II-I-17:EPA Request for Information - 19 March, 1997

Honorable Alvin Alm.
Assistant Secretary for Environmental Management
U.S. Department of Energy
1000 Independence Ave., SW
Washington, DC 20585

Dear Mr. Alm:

The U.S. Environmental Protection Agency (EPA) received the U.S. Department of Energy's (DOE) Compliance Certification Application (CCA) for the Waste Isolation Pilot Plant (WIPP) on October 29, 1996. The Agency immediately commenced its review pursuant to. Section 3(d)(1) of the WIPP Land Withdrawal Act, as amended, to evaluate whether the CCA demonstrates and documents WIPP's compliance with EPA's radioactive waste disposal regulations at subparts B and C of 40 C.F.R. Part 191.

On December 19, 1996, Mary Nichols, Assistant Administrator for the Office of Air and Radiation, sent you a letter identifying certain aspects of the CCA that my staff had preliminarily determined to require additional support or documentation. The purpose of that letter was to provide DOE, as early as possible, with a preliminary assessment of EPA's concerns regarding the CCA. Since we sent that letter, we have had the opportunity to: (1) conduct a more detailed review of the CCA; (2) preliminarily consider numerous public comments received on the CCA during the public comment period; and (3) evaluate DOE's responses to the letter. Based upon careful evaluation of each of these factors, we have developed lists of issues that need to be addressed by DOE in order for EPA to render a compliance certification decision (see Enclosures 1-6). This letter is based on a review of all materials received by EPA by March 12th. Since we continue to receive information from DOE on a regular basis, some of the information received since March 12th may address certain points raised in the enclosures. We will expeditiously review these materials, as well as materials received in the future.

The first issue is the adequacy of certain conceptual models. As you are aware, the

Spallings Model predicts the amount of solid material released during a drilling event – an important release scenario. The Spallings Model has been found inadequate by DOE's independent peer review panel. Also, the Chemical Conditions Model, which determines the dissolution of radionuclides in brine found around WIPP, has been deemed inadequate by the same DOE peer review panel. We have been informed by your staff that the peer review panel will be re-convened March 31 to April.4, 1997, to re-evaluate these models. The results of these peer reviews are critical to the Agency's evaluation of the CCA. We request that DOE provide us with the peer review reports and DOE's assessment of the status of the conceptual models. This will enable us to determine the impact on our review of the CCA.

The second area of concern is the derivation of important input parameters, and their associated values, for the performance assessment. This concern is significant because parameters are used as inputs to the computer codes that calculate potential releases from the WIPP. Of the approximately 1,600 input parameters reviewed by EPA, 58 parameters that could have a significant impact on the results of the performance assessment are of concern. I have divided these 58 parameters into three different categories, each of which is listed in a separate enclosure.

The first set of parameters is those for which we have been unable to find supporting data (see Enclosure 2). My staff has been working continuously since November to establish the traceability of the parameter and data record packages that support the input parameter values used in the performance assessment. The Records Center has greatly improved since November. We encourage the Department to continue with these improvements to facilitate retrieveability of records. To date, 13 key input parameters are either not supported by experimental or field data, or the data trail is untraceable. The Compliance Criteria, at 40 C.F.R. §194.26(a), clearly indicate that input parameters should be based on actual experimental data. To the extent that certain input parameter values cannot be obtained through data collection or experimentation, DOE may derive such values using, "expert judgment." The Compliance Criteria set forth explicit requirements for the proper conduct of elicitation of such expert judgment. Thus, in accordance with the Compliance Criteria, DOE must provide the following support for the critical input parameters that appear to be unsupported by actual data: (1)

documentation of actual data collection and/or results of experimentation, or (2) demonstration that EPA's expert judgment procedures were followed in selecting the parameter values.

The second set of five input parameters are those for which EPA has reviewed the supporting information and finds that the information in the record supports a value or range of values different from those selected by DOE (see Enclosure 3). EPA Suggests that new values or ranges be selected for these parameters. My staff will be available to meet with DOE to explain these suggested changes.

The final set of 40 input parameters are those for which EPA has reviewed the supporting data and has questions about the value(s) selected (see Enclosure 4). My staff will be available to meet with DOE staff to review the supporting documentation for each of these parameters to see if changes to the value or range selected for each parameter are needed.

The third area of concern relates to specific scenarios that were eliminated from the CCA's performance assessment calculations. As you know, conceptual models represent our understanding of WIPP and include different types of scenarios, such as human activities (e.g. drilling) and geologic processes (e.g. earthquakes), that could occur over the regulatory time frame. EPA has concluded, as have numerous public commenters, that the CCA does not contain adequate justification for eliminating consideration of the occurrence of certain fluid injection scenarios at WIPP. Therefore, EPA requires either additional substantiation to support the elimination of fluid injection scenarios from performance assessment calculations, or revision of the performance assessment to include appropriate fluid injection scenarios.

The last item of concern relates to the final results of the performance assessment calculations. Since-the performance assessment represents how WIPP is expected to perform in the future, it is critical that site characteristics, conceptual models, computer codes, and input parameters be as representative of the disposal system as possible. EPA believes that final resolution of the three issues identified above may result in different performance assessment input values, as well as revisions to some of the models. Further, EPA is aware that some models have already been changed by DOE and its contractors. Accordingly, DOE will probably need to rerun the performance assessment to demonstrate that the WIPP complies with the disposal criteria using the revised models, input parameters and scenarios. If DOE decides not to rerun the performance assessment, the Department will have to demonstrate why the combined effect of all the changes is not significant enough to require new performance assessment computer runs. An individual impact analysis of each change that does not take into account the synergistic and holistic effects of all of the changes will not be sufficient. This new performance assessment or demonstration will enable us to complete our review of the CCA.

The above requests, as well as a complete listing of other Agency concerns, are explained in detail in Enclosures 1-6 to this letter. Enclosures 5 and 6 list findings from recent quality assurance and peer review audits conducted to verify conformance with the Compliance Criteria at.40 C.F.R.§194.22(a)(1) and §194.27(b), respectively. The issues described in this letter and enclosures include EPA's outstanding concerns with the CCA. In order to facilitate EPA's decision-making process, please send, me a letter describing how, and when, the Department will resolve these concerns.

Thank you for your continued cooperation during our review process. Should you have questions regarding this request, please call me at (202) 233-9320.

Sincerely.

E. Ramona Trovato, Director
Office of Padiation and Indoor Air

Enclosures
cc: Mary D. Nichals (EPA)
Tom Grumbly (DOE/HQ)
George Dials (DOE/CAO).

ENCLOSURE 1 - WIPP Compliance Certification Application Technical Issues Requiring Additional Information Prior to EPA Rendering a Certification Decision

Content of Compliance Certification Applications

194.14(a)(2)

Section 194.14(a)(2) states that the description of the disposal system shall include a description of the geology, geophysics, hydrogeology, hydrology, and geochemistry of the disposal system and its vicinity and how these are expected to change and interact over the regulatory time frame.

The CCA identifies a new conceptualization of the origin of the hydrogeochemical facies in the Culebra. The explanation of the relationship between the hydrochemical facies and the groundwater basin modeling is not adequate. Section 2.2.1.4.1.2 briefly mentions a potential relationship but does not provide support for the relationship.

DOE needs to provide a discussion of the origin of the hydrochemical facies that incorporates the modeled Culebra paleoflow directions with geochemical principles.

Data Quality Characteristics

194.22(c)

Section 194.22(c) requires that the compliance application describe, to the extent practicable, how data used to support compliance have been assessed for the five referenced data quality characteristics: accuracy, precision, representativeness, completeness and comparability.

Section 5.3.21.1 of the CCA states that "...it is not practical to apply data quality characteristics to most scientific investigations used to support a performance assessment in which there is uncertainty in the conceptual models and the resultant ranges of parameters."

While some information that supports this statement was provided in the CCA, EPA requires additional documentation from DOE that supports the CCA arguments and uses specific measured data points as examples.

Models and Computer Codes

194.23(a)(3)(i)

Section 194.23(a)(3)(i) states that any compliance application shall include documentation that conceptual models and scenarios reasonably represent possible future states of the disposal system.

It is EPA's understanding that after an initial E2 drilling intrusion, subsequent E2 drilling intrusions do not produce releases via spallings or direct brine release. It is not clear whether this is a modeling outcome or an assumption.

DOE needs to provide a description of the implementation of the E2 scenario that addresses releases when another E2 event occurs.

194.23(a)(3)(iv)

Section 194.23(a)(3)(iv) states that computer models must accurately implement the numerical models; i.e., computer codes are free of coding errors and produce stable solutions.

(1) Testing of the functional requirements for SECOTP2D is not documented in the CCA's validation documents. The information presented in the Analysis Plan (provided in December 1996) addresses this comment from a completeness standpoint; however, the testing of the SECOTP2D is not technically adequate.

DOE needs to test SECOTP2D with a heterogeneous transmissivity field.

(2) There appears to be a mass balance problem in SECOTP2D that could cause the computer code to produce calculations with errors and thus inaccurately implement the numerical models.

DOE needs to provide an analysis of the mass balance in SECOTP2D and its effects on calculations of radionuclide transport in the Culebra.

(3) Potential errors have been found in the computer codes.

DOE needs to identify errors that have been found in the computer codes since the PA calculations were run for the 10/29/96 CCA submission. DOE needs to *describe the impact of those errors on the results of PA.*

(4) While the type of testing for the SECO3D code appears to be appropriate, the most relevant tests (listed in Record 25, WPO 43367) are only briefly described, and test results are not presented.

The tests mentioned in Record 25 need to be fully described and the results provided.

194.23(c)(2)

Section 194.23(c)(2) requires that the CCA include detailed instructions for executing the computer codes, including hardware and software requirements, input and output formats, listings of input and output files from a sample computer run, etc.

NUTS Validation Document, page 1205: EPA commented in the December 1996 letter that there is no obvious physical reason for oscillations in the concentration profile and there are concerns about the adequacy of the testing. DOE responded that the "apparent oscillations" are actually concentration accumulations due to the velocity field and coarse grid that was used. DOE also stated that no attempt was made to actually solve the problem described in the test, but instead, the purpose was to determine whether NUTS could track the results computed by an independent technique (i.e., MT3D) given the velocity field. This may be true, although it raises two issues: (1) Since MT3D is known to have problems producing accurate solutions, an essentially perfect match of the NUTS results to these inaccuracies does not produce confidence that the NUTS code is providing accurate solutions; and (2) the fact that the same degree of grid coarseness leads to exactly the same level of inaccuracy in both codes is unusual behavior for two independently formulated codes.

DOE should use the computer code SWIFT to benchmark NUTS for the same problem, with the exception that the grid be made fine enough to provide an accurate solution.

194.23(c)(4)

Section 194.23(c)(4) states that detailed descriptions of data collection procedures, sources of data, data reduction and analysis, and code input parameter development must be documented in the CCA.

(1) Concerns regarding anhydrite marker beds still need to be addressed. Specifically, the information on the incorporation of the anhydrite behavior is very general and does not provide the detailed information necessary to reproduce DOE's results regarding the incorporation of permeability and porosity.

DOE needs to provide information that explains the methodology by which the permeability versus pressure curves and porosity versus pressure curves were developed. DOE needs to explain the permeability and porosity curves generated by Mike Lord (attached to the February 26 response as the 1/29/96 memo to Margaret Chu and the 1/24/96 memo from Kurt Larson to Mike Lord and others).

(2) Concerns regarding a low transmissivity feature still remain. A low transmissivity region appears consistently in the calibrated transmissivity fields in the northeastern portion of the site where there are little data. Care must be taken with model interpretations in regions where there are little data to corroborate the interpretation. Low transmissivity produces long travel times and could produce an overly optimistic PA.

Information provided by M. LaVenue at a DOE meeting on 17 and 18 September 1996 at Sandia originally indicated that the low transmissivity region is due to a single very low transmissivity data point at P-18. From the histogram of Culebra transmissivity data, the P-18 data point could be argued to be a statistical outlier. Given the large variation of transmissivity data over the wider region, the P-18 data point could also be valid. But the geostatistical methods in GRASP_INV should not allow the data point at P-18 to produce low transmissivity in the northeastern portion of the site that is far separated from P-18.

The DOE response to EPA's request of December 19, 1996 stated that there are no independent data to confirm the P-18 data point. But it is stated that the P-18 data point is consistent with the geological conceptual model. Further, it is stated the P-18 data point has a minor effect because of the geostatistical methods used in GRASP_INV.

While the above DOE response is reasonable, the original question still remains as to why there is a low transmissivity feature in the eastern portion of the site where there are little data to confirm the feature.

DOE needs to provide the transmissivity field that results from bringing the transmissivity data and which does not show the low transmissivity region in the northeastern part. DOE needs to provide several typical transmissivity fields calibrated to steady-state head data that show the appearance of the low transmissivity feature in the northeastern part of the site. These plots need to be accompanied with an explanation as to the reasons why the calibration causes this low transmissivity feature in the northeastern part of the site.

(3) "Legacy" parameters were developed and used in the 1992 PA calculation in the CCA PA calculations without alternation. Current parameter packages simply reference "Legacy" parameters without explaining how they are developed or providing traceability to source documents.

DOE needs to document the development of "Legacy" parameters to show traceability.

Waste Characterization

194.24(a)

Section 194.24 requires the CCA to include a description of the chemical, radiological and physical composition of all existing waste (and, to the extent practicable, to-be generated waste) proposed for disposal in the WIPP.

(1) The BIR indicates that the Department has collected more recent information on the waste inventory of the generator sites, in particular, information were collected during the January 1996 data call.

If the Department would like this information considered as part of the application, then it should provide that to the Agency. Otherwise, EPA will assume that the waste inventory information submitted with the October, 29, 1996 application is that on which we will base our certification decision.

194.24(b)

Section 194.24(b) requires the CCA to include a complete discussion of all waste characteristics that influence disposal performance, including but not limited to solubility, formation of colloids suspensions, gas generation, shear strength, compatibility, and other waste-related input to model parameters.

1) Adsorption of actinides by immobile mineral surfaces or metal corrosion products can retard the migration of actinides relative to the flow of brine through the repository. Adsorption of actinides onto colloids can enhance actinide migration. The CCA apparently does not account for the adsorption of actinides onto colloids in determining the releases during cuttings/cavings.

The Department needs to provide a description of how adsorption of actinides was accounted for in releases of cuttings/cavings. If adsorption not taken into account, the Department needs to show how this would lead to a conservative release estimate.

2) The effects of organic complexants on actinide solid solubilities within a brine system has not been well documented through experimental or modeling studies.

The Department needs to provide more detail discussion on the use of HYDRAQL code, especially in respect to quantity of organic complexants used in the calculation.(1)

194.24(c)(1)

Section 194.24(c)(1) requires DOE to demonstrate that for total inventory of waste proposed for disposal, WIPP complies with the numeric requirements of section 194.34 for the upper and lower waste limits, including their associated uncertainties.

It is not evident in the CCA how the Department is treating the associated uncertainties for the upper and lower limit for each waste component.

The Department needs to identify the method by which the uncertainties associated with the upper and lower limits for each waste component are being incorporated into the results of the performance assessment.(2)

194.24(c)(3)

Section 194.24(c)(3) requires the Department to provide information which demonstrates the use of process knowledge to quantify waste components.

Acceptable knowledge plays a key role in identifying the origin or generation of TRU wastes. This information is used to help inform the non-destructive assay (NDA) process in the selection of the appropriate correction or calibration factors. The operational history of a site indicates many important details of the waste matrix. Each TRU generator site considers acceptable knowledge in choosing measurement equipment, designing analytical protocols and establishing the types and ranges of correction and/or calibration factors for NDA measurement systems. However, the CCA is not clear on what the protocol is for determining this information when no acceptable knowledge information is available.

The Department needs to provide the protocol for determining the NDA measurement equipment, designing analytical protocols and establishing the types and ranges of correction and/or calibration factors for NDA measurement systems when no acceptable knowledge information is available.

194.24(c)(4)

Section 194.24(c)(4) requires the CCA to provide information which demonstrates that a system of controls has been and will continue to be implemented to confirm that the total amount of each waste component that will be emplaced in the disposal system will not exceed the upper limit or fall below the lower limit.

The CCA discusses the WIPP Waste Information System (WWIS) which the Department proposes to use for the purpose of tracking the quantity of waste emplaced in the WIPP. It is not clear what information will be collected regarding the location of drums in the repository. In addition, the WWIS Software Design Description contains the internal details of each design entity including a description of the data elements associated with each entity. Although the WWIS lists the data elements, it is not clear which data elements are active or inactive and are functioning as placeholders.

EPA will soon be conducting an audit of the WWIS system. The Department should be prepared to address the above issues during the conduct of that audit.

194.24(d)

Section 194.24(d) requires the Department to provide a waste loading scheme, or else the performance assessments shall assume random placement of waste in the disposal system.

The CCA assumed that the containers of waste would be emplaced randomly for the 569 waste streams tracked in the TWBIR. The CCA also assumes that the sampling of 10,000 futures was large enough that the relatively low probability combination of three of the waste streams with higher activity loading occurring in a single drilling event was captured in the CCDFs. However, the assumption that containers will be randomly placed in the WIPP does not take into account likely "real world" scenarios where a specific generator sends a large shipment of a particular waste stream at one particular time (e.g. RF-Residues from Rocky Flats which is estimated to represent 15 percent of the total curies emplaced in the WIPP at 2133).

The Department needs to address how it is planning to achieve random loading of waste drums at WIPP. If the Department cannot achieve random loading they need to analyze the effect of non-random loading.

Scope of Performance Assessments

194.32(a)

Section 194.32(a) states that performance assessments shall consider natural processes and events, mining, deep drilling, and shallow drilling that may affect the disposal system during the regulatory time frame.

The CCA does not provide adequate information as to the behavior of short-term brine flow to the surface if a brine pocket is hit.

DOE needs to document the modeling results that support the current approach, which assumes that brine flow to the surface from hitting a brine pocket does not result in releases.

194.32(c)

Section 194.32(c) specifically requires that the PA include an analysis of the effects on the disposal system of any activities that occur in the vicinity of the disposal system prior to disposal and are expected to occur in the vicinity of the disposal system soon after disposal system. These activities include boreholes and leases that may be used for fluid injection activities.

