anhydrite from Marker Bed 139 and anhydrite a and b, since the anhydrite material will be encapsulated in broken salt. These processes of stress induced consolidation and fracture healing will ensure that the rooms return to close to their unmined state within a few hundred years. It should also be noted that there are numerous examples of rooms in operating mines totally closing in short periods of time (years). While the conditions in these mines are generally more severe than at the WIPP, since the extraction ratios, and thus the pillar loading are much higher, these differences will only affect the timing of the closure, not its eventual occurrence.

If rooms in Panel 1 were filled with mined salt, the granular salt would reconsolidate and reduce porosity and permeability. As depicted in Figure 3, creep closure and the natural healing mechanisms of crushed salt would tend to eliminate void space. The relatively high mean stresses calculated by Callahan and DeVries (greater than 10 MPa) ensures the granular salt would have porosity less than 5% in a very short time. Based on the permeability/density relationship noted earlier (Sandia, 1996), this range of consolidation equates to a permeability less than or equal to 10^{-18} m^2. Eventually, in a few hundred years, permeability will return to values equivalent to intact salt ($K<10^{-19}$ m^2). These porosity and permeability values are estimated from a body of experimental work supporting the compliance shaft seal design report (Sandia, 1996), and indicate that both permeability and porosity of rooms backfilled with mined salt would become much lower than the value of typical waste rooms. Behavior of rooms left empty would mimic rooms back-filled with crushed salt, because the salt debris is analogous to salt back-fill. The requisite closure for re-consolidation would ensue within decades.

In terms of the performance of the repository over the regulatory period, the permeability of the closed room will be more than several orders of magnitude less than the waste (value for waste permeability in the Compliance Certification Application was 1.7×10^{-13} m^2). Given this wide diversity of permeability, the closed rooms will behave from a performance standpoint as if they represented intact salt. Early in the life of the repository, before the rooms have fully closed, the open rooms will have the potential to act as open conduits, and therefore as preferential pathways for fluid, in the event of a human intrusion. However, when the rooms close in a time on the order of 200 years, as indicated by Morgan's calculations and by mining experience, total closure will occur before likely intrusion. In the CCA model, the first intrusion could not occur until 700 years after WIPP decommissioning, and in the PAVT until 100 years, and in both cases the mean time for the first intrusion was on the order of 1500 to 2000 years. Also, note that even if certain rooms in Panel 1 remain empty, panel closures will still control flow of fluids into and out of the Panels – any high permeability path through an empty room would only effect flow regimes within the Panel. Finally, it should be noted that a fully closed room will not have any remaining channels for flow. The only effect in PA of leaving certain rooms open will therefore be to marginally reduce the waste storage area.

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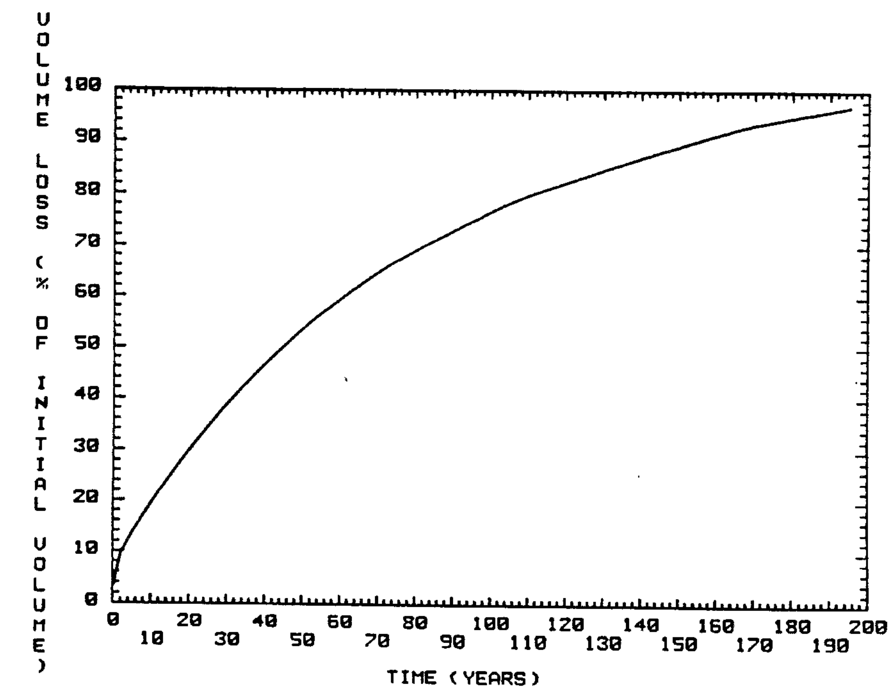

Figure 1. Closure of Empty Storage Room (Morgan, 1987)

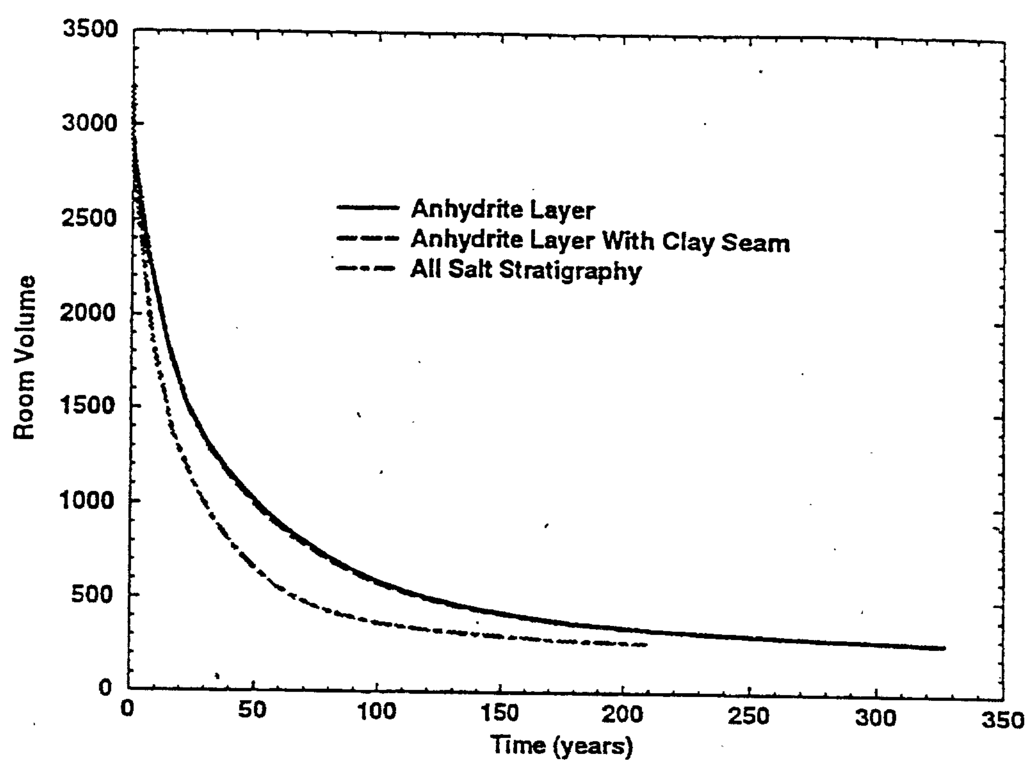

Figure 2. Disposal Room Volume (m^3) Reduction with Time.