The process for solution mining for extraction of brine is distinctly different from other resource extraction techniques. The fluid injection activities used in solution mining can potentially induce alterations, which may not be limited to subsidence and caving, in the host rock (Salado).

DOE needs to consider in the PA existing boreholes in which solution mining can reasonably be expected to occur in the near future.

194.32(e)

Section 194.32(e) states that compliance application(s) shall include information which: (1) identifies all potential processes, events or sequences and combinations of processes and events that may occur during the regulatory time frame and may affect the disposal system; (2) identifies the processes, events or sequences and combinations of processes and events included in performance assessments; and (3) Documents why any processes, events or sequences and combinations of processes and events identified pursuant to paragraph (e)(1) of this section were not included in performance assessment results provided in any compliance application.

(1) The Stoelzel and O'Brien features, events and processes (FEP) analysis (Reference 611) provides information on how fluid injection may effect the disposal system. This approach does not appropriately model this event.

DOE needs to:

(a) Use a 150-year period as the period of simulation.

(b) Identify the extent to which the initial conditions (i.e., conditions before an intrusion event) of the repository could change with the longer period of fluid injection.

(c) Analyze the effects of a human intrusion event subsequent to fluid reaching the repository via a fluid injection event.

(d) Increase the transmissivity of Bell Canyon to allow higher volumes of brine to be injected.

(e) Reduce, by one-half, the DRZ volume.

(f) Estimate the frequency of fluid injection wells that have failed or appear to have failed.

(g) Substantiate why a two-dimensional cross-sectional modeling approach is appropriate for this analysis.

(2) DOE has not analyzed (screened) the potential effects of solution mining of halite in the CCA. Section 194.32(c) requires that performance assessments include an analysis of the effects on the disposal system of such activities in its vicinity prior to disposal or that can reasonable be expected soon after disposal.

DOE needs to provide an analysis of the effects of solution mining for halite. Since the mining of the halite is associated with the production of oil, the time frame for the modeling study may be limited to the potential life of oil production around WIPP (i.e., 150 years).

ENCLOSURE 2 - WIPP Performance Assessment Parameters Lacking Supporting Evidence.

No	ID	Material ID	Parameter ID	Description
1	3245	BLOWOUT	CEMENT	Waste cementation strength
2	3246	BLOWOUT	PARTDIA	Waste particle diameter in Cuttings Model for dir brine release
3	198	DRZ-1	PRMX-LOG	Log of intrinsic permeability, X-direction; disturb rock zone; time period 0 to 1000 years
4	2177	S-MB-139	DPHIMAX	Incremental increase on porosity relative to intact conditions in the Salado Marker Bed 139
5	2180	S-MB-139	PF-DELTA	Incremental pressure for full fracture developmen
6	586	S-MB-139	PI-DELTA	Fracture initiation pressure increment
7	2178	S-MB-139	KMAXLOG	Log of max permeability altered anhydrite flow model

8	3134	BH-OPEN	PRMX-LOG	Log of intrinsic permeability x – direction boreho unrestricted
9	2158	S-ANH-AB	DPHIMAX	Incremental increase in porosity relative to intact conditions in the Salado anhydrite beds A and B
10	214	EXP-AREA	PRMX-LOG	Log of intrinsic permeability, x-direction, experimental area
11	3473	BLOWOUT	THICK-CAS	Thickness of the Castile formation, direct brine releases
12	3456	BLOWOUT	RE-CAST	External drainage radius for the Castile formation direct brine releases
13	3194	CASTILER	GRIDFLOW	Index for selecting brine pockets

ENCLOSURE 3 - WIPP Performance Assessment Parameters Where the Record Supports Values Other Than Those Selected by the DOE.

No	ID #	Material ID	Parameter ID	Description
1	3493	GLOBAL	PBRINE	Probability of Encountering Pressuri
2	2254	BOREHOLE	TAUFAIL	Waste Shear Strength
3	3184	BH-SAND	PRMX-LOG	Log of Intrinsic Permeability, x-dire
4	2918	CASTILER	VOLUME	Total Reservoir Volume
5	61	CASTILER	COM-RCK	Bulk Compressibility

ENCLOSURE 4 - WIPP Performance Assessment Parameters Not Explicitly Supported by the Relevant

Data/Information.

No	ID #	Material ID	Parameter ID	Description
1	27	BOREHOLE	DOMEGA	Drill String Angular Velocity
2	64	CASTILER	POROSITY	Effective Porosity
3	66	CASTILER	PRESSURE	Brine Far-field Pore Pressure
4	259	PAN-SEAL	PRMX-LOG	Panel Seal Permeability
5	528	S-ANH-AB	POROSITY	Effective Porosity
6	567	S-MB 138	POROSITY	Effective Porosity
7	588	2-MB 139	POROSITY	Effective Porosity
8	651	WAS-AREA	ABSROUGH	Absolute Roughness of Material
9	653	WAS-AREA	COMP-RCK	Bulk Compressibility
10	1992	WAS-AREA	DIRNCCHW	Bulk Density of Iron Containers CH Was
11	1993	WAS-AREA	DIRNCRHW	Bulk Density of Iron Containers RH Was
12	2040	WAS-AREA	DIRNCCHW	Average Density of Iron-Based Material Waste
13	2041	WAS-AREA	DCELLCHW	Average Density of Cellulosic in CH Wa
14	2274	WAS-AREA	DECELLRHW	Average Density of Cellulosic in RH Wa
15	2907	STEEL	CORRMCO2	Inundated Corrosion Rate of Steel w/o C Present
16	3147	CONC-PLG	POROSITY	Effective Porosity
17	3185	CONC-PLG	PRMX-LOG	Log of Intrinsic Permeability, x-direction
18	3256	BLOWOUT	FGE	Gravity Effectiveness Factor
19	3259	BLOWOUT	APORO	Waste Permeability in CUTTINGS Mode
20	3429	PHUMOX3	PHUMOX	Proportionality Constant Humic Colloids

21	3471	BLOWOUT	MAXFLOW	Maximum Blowout Flow
22	3472	BLOWOUT	MAXFLOW	Minimum Blowout Flow
23	3433	PHUMOX3	PHUMSIM	Proportionality constant of actinides in S Brine with humic colloids, inorganic
24	3470	BLOWOUT	GAS-MIN	Gas Rate Cutoff
25	3317	PU	PROPMIC	Microbial Proportionality Constant
26	3405	SOLMOD6	SOLCIM	U(VI) Solubility Limits - Castile
27	3406	SOLMOD6	SOLSIM	U(VI) solubility Limits - Salado
28	3402	SOLMOD3	SOLCIM	Oxidation State + III Model
29	3403	SOLMOD4	SOLCIM	Oxidation State + IV Model
30	3407	SOLMOD4	SOLSIM	Oxidation State + IV Model
31	3404	SOLMOD5	SOLCIM	Oxidation State + V Model
32	3408	SOLMOD5	SOLSIM	Oxidation State + V Model
33	3311	AM	PROPMIC	Microbial Proportionality Constant
34	3482	AM+3	MKD-AM	Matrix Partition Coefficient for Am
35	3480	PU+3	MKD-PU	Matrix Partition Coefficient for PU
36	3481	PU+4	MKD-PU	Matrix Partition Coefficient for PU
37	3479	U+4	MKD-U	Matrix Partition Coefficient for U
38	3475	U+6	MKD-U	Matrix Partition Coefficient for U
39	656	WAS-AREA	GRATMICH	Gas Production Rate – Microbial Humid Conditions
40	657	WAS-AREA	GRATMICH	Gas Production Rate – Microbial Inundat Conditions

ENCLOSURE 5 - EPA Quality Assurance Audits:

Findings and Observations.

Since the Department submitted its WIPP Compliance Certification Application on October 29, 1996, EPA has performed quality assurance audits of DOE's Carlsbad Area Office (CAO), Sandia National Laboratory (SNL) and Westinghouse Corporation pursuant to 40 CFR Part 194.22(e) . The purpose of these audits was to verify the appropriate execution of the requirements of 40 CFR 194.22(a)(1), which addresses quality assurance for activities associated with the Waste Isolation Pilot Plant (WIPP).

The Agency's findings and observations from the CAO and SNL quality assurance audits are listed below. There were no findings or observations from the audit of the quality assurance program of the Westinghouse Corporation. A finding is a specific nonconformance with an applicable NQA element or the element's implementing procedure. An observation is not a nonconformance, but does require a response.

Findings and Observations From EPA's Quality Assurance Audit of the Carlsbad Area Office

On December 9-13, 1996, EPA performed an audit of DOE's CAO quality assurance program pursuant to 194.22(e). The purpose of the audit was to verify the appropriate execution of the requirements of 40 CFR 194.22(a)(1). The audit team identified four findings of relatively minor and isolated consequences during the audit.

Finding No1

NQA-1, Requirement 2 states that the management of those organizations implementing the quality assurance program shall regularly assess the adequacy of that part of the program for which they are responsible and shall assure its effective implementation.

However, CAO's MP 9 1, which implements this NQA requirement, contained no provision for regular assessments. At the time of the audit, MP 9.1 was under revision and was to be changed to address this finding.

Finding No.2

Team Procedure TP 10.5, Requirements 3.4.2(a) and (c) require documentation of orientation of peer review team members.

However, documentation was not available to demonstrate orientation training for one of the panel members for Peer Review No. 3.

Finding No.3

Team Procedure TP 10.5 (Rev 0), Requirement 3.1.3 (a), requires that the peer review selection committee shall be impartial and have no conflict of interest, including financial gain.

However, the chair of the peer review selection committee, which chose the panel for Peer Review No. 3, is the executive vice president of the firm where one of the selected panel members is employed. It was not clear from the information presented during the audit whether the chair of the selection committee may have been in a position in which his own personal interest was conflicted with the independent performance of the Peer Review panel No. 3.

Finding No.4

The audit team identified some documentation that was missing from the DRR files for TP 10.5 (Rev. 0 and Rev-. 1)

Copies of the missing information were found and placed in the DRR files during the audit.

Findings and Observations From EPA's Quality Assurance Audit of Sandia National Lab

On January 13 -24, 1997, EPA performed an audit of the Sandia National Laboratory Quality Assurance Program pursuant to 194.22(e). The purpose of the audit was to verify the appropriate execution of the requirements of 40 CFR 194.22(a)(1). The audit team identified six findings and six observations during the audit.

Finding 1

NQA-1, Supplement 1, states "quality achievement. is verified by persons or organizations not directly responsible for performing the work." However. QAP 1-1 states "line management is responsible for verifying the quality."

Finding 2

NQA-3, Requirement 2.4, states "Management assessments of the quality assurance program shall be conducted regularly and reported at least annually."

However, the last management assessment was performed in April 1995.

Finding 3

Several CAR files requested from the Records Center were found to be incomplete, i.e., referenced documents were not included in the files, or listed on the Record Package Table of Contents.

CAR	Missing Documents
EA96-15-QAF-1	Original log sheet and correction
EA96-15-QAF-5	Attachment documenting sample identification scheme
EA86-26-QAF-1	Corrective Action Request form, initial proposed solution of CAR (determined to be unacceptable), and revised proposed solution of CAR (acceptable)
W97-003	Summary memo, including Statement of Impact

Finding 4

Section 4.1, Step 4, of QAP 5 1 requires the use of the format described in Appendix A.

QAP 5-1 does not conform to its own requirements for procedure format.

Finding 5

NQA-3, Supplement 3SW-1 states "All data shall be recorded so that they are clearly identifiable and traceable to test experiment, study, or other source from which they were generated."

However, the supporting documentation for the following parameters analyses do not meet traceability requirements:

Parameter No Id. 34, Borehole PRMX_LOG is listed as a placeholder parameter. The parameter value listed in Form 464 is not traceable.

Parameter No Id. 3148, CONC_PLG COMP_RCK, listed two sets of parameter values. There is no traceability documentation provided for the first set of data, which has a parameter value of "0." The second set of data has a parameter value of 1.2E-09, which was listed in Form 464 and is traceable, but has never been used. Instead, the parameter value of 2.64E-09 was used, but this value has never been entered into Form 464.

Although 2.64E-09 is the wrong value to use in the analysis, traceability documentation must still be provided with Form 464.

Finding 6

QAP 5-1, Revision 2, Section 4.2, Step 1, Note 1 states that QAPs are allowed to carry ICN changes for up to one year before they are revised and reissued.

QAP 2-4 has two ICNs that exceed the one-year limitation. ICN 01's effective date is 10/27/95 and ICN 02 has an effective date of 11/17/95. QAP 20-3 has an ICN with an effective date of 10/13/95. ICN 01 for QAP 5-1 rescinds the one-year limitation on the incorporation of ICNs through QAP revision. However, this ICN was not effective until December 18, 1996.

Observation 1

CAR W97-013 was issued due to a deviation from NQA-3, Requirement 2.4, which requires the annual performance of management assessments. The corrective action for this CAR provided for the scheduling of a management assessment in April 1997. The corrective action was accepted by SNL WIPP QA and the CAR was closed out on January 9, 1991. The audit team is concerned that this corrective action is inappropriate and that the CAR should not be closed until the management assessment is completed.

Observation 2

CAO CAR 96-039 was issued due to deviations from SNL QAPs 13-1 and 13-2, which prescribe sample control and chain-of-custody, respectively. Numerous samples were transferred without proper chain-of-custody. The corrective action performed included revision of existing chain-of-custody forms for several samples. In addition, chain-of-custody forms were filled out for those samples which had been transferred without maintaining chain-of-custody. The audit team is concerned that the chain-of-custody forms were improperly used and, as a result, the data generated from the subject samples is legally inadmissible.

Observation 3

The software disaster recovery process does not readily describe the procedure by which the software configuration management system and the PA software will be restored with adequate assurance that superseded software versions will not be recreated as "current" versions.

Observation 4

The Validation Document Reviewer's Form should explicitly require the reviewer to confirm that the executed test cases are the same as the test cases listed in the Validation Plan document.

Observation 5

The definition of gradation provided in QAP 19-1 is not clearly stated. For example, if software is exempt from QAP 19-1, it will be qualified under QAP 9-1 This optional means of approving software demonstrates that gradation has a different meaning than the definition of grading set forth in NQA-1.

Observation 6

NQA-1, Requirement 5, requires procedures for activities which affect quality to have quantitative or qualitative acceptance criteria.

However, the format specified by QAP 5-1 for developing QAPs does not clearly include a section for acceptance criteria. No QAPs contain acceptance criteria.

ENCLOSURE 6 - EPA Peer Review Audit: Findings and Observations..

On February 10-12, 1997, EPA performed an audit of DOE's documentation of its peer review processes conducted in support of the WIPP Compliance Certification Application to establish that they were conducted in a manner compatible with NUREG-1297, "Peer Review for High-Level Nuclear Waste Repositories," as required by 40 CFR Part 194.27(b). The audit team identified seven findings of relatively minor and isolated consequences during the audit. A finding is a specific nonconformance with an applicable NQA element or the element’s implementing procedure. An observation is not a nonconformance, but does require a response like a finding. The findings and observations resulting from this audit are listed below.

Finding 1

NUREG-1297 states that Peer Reviewers should have sufficient freedom from funding considerations to assure the work is impartially reviewed.

To address this issue, the DOE's Carlsbad Area Office (CAO) included conflict of interest forms which require financial disclosure to identify whether a conflict exists. Mr. Evaristo Bonano and Ms. Patricia Robinson, members of the Waste Characterization Peer Review, checked that they had conflicts of interest but did not complete the required disclosure form.

Finding 2

NUREG-1297 states that in cases where total independence cannot be met, the peer review report should contain a documented rationale as to why someone of equivalent technical qualifications and greater independence was not selected

A Non-Selection Justification form was included for the Waste Characterization Peer Review. Ms Patricia Robinson, a Nuclear Engineer with a Master of Science

Degree pending, was selected for the Waste Characterization Peer Review Panel. Ms Robinson is currently employed by a DOE contractor. The form lists Dr. Peter K.Mask, a Nuclear Engineer with a Ph.D., and notes that other equally or more qualified individuals are available. From the form, it appears that persons of equivalent technical qualification were available but not selected. However, the Non-Selection Justification form does not document the rationale.

Finding 3

CAO Team Procedure TP 10.5 (Rev. 1), Section 3.1.3(c), requires peer review panel members be selected from a predetermined list of personnel. However, Section 5.4, the responsibilities section of this procedure, states that the Peer Review Selection Committee shall generate a list of qualified Peer Reviewers using its knowledge of university contacts, professional organizations, and qualified industry professionals. A conflict exists within the procedure and should be revised.

Additionally, with the exception of the Engineered Alternatives Peer Review, neither a predetermined list nor a list generated from university contacts, professional organizations, and qualified industry professionals was located in the files reviewed

Finding 4

CAO Team Procedure TP 10.5 (Rev.1), Section 5.7, requires Peer Review Panel Members to complete and document the necessary training prior to the start of the Peer Review process.

Training forms for Mr. Chuan-Mian Zhang and Mr. Paul Cloke, members of the Natural Barriers Peer Review Panel, are dated May 15, 1996, while the meeting minutes of May 14, 1996, show them already in attendance.

Finding 5

CAO Team Procedure TP 10.5 (Rev.1) Section 3.4.2, requires that all Peer Revicw Panel Members receive an orientation prior to the start of the Peer Review process. At a minimum, the orientation shall cover subjects or documents related to the Peer

Review process, including administrative requirements, the applicable Peer Review Plan, a brief summary of the Peer Review technical subject matter, an overview of the requirements of TP 10.5, and any other appropriate topic.

Records indicate that Mr. David Sommers did not receive administrative orientation prior to the start of the Peer Review process.

Finding 6

CAO Team Procedure TP 10.5 (Rev. 1), Section 3.4.2, requires that all Peer Review Panel Members receive an orientation prior to the start of the Peer Review process.

There is no evidence that Mr. Florie Caporuscio received orientation when the Conceptual Models Peer Review Panel reconvened in January 1997.

Finding 7

CAO Team Procedure TP 10.5 (Rev. 1), Section 3.4.4, requires minutes for all meetings, activities, and deliberations

Minutes for the Natural Barriers Orientation Meeting conducted on May 14, 1996, were not included in the Peer Review file.

Observation 1

CAO Team Procedure TP 10.5 (Rev. 1), Section 3.1.3a, requires that the Selection Committee shall be impartial and have no organizational conflict of interest.

The appearance of a conflict of interest exists for both Peer Review Managers. The CAO Technical Assistance Contractor (CTAC) was tasked by CAO to contract for the management of the Peer Review process. Informatics, Inc, was selected. Mr. John Thies, Executive Vice President of Informatics and Peer Review Manager, selected Mr. Leif Errikson of CTAC to serve on the selection committee. Mr. Thies also selected Informatics employees as Peer Reviewers

Dr. Abbas Ghassemi, Manager of Peer Review for Engineered Alternatives and Director of Special Programs for WERC, selected Dr. Ron Bhada, Administrative

Director of WERC, to serve as Peer Review Panel Leader.

Observation 2

NUREG-1297 states that a rationale as to why someone of equivalent technical qualification and greater independence was not selected should be documented.

Several of the Engineered Alternative Peer Review panel members disclosed, in their Determination of Independence forms, current or previous affiliation with DOE. However, a documented rationale as to why someone of equivalent technical qualification and greater independence was not selected was not included with the support documents.

Observation 3

The Peer Review Selection Committee is required to document the rationale for selection of Peer Review Panel Members on a Peer Review Panel Selection, Size and Composition Justification/Decision Form.

A form was completed for each peer review, however, the form only repeats the requirements and does not provide a rationale for the selection of peer review panel members.

II-I-24: First set of responses to EPA's March 19, 1997 letter - 15 April, 1997

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EPA Comment 2 - Enclosure 1, page 1 - 194.22(c)

Text of Comment

Data Quality Characteristics

194.22(c)
Section 194.22(c) requires that the compliance application describe, to the extent practicable, how data used to support compliance have been assessed for the five referenced data quality characteristics: accuracy, precision, representativeness, completeness and comparability.

Section 5.3.21.1 of the CCA states that "...it is not practical to apply data quality characteristics to most scientific investigations used to support a performance assessment in which there is uncertainty in the conceptual models and the resultant ranges of parameters."

While some information that supports this statement was provided in the CCA, EPA requires additional documentation from DOE that supports the CCA arguments and uses specific measured data points as examples.

DOE Response

The DOE believes that these data quality characteristics are applicable to tasks involving the quantification through sampling and analysis of specific constituents in an environmental medium. The DOE also believes that these requirements are intended to address activities such as the determination of the presence or absence of pollutants in waste streams. It was not practicable to develop data quality objectives against which the data quality characteristics could be assessed, and it was therefore not practicable to assess the data used to support the performance assessment for data quality characteristics. The DOE believes that assessment in context of regulatory compliance implies comparison to a standard, and it is not practicable to develop that standard. Further, data quality characteristics have a relatively small impact on compliance certainty because the uncertainties in the performance assessment related to geological heterogeneity, extrapolation to 10,000 years, future human activities, and uncertain processes that dominate the uncertainties in the individual experimental measurements. However, the controls and processes under the NQA-1 program provide confidence in the quality of the data used to support the performance assessment in the CCA. A more detailed explanation of the use of data quality characteristics for application to the WIPP CCA is attached.

Data Quality Characteristics in the WIPP Compliance Certification Application

Introduction

As was stated in the application, it was not practicable to assess the data used to support the performance assessment in the compliance application for data quality characteristics (DQCs) because it was not practicable to develop data quality objectives (DQOs) against which the DQCs could be assessed. DQOs and DQCs were assessed for waste characterization and environmental monitoring data, and can be provided if desired; however, these data were not necessary to support performance assessment. DQCs were not developed for WIPP experimental data used in the performance assessment because of the impracticability of developing DQOs based on the regulatory requirements, as well as because the issuance of 40 CFR 194 post-dated the initiation of experiments and the initiation of collection of data. It would also add no value to retrospectively develop DQCs, since DQCs have a relatively small impact on compliance certainty for the WIPP. This is because the uncertainties in the performance assessment related to geological heterogeneity, extrapolation to 10,000 years, human activities, and uncertain processes dominate the uncertainties in the individual experimental measurements. The DOE can provide information on how appropriate aspects of data quality were evaluated for the information used in the CCA. These evaluations were performed in the normal process of analyzing experimental results, as well as in the context of peer review and the Independent Review Team process. Casting this information into the format of DQCs would not add any value, since other activities under the QA program already provide assurance of the quality of the data.

It is not practicable to assess the data quality characteristics

The CCA is required by 40 CFR 194.22(c) to "provide, to the extent practicable, information which describes how all data used to support the compliance application have been assessed for their quality characteristics."

The DOE has determined that it is not practicable to assess the data quality characteristics of the data used to support the CCA. Assessment implies comparison to a standard, and it is not practicable to develop that standard.

The key action word in the requirement is "assessed." 40 CFR 194 provides no explicit guidance on how this action word is to be interpreted. In the absence of this explicit guidance, the DOE sought out other guidance documents related to "assessment" of data quality for regulatory compliance. In particular, EPA QA/G-9, Guidance for Data Quality Assessment, states in the introduction that "This document provides general guidance to organizations on assessing data quality criteria and performance specifications for decision making." *(EPA QA/G-9 QA96 version p. i)* The DOE assumes that this guidance is relevant in understanding what the EPA expects to be provided in response to a requirement to “assess ... data quality characteristics.”

In EPA QA/G-9, the first step of a data quality assessment is to “Review the data quality objectives.” The process for reviewing data quality objectives is quite explicit. It is to “Review the DQO outputs to assure that they are still applicable. If DQOs have not been developed, specify DQOs before evaluating the data (e.g., for environmental decisions, define the statistical hypothesis and specify tolerable limits on decision errors; for estimation problems, define an acceptable confidence or probability width). Review the sampling design and data collection documentation for consistency with the DQOs.” *(EPA QA/G-9 QA96 version p. 0-2)*

For the WIPP, DQOs have not previously been developed because the issuance of the requirement post-dated the initiation of experiments and the collection of data. Therefore, it is necessary to specify DQOs before evaluating the data. However, it is not practicable to specify DQOs for data supporting WIPP compliance. The regulatory requirement applies to the results of a probabilistic performance assessment which calculates the total release to the accessible environment over a 10,000 year period. This performance assessment includes many complex, highly interactive processes which make it impracticable to work backwards from the regulatory requirement to data quality objectives.

Since it is not practicable to complete the step in which DQOs are specified, it is not practicable to complete the step “Review the Data Quality Objectives.” Since this is one of the essential elements of a data quality assessment, it is therefore not practicable to complete an assessment of the data quality characteristics of the data supporting the WIPP compliance application.

Data uncertainties make a relatively small contribution to compliance uncertainty

An important point to remember when discussing data quality in the context of the performance assessment is that the performance assessment is a probabilistic calculation which accepts substantial uncertainty in important parameters. These uncertain parameters relate to the fact that the repository is located in a heterogeneous geologic setting, the fact that the repository performance must be calculated for a 10,000 year period, and the fact that the outcomes of some processes are simply not known, among others. These uncertain parameters are represented in the calculations by distributions which reflect this lack of information.

An important source of uncertainty is the heterogeneity of the geologic setting. The uncertainty associated with this heterogeneity is reflected in broad distributions for the values of important parameters related to the properties of this geologic setting. In fact, these distributions are much broader than the uncertainties related to individual measurements. For example, permeabilities of units in the Salado have been measured, with estimated errors of less than an order of magnitude. However, the distributions used in the calculations span three orders of magnitude.

In general, the uncertainties in the performance assessment related to geological heterogeneity, extrapolation to 10,000 years, human activities, and uncertain processes tend to dominate the uncertainties in the individual measurements. Good scientific practice, which tends to minimize data uncertainties, was used in developing data used to support the CCA. However, because of the width of the distributions used in the compliance calculations, even large uncertainties in the data would have a minimal effect on the evaluation of compliance.

The quality of the data used has been critically evaluated

Even though it is not practicable to assess the data quality characteristics of the data used to support the CCA, as discussed above, the quality of the data has received considerable attention. Technical reviews and other review activities, such as Data Qualification Peer Reviews and reviews by the Independent Review Team, of the experimental results assure that these evaluations are performed as appropriate.

As part of the NQA-1-based program, review of the data by the principal investigator and by an independent technical reviewer is required. This requirement appears in the QAPD (Paragraph 5.3.2(b)(1), (2), and (3)). In addition, experimental data used to support the compliance calculations was used to support the development of parameter distributions. Sandia National Laboratories QAP 9-2, which controls this process, requires the principal investigator and performance assessment analyst to agree on the parameter distribution to be used for the calculations. This constitutes additional technical review of the data.

For those data that were subjected to peer review in the data qualification process, the peer reviewers were tasked to evaluate whether, in the context of the use of the data in performance assessment, the data were adequate, with the data quality as one of the important elements considered.

For those data that were subjected to an IRT in the Qualification of Existing Data (QED) process, a standard checklist based on NQA-1, -2, and -3 required review of various aspects of data quality. The detailed checklist included many questions related to data quality.

Summary

It is not practicable to assess the data quality characteristics of these data because it is not practicable to develop a regulatory-driven set of data quality objectives against which these characteristics can be assessed. However, because the performance assessment includes substantial uncertainties related to the heterogeneity of geological systems, the extrapolation of processes to ten thousand years, human activities, and uncertain processes, the uncertainties in the data have little to no effect on compliance certainty. Finally, though it is not practicable to assess the data quality characteristics of the data used in the performance assessment, the quality of the data has been critically evaluated.

Appropriate measures were taken to assure the quality of the data used to support the performance assessment in the compliance certification application. These measures included multiple independent reviews during the test planning, execution, and analysis processes, as well as procedural controls on the conduct of the experiments.

EPA Comment 3 - Enclosure 1, page 1 - 194.23(a)(3)(i)

Text of Comment

Models and Computer Codes

194.23(a)(3)(i)

Section 194.23(a)(3)(i) states that any compliance application shall include documentation that conceptual models and scenarios reasonably represent possible future states of the disposal system.

It is EPA's understanding that after an initial E2 drilling intrusion, subsequent E2 drilling intrusions do not produce releases via spallings or direct brine release. It is not clear whether this is a modeling outcome or an assumption.

DOE needs to provide a description of the implementation of the E2 scenario that addresses releases when another E2 event occurs.

DOE Response

The EPA's understanding regarding the treatment of direct releases from an E2 intrusion following a previous E2 intrusion is incorrect. Direct releases from E2 intrusions that follow E2 intrusions are modeled in the CCA, and, although spalling and direct brine releases are generally smaller than those that occur from first intrusions (because the repository pressure is generally lower after the first intrusion), they can occur and are included in CCDF construction.

The descriptions requested by the EPA are contained in the CCA. Implementation of the E2 event following a previous E2 event is described in the CCA in Chapter 6, Section 6.4.13.4 and Section 6.4.13.7.

The discussion in Section 6.4.13.4 addresses long-term releases E2 intrusions following a previous E2 intrusion with the following text (page 6-204, lines 23-29):

> "For futures with two or more E2-type intrusions (and no E1-type intrusions), a simplifying assumption is made. The additional increment to the source term to the Culebra for the second and subsequent intrusions is assumed to be zero. This is considered reasonable because in the E2 scenario the flux of brine to the Culebra is limited by the rate of flow from the Salado to the waste panels rather than by borehole properties. For second and subsequent E2 scenarios, only the direct releases to the surface are therefore considered in CCDF construction."

Because the modeling of direct releases is not affected by the behavior of the intruding borehole after it passes through the repository, releases depend on the condition of the repository at the time of intrusion. Direct releases from a specified intrusion borehole do not depend on whether that borehole subsequently encounters or misses Castile brine and is classed as an E1 or E2 event. Direct releases are, therefore, calculated using the same modeling system for all ***first*** intrusions, regardless of whether they are E1- or E2-type events. Calculation of direct releases from second and subsequent intrusions may require different modeling assumptions, depending on whether a previous borehole has encountered Castile brine. Modeling of direct releases for intrusions that follow a previous E2 intrusion uses the BRAGFLO-calculated reference repository conditions following an E2 intrusion, and intrusions that follow a previous E1 intrusion use reference conditions calculated following an E1 intrusion. For futures that involve multiple intrusions, E2 reference conditions are used until an E1 intrusion occurs, after which all subsequent intrusions are referenced to E1 conditions. Similar to the situation for first intrusions, however, direct releases from second and subsequent intrusions are not affected by whether the intruding borehole itself is an E1 or E2 event. Thus, direct releases for an E1 event following an E2 event are estimated with the same models as direct releases from an E2 event following an E2 event.

The discussion in Section 6.4.13.7 addresses the treatment of direct releases from second and subsequent intrusions with the following text (page 6-212, lines 10-36):

"For multiple-intrusion scenarios, the pressure in the repository at the time of the second and subsequent intrusions may be quite different from the pressure at the time of the first intrusion. This is expected because of the assumptions of relatively permeable boreholes adopted in performance assessment. Therefore, estimates of drilling releases to the accessible environment need to be formed for penetrations of a previously intruded repository. The reference behavior for these releases for subsequent intrusions is calculated by the CUTTINGS_S code from BRAGFLO histories with E1- and E2-type intrusions at 350 and 1,000 years. Repository conditions from the calculations of the effects of a subsequent E1-type penetration are used in consequence analysis for both E1- and E2-type intrusions that follow an E1 intrusion. Conditions from the subsequent E2 calculations are used for intrusions that follow E2 intrusions only. E1 conditions are used for multiple combinations of boreholes that include at least one E1 intrusion, based on the assumption that repository conditions will be dominated by Castile brine if any borehole connects to a brine reservoir. For futures in which more than two E2-type intrusions occur (and no E1-type intrusions occur), third and subsequent spall and direct brine releases are assumed to be the same as for the second release.

For both E1 and E2 conditions following a 350-year intrusion, spall and direct brine release calculations are performed at 550, 750, 2,000, 4,000, and 10,000 years. For the 1,000-year E1 and E2 intrusions, spall and direct brine release calculations are performed at 1,200, 1,400, 3,000, 5,000, and 10,000 years. Because the subsequent intrusion may penetrate either a previously-intruded panel or an unintruded panel, these calculations are done twice, once with initial conditions drawn from the previously-intruded panel in BRAGFLO, and once with conditions drawn from the BRAGFLO subsequent intrusion of the waste-disposal region. As is done for the first intrusion into a previously undisturbed repository, radionuclide releases from spall and direct brine release for intrusions occurring at intermediate times are scaled from the closest calculated releases, correcting for radioactive decay."

Relevant discussions are also provided in Appendix SA of the CCA, where the treatment of spallings releases is described on page SA-18, lines 9-18:

> "Spallings calculations were also performed for intrusions subsequent to an initial intrusion into the repository for the following cases: (1) an initial E1 intrusion at 350 years followed by a second intrusion at 550, 750, 2000, 4,000, or 10,000 years (Figure SA-11, (2) an initial E1 intrusion at 1,000 years followed by a second intrusion at 1,200, 1,400, 3,000, 5,000, or 10,000 years (Figure SA-11), (3) an initial E2 intrusion at 350 years followed by a second intrusion at 550, 750, 2,000, 4,000, or 10,000 years (Figure SA-12), and (4) an initial E2 intrusion at 1,000 years followed by a second intrusion at 1,200, 1,400, 3,000, 5,000, or 10,000 years (Figure SA-12). Further, spallings releases were calculated for two cases for each of the second intrusion times: (1) Intrusion into the same waste panel as the first intrusion, and (2) intrusion into a different waste panel than the first intrusion."

The estimation of direct releases from third and subsequent intrusions based on the calculation of consequences of second intrusions is also discussed in Appendix SA of the CCA. As stated on page SA-32, lines 11-14, "The lack of results for more than two intrusions is handled by ignoring intermediate intrusions and treating the initial intrusion and the particular subsequent intrusion under consideration as if they were the only two intrusions in existence (Table SA-2)." Table SA-2 (Appendix SA page SA-31) lists the model results used in calculating spalling releases from second intrusions into a repository previously penetrated by both E1- and E2-type intrusions.

Direct brine releases are addressed in Appendix SA on page SA-41, lines 15-16: "Direct brine release calculations were also performed for intrusions subsequent to an initial intrusion for the same intrusion combinations as used for spallings (Figures SA-20 and SA-21)." Table SA-4 (Appendix SA page SA-59) provides a list of the computational results used in calculating direct brine releases from second intrusions into a repository previously penetrated by both E1- and E2-type intrusions.

More detail regarding the computational procedures used in constructing CCDFs incorporating direct releases from second and subsequent intrusions (including those following E2-type intrusions) is provided in Appendix CCDFGF of the CCA, Sections 4.3 and 4.4 (pages 27-37 of Appendix CCDFGF), and specifically in Table 4-3 (pages 31-33 of Appendix CCDFGF).

EPA Comment 9 - Enclosure 1, page 3 - 194.23(c)(4)

Text of Comment

194.23(c)(4)
Section 194.23(c)(4) states that detailed descriptions of data collection procedures, sources of data, data reduction and analysis, and code input parameter development must be documented in the CCA.

(1) Concerns regarding anhydrite marker beds still need to be addressed. Specifically, the information on the incorporation of the anhydrite behavior is very general and does not provide the detailed information necessary to reproduce DOE's results regarding the incorporation of permeability and porosity.

DOE needs to provide information that explains the methodology by which the permeability versus pressure curves and porosity versus pressure curves were developed. DOE needs to explain the permeability and porosity curves generated by Mike Lord (attached to the February 26 response as the 1/29/96 memo to Margaret Chu and the 1/24/96 memo from Kurt Larson to Mike Lord and others).

DOE Response

Concerns regarding anhydrite markerbed parameters (i.e., porosity/permeability response to pressure within the markerbeds) for the compliance certification application (CCA) have been updated from the 1/29/96 memorandum from Michael Lord to Margaret Chu. The analysis with plots have been reconstructed and further discussion and information on the plots that provide more understanding of the results are included in a memorandum from Michael Lord to Margaret Chu, dated March 31, 1997. This memorandum and subsequent information is attached.