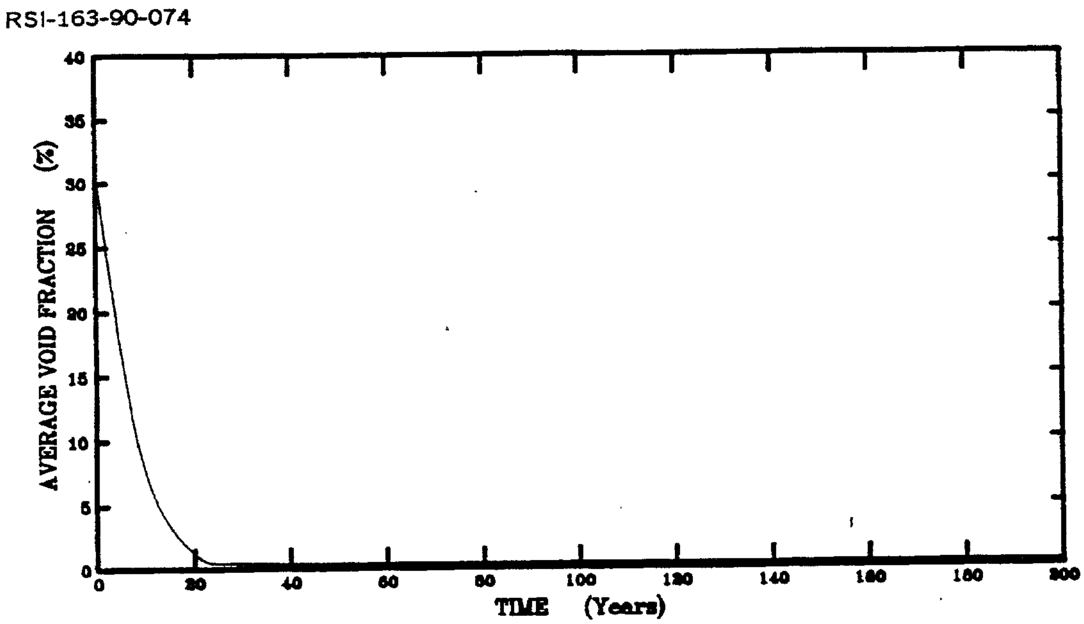

Figure 3. Disposal Room Volume Reduction when Back-filled with Crushed Salt.

4. Waste Loading:

It appears that your conclusion that the expected total releases from the repository are independent of the waste loading scheme is predicated on the assumption that waste is uniformly emplaced. Under the proposed changes, waste will not be uniformly emplaced in Panel 1. Is this conclusion still appropriate? Please explain.

CBFO believes that the conclusion is still appropriate. Attachment IV and Section 3.6 of the DOE submittal on Panel 1 Utilization present detailed analyses and a reasoned argument to demonstrate that the expected release from the repository will be independent of the waste emplacement scheme. It may be helpful to rephrase the assumptions, arguments and reasoning used in the Appendix IV mathematical analyses, since those analyses are rather abstract.

The basis for concluding that the expected total release from the repository is independent of the waste emplacement scheme has two components. First, the mathematical analysis in Attachment IV demonstrates that the expected release from cuttings/cavings is independent of the waste loading scheme. Then, Section 3.6 of the DOE submittal provides a reasoned argument to demonstrate that this result is also applicable to the total release from the repository.

Before discussing each component, it is useful to define the "expected" release from the repository. The expected value is the average or mean value of all the releases from a CCDF, i.e., each point on a CCDF represents a consequence (a release) for a specific time history of borehole intrusions. The average value of all these consequences represents the expected or mean value of the release from the repository. Note that this expected value will be a single value, as opposed to a CCDF that has a range of values for various intrusion time histories.

Mathematical Analysis (Attachment IV)

Attachment IV demonstrates that nonuniform loading of waste within the repository will have no effect on the expected value of the CCDF for cuttings/cavings. This is demonstrated by proving that the expected volume released by cuttings/cavings is independent of the area over which the waste is emplaced and of local variations in the (physical) density of the emplaced waste (see Sections IV.2(a) and IV.2(b)). The mathematical proof for this conclusion is derived in Section IV.2(b). Equation IV.2 of Section IV.2(b) demonstrates that the expected volume is independent of the fraction of the waste, fWD_i, loaded in each separate area of the repository, $aWDi$, and of the total number of separate areas in the repository, nWD, so that the number of panels and rooms is irrelevant to the expected volume released by cuttings/cavings. In fact, the repository can be divided into an arbitrary number of small areas, each with its own unique conditions (e.g., loading), but the expected or average volume released will be the same.

Section IV.3 extends this argument from the expected volume released to the expected activity of the radionuclides released by cuttings/cavings. The expected value of radionuclide release, shown in Equation IV.10, is independent of: the initial areal density, dR_i, of radionuclide in the i^{th} area; the fraction of the total amount of radionuclide, fR_i present in the i^{th} area; and, the total number of separate areas, nWD, in the repository. Again, the repository can be divided into an arbitrary number of small areas, each with its own radioactive waste loading without affecting the expected or average activity released.

A key assumption for the derivation in Section IV.3 is that the activity of the waste removed by cuttings/cavings is proportional to the product of the cuttings/cavings area and the areal density in the i_{th} area of the repository. This is certainly true for cuttings/cavings, which is conceptualized to remove a plug of material with all its radionuclides from the repository immediately to the surface.