Also attached is an additional memorandum from Kurt Larson, Rick Beauheim, and Wendell Weart to Les Shephard regarding Experimental Data and BRAGFLO Fracture Model Parameter Values, dated March 31, 1997. This memorandum shows that the fracture model input parameters were derived from, and are consistent with, experimental data.

Attachment 1 - Memorandum from Lord to Chu dated March 31, 1997 "Response to Expedited CCA Activity Request for Anhydrite Fracture Parameters".

Attachment not available.

Attachment 2 - Memorandum from Larson, Beauheim, and Weart to Shephard dated March 31, 1997

Attachment not available.

EPA Comment 12 - Enclosure 1, page 4 - 194.24(a)

Text of Comment

Waste Characterization

194.24(a)
Section 194.24 requires the CCA to include a description of the chemical, radiological and physical composition of all existing waste (and, to the extent practicable, to-be generated waste) proposed for disposal in the WIPP.

(1) The BIR indicates that the Department has collected more recent information on the waste inventory of the generator sites, in particular,

information were collected during the January 1996 data call.

If the Department would like this information considered as part of the application, then it should provide that to the Agency. Otherwise, EPA will assume that the waste inventory information submitted with the October, 29, 1996 application is that on which we will base our certification decision.

DOE Response

The Department expects the certification decision to be based on the waste inventory information submitted with the October 29, 1996 application. The Department is continuously updating the information in the waste inventory data base as new information becomes available to update the Integrated Data Base, Mixed TRU Waste Inventory Report, and the CAO National TRU Waste Management Plan. It will always be the case that more recent information on the waste inventory will be in the process of being collected or finalized. This newer information will be taken into account during the five year recertification effort and the latest finalized inventory information will be used for each five year recertification application.

EPA Comment 13 - Enclosure 1, page 5 - 194.24(b)

Text of Comment

194.24(b)
Section 194.24(b) requires the CCA to include a complete discussion of all waste characteristics that influence disposal performance, including but not limited to solubility, formation of colloids suspensions, gas generation, shear strength, compatibility, and other waste-related input to model parameters.

1) Adsorption of actinides by immobile mineral surfaces or metal corrosion products can retard the migration of actinides relative to the flow of brine through the repository. Adsorption of actinides onto colloids can enhance actinide migration. The CCA apparently does not account for the adsorption of actinides onto colloids in determining the releases during cuttings/cavings.

The Department needs to provide a description of how adsorption of actinides was accounted for in releases of cuttings/cavings. If adsorption not taken into account, the Department needs to show how this would lead to a conservative release estimate.

DOE Response

Cuttings/cavings releases represent a volumetric extraction of waste from the repository during drilling, taking into account drum-scale variability in activity loading. The movement of actinides within the disposal room brine due to adsorption (sorption) would tend to homogenize the drum-scale distribution of actinides in the disposal room. Therefore, the effects of sorption (adsorption) on cuttings/cavings releases may serve to reduce the radionuclide concentrations for some intrusions.

The following is an excerpt from Appendix SCR, Section SCR.2.5.4, describing the effect of sorption on actinide concentrations in brine:

> "Sorption within the disposal rooms, which would serve to reduce radionuclide concentrations, has been eliminated from performance assessment calculations on the basis of beneficial consequence to the performance of the disposal system. The effects of sorption processes in shaft seals and panel closures have been eliminated from performance assessment calculations on the basis of beneficial consequence to the performance of the disposal system. Sorption within the Culebra and the Dewey Lake is accounted for in performance assessment calculations. Sorption processes within other geological units of the disposal system have been eliminated from performance assessment calculations on the basis of beneficial consequence to the performance of the disposal system. Mobile adsorbents (for example, microbes and humic acids), and the sorption of radionuclides at their surfaces, are accounted for in performance assessment calculations in the estimates of the concentrations of actinides that may be carried. The potential effects of reaction kinetics in adsorption processes and of changes in sorptive surfaces are accounted for in performance assessment calculations."

Continuing from SCR.2.5.4.1:

> "The concentrations of radionuclides that dissolve in waters entering the disposal room will be controlled by a combination of sorption and dissolution reactions. However, because sorption processes are surface phenomena, the amount of material that is likely to be involved in sorption mass transfer processes will be small relative to that involved in the bulk dissolution of waste. WIPP performance assessment calculations therefore assume that dissolution reactions control radionuclide concentrations. Sorption on waste, containers, and backfill within the disposal rooms, which would serve to reduce radionuclide concentrations, has been eliminated from performance assessment calculations on the basis of beneficial consequence to the performance of the disposal system."

The treatment of brine transport to the surface from a borehole including sorbed materials is discussed in Appendix WCA, Section WCA.3.2.2 as follows:

> "Direct release of brine to the surface carries radionuclides that are dissolved in the brine or sorbed on colloidal particles.
>
> The radionuclides released in direct release of brine to the surface include several isotopes that comprise negligible fractions of the total EPA unit, but must be included in the source term because of their influence on the total quantity of dissolved radionuclides. This influence occurs because the isotopes of a radionuclide will dissolve based on mass ratio, rather than the activity ratio, in which they are present in the waste. That is, if 90 percent of the mass of uranium in the waste is U-238 (for example), 90 percent of the dissolved uranium in moles/liter will be U-238, even though 90 percent of the radioactivity will not be U-238. This phenomenon is illustrated for the uranium isotopes in Table WCA-7.
>
> The EPA units of Sr-90 and Cs-137 at closure are large enough that an explanation is needed for not including them in the source term for direct release of brine. Although the EPA units of Sr-90 and Cs-137

are initially large (about 55), rapid decay from a short half-life (about 30 years) results in negligible impact on the performance assessment from those two isotopes. The lack of impact on compliance is explained below.

> Sr-90 and Cs-137 decay by about 90 percent during the first 100 years after closure, when borehole intrusions are excluded by 40 CFR Part 191. During this time period, the EPA unit of either isotope decays from 55 down to 5.5 for the whole repository. At 200 years, the EPA unit for either isotope are down to 0.94, again for the whole repository.

> In addition to the rapid decay, were an individual borehole intrusion to occur at 100 years, it would release 5.5 EPA units (Appendix SA) much less than the total inventory. Even at 350 years, when either isotope decays down to 0.03 percent of the initial inventory, the maximum volume of brine release is only 0.01 m^3. In summary, the rapid decay of Cs-137 and Sr-90 and the negligible volumes of brine release at early times provide the basis for excluding these isotopes from the inventory."

Adsorption (or sorption) of radionuclides on waste solids would not cause a significant change in the volumetric distribution of the radionuclides in the disposal area. For these reasons the DOE uses the assumption that cuttings/cavings releases would be unaffected by sorption processes.

EPA Comment 14 - Enclosure 1, page 5 - 194.24(b) Part 2

Text of Comment

194.24(b)
2) The effects of organic complexants on actinide solid solubilities within a brine system has not been well documented through experimental or modeling studies.

The Department needs to provide more detail discussion on the use of HYDRAQL code, especially in respect to quantity of organic complexants used in the calculation.

DOE Response

HYDRAQL is an equilibrium speciation code which includes parameters for certain organics such as EDTA. The code was used to calculate equilibrium concentration of EDTA in a salt solution with Ni^{2+} and Fe^{2+}. The HYDRAQL code was used for scoping studies only. Results were not used in the Performance Assessment, and therefore the calculations did not undergo the full QA review process. Scoping calculations should not be subjected to the same QA rigor as PA calculations. Results from simple equilibrium calculations, as described in Appendix SOTERM, indicated organic ligands will be complexed with other metals in the repository and not actinides.

The effects of organic complexants at WIPP is explained in Appendix SOTERM. A thorough and QA-approved experimental program was conducted by DOE to investigate organic ligand-actinide complexation in brine systems. Calculations were performed as described in SOTERM.5 and restated below by solving simultaneous equations for the complexation of an organic ligand with actinides and competing metals including iron, nickel, and magnesium.

"The complexation constants for the various metals cited above with the four representative organic ligands are listed in Table SOTERM-7. To assess the ability of these metals to complex with the organic ligands, competition calculations with EDTA (selected because it is the most strongly complexing of the four organic ligands under consideration) in low ionic strength NaCl solution saturated with iron hydroxide, nickel hydroxide and magnesium oxide (backfill) were performed. The calculations showed that under these conditions 99.8 percent of the EDTA was complexed by Ni, thus effectively rendering the EDTA unavailable for complexation with the actinides and rendering complexation of actinides by organic ligands inconsequential. Although these results are approximate because complexation constants for low ionic strength media were used, the fact that a single metal cation could bind more than 99 percent of the EDTA strongly suggests that the full range of metals that will be present will readily overwhelm the complexation sites of the organic ligands. Additionally, at higher ionic strength, iron and nickel have much higher solubility than in dilute solutions. Variation in ionic strength is not expected to change the complexation constants sufficiently to reduce this effect on the organics.

In addition to the calculations using the HYDRAQL code, simple scoping type equilibrium calculations were performed including several of the expected transition metals. The following equations were solved simultaneously:

$$\beta_{Fe(II)} = [EDTA\text{-}Fe^{2-}] / [EDTA^{4-}] [Fe^{2+}]$$

$$\beta_{Ni(II)} = [EDTA\text{-}Ni^{2-}] / [EDTA^{4-}] [Ni^{2+}]$$

$$\beta_{Mg(II)} = [EDTA\text{-}Mg^{2-}] / [EDTA^{4-}] [Mg^{2+}]$$

$$\beta_{Th(IV)} = [EDTA\text{-}Th] / [EDTA^{4-}] [Th^{4+}]$$

along with mass balance equations for each metal. The nickel concentration of 3.65×10^{-4} used in the calculations was determined by taking the minimum number of moles of nickel expected in the repository, dividing by the available repository volume reported by Weiner (1996) and converting the value to molality. An approximation of 1×10^{-4} molal was chosen for the iron concentration. All other values for component concentrations and apparent stability constants are reported above. To approximate the effect of ionic strength on the apparent stability constants for nickel and iron the values used were an order of magnitude lower than those reported in Table WCA-10. These calculations do not include all possible metal ions expected under repository conditions, for example calcium and chromium are not included. Therefore, these results are considered conservative. The results indicate more than 97 percent of the total EDTA is complexed by the transition metals. Thus the excess of nonradioactive metals present in the repository will overwhelm the complexation sites of the organic ligands and complexation of the organic ligands with actinides will be negligible."

In summary, these experiments showed that the complexation of the organic ligands with the actinides is negligible compared to their complexation with the transition metal ions. This phenomenon is assisted by the fact that the number of moles of transition metals present far exceeds the number of moles of plutonium and americium.

EPA Comment 15 - Enclosure 1, page 5 - 194.24(c)(1)

Text of Comment

194.24(c)(1)
Section 194.24(c)(1) requires DOE to demonstrate that for total inventory of waste proposed for disposal, WIPP complies with the numeric requirements of section 194.34 for the upper and lower waste limits, including their associated uncertainties.

It is not evident in the CCA how the Department is treating the associated uncertainties for the upper and lower limit for each waste component.

The Department needs to identify the method by which the uncertainties associated with the upper and lower limits for each waste component are being incorporated into the results of the performance assessment.

DOE Response

The CCA describes a consistent and logical framework that was used for arriving at the waste limits listed in Table WCL-1, Appendix WCL. First, prior to the execution of the calculations for the CCA Performance Assessment (PA), the waste components and characteristics were evaluated through four iterative PAs and Sensitivity Analyses (SA) for their significance to compliance (see Appendix WCA). The rationale for those waste components and characteristics retained for inclusion in the CCA PA is presented in Section WCA.6. The rationale for waste components and characteristics not retained for inclusion in the CCA PA is also presented in Section WCA.6 . The anticipated inventory for those waste components retained in PA is taken from the TWBIR (Appendix BIR, Rev. 3). The

TWBIR satisfies the Requirements of 194.24(a). Appendix WCA satisfies the Requirements of 194.24(b).

Inventory information on waste components enters the PA calculation through fixed-value parameters in the PA data base or inputs to non-PA codes (e.g. SANTOS or FMT) that generate parameter values for input to the PA. In addition, some waste component information was used to ensure that conditions under which modeling assumptions are valid will exist in the waste panels. The PA calculations were completed and generated a CCDF that is compliant. The fixed values for waste components used in either the PA calculations, or for ensuring the validity of modeling assumptions for those PA calculations, establish an envelope of fixed waste component inventory values on a repository scale. The sensitivity analysis reported in Appendix SA determined which parameters were most important to repository performance, i.e. to the variability in final (total) releases that are used in the CCDF generation. This understanding of the results and the modeling used for the PA calculations establish fixed-value repository-scale limits or no limits for waste components, as listed in Table WCL-1, Appendix WCL.

To ensure that these limits are not exceeded, inventory quantities, plus the uncertainties in those quantities will be tracked during the disposal phase to ensure continued compliance with the limits. This tracking is accomplished by the WWIS. If inventory estimates change over the operational life of WIPP, a revised set of fixed values for waste components can be used in a rerun of the performance assessment during recertification.

Since waste-component values are all fixed (no associated uncertainty), the plausible combinations of upper and lower limits are equivalent to the fixed values selected and are included in the CCA performance assessment calculations. Therefore, the combination of selected limits that result in the greatest estimated releases was used in the analysis.

EPA Comment 16 - Enclosure 1, page 5 - 194.24(c)(3)

Text of Comment

194.24(c)(3)
Section 194.24(c)(3) requires the Department to provide information which demonstrates the use of process knowledge to quantify waste components.

Acceptable knowledge plays a key role in identifying the origin or generation of TRU wastes. This information is used to help inform the non-destructive assay (NDA) process in the selection of the appropriate correction or calibration factors. The operational history of a site indicates many important details of the waste matrix. Each TRU generator site considers acceptable knowledge in choosing measurement equipment, designing analytical protocols and establishing the types and ranges of correction and/or calibration factors for NDA measurement systems. However, the CCA is not clear on what the protocol is for determining this information when no acceptable knowledge information is available.

The Department needs to provide the protocol for determining the NDA measurement equipment, designing analytical protocols and establishing the types and ranges of correction and/or calibration factors for NDA measurement systems when no acceptable knowledge information is available.

DOE Response

For the purposes of the program, two parameters describing the activity of the waste must be known: the total alpha activity and the activity of the individual isotopes present. The Department of Energy does not specify what methods or measurement equipment is to be used to determine these parameters (regardless of the availability of acceptable knowledge), only that the Quality Assurance Objectives (QAOs), as outlined in section 9 of the CAO Transuranic Waste Characterization Quality Assurance Program Plan (QAPP), are met. Therefore, the Department has established no protocol for determining the NDA measurement equipment. Nor has it established the types and ranges of correction or calibration factors the sites will use (with or without acceptable knowledge). This will be determined by the individual sites. The Performance Demonstration Program and the site certification audits are used by the Department to ensure that the QAOs as outlined in the QAPP are met. The sites must successfully participate in the Performance Demonstration Program, ensuring compliance with the QAPP QAOs as described in Section 4.3.3.1 of the CCA. In addition, the Department will verify that the QAOs as outlined in the QAPP are met as part of the required annual certification audits of the sites.

EPA Comment 17 - Enclosure 1, page 6 - 194.24(c)(4)

Text of Comment

194.24(c)(4)
Section 194.24(c)(4) requires the CCA to provide information which demonstrates that a system of controls has been and will continue to be implemented to confirm that the total amount of each waste component that will be emplaced in the disposal system will not exceed the upper limit or fall below the lower limit.

The CCA discusses the WIPP Waste Information System (WWIS) which the Department proposes to use for the purpose of tracking the quantity of waste emplaced in the WIPP. It is not clear what information will be collected regarding the location of drums in the repository. In addition, the WWIS Software Design Description contains the internal details of each design entity including a description of the data elements associated with each entity. Although the WWIS lists the data elements, it is not clear which data elements are active or inactive and are functioning as placeholders.

EPA will soon be conducting an audit of the WWIS system. The Department should be prepared to address the above issues during the conduct of that audit.

DOE Response

The Department of Energy is prepared to support the EPA follow-up audit of the WWIS at Westinghouse in May, 1997 and will be prepared to address the issues raised in this comment.

EPA Comment 19 - Enclosure 1, page 7 - 194.32(a)

Text of Comment

Scope of Performance Assessment

194.32(a)
Section 194.32(a) states that performance assessments shall consider natural processes and events, mining, deep drilling, and shallow drilling that may affect the disposal system during the regulatory time frame.

The CCA does not provide adequate information as to the behavior of short-term brine flow to the surface if a brine pocket is hit.

DOE needs to document the modeling results that support the current approach, which assumes that brine flow to the surface from hitting a brine pocket does not result in releases.

DOE Response

The possibility of direct releases resulting from intruding into a brine reservoir was addressed by the Conceptual Model Peer Review Panel and documented in their December 1996 report. The report states in section 3.15.3.1:

> "The following key concerns related to the Direct Brine Release model were identified in the July 1996 Panel report.
>
> - The basis for the assumption that radionuclides do not accompany the direct discharge of Castile brine has not been adequately supported. This assumption could lead to underestimating radionuclide releases."

Part of the DOE response to the Peer Panel's concern was a presentation by D. Stoelzel, SNL. The presentation materials are attached and led to the following "Summary of DOE Responses to Finding" by the panel:

> "The DOE response to the first concern addressed the small likelihood that Castile brine flowing up an open borehole would circulate significantly within the repository, displacing contaminated repository brine, which would flow up the borehole. This was considered unlikely because of the unlikely set of pressure conditions that would first allow Castile brine to flow into the repository and then, a few hours or days later, would reverse and allow repository brine to flow into the borehole. Also, unless the pressure gradients were large, the volume of such flow would be small (as described in Section 3.12)."

The Peer Panel's review of the DOE response was positive and lead to the following conclusions.

> "The DOE response to the first concern (entrainment of waste in Castile brine discharges during drilling) was considered to be adequate with regard to the circulation of Castile brine within the repository."

While the panel found the DOE response to the first concern adequate with regard to circulation of Castile brine within the repository, the panel went on to request information on the possible effect of Castile brine flow on the cuttings and cavings releases. A conservative estimate of these releases is attached. These data indicated that a 22 to 87% increase in releases from an E1 event was possible with an average increase of 38%. With an assumed probability of 8 to 30% of intersecting a brine reservoir (note that the panel chose, for the purpose of this analysis to consider conservatively higher probabilities of brine encounters than that developed by the DOE) the panel concluded that there was a 3 to 13% probability of increasing cuttings and cavings releases possible. The panel concluded:

> "While such an increase may be considered significant, in view of the overall uncertainties in the performance assessment model, such an increase is not expected to have a strong impact on the final CCDFs and the Panel considers this concern to have been adequately addressed."

Additional information describing the behavior and modeling results of short-term brine flow to the surface if a brine pocket is encountered can be found in the October Application, Chapter 6, Sections 6.0 and 6.4; Chapter 9, Section 9.3; Appendix MASS, Section Mass 16.2; Appendix MASS, Attachment 16-2; and Appendix SA, Sections SA.6 and SA.8. Direct releases of contaminated brine at the ground surface resulting from the first intrusion into a Castile reservoir will not carry notable amounts of contamination, because brine moving straight up a borehole will not mix significantly with the waste. As stated in the compliance certification application (Chapter 9, Section 9.3) this E1 scenario is modeled through the treatment of abandoned boreholes.

> "The possibility of Castile brine entering the waste panel and removing contaminants is accounted for in the compliance certification application calculations, through the treatment of abandoned boreholes. The two-plug scenario, which is the highest probability plugging scenario, assumes 200 years of open, relatively isolated flow between the Castile and the intruded panel. During this time significant volumes of Castile brine can enter the panel, pick up dissolved radionuclides, and simultaneously increase the panel pressure via gas generation. Once the abandoned borehole assumes the permeability of silty sand, brine can leave the panel and flow to the accessible environment through the surrounding geology."

The processes that contribute to these assumptions are further explained in the peer review responses found in Section 9.3.1.2.6.3 as follows:

> "If it is now assumed that drilling continues, and the drill bit penetrates a high pressure brine pocket in the Castile (E1 scenario), it is now possible for Castile brine to flow up the borehole and interact with the previously intruded waste panel on its way to the surface ($Q_{BP} = Q_{BO}$ in Figure 9-5). The flow into or out of the panel is still governed by the pressure differential between the panel (P_{panel}) and the borehole ($P_{wf\ panel}$). Assuming Castile brine has the same specific gravity as the drilling mud, $P_{wf\ panel}$ would be the same as it was for the initial penetration into the panel. This is because the pressures down the

length of the open borehole are governed by the outlet pressure (atmospheric), which is the same for the drilling mud flows and Castile brine flows. Therefore, the high brine pocket pressure (P_{BP}) has no effect on flow into or out of the panel, other than increasing Castile brine flow up the borehole past the panel. If anything, pressures in the borehole due to Castile brine flows could only increase as a result of higher frictional forces. As previously mentioned, Castile brine pocket encounters cause little concern to present-day drillers, and flows are stopped once the hole is cased (maximum three day flow duration). The effects of this transient Castile brine flow into the waste panel on corrosion, waste degradation, and gas production will be minimal and are in any case bounded by the higher-probability 2 plug scenarios for long term release. In order for Castile brine to carry contaminated brine from the panel to the surface, it would have to flow through the plug previously set to control the aforementioned blowout or lost circulation events, into the panel, then back into the wellbore. This "circular" flow can happen only if conditions change enough during the three-day flow period to cause the pressure differentials to reverse, that is, from $P_{panel} < P_{wf\ Panel}$ to $P_{panel} > P_{wf\ Panel}$. As long as the borehole is filled with brine, $P_{wf\ panel}$ will remain unchanged. Therefore P_{panel} would have to increase. This can only be accomplished through an increase in pressures via gas generation through corrosion and/or biodegradation. These processes take many years to generate significant gas volumes, and therefore are of no concern during the three-day time frame of active drilling through the Castile."

Continuing later in the same section:

"As pointed out in the initial response, according to pipe flow dynamics, 'the pressures down the length of the open borehole are governed by the outlet pressure (atmospheric), which is the same for the drilling mud flows and Castile brine flows. Therefore, the high brine pocket pressure has no effect on flow into or out of the panel, other than increasing Castile brine flow up the borehole past the panel.'

> It should be noted that, as pointed out in the original response, 'the sequence of events is that the borehole intersects the repository before it intersects the brine reservoir.'
>
> Case 1. If there is significant flow from the borehole to the repository, this would be a source of circulation loss to the driller. Therefore, the aperture from the borehole to the repository would be plugged by the driller before the borehole intersects a Castile brine reservoir. "In this case, the amount of drilling mud lost to the panel would be no more than several hundred cubic meters, which is the volume of the drilling mud pits (1,000 to 2,000 oil field barrels), should the driller pump the pits completely dry prior to circulating the LCM plug. This volume is significantly less (and therefore bounded) by the amount of brine available to flow from the Castile to the panel for the two-plug abandoned E1 borehole, as modeled by BRAGFLO.
>
> Case 2. If the flow from the borehole to the repository is too small for the driller to notice, it will be less than a few gallons a minute. In this case, Castile brine may flow from the borehole into the repository after the borehole intersects the brine reservoir "and flows are stopped once the hole is cased (maximum three day flow duration)." In this case, "The effects of this transient Castile brine flow into the waste panel on corrosion, waste degradation, and gas production will be minimal and are in any case bounded by the higher-probability 2-plug scenarios for long term release."

Further discussion can be found in Section 9.3.1.2.8.1.

Assuming present-day drilling practices, the likelihood of a Castile brine flow carrying significant quantities of radionuclides from the repository to the surface during active drilling is highly unlikely because brine moving straight up a borehole will not mix significantly with the waste. It should be further pointed out that the pressure differentials in the repository and borehole required to accomplish the flow through the repository and then up the borehole could not occur in the short time frame of expected drilling in the vicinity of the site.

Attachment 1 - Presentation by D. Stoelzel, SNL to the Conceptual Model Peer Review Panel on the possibility of direct releases resulting from intruding into a brine reservoir.

Attachment not available.

II-I-25:EPA follow-up to EPA’s March 19, 1997 letter regarding PA input parameters - 17 April, 1997

George Dials, Manager
Carlsbad Area Office
U.S. Department of Energy
P.0, Box 3090
Carlsbad, NM 88221-3090

Dear Mr. Dials:

This letter is a follow-up to the letter I sent to Alvin Alm, Assistant Secretary for Environmental Management, on March 19, 1997, regarding the U.S. Environmental Protection Agency's (EPA) review of the U.S. Department of Energy's (DOE) Compliance Certification Application for the Waste Isolation Pilot Plant (WIPP). In that letter, EPA identified a list of performance assessment (PA) input parameters for which EPA had questions about the value(s) selected.

Since the March 19, 1997 letter was sent, my staff have been reviewing parameter values based on information provided by DOE and Sandia staff, and conducting sensitivity analyses to determine the impact of relevant parameters on the overall performance of the disposal system. Based on those activities, twelve parameters are no longer in question (see Enclosure 1).

As you are aware, some parameters and associated values used as inputs to the PA submitted on October 29, 1996, have been found by my staff to not be representative of the data. Therefore, EPA requires DOE to use the parameter values found in Enclosure 2 to this letter in a PA verification test. EPA understands that DOE is anxious to receive guidance on parameters and associated values that are inputs to the test. For this reason, my staff examined BRAGFLO parameters first, since BRAGFLO is the first computer code to be activated in producing the results of the test. The BRAGFLO parameters and associated values are those listed in Enclosure 2. DOE should use these parameter values as the Department conducts the PA verification test.

My staff are still examining the remaining parameters identified in my March 19, 1997 letter. EPA will provide the associated input values to DOE by April 25, 1997. In the meantime, DOE can begin the PA verification test, so no time is lost producing its results.

Should you have questions, please call Frank Marcinowski at (0202) 233-9310.

Sincerely

E Ramona Trovato, Director
Office of Radiation and Indoor Air

Enclosure (2)

Cc: Mary D Nichols (EPA)
Alvin Alm (DOE/HQ)

Enclosure 1 - Parameters no longer in question.

Parameters identified in the March 19, 1997 letter, which have subsequently been determined by EPA, based on information provided by DOE and Sandia staff or through sensitivity analyses, to no longer be in question.

ID #	Material ID	Parameter ID	Description
259	PAN-SEAL	PRMX-LOG	Panel Seal Permeability
528	S-ANH-AB	POROSITY	Effective Porosity
567	S-MB 138	POROSITY	Effective Porosity
588	2-MB 139	POROSITY	Effective Porosity
1992	WAS-AREA	DIRNCCHW	Bulk Density of Iron Containers CH Waste
1993	WAS-AREA	DIRNCRHW	Bulk Density of Iron Containers RH Waste
3147	CONC-PLG	POROSITY	Effective Porosity
656	WAS-AREA	GRATMICH	Gas Production Rate – Microbial Humid Conditions
2040	WAS-AREA	DIRNCCHW	Average Density of Iron-Based Material in CH Was

2274	WAS-AREA	DECELLRHW	Average Density of Cellulosic in RH Waste
2041	WAS-AREA	DCELLCHW	Average Density of Cellulosic in CH Waste
657	WAS-AREA	GRATMICH	Gas Production Rate – Microbial Inundated Conditi

Enclosure 2 - Parameters not representative of the data.

Text not available.

II-I-27:EPA follow-up to EPA's March 19, 1997 letter regarding PA input parameters - 25 April, 1997

George Dials, Manager
Carlsbad Area Office
U.S. Department of Energy
P.O. Box 3090
Carlsbad, NM 88221-3090

Dear Mr. Dials:

This letter is a follow-up to the letter I sent to Alvin Alm, Assistant Secretary for Environmental Management, on March 19, 1997, regarding the U.S. Environmental Protection Agency's (EPA) review of the US Department of Energy's (DOE) Compliance Certification Application for the Waste Isolation Pilot Plant (WIPP). In that letter, EPA identified lists of performance assessment (PA) input parameters for which EPA had questions about the value(s) selected.

In Enclosure 2, to the March 19, 1997 letter, EPA identified a list of performance assessment input parameters for which my staff had been unable to find supporting data. At that time, 13 key input parameters were either not supported by experimental or field data, or the data trail was untraceable. DOE and Sandia National Laboratory staff have since been able to identify data that were used as the bases for the values chosen for nine of the 13 parameters on the list. In addition, three parameters on the list were subsequently determined by my staff to be "non-sensitive" parameters (i.e., sensitivity analyses results indicate that the parameters do not have a significant impact on the results of the performance assessment). The one parameter remaining (#2, ID# 3246, Material BLOWOUT, Parameter PARTDIA, waste particle diameter in Cuttings Model for direct brine release) is considered "sensitive" but the value for that parameter is not supported by data. Therefore, the parameter value must be derived through "expert judgement" in accordance with EPA's WIPP Compliance Criteria at 40 C.F.R. §194.26 (expert judgement) and 40 C.F.R. §194.22(a)(2)(v) (quality assurance procedures for the implementation of expert judgement elicitation). The provisions of these regulatory requirements, including the requirements for documentation and public participation, must be satisfactorily applied to the parameter value.

My staff has continued to review parameter values and conduct sensitivity analyses to determine the impact of other relevant parameters on the overall performance of the disposal system. On April 17, 1997, I transmitted a letter to you that included a list of parameters that are no longer in question, and a list of revised parameter values to use in running the BRAGFLO computer code. As I mentioned in my letter, the BRAGFLO parameter values were provided to DOE first because BRAGFLO is the first code to be activated in running the overall performance assessment (PA).

My staff has now completed the review of the remaining parameters identified in my March 19, 1997 letter. Enclosed are two tables: the first table includes parameters that are no longer in question; the second table includes important parameters and associated input values that EPA requires to be used in DOE's PA verification test.

Should you have questions, please call Frank Marcinowski at (202) 233-9310.

Sincerely,

E. Ramona Trovato, Director

Office of Radiation and Indoor Air

Enclosures (2)

cc: Mary D. Nichols (EPA)
Alvin Alm (DOE/HQ)

Enclosure 1 - Parameters no longer in question.

Text not available.

Enclosure 2 - Parameters and associated input values that EPA requires to be used in DOE's PA Verification

Test.

Text not available.

II-I-28: Second set of responses to EPA's March 19, 1997 letter - 2 May, 1997

EPA Comment 10 - Enclosure 1, pages 3 and 4 - 194.23(c)(4), Part 2

Text of Comment

194.23(c)(4)

Section 194.23(c)(4) states that detailed descriptions of data collection procedures, sources of data, data reduction and analysis, and code input parameter development must be documented in the CCA.

(2) Concerns regarding a low transmissivity feature still remain. A low transmissivity region appears consistently in the calibrated transmissivity fields in the northeastern portion of the site where there are little data. Care must be taken with model interpretations in regions where there are little data to corroborate the interpretation. Low transmissivity produces long travel times and could produce an overly optimistic PA.

Information provided by M. LaVenue at a DOE meeting on 17 and 18 September 1996 at Sandia originally indicated that the low transmissivity region is due to a single very low transmissivity data point at P-18. From the histogram of Culebra transmissivity data, the P-18 data point could be argued to be a statistical outlier. Given the large variation of transmissivity data over the wider region, the P-18 data point could also be valid. But the geostatistical methods in GRASP_INV should not allow the data point at P-18 to produce low transmissivity in the northeastern portion of the site that is far separated from P-18.

The DOE response to EPA's request of December 19, 1996 stated that there are no independent data to confirm the P-18 data point. But it is stated that the P-18 data point is consistent with the geological conceptual model. Further, it is stated the P-18 data point has a minor effect because of the geostatistical methods used in GRASP_INV.

While the above DOE response is reasonable, the original question still remains as to why there is a low transmissivity feature in the eastern portion of the site where there are little data to confirm the feature.

DOE needs to provide the transmissivity field that results from bringing the transmissivity data and which does not show the low transmissivity region in the northeastern part. DOE needs to provide several typical transmissivity fields calibrated to steady-state head data that show the appearance of the low transmissivity feature in the northeastern part of the site. These plots need to be accompanied with an explanation as to the reasons why the calibration causes this low transmissivity feature in the northeastern part of the site.

DOE Response

The DOE has taken care in the corroboration of model interpretations concerning transmissivity regions where there are little data. The department has provided (attached) an analysis of the low transmissivity regions in the northeast portion of the WIPP site for several transmissivity fields before and after steady-state calibration. The transmissivity fields prior to calibration are generated by the same geostatistical subroutine of GRASP-INV code, CONSIM II used in the CCA calculations. The calibrated transmissivity fields are modified from the initial transmissivities by the addition of pilot points. These fields are calibrated to the steady-state heads since the low transmissivity region in the northeast section of the WIPP site is generated by pilot points added during steady-state calibration. The low transmissivities in the northeast portion of the WIPP-site area were shown to match the head values at the H-11 and DOE-1 boreholes. The analysis illustrates that the transmissivity value of -10.0($\log_{10} m^2/s$) assigned to the P-18 borehole did not have a significant impact upon the transmissivity estimates because the value has a low probability of occurrence. The analysis also illustrates the initial transmissivity fields generated by the CONSIM II subroutine were shown not to contain anomalously low transmissivities in the northeast portion of the WIPP-site area.

Attachment 1 - Memorandum from M. Chu to M. Marietta dated April 15, 1997 "Transmittal Record for SNL QAP9-6 Activity: Analysis of a low transmissivity region in the calibrated transmissivity fields generated by GRASP-INV (Version 2.01)" WPO#44600.

Attachment not available.

EPA Comment 14 - Enclosure 1, page 5 - 194.24(b) Part 2

Text of Comment

194.24(b)

2) The effects of organic complexants on actinide solid solubilities within a brine system has not been well documented through experimental or modeling studies.

The Department needs to provide more detail discussion on the use of HYDRAQL code, especially in respect to quantity of organic complexants used in the calculation.

DOE Response

HYDRAQL is an equilibrium speciation code which includes parameters for certain organics such as EDTA. The code was used to calculate equilibrium concentration of EDTA in a salt solution with Ni^{2+} and Fe^{2+}. The HYDRAQL code was used for scoping studies only. Results were not used in the Performance Assessment, and therefore the calculations did not undergo the full QA review process. Results from simple equilibrium calculations, as described in Appendix SOTERM, indicated organic ligands will be complexed with other metals in the repository and not actinides.

A thorough and QA-approved experimental program was conducted at Florida State University to investigate organic ligand-actinide complexation in brine systems. Calculations were performed as described in SOTERM.5 and restated below by solving simultaneous equations for the complexation of an organic ligand with actinides and competing metals including iron, nickel, and magnesium.

> “The complexation constants for the various metals cited above with the four representative organic ligands are listed in Table SOTERM-7. To assess the ability of these metals to complex with the organic ligands, competition calculations with EDTA (selected because it is the most strongly complexing of the four organic ligands under consideration) in low ionic strength NaCl solution saturated with iron hydroxide, nickel hydroxide and magnesium oxide (backfill) were performed. The calculations showed that under these conditions 99.8 percent of the EDTA was complexed by Ni, thus effectively rendering the EDTA unavailable for complexation with the actinides and rendering complexation of actinides by organic ligands inconsequential. Although these results are approximate because complexation constants for low ionic strength media were used, the fact that a single metal cation could bind more than 99 percent of the EDTA strongly suggests that the full range of metals that will be present will readily overwhelm the complexation sites of the organic ligands. Additionally, at higher ionic strength, iron and nickel have much higher solubility than in dilute solutions. Variation in ionic strength is not expected to change the complexation constants sufficiently to reduce this effect on the organics.
>
> In addition to the calculations using the HYDRAQL code, simple scoping type equilibrium calculations were performed including several of the expected transition metals. The following equations were solved simultaneously:

$$\beta_{Fe(II)} = [EDTA\text{-}Fe^{2-}] / [EDTA^{4-}] [Fe^{2+}]$$

$$\beta_{Ni(II)} = [EDTA\text{-}Ni^{2-}] / [EDTA^{4-}] [Ni^{2+}]$$

$$\beta_{Mg(II)} = [EDTA\text{-}Mg^{2-}] / [EDTA^{4-}] [Mg^{2+}]$$

$$\beta_{Th(IV)} = [EDTA\text{-}Th] / [EDTA^{4-}] [Th^{4+}]$$

along with mass balance equations for each metal. The nickel concentration of 3.65×10^{-4} used in the calculations was determined by taking the minimum number of moles of nickel expected in the repository, dividing by the available repository volume reported by Weiner (1996) and converting the value to molality. An approximation of 1×10^{-4} molal was chosen for the iron concentration. All other values for component concentrations and apparent stability constants are reported above. To approximate the effect of ionic strength on the apparent stability constants for nickel and iron the values used were an order of magnitude lower than those reported in Table WCA-10. These calculations do not include all possible metal ions expected under repository conditions, for example calcium and chromium are not included. Therefore, these results are considered conservative. The results indicate more than 97 percent of the total EDTA is complexed by the transition metals. Thus the excess of nonradioactive metals present in the repository will overwhelm the complexation sites of the organic ligands and complexation of the organic ligands with actinides will be negligible."