Reasoned Argument (Section 3.6)

The analysis in Attachment IV is specific to cuttings and cavings, but it can be extrapolated to demonstrate that the expected total release from the repository is independent of the actual waste loading scheme. The reasoned argument is as follows:

- Attachment IV shows that the expected radioactive release through cuttings/cavings is independent of the detailed waste-loading scheme in individual rooms and of the waste loading scheme in smaller areas within each room.

- The analysis in Attachment IV.3 also applies to the expected releases of CH-TRU through spallings, if 1) the spall volume is unchanged by the waste loading scheme and 2) the activity of the released material varies linearly with the fraction of waste activity emplaced in each room. The first condition is consistent with the CCA, wherein spall volume depends on the physical properties of the waste but is independent of the radioactive content. The second condition is also reasonable because an area with (for example) one-half of the nominal complement of radionuclides will generally release one-half of the activity that an area with the nominal complement of radionuclides will release.

- Cuttings/cavings and spallings are the main components of the total expected release from the repository (see Figure 13.2.3, Helton et al. 1998). Since the expected releases from cuttings/cavings and spallings are independent of the waste loading scheme, and since the total release is essentially the sum of the releases from cuttings/cavings and spallings, it follows that the total expected release will also be independent of the actual waste loading scheme.

Reference:

Helton, J.C., J.E. Bean, J.W. Berglund, F.J. Davis, K. Economy, J.W. Garner, J.D. Johnson, R.J. MacKinnon, J. Miller, D. G. O'Brien, J. L. Ramsey, J.D. Schreiber, A. Shinta, L. N. Smith, D.M. Stoelzel, C. Stockman, and P. Vaughn. 1998. *Uncertainty and Sensitivity Analysis Results Obtained in the 1996 Performance Assessment for the Waste Isolation Pilot Plant.* SAND98-0365. Albuquerque, NM: Sandia National Laboratories.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

AUG 7 2001

OFFICE OF
AIR AND RADIATION

Dr. Inés R. Triay, Manager
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Department of Energy
P.O. Box 3090
Carlsbad, NM 88221

Dear Dr. Triay:

The Environmental Protection Agency (EPA) has completed an evaluation of the Department of Energy's (DOE) requests of April 26, 2001, and June 29, 2001, to consider an alternative use of Panel 1 of the Waste Isolation Pilot Plant (WIPP). Based on our review of the information that you provided, and in accordance with section 194.4(b)(3)(vi) of the Compliance Criteria, we hereby inform you of our determination that DOE's proposed alternative use of WIPP Panel 1 is compliant with the terms and conditions of EPA's WIPP certification. Therefore, you may implement the following specific changes set forth in the April 26 and June 29 letters:

> Use of all, part, or none of the space in each of the rooms in Panel 1 for CH-TRU waste disposal, and
>
> Closure of Panel 1 without emplacement of any RH-TRU waste.

As we explain in the enclosed report, we have determined that these changes will not adversely impact the ability of disposal system to contain transuranic radioactive waste. In addition, we do not believe that these changes affect any other conditions of our May 1998 Certification Decision.

We appreciate your efforts in responding quickly to our requests for more information, thus enabling us to make this determination. In accordance with section 194.4(b) of the Compliance Criteria, DOE is required to inform EPA of any further design modifications that differ from the Compliance Certification Application. If you have any questions about this determination, please contact Agnes Ortiz at (202)564-9310.

Sincerely,

Frank Marcinowski, Director
Radiation Protection Division

Enclosures
cc: Cindy Zvonar, CBFO
Matthew Silva, EEG
Steve Zappe, NMED

Enclosure: EPA Review of 4/26/01 and 6/29/01 Panel 1 Use Proposal

1. Introduction

This report summarizes the Environmental Protection Agency's (EPA's) review of the Department of Energy's (DOE's) request for alternative use of Panel 1 of the Waste Isolation Pilot Plant (WIPP). In an April 26, 2001, letter (Attachment 1), DOE proposed three changes to the use of Panel 1:

1) Place CH-TRU waste containers in either 1-, 2-, or 3-high stacks. MgO backfill will be emplaced with the waste so that the ratio of backfill to waste remains consistent with ratios described in the CCA.