In summary, the Florida State experiments showed that the complexation of the organic ligands with the actinides is negligible compared to their complexation with the transition metal ions. This phenomenon is assisted by the fact that the number of moles of transition metals present far exceeds the number of moles of plutonium and americium. **Information pertaining to the experimental program investigating organic-actinide complexation in brine systems can be found in the Sandia WIPP central files (WPO Number 036475 an 036329 data record packages).**

New text to the original response is in Bold

EPA Comment 15 - Enclosure 1, page 5 - 194.24(c)(1)

Text of Comment

194.24(c)(1)

Section 194.24(c)(1) requires DOE to demonstrate that for total inventory of waste proposed for disposal, WIPP complies with the numeric requirements of section 194.34 for the upper and lower waste limits, including their associated uncertainties.

It is not evident in the CCA how the Department is treating the associated uncertainties for the upper and lower limit for each waste component.

The Department needs to identify the method by which the uncertainties associated with the upper and lower limits for each waste component are being incorporated into the results of the performance assessment.

DOE Response

The following four paragraphs are a response to EPA Comment, Enclosure 1, page 12, Part 1 from the December 1996 comments on the CCA.

> "The CCA describes a consistent and logical framework that was used for arriving at the waste limits listed in Table WCL-1, Appendix WCL. First, prior to the execution of the calculations for the CCA Performance Assessment (PA), the waste components and characteristics were evaluated through four iterative PAs and Sensitivity Analyses (SA) for their significance to compliance (see Appendix WCA). The rationale for those waste components and characteristics retained for inclusion in the CCA PA is presented in Section WCA.6. The rationale for waste components and characteristics not retained for inclusion in the CCA PA is also presented in Section WCA.6. The anticipated inventory for those waste components retained in PA is taken from the TWBIR (Appendix BIR, Rev. 3). The TWBIR satisfies the Requirements of

194.24(a). Appendix WCA satisfies the Requirements of 194.24(b).

Inventory information on waste components enters the PA calculation through fixed-value parameters in the PA data base or inputs to non-PA codes (e.g. SANTOS or FMT) that generate parameter values for input to the PA. In addition, some waste component information was used to ensure that conditions under which modeling assumptions are valid will exist in the waste panels. The PA calculations were completed and generated a CCDF that is compliant. The fixed values for waste components used in either the PA calculations, or for ensuring the validity of modeling assumptions for those PA calculations, establish an envelope of fixed waste component inventory values on a repository scale. The sensitivity analysis reported in Appendix SA determined which parameters were most important to repository performance, i.e. to the variability in final (total) releases that are used in the CCDF generation. This understanding of the results and the modeling used for the PA calculations establish fixed-value repository-scale limits or no limits for waste components, as listed in Table WCL-1, Appendix WCL. Additional rationale for not assigning an emplacement limit to organic ligands is provided in response to the EPA's comment on page 12 of enclosure 1, relevant to 40 CFR § 194.24(a).

To ensure that these limits are not exceeded, inventory quantities, plus the uncertainties in those quantities will be tracked during the disposal phase to ensure continued compliance with the limits. This tracking is accomplished by the WWIS. If inventory estimates change over the operational life of WIPP, a revised set of fixed values for waste components can be used in a rerun of the performance assessment during recertification.

Since waste-component values are all fixed (no associated uncertainty), the plausible combinations of upper and lower limits are equivalent to the fixed values selected and are included in the CCA performance assessment calculations. Therefore, the combination of selected limits that result in the greatest estimated releases was used in the analysis."

During the Waste Characterization Technical Exchange in January 1997, a question was raised regarding the sensitivity of the Waste Unit Factor on the mean CCDF. A measure of this sensitivity can be viewed by comparing the mean CCDFs for waste decayed to 1995 and waste decayed to 2033 (WPO# 41870, attached). The Waste Unit Factors for 1995 and 2033 are 4.07 and 3.44 respectively. There is a 15.5% change in the Waste Unit Factor resulting in a similar change in the mean CCDF location with the CCDF shifting to the right as Waste Unit Factor decreases. For the case with a value of 3.44 the mean CCDF falls at a probability value of about 10^{-1} for a normalized release of 10^{-1}. The 95% curve nearly overlies the mean (Figure 6.39). For the purpose of discussion of sensitivity parameters only, a hypothetical change in the Waste Unit Factor of an order of magnitude from 3.44 to 0.344 will result in a similar shift of the mean CCDF to the right falling at a probability value of about 10^{-1} for a normalized release of 1. Stored waste alone comprises about 36% of the total Ci used to generate the 1995 value of 4.07 (Stored CH is 2.31E+06 and Total = Stored + Projected is 6.41E+06 in Table 1 in Attachment WCA.8.1 of Appendix WCA). Therefore stored waste alone would have a Waste Unit Factor of about 1.2 which would result in a compliant mean CCDF. If only currently stored waste, i.e., waste which has already been placed in drums and inventoried, is emplaced in the repository, the CCDF would still be compliant. However, the CCA evaluates stored plus projected waste as described in Appendix BIR, and the correct value for the Waste Unit Factor is 3.44 as used in the CCA.

New text to the original response is in Bold

EPA Comment 18 - Enclosure 1, page 6 - 194.24(d)

Text of Comment

194.24(d)

Section 194.24(d) requires the Department to provide a waste loading scheme, or else the performance assessments shall assume random placement of waste in the disposal system.

The CCA assumed that the containers of waste would be emplaced randomly for the 569 waste streams tracked in the TWBIR. The CCA also assumes that the sampling of 10,000 futures was large enough that the relatively low probability combination of three of the waste streams with higher activity loading occurring in a single drilling event was captured in the CCDFs. However, the assumption that containers will be randomly placed in the WIPP does not take into account likely "real world" scenarios where a specific generator sends a large shipment of a particular waste stream at one time (e.g. RF-Residues from Rocky Flats which is estimated to represent 15 percent of the total curies emplaced in the WIPP at 2133).

The Department needs to address how it is planning to achieve random loading of waste drums at WIPP. If the Department cannot achieve random loading they need to analyze the effect of non-random loading.

DOE Response

The DOE believes that the approach taken in the CCA is fully consistent with the requirements of 40 CFR § 194.24(d), which states:

> "The Department shall include a waste loading scheme in any compliance application, or else performance assessments conducted pursuant to § 194.32 and compliance assessments conducted pursuant to § 194.54 shall assume random placement of waste in the disposal system."

The DOE has chosen to assume random loading of waste within the repository, as required by 40 CFR § 194.24(d), in lieu of providing a detailed waste-loading scheme.

The DOE acknowledges that the actual loading of waste into the repository in the future is uncertain, and concurs with the EPA that the assumption of random loading is an appropriate way to characterize that uncertainty. The DOE does not believe that it is either reasonable or necessary to implement a loading scheme designed to ensure random emplacement.

The DOE believes that the EPA's request to "analyze the effect of non-random loading" goes beyond the regulatory requirements of 40 CFR § 194.24(d), but recognizes that additional information will be useful in providing further assurance that the WIPP will perform as designed. Because the analyses requested by the EPA are conditional on specific assumptions about waste loading, and are therefore not fully probabilistic in nature, results are not suitable for direct comparison to the quantitative containment requirements. Specifically, the analyses described below are conditional on the assumption of the loading scheme suggested by the EPA in their comment, in which large quantities of a single waste stream are shipped to WIPP at the same time and emplaced in the same portion of the disposal region. The DOE makes no estimate here of the likelihood of such emplacement occurring.

The assumption of random loading potentially enters into the performance assessment in two ways. First, as discussed in Section 6.4.3.4 of the CCA, "brine and waste within the WIPP repository are modeled as a uniform mixture of dissolved and solid-state species" (page 6-106, lines 1-2) for the purposes of estimating future chemical conditions, including the concentrations of actinides in brine. Actinide concentrations in brine are of interest in evaluating both undisturbed and disturbed performance. Second, as discussed in Sections 6.4.7.1 and 6.4.12.4 of the CCA, containers of waste are assumed "to be placed in the WIPP from the various waste streams in a random manner" (page 6-189, lines 41-42) for the estimation of cuttings and cavings releases. Spalling releases "are assumed to be derived from a sufficiently large volume of waste that container-scale variability can be neglected" (page 6-189, lines 27-28). The possible effects of non-random loading on actinide concentrations in brine and on direct releases of solids from cuttings, cavings, and spallings are discussed separately here.

Possible Effects of Non-Random Waste Loading on Actinide Concentrations in Brine

Actinide concentrations in brine that is released either during undisturbed performance, at the surface during an inadvertent drilling intrusion event, or into the Culebra following long-term flow in an abandoned borehole will be determined by the brine chemistry and the waste it has contacted. As stated in Section 6.4.3.4 of the CCA (page 6-106, lines 2-7), “thermodynamic equilibrium is assumed for dissolved actinide concentrations, but oxidation-reduction reactions between the actinides and other waste components are not assumed to proceed to equilibrium. Although materials in the waste will actually dissolve at different rates, the presumption of homogeneity and solubility equilibrium, along with assumed disequilibrium reduction-oxidation conditions, yields the largest reasonable concentration of aqueous actinides in the repository.”

The assumption that brine within the waste is well mixed may not be realistic for conditions in which very little brine is present in the repository. However, conditions in which very little brine is present in the repository do not result in releases of contaminated brine from the controlled area because brine mobility is greatly reduced at low saturations. As discussed below, releases of radionuclides in brine require relatively large quantities of brine in the repository, and sufficiently long travel paths and residence times for this brine to be in the waste, that it is reasonable to assume that complete mixing occurs and that the assumption of equilibrium solubilities will result in the largest reasonable aqueous concentrations of actinides.

For undisturbed performance, brine enters the entire repository by drainage from the DRZ and by long-term inflow from anhydrite interbeds, and by necessity must flow through a large volume of waste before reaching a potential exit point at the down-dip (southern) portion of the disposal region. No plausible mechanism exists by which large volumes of brine could enter and exit an undisturbed repository without long travel paths and residence times in the waste.

For disturbed performance, the volume of brine that must be present in a single panel before a brine release occurs can be estimated from examination of performance assessment results. For long-term brine flow up an intrusion borehole to occur, the entire intruded panel must be filled, or nearly filled, with brine, starting from the bottom up. This volume of brine can be estimated by considering a panel volume of approximately 46,000 cubic meters [from Figures 6-14 and 6-15 of the CCA] and a representative final porosity [as implemented in BRAGFLO] of approximately 15% [from Figure 7.1-18 of the *Analysis Package for the Salado Flow Calculations (Task 1) of the Performance Assessment Analysis Supporting the Compliance Certification Application* [previously transmitted to the EPA], yielding a panel pore volume of approximately 6900 cubic meters. Neglecting the extremely small quantity of liquid present in the waste initially and the much larger quantities of brine that may flow out into marker beds and be consumed by corrosion, a minimum of 6900 cubic meters of brine therefore must flow through the waste before flowing up an intrusion borehole. Nearly all pore surfaces within the waste will have been contacted by brine before flow up the borehole begins.

The panel need not be completely filled for direct brine releases to occur at the surface during drilling, but the volume of brine required within the panel is still large. As shown in Appendix SA, Figure SA-17, no direct brine releases occur until brine saturation exceeds approximately 20%, and the largest volumes of direct brine release occur at brine saturations between approximately 50% and 80%. As discussed above, a single panel may have a pore volume of approximately 6900 cubic meters, and a brine saturation of 50% therefore requires the inflow of a minimum of approximately 3450 cubic meters of brine into a single panel, again neglecting brine outflow and consumption of brine during corrosion. For intrusions into a previously unintruded repository, brine will have entered the waste by drainage from the DRZ and by long-term flow from anhydrite interbeds. In either case, brine must flow from the floor and ceiling of the disposal region through the waste and backfill before it reaches the location of the future intrusion borehole. Before brine participates in a direct release, it therefore must have contacted a large volume of waste for a relatively long period of time, and therefore achieved chemical conditions representative of a large and well-mixed region of waste.

Intrusions into a previously intruded repository are less likely to result in direct brine releases than those into an undisturbed repository, because pressures are generally lower following the first intrusion. However, in those realizations in which pressures do rise sufficiently after intrusion to allow direct brine releases, the previous borehole may provide an additional pathway for brine to flow into the repository. In this case, the brine entering from the previous borehole will flow outward radially into the repository, mixing with brine already present in the waste. The minimum distance any portion of this brine must travel through the waste to participate in a direct brine release from a later intrusion is the distance between the two intrusion holes. Other brine present near the second borehole at the time of intrusion will have traveled to that location by longer and more complex flow paths. It is reasonable, therefore, to assume that flow will have resulted in a brine composition representative of a large volume of waste.

Possible Effects of Non-Random Waste Loading on Cuttings and Cavings Releases

The Conceptual Model Peer Review Panel noted that the DOE's assumption that drums of waste were randomly emplaced resulted in a lower probability that a single intrusion would penetrate three stacked drums from the same waste stream, and requested further clarification of the consequences of non-random loading with respect to cuttings and cavings releases. In the December 1996 *Supplementary Conceptual Models Peer Review Report*, the panel considered this issue in the context of new information provided to them about changes in the implementation of the cavings model since their July 1996 report. Quoting from the December 1996 report, page 33:

> "The Panel considered this model to be adequate in its July 1996 report. During review of the changes, the Panel obtained an evaluation of the significance of drilling through three drums from the same waste stream at the high end of the range of concentrations of contact handled waste, on the basis that this would be a possible, thought not likely, event. DOE provided waste concentration distributions, probabilities, and corresponding releases that would result, and showed that this would not have a significant effect on the location of the highest CCDF curves.
>
> In summary, the Panel believes this model to remain adequate, as

changed."

Copies of CCDF curves presented by the DOE to the Conceptual Model Peer Review Panel on November 19, 1996 are attached. These CCDFs are the result of preliminary calculations using the CCA modeling system, and show cuttings and cavings releases only (no spallings or direct brine releases) for the 100 realizations of replicate 1, calculated for randomly loaded waste (as used in the CCA) and for a loading scheme in which stacks of waste were randomly emplaced but each stack was constrained to have three drums from a single waste stream. These CCDFs differ from those displayed in Chapter 6 of the CCA in that they are based on preliminary modeling assumptions (including normalization of releases to the activity of the transuranic inventory in 1995, rather than 2033 as used in the CCA), and they were presented to the Peer Review Panel for illustrative purposes only. The attached CCDFs should be interpreted only as a display of the extent to which changing assumptions about waste emplacement might change the CCDF resulting from cuttings and cavings releases, and they should not be used for direct comparison to the regulatory limits.

As shown in Figure SA-3 of Appendix SA of the CCA, most cuttings and cavings releases involve less than a cubic meter of waste material (including backfill and the void space between drums, and adjusted to its initial, uncompacted volume). However, the largest cuttings and cavings releases may involve up to almost 3 cubic meters of waste material (see Figure SA-3), and for these releases the assumption that individual stacks of drums are randomly emplaced may not result in the largest cuttings and cavings releases possible from non-random loading. In the relatively few realizations that result in such releases, possible impacts of non-random loading are analogous to those discussed in the following section for spalling events.

Possible Effects of Non-Random Waste Loading on Spalling Releases

As shown in Figure SA-10 of Appendix SA of the CCA, the largest spall events result in the release of nearly 4 cubic meters of waste material (including backfill and the void space between drums, and adjusted to its initial, uncompacted volume). If waste were non-randomly loaded in the repository such that all drum equivalents in a single waste stream remained together, this volume could, in principle, come from any waste stream that contained at least 4 cubic meters of waste. Many of the high-activity waste streams contain only a very small number of drums, however (see *WIPP PA Analysis Report for EPAUNI: Estimating Probability Distribution of EPA Unit Loading in the WIPP Repository for Performance Assessment Calculations, Document Version 1.01*, *February 17, 1997*, FigureH-1d and Table H.2-1), and the probability of an intrusion borehole intersecting these waste streams is extremely small. Only those waste streams that contain more than one one-thousandth of the total number of drum equivalents (i.e., more than approximately 810 drums) have a probability (conditional on the occurrence of a single intrusion) of intersection of more than 0.001, which is the probability limit established in 40 CFR § 191.13(a). Thus, the DOE has chosen to address the possible impact of non-random loading on spallings releases by considering releases conditional both on the occurrence of a single intrusion 100 years after decommissioning into the highest-activity waste stream containing at least 810 drums and on the association of a maximum-volume spalling event with that intrusion. As noted above, the same reasoning is also applied to the largest-volume cuttings and cavings releases. The DOE makes no estimate here of the likelihood of such events occurring.

As shown in Figure H-1d, and Tables H.4-1 and H.2-1 of the *WIPP PA Analysis Report for EPAUNI: Estimating Probability Distribution of EPA Unit Loading in the WIPP Repository for Performance Assessment Calculations, Document Version 1.01, February 17, 1997*, the highest activity waste stream to contain more than 810 drums is the Rocky Flats residues, containing 20,100 drum equivalents of waste (page H-289) with 0.0496 EPA units per drum equivalent at 100 years (page H-201). This activity loading corresponds to 0.238 EPA units per cubic meter of waste (page H-201), or 0.092 EPA units per cubic meter of the waste and backfill mixture filling the disposal-region volume. (As described in Appendix SA of the CCA, page SA-9, the ratio of waste volume to disposal-region volume is 0.386, found by dividing the total volume of waste containers by the total disposal volume.)

Based on an average activity of 0.092 EPA units per cubic meter, the release of 4 cubic meters of Rocky Flats residues from an intrusion at 100 years would result in the release of 0.368 EPA units, well below the allowable releases specified in 40 CFR § 191.13(a) of 10 EPA units at a probability of 0.001. The DOE has not conducted a complete analysis of the probability of one or more such intrusions occurring into the Rocky Flats residues within 10,000 years, conditional on the specific non-random loading scheme suggested by the EPA, but multiple such intrusions are highly unlikely. Based on the observation that the Rocky Flats residues are approximately 2.5 % of the WIPP waste by volume, multiple intrusions into the residues will be far less likely than the multiple intrusions into the entire disposal region considered in the CCA. Thus, of the 14 intrusions that occurred into the entire disposal region in the CCA analysis with a probability of 0.001 in 10,000 years (see table 6-28 of the CCA), less than one would be expected to occur into Rocky Flats residues if they were emplaced in a single region.

Conclusions

Based on the reasoning presented in the preceding discussion, the DOE concludes that if alternative regulatory standards were promulgated that required consideration of non-random loading of waste, regulatory compliance would not be affected even if the least favorable non-random loading of the WIPP that can reasonably be imagined were to occur. Such non-random loading would have essentially no effect on concentrations of actinides in brine that could be released from the repository as a result of human intrusion. Effects on cuttings, cavings, and spallings releases could result in a shift in the compliance measure, but an analysis of the least favorable consequences shows that regulatory limits would not be exceeded.

Attachment 1 - Preliminary CCDFs showing cuttings and cavings releases calculated for random and non-random waste emplacement

Copies of CCDF curves presented by the DOE to the Conceptual Model Peer Review Panel on November 19, 1996 are presented as Figures 1 through 4. These CCDFs are the result of preliminary calculations using the CCA modeling system, and show cuttings and cavings releases only (no spallings or direct brine releases) for the 100 realizations of replicate 1, calculated for randomly loaded waste (as used in the CCA) and for a loading scheme in which stacks of waste were randomly emplaced but each stack was constrained to have three drums from a single waste stream. These CCDFs differ from those displayed in Chapter 6 of the CCA in that they are based on preliminary modeling assumptions (including normalization of releases to the activity of the transuranic inventory in 1995, rather than 2033 as used in the CCA), and they were presented to the Peer Review Panel for illustrative purposes only. They should be interpreted only as a display of the extent to which changing assumptions about waste emplacement might change the CCDF resulting from cuttings and cavings releases, and they should not be used for direct comparison to the regulatory limits.

Figures 1 to 4. *(Not available).(3)*

RESPONSES TO EPA FINDINGS FROM EPA AUDIT OF CAO, 12/9-13/96

Finding No. 1:

NQA-1, Requirement 2 states that the management of those organizations implementing the quality assurance program shall regularly assess the adequacy of that part of the program for which they are responsible and shall assure its effective implementation.

However, CAOs MP 9.1, which implements this NQA requirement, contained no provision for regular assessments. At the time of the audit, MP 9.1 was under revision and was to be changed to address this finding.

Response: MP 9.1 was revised to include the requirement for annual reporting of assessment results: includes the requirement for annual reporting of assessment results:

"§4.1 **CAO Manager**

The CAO Manager is responsible for ensuring that management assessments are conducted regularly and reported at least annually....

"§5.1.1 Management assessments are conducted regularly and reported at least annually...."

A copy of Revision 1 is enclosed as Attachment 1.

Finding No. 2:

Team Procedure "TP 10.5, Peer Reviews para. 3.4.2 (a) and (c) require documentation of orientation of peer review team members. However, documentation was not available to demonstrate orientation training for one of the panel members for Peer Review No. 3.

Response: The documentation of orientation for Mr. Bresson, which was missing during the audit, has been located and placed in the file. A copy (Attachment 2) is attached to this response, as well as a memo (Attachment 3) from Mr. Bresson describing his participation in team orientation.

Finding No. 3:

Team Procedure TP 10.5 (Rev. 0), Requirement 3.1.3 (a), requires that the peer review selection committee shall be impartial and have no conflict of interest, including financial gain.

However, the chair of the peer review selection committee, which chose the panel for Peer Review No. 3, is the executive vice president of the firm where one of the selected panel members is employed. It was not clear from the information presented during the audit whether the chair of the selection committee may have been in a position in which his own personal interest was conflicted with the independent performance of the Peer Review panel No. 3.

Response: To further clarify the relationship between Mr. Thies and Mr. Bresson, a signed statement (Attachment 4) is attached in which Mr. Bresson states that in no way did Mr. Thies attempt to influence his participation in the peer review activities.

NUREG-1297 contains the criteria for selection of peer review team members in Section IV.3.b. These criteria peer review team members to have: 1) technical qualifications equivalent to those needed to perform the work under review, 2) independence from previous involvement as a participant, supervisor, technical reviewer or advisor, and 3) freedom from funding considerations. Mr. Thies selected peer review team members based on these criteria.

Finding No. 4:

"The audit team identified some documentation that was missing from the DRR files for TP 10.5 (Rev. 0 and Rev. 1).

Copies of the missing information were found and placed in the DRR files during the audit."

Response: This was corrected during the audit. No further action was requested by EPA.

Attachment 1 - CAO Management Procedure MP 9.1, Revision 1, entitled "Management Assessment", dated April 17, 1997.

Attachment not available.

Attachment 2 - Peer Review Panel Orientation Forms.

Attachment not available.

Attachment 3 - Memorandum from Mr. Bresson describing his participation in team orientation.

Attachment not available.

Attachment 4 - Statement by Mr. Bresson.

Attachment not available.

RESPONSES TO EPA FINDINGS/OBSERVATIONS FROM EPA AUDIT OF SNL, 1/13-24/97

Finding No. 1:

"NQA-1, Supplement 1S-1, states "quality achievement is verified by persons or organizations not directly responsible for performing the work." However, QAP 1-1 states "line management is responsible for verifying the quality."

Response:

As a result of this finding, SNL has issued an ICN (01) to QAP 1-1. The statement, "verifying the quality" has been changed to "evaluating the quality" in two places in the procedure. See Attachment 1.

Finding No. 2:

"NQA-3, Requirement 2.4, states "Management assessments of the quality assurance program shall be conducted regularly and reported at least annually." However, the last management assessment was performed in April 1995."

Response:

The CAO QA Manager briefed the SNL Project Manager and QA Manager on the importance of performing these management assessments annually. The SNL Management Assessment was completed on April 8, 1997. The Management Assessment had not been completed during the 12 month period because of the numerous external assessments by CAO and EPA. Because of these frequent external assessments conducted in the last eighteen months, there was no impact to the adequacy of SNL work.

Finding No. 3:

"Several CAR files requested from the Records Center were found to be incomplete, i.e., referenced documents were not included in the files, or listed on the Record Package Table of Contents.

CAR	Missing Documents
EA96-15-QAF-1	Original log sheet and correction
EA96-15-QAF-5	Attachment documenting sample identification scheme
EA96-26-QAF-1	Corrective Action Request form, initial proposed resolution of CAR (determined to be unacceptable), and revised proposed resolution of CAR (acceptable)
W97-003	Summary memo, including Statement of Impact"

Response:

The record files for the cited CARs were reviewed and have since been updated to assure that the cited deficiencies were addressed. CAO performed a follow-up audit and reviewed the cited CAR records packages for completeness. In addition, CAO reviewed an additional sample of three (3) CAR files to determine if they were complete. All packages reviewed (seven) by CAO during the follow-up audit were found to be complete.

Finding No. 4:

Sections 4.1, Step 4, of QAP 5-1 requires the use of the format described in Appendix A. QAP 5-1 does not conform to its own requirements for procedure format.

Response:

QAP 5-1 was revised and reissued on 2/7/97 to correct the formatting inconsistencies (see Attachment 2). QAP 5-1 now meets the required format specifications in Appendix A.

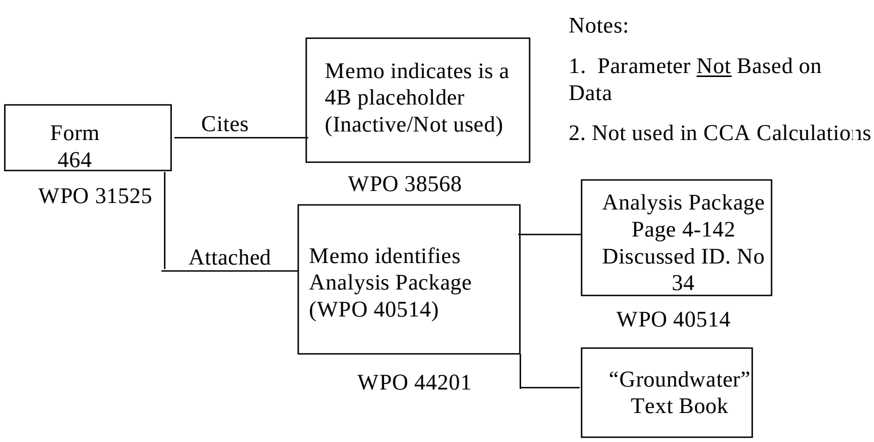
Finding No. 5:

NQA-3, Supplement 3SW-1 "All data shall be recorded so that they are clearly identifiable and traceable to test experiment, study, or other source from which they were generated."

However, the supporting documentation for the following parameters analyses do not meet traceability requirements:

Parameter No. Id. 34, Borehole PRMX_LOG is listed as a placeholder parameter. The parameter value listed in Form 464 is not traceable.

Parameter No. Id. 3148, CONC_PLG COMP_RCK, listed two sets of parameter values. There is no traceability documentation provided for the first set of data, which has a parameter value of "0." The second set of data has a parameter value of 1.2E-09, which was listed in Form 464 and is traceable, but has never been used. Instead, the parameter value of 2.64E-09 was used, but this value has never been entered into Form 464. Although 2.64E-09 is the wrong value to use in the analysis, traceability documentation must still be provided with Form 464.



Response:

An inconsistency previously noted by the EPA audit team in the BRAGFLO input data for the value of the parameter COMP_RCK in material CONC_PLG was investigated. The CAO audit team determined that the

EPA audit team may not have been provided all documentation necessary to resolve the inconsistency and traceability of parameter No. ID 3148. This inconsistency is really two separate issues, one relating to parameters for boreholes and the second to parameters for shaft seals.

With regard to borehole parameters, a value of zero (0) was selected for COMP_RCK by the SNL analyst for the BRAGFLO calculations for the CCA. This value is consistent with the value in the Form 464 (WPO 36591), with the listed source references (WPOs 43443, 35134), and with the versions of the controlled database at the time of the BRAGFLO calculations, CCA2 and CCA3. The value of COMP_RCK for a borehole is a type "4b" parameter, which means that it is selected by the analyst and must be documented in the analysis package. The rationale for selecting a value of zero (0) is documented in Chapter 4, Table 4.2.4-1 of WPO 40514, Analysis Package for the Salado Flow Calculations (Task 1 of the Performance Assessment supporting the compliance Certification Application), *SWCF-1.2.07.4.1:PA:QA:CCA:Analysis Package for Salado Flow Task 1*. The rationale in Table 4.2.4-1 is that the PA analyses will be insensitive to the value of the concrete porosity because the flow in the borehole is insensitive to the total pore volume of the concrete plug, which is a small quantity relative to the volume of a borehole.

The parameter values for shaft seals are separate and independent from the parameter values for boreholes. The value for COMP_RCK for a concrete shaft seal was set to 2.64 x 10^{-9} Pa^{-1} for the BRAGFLO analyses for the CCA. This value is in error because it is based on a porosity of 2.5% rather than the 5% concrete porosity that has been used for the CCA. This numerical error has been corrected in a memo date April 24, 1996, *SWCF-A:WBS 1.1.03.2.1:QA:BRAGFLO Seal Parameters.* The corrected value is 1.2 x 10^{-9} Pa^{-1}, which is the value which appears in table PAR-12 of the CCA. This corrected value applies to seal parameters, not borehole parameters.

Finding No. 6:

"QAP 5-1, Revision 2, Section 4.2, Step 1, Note 1 states that QAPs are allowed to carry ICN changes for up to one year before they are revised and reissued.

QAP 2-4 has two ICNs that exceed the one-year limitation. ICN 01's effective date is 10/27/95 and ICN 02 has an effective date of 11/17/95. QAP 20-3 has an ICN with an effective date of 10/13/95. ICN 01 for QAP 5-1 rescinds the one-year limitation on the incorporation of ICNs through QAP revision. However, this ICN was not effective until December 18, 1996."

Response:

When these overdue ICNs were discovered on or prior to December 18, 1996, an investigation determined that requirement concerning ICNs conflicted with QAP 6-1 and was an unnecessary requirement. ICN 01 to QAP 5-1 was processed and issued on December 18, 1996 to eliminate this unnecessary requirement and bring QAP 5-1 into agreement with QAP 6-1. A review of work completed using the ICNs revealed that there was no impact on the quality of work because of the failure to convert the ICNs to procedural revisions. Revision 3 to QAP 5-1 incorporates ICN 01 (Attachment 1).

Observation No. 1:

"CAR W97-013 was issued due to a deviation from NQA-3, Requirement 2.4, which requires the annual performance of management assessments. The corrective action for this CAR provided for the scheduling of a management assessment in April 1997. The corrective action was accepted by SNL WIPP QA and the CAR was closed out on January 9, 1997. The audit team [EPA] is concerned that this corrective action is inappropriate and that the CAR should not be closed until the management assessment is completed."

Response:

An investigation revealed that the closure of this CAR prior to completion of the management assessment was an isolated incident of noncompliance in this area. The management assessment was completed on April 8, 1997.

Once this situation was discussed with SNL, they realized that they should have waited for the completion of the management assessment to close the CAR. As a result, they issued internal CAR W 97-023. CAO will pay special attention to corrective action in future CAO assessments of SNL.

Observation No. 2:

CAO CAR 96-039 was issued due to deviations from SNL QAPs 13-1 and 13-2, which prescribe sample control and chain-of-custody, respectively. Numerous samples transferred without proper chain-of-custody. The corrective action performed included revision of existing chain-of-custody forms for several samples. In addition, chain-of-custody forms were filled out for those samples which had been transferred without maintaining chain-of-custody. The audit team is concerned that the chain-of-custody forms were improperly used and, as a result, the data generated from the subject samples is legally inadmissible.

Response:

CAO issued CAR 96-039 to SNL in May of 1996 shortly after the CAO QAPD, Revision 1 was approved. This CAR was issued in order to initiate corrective actions on several sample related deficiencies. The response to the CAR committed to correcting and completing the CoC forms. These forms were completed using information from other validated sample records. CAO verified that there was "traceability" for the samples collected. This traceability was all that was required by the CAO QAPD, Revision 0 and NQA-1. However, the SNL QA program required the use of CoC forms and therefore, SNL was in violation of their procedures. Although SNL did not fully comply with their procedure, they met the intent of the upper tier requirements to have acceptable traceability. There was no impact on the usability of the data because the QAPD did not require CoC forms until Revision 1 was issued and because the data generated from these cited samples was not used in Performance Assessment calculations.

Observation No. 3:

“The software disaster recovery process does not readily describe the procedure by which the software configuration management system and the PA software will be restored with adequate assurance that superseded versions will not be recreated as “current” versions.”

Response:

The audit team (for CAO Audit A-97-013) evaluated the recovery process identified by SNL for a catastrophic loss of system hardware and software. Emphasis was placed on the re-establishment of the Performance Assessment (PA) software (and data) baseline codes. While there is no specific requirement to have such a procedure, it makes good business sense to do so. The team determined that SNL procedures are being developed to describe the restoration of Alpha System hardware and operating system software. CAO is providing input in the development of these procedures and will be included in the review process.

In addition, during the evaluation of the maintenance of analysis records, the CAO audit team determined that there is no established procedure for magnetic media “migrating forward” process. “Migrating forward” is the SNL term for the periodic copying or re-recording of the magnetic media to ensure that the recorded data is not lost due to deterioration of the media over time. The SWCF staff is in the process of identifying and documenting all magnetic media currently maintained in the SWCF. However, a procedure has not yet been developed to ensure that magnetic media are properly “migrated forward” to ensure their continued accuracy and usability.

To date, no specific processing directions, procedures nor requirements have been identified or developed as to the preferred process for the migration of WIPP generated magnetic media. However, the Sandia Computer Support Manager and the Records Manager formed a team, including a CAO representative, in February 1997 to research the appropriate requirements, specifications, and resources necessary for such activities for each media utilized by Sandia WIPP personnel.

Observation No. 4:

"The Validation Document Reviewer's Form should explicitly require the reviewer to confirm that the executed test cases are the same as the test cases listed in the Validation Plan document."

Response:

SNL has revised the Validation Document Reviewers Form (Form 452-D) which requires that test cases executed during validation be the same as those identified in the verification and validation plan. A copy of Form 452-D is attached (see Attachment 3, question 5).

Observation No. 5:

"The definition of gradation provided in QAP 19-1 is not clearly stated. For example, if software is exempt form QAP 19-1, it will be qualified under QAP 9-1. This optional means of approving software demonstrates that gradation has a different meaning than the definition of grading set forth in NQA-1."

Response:

Interim Change Notice No. 2 to QAP 19-1 was issued by SNL on 2/6/97 to remove the "Gradation" Section (see Attachment 4).

The issuance of ICN 02 to QAP 19-1 has brought the procedure into compliance with NQA-1 and QAPD requirements.

CAO did not identify any cases where the "gradation" of software had been improperly applied in the qualification of software for Performance Assessment (PA) or CCA activities.

Observation No. 6:

"NQA-1, Requirement 5, requires procedures for activities which affect quality to have quantitative or qualitative acceptance criteria. However, the format specified by QAP 5-1 for developing QAPs does not include a section for acceptance criteria. No QAPs contain acceptance criteria."

Response:

QAP 5-1, Revision 3 was issued on 2/7/97 (see Attachment 2) and specifically added "Qualitative or Quantitative Criteria" in Appendix B, "Procedure Format and Content." The requirement for qualitative and quantitative acceptance criteria is now contained in Appendix A, "Technical Operating Procedure (TOP) Content."

In addition to the review of QAP 5-1 and 5-3, CAO reviewed a sample of six (6) additional QAPs and all referenced and/or included the applicable qualitative or quantitative acceptance criteria.