2) Use all or only part of the space in each of the seven Panel 1 rooms for waste disposal. Some rooms could be bypassed and left void of waste.

3) Close Panel 1 without emplacing any RH-TRU waste.

Based on this proposal, on June 22, 2001, EPA requested additional information on the proposed changes (Attachment 2). DOE responded with additional data and information related to requests 2 and 3, and revised the initial proposal to rescind the request for approval to stack waste containers in 1- or 2-high stacks (Attachment 3).

Therefore, this evaluation considers the proposed changes of using all, part, or none of space in each of the rooms of Panel 1 and closing Panel 1 without RH-TRU waste (items 2 and 3 above).

2. Review of Proposed Changes

During numerous site visits EPA staff have noted the degraded condition of Panel 1 because of its advanced age, and we are concerned about the possible effects of the condition of Panel 1 on the safe emplacement of waste.

The Environmental Evaluation Group (EEG) recommended in August 1996, EEG-63, Stability Evaluation of the Panel 1 Rooms and The E140 Drift at WIPP (obtainable from EEG) ". . . it is best to abandon Panel 1 and mine a new panel as soon as all permitting process are complete." EEG also noted,

> . . . with a high degree of confidence, it would be possible to safely use portions of Panel 1 for waste storage. This would require close monitoring and periodic stability assessments to identify the most stable rooms. In addition, we foresee the need for installation of external support systems to prevent the potential for roof falls during waste emplacement operations [p. 30].

DOE's proposal attempts to implement EEG's recommendation to use Panel 1 appropriately.

DOE did not provide any information in response to EPA's June 22, 2001, request for additional information on roof falls because DOE is no longer proposing to stack drums 1- or 2-high stacks. Therefore the main remaining technical issue was the impact that partially filled or empty rooms, or the absence of RH-TRU waste in Panel 1, could have on the ability of the repository to contain waste. EPA's June 22 letter also requested additional information on whether or not partially filled or empty rooms could act as preferential pathway for releases of radionuclides (Attachment 2).

On June 29, 2001, DOE provided additional data and information responding to EPA's June 22 letter (Attachment 3). The data and information provided in DOE's response support the conclusion that the characteristics of the empty or partially filled rooms will be much like native salt, with permeabilities several orders of magnitude less than rooms that contain waste (as stated in the Compliance Certification Application). DOE references modeling that shows that empty rooms will approach a permeability of approximately intact salt ($K<10^{-19}$ m^2) (Attachment 3). After approximately two hundred years, partially filled or abandoned rooms will have permeabilities similar to unmined salt and will not be able to act as preferential pathways for fluids (Attachment 3, p. 3). Releases as predicted in the certification performance assessment will not increase (Docket A-93-02, Item II-G-1). EPA determines that the data and information presented in Attachment 3 adequately support the conclusion that partially filled or empty rooms will not act as preferential pathways for release of radionuclides.

EPA also requested additional information on whether or not the waste loading scheme for the entire repository will be affected by the proposed change in use of Panel 1. DOE's June 29 letter presents data supporting the conclusion that the proposed changes in waste loading will not increase predicted future releases from the repository. EPA concurs with these findings and determines that DOE's statistical analyses are sufficient to support the conclusion that the effects of the proposed changes on potential releases will be insignificant. EPA determines that this conclusion applies to the proposed geometry and current design of the waste disposal area.

DOE's proposal not to emplace RH-TRU waste in Panel 1 will lower the overall actinide inventory of Panel 1, given the assumption that the total RH inventory will be less than the approved CCA inventory because of the exclusion of panel one RH waste. If the actinide source term is less, then potential releases from the repository are not increased. The exclusion of RH-TRU waste from Panel 1 should not impact the predicted long-term predicted performance of the WIPP. If DOE were to seek an increase in the amount of RH-TRU waste in remaining panels, or any other change related to RH-waste emplacement design, it would be necessary to obtain EPA's approval of the proposed change prior to implementation.

3. Conclusion

We determine that the proposed changes to the usage of Panel 1, involving:

- use of all, part, or none of the space in each of the rooms in Panel 1 for CH-TRU waste disposal, and
- closure of Panel 1 without emplacing any RH-TRU waste,

will not increase projected certification releases and are insignificant to long-term performance of the WIPP disposal system. Therefore, we approve these requested changes. This change should be noted in the annual change report.