Attachment 1 - SNL Interim Change Notice for Procedure QAP 5-1, No. 1.

Attachment not available.

Attachment 2 - SNL QAP 5-1 "Preparing, reviewing and approving Quality Assurance Procedures (QAPs) and Abstracts", Revision 3, dated February 7, 1997.

Attachment not available.

Attachment 3 - SNL Validation Document Reviewer's Form, Form Number 452-D for Procedure 19-1, Revision 2.

Attachment not available.

Attachment 4 - SNL Intermin Change Notice for Procedure QAP 19-1, No. 2.

Attachment not available.

Response to EPA Finding/Observations from EPA

Audit of CAO Peer Review, 2/10-12/97

Finding 1

NUREG-1297 states that Peer Reviewers should have sufficient freedom from funding considerations to assure the work is impartially reviewed.

To address this issue, the DOE's Carlsbad Area Office (CAO) included conflict of interest forms which requires financial disclosure to identify whether a conflict exists. Mr. Evaristo Bonano and Ms. Patricia Robinson, members of the Waste Characterization Peer Review, checked that they had conflicts of interest but did not complete the required disclosure form.

Response:

As required, the disclosure forms have now been completed and placed in the Peer Review QA record files.

Finding 2

NUREG-1297 states that in cases where total independence cannot be met, the peer review report should contain a documented rationale as to why someone of equivalent technical qualifications and greater independence was not selected.

A Non-Selection Justification form was included for the Waste Characterization Peer Review. Ms. Patricia Robinson, a Nuclear Engineer with a Master of Science Degree pending, was selected for the Waste Characterization Peer Review Panel. Ms. Robinson is currently employed by a DOE contractor. The form lists Dr. Peter K. Mast, a Nuclear Engineer with a Ph.D, and notes that other equally or more qualified individuals are available. From the form, it appears that persons of equivalent technical qualification were available but not selected. However, the Non-Selection Justification form does not document the rationale.

Response:

The depth of Dr. Mast's expertise concerning WIPP related waste characterization was well understood at the time the Waste Characterization Peer Review Panel was selected. Dr. Mast had previously served on an Independent Review Team (IRT) for WIPP data. Although he is expert in nuclear engineering, he is no expert in transuranic waste characterization as is Ms. Robinson. It was determined that Ms. Robinson, although she had lesser education, had more directly relevant practical experience related to the types of transuranic waste pertinent to WIPP. At the time the Peer Panel members were selected both Ms. Robinson's company and Dr. Mast's company had sub-contracts with Department of Energy prime contracts that were not related to WIPP. Ms. Robinson was best qualified (based on her experience) than was Dr. Mast for the position in question.

Finding 3

CAO Team Procedure TP 10.5 (Rev. 1), Section 3.1.3(c), requires peer review panel members be selected from a predetermined list of personnel. However, Section 5.4, the responsibilities section of this procedure, states that the Peer Review Selection Committee shall generate a list of qualified Peer Reviewers using its knowledge of university contacts, professional organizations, and qualified industry professionals. A conflict exists within the procedure and should be revised.

Additionally, with the exception of the Engineered Alternatives Peer Review, neither a predetermined list nor a list generated from university contacts, professional organizations, and qualified industry professionals was located in the files reviewed.

Response:

The CAO ORC revised TP10.5 to remove the conflicting statements (Rev. 2). A copy is attached (See Attachment 1).

The list of qualified potential peer reviewers was generated by the Peer Review Selection Committee. This generated list became the predetermined list referred to in TP 10.5 (Rev. 1), Section 3.3.1(c). The generated lists that became the predetermined lists are attached (See Attachment 2).

Finding 4

CAO Team Procedure TP 10.5 (Rev. 1), Section 5.7 requires Peer Review Panel Members to complete and document the necessary training prior to the start of the Peer Review process.

Training forms for Mr. Chuan-Mian Zhang and Mr. Paul Cloke, members of the Natural Barriers Peer Review Panel, are dated May 15, 1996, while the meeting minutes of May 14, 1996 show them already in attendance.

Response:

Two individuals were added to the Natural Barriers (NB) Peer Review Panel due to the untimely loss of two other individuals. Dr. Chuan-Mian Zhang and Dr. Paul Cloke were added after the NB Panel was already in process. Please note that the May 14, 1996 NB Peer Review Meeting Minutes (See Attachment 3) indicate that their involvement with the Panel on this day was to be introduced as new panel members.

They completed their orientation on May 14, 1996 and training on May 15, 1996 prior to performing review activities with the NB Peer Review Panel on May 15, 1996 (See Attachment 4).

Finding 5

CAO Team Procedure TP 10.5 (Rev. 1), Section 3.4.2, requires that all Peer Review Panel Members receive an orientation prior to the start of the Peer Review process. At a minimum, the orientation shall cover subjects or documents related to the Peer Review process, including administrative requirements, the applicable Peer Review Plan, a brief summary of the Peer Review technical subject matter, an overview of the requirements of TP 10.5, and any other appropriate topic.

Records indicate that Mr. David Sommers did not receive administrative orientation prior to the start of the Peer Review process.

Response:

Dr. Sommers did complete his required training and orientation prior to the start of the Natural Barriers Peer Review. Records have been corrected to indicate this. He has also provided a statement attesting to his presence at the administrative orientation. A copy of his statement and the orientation form are attached (See Attachment 5).

Finding 6

CAO Team Procedure TP 10.5 (Rev. 1), Section 3.4.2, requires that all Peer Review Panel Members receive an orientation prior to the start of the Peer Review process.

There is no evidence that Mr. Florie Caporuscio received orientation when the Conceptual Models Peer Review Panel reconvened in January 1997.

Response:

Evidence is now available that Mr. Florie Caporuscio did receive orientation when the conceptual models Peer Review Panel reconvened in January 1997. A copy of the signature page confirming Dr. Caporuscio's orientation is attached (See Attachment 6). The reason the supplemental orientation (January 1997) file was not readily apparent is because the original Natural Barriers orientation file and the supplemental orientation files are separate files.

Finding 7

CAO Team Procedure TP 10.5 (Rev. 1), Section 3.4.4 requires minutes for all meetings, activities, and deliberations.

Minutes for the Natural Barriers Orientation Meeting conducted on May 14, 1996 were not included in the Peer Review files.

Response:

Minutes are now included in the Peer Review files for the Natural Barriers Orientation Meeting conducted on May 14, 1996 (See Attachment 7).

Observation 1

CAO Team Procedure TP 10.5 (Rev. 1), Section 3.1.3a requires that the Selection Committee shall be impartial and have no organizational conflict of interest.

The appearance of a conflict of interest exists for both Peer Review Managers. The CAO Technical Assistance Contractor (CTAC) was tasked by CAO to contract for the management of the Peer Review process. Informatics, Inc. was selected. Mr. John Thies, Executive Vice President of Informatics and Peer Review Manager, selected Mr. Leif Eriksson of CTAC to serve on the selection committee. Mr. Thies also selected Informatics employees as Peer Reviewers.

Dr. Abbas Ghasemi, Manager of Peer Review for Engineered Alternatives and Director of Special Programs for WERC, selected Dr. Ron Bhada, Administrative Director of WERC, to serve as Peer Review Panel Leader.

Response:

It is not clear where there is a conflict of interest.

First, concerning the selection of Mr. Leif Eriksson to serve on the Peer Reviewer Selection Committee. The Peer Review Manager (John Thies) has remained impartial throughout the peer review process. Although Mr. Leif Eriksson's professional judgment was never in question, he could not have compromised the partiality of the peer reviewer selection process because neither Mr. Eriksson nor Dr. Thompson (alone or together) had the authority to place members on the peer review panel. Mr. Thies had to take part in, and approve, all peer panel member selections, as did Mr. Eriksson and Dr. Thompson. Furthermore, there was no way for any of the selection committee members, their parent companies, the Department of Energy, or the selected peer panel members to benefit from the placement of Mr. Eriksson on the Peer Review Selection Committee.

Second, the selection of Dr. Caporuscio and Mr. Bresson (Informatics employees) as peer reviewers was based purely on their relevant education and experience. Upon review of their qualifications it is obvious that they are qualified peer reviewers in the areas they were selected to represent. In addition, to eliminate any questions concerning their independence, each was requested to document a statement for the peer review file. Copies of the statements are attached for your consideration (See Attachment 8). The DOE contracting officer also screened potential panel members for Organizational Conflict of Interest (OCI).

Third, for the Engineered Alternatives (EA) Peer review, there is an EA record in the records center that documents the peer review managers justification for selection Ron Bhada. Please see attached memo (See Attachment 9).

Observation 2

NUREG-1297 states that a rationale as to why someone of equivalent technical qualification and greater independence was not selected should be documented.

March 27, 1997

Several of the Engineered Alternative Peer Review panel members disclosed in their Determination of Independence forms, current or previous affiliation with DOE. However, a documented rationale as to why someone of equivalent technical qualification and greater independence was not selected was not included with the support documents.

Response:

Each of the Peer Panel members selected to serve on the Engineered Alternatives Peer Review Panel met the above requirements for independence. The documentation of the peer reviewer independence is included in the EA peer review records. The Peer Review Member Independence Form documents the NUREG 1297 requirements.

All EACBS members documented, on the peer reviewer independence form, that they did not have direct involvement in the work under review nor did they have any financial interest in the work. Because of this independence, no further documentation of the peer reviewer affiliation with DOE is necessary. No direct conflict was realized so no justification as to the rational why someone with a different employer having similar qualifications was not selected. This justification would have been required if a person was funded by the project under review or they were somehow involved with the work under review. Additional qualifications for each peer review was also provided in Appendix A of the Peer Review Final Report.

Also documented in the EA peer review records is the process the peer review selection committee used in peer review selection. The selection committee was overly aware of possible independence issues with potential peer reviews being considered. In this document, the committee excluded prospective peer reviewers that had a "perceived conflict of interest, even though they have no direct connection with the WIPP EACBS project."

The DOE contracting officer also screened potential panel members for OCI.

Observation 3

The Peer Review Selection Committee is required to document the rationale for selection of Peer Review Panel Members on a Peer Review Panel Selection, Size and Composition Justification/Decision Form.

A form was completed for each peer review, however, the form only repeats the requirements and does not provide a rationale for the selection of peer review panel members.

Response:

This is more of an issue with the sufficiency of detail in the procedure than with the actual implementation of the procedure. As part of the process, both organizations implementing the procedure performed supplemental actions to ensure completeness.

The requirement to include a rationale for the selection of the peer review members was recognized by the EA peer reviewer selection committee. The committee also recognized that this criteria was included in TP-10.5 and was not a NUREG 1297 requirement. The CAO team procedure TP 10.5 states that selection committee is to document the selection rationale on the form. The selection committee completed the form and included additional text explaining the rationale for selection of the peer review members. This text is attached (See Attachment 10).

For the peer reviews managed by Informatics, a memo to the peer review file (See Attachment 11) on July 22, 1996 explained the process and rationale used to select peer review panel members. This memo refers to the documented rationale for selection of members to the peer review panel on a Peer Review Panel Selection, Size and Composition Justification/Discussion form.

Attachment 1 - CAO Team Procedure TP10.5, entitled "Peer Review", Revision 2, dated April 16, 1997.

Attachment not available.

Attachment 2 - List of names and justification for why they were not selected to be on a peer review panel.

Attachment not available.

Attachment 3 - Meeting minutes for Natural Barriers Peer Review Panel, May 14, 1996.

Attachment not available.

Attachment 4 - Peer review panel member training forms.

Attachment not available.

Attachment 5 - Memorandum from D.A. Sommers to C. Elson, dated March 27, 1997, "Attendance of Peer Review Panel

Training".

Attachment not available.

Attachment 6 - Peer review re-orientation form for Conceptual Models Peer Review Panel.

Attachment not available.

Attachment 7 - Meeting minutes for Natural Barriers Peer Review Panel, May 14, 1996.

Attachment not available. Also filed above as Attachment 3.

Attachment 8 - Memorandum from F.A. Caporuscio, Informatics, to Peer Review File on conflict of interest, dated December 2, 1996.

Attachment not available.

Attachment 9 - Memorandum to file dated June 10, 1996 on conflict of interest.

Attachment not available.

Attachment 10 - Process for identifying and selecting the WIPP EABCS Peer Review Panel.

Attachment not available.

Attachment 11 - Memorandum to file dated July 22, 1996 on process used to select peer review panel members, by J. Thies.

Attachment not available.

II-I-31: Third set of responses to EPA's March 19, 1997 letter - 14 May, 1997

Contents:

Comment No. 1 Paleoflow Directions	Origin of Hydrochemical Facies and Modeled
Comment No. 4	SECOTP2D - Test with a Heterogeneous T-Field
Comment No. 5	SECOTP2D - Mass Balance
Comment No. 6	Quantify Impacts of Code Errors
Comment No. 7	SECO3D Code Test Results
Comment No. 8	Benchmark NUTS with SWIFT
Comment No. 11	Traceability of Development of Legacy Parameters
Comment No. 20 and 22	Solution Mining

EPA Comment 1 - Enclosure 1, page 1 - 194.14(a)(2)

Text of Comment

194.14(a)(2)

Section 194.14(a)(2) states that the description of the disposal system shall include a description of the geology, geophysics, hydrogeology, hydrology, and geochemistry of the disposal system and its vicinity and how these are expected to change and interact over the regulatory time frame.

The CCA identifies a new conceptualization of the origin of the hydrogeochemical facies in the Culebra. The explanation of the relationship between the hydrochemical facies and the groundwater basin modeling is not adequate. Section 2.2.1.4.1.2 briefly mentions a potential relationship but does not provide support for the relationship.

DOE needs to provide a discussion of the origin of the hydrochemical facies that incorporates the modeled Culebra paleoflow directions with *geochemical principles.*

DOE Response

The comment requests a discussion of the origin of the hydrochemical facies that were used in assessing the Culebra paleoflow directions. Attached is a paper documenting the re-evaluation of regional groundwater flow in the vicinity of the Waste Isolation Pilot Plant (WIPP). Previous interpretations of the geochemical data for groundwater flow in the Culebra Member of the Rustler Formation were re-evaluated in light of a more recent conceptualization of the regional groundwater flow in the vicinity of the WIPP. Past indications of the inconsistency between groundwater flow paths and solute chemistry in the Culebra Member of the Rustler are based on the premise that groundwater flow in the Culebra is perfectly confined and that rock/water interactions along a flow path away from the WIPP site must transform more saline NaCl-type water to a more dilute $CaSO_4$-type water. However, the attached paper demonstrates that a three-dimensional flow field that includes all members of the Rustler Formation does not require such a transformation. Instead, these water types are interpreted to have different recharge areas and travel paths to the Culebra. The solute chemistry of these waters are consistent with interactions with the rocks that occur along their respective flow paths to the Culebra.

Attachment 1 - "Expedited CCA Activity: Integration of hydrogeology and geochemistry of the Culebra Member of the Rustler Formation in the vicinity of the Waste Isolation Pilot Plant" by T. Corbet

Attachment not available.

EPA Comment 4 - Enclosure 1, page 2 - 194.23(a)(3)(iv)

Text of Comment

194.23(a)(3)(iv)

Section 194.23(a)(3)(iv) states that computer models must accurately implement the numerical models; i.e., computer codes are free of coding errors and produce stable solutions.

(1) Testing of the functional requirements for SECOTP2D is not documented in the CCA's validation documents. The information presented in the Analysis Plan (provided in December 1996) addresses this comment from a completeness standpoint; however, the testing of the SECOTP2D is not technically adequate.

DOE needs to test SECOTP2D with a heterogeneous transmissivity field.

DOE Response

The attached paper contains the requested analysis of the SECOTP2D code's ability to simulate solute transport within a heterogeneous flow field. A comparison was made to another numerical dual-porosity transport code, SWIFT II in order to evaluate the adequacy of the SECOTP2D code with a heterogeneous transmissivity field. A single vector from the suite of CCA runs was selected for the comparison. The vector was selected in part due to the fact that its modeled solute plume (^{234}U) encountered a greater range and area of the aquifer heterogeneity than 99% of the plumes modeled in the other vectors.

The SWIFT II simulation was set up to be as close as possible, in every respect, to the SECOTP2D vector. Both codes have several options for conducting the finite-difference approximations. SECOFTP2D employed a total variational diminishing (TVD) differenceing scheme. SWIFT II has an equivalent upwinding option, but not a TVD scheme. The primary SWIFT II solution used for this comparison utilized the upwinding option. When SECOTP2D was rerun using the upwinding option, the plume patterns for each code were nearly identical. The modeled SWIFT II plume result was qualitatively similar, yet more dispersed, as compared to the CCA vector modeled by SECOTP2D with the TVD scheme. The differences between the results appear to be caused by the varying degrees of numerical dispersion associated with the two finite-difference schemes, and are consistent with literature sources for conducting finite difference approximations. The extremely good agreement between SECOTP2D and SWIFT II verifies the ability of SECOTP2D to produce technically adequate results in a heterogeneous transmissivity field.

Attachment 1 - "Expedited CCA Activity: Evaluation of SECOTP in a heterogeneous t-field" WPO# 44599, Revision 2, dated May 13, 1997.

Attachment not available.

EPA Comment 5 - Enclosure 1, page 2 - 194.23(a)(3)(iv)

Text of Comment

194.23(a)(3)(iv)

(2) There appears to be a mass balance problem in SECOTP2D that could cause the computer code to produce calculations with errors and thus inaccurately implement the numerical models.

DOE needs to provide an analysis of the mass balance in SECOTP2D and its effects on calculations of radionuclide transport in the Culebra.

DOE Response

Attached (WPO #44700) is the requested analysis of mass balance in the SECOTP2D simulations and an explanation of its impact on CCA performance calculations regarding radionuclide transport in the Culebra. The mass balance errors were identified during Analysis QA review after the CCA was submitted. The source of mass balance errors has been identified and a procedure for minimizing and controlling mass balance errors in future calculations has been incorporated into the code. Results from the investigation indicate there is no impact on the CCA performance calculation results from mass balance errors in the Culebra transport calculations.

The WIPP CCA Culebra transport calculations were performed using SECOTP2D (Version 1.30). This version of the code does not have mass balance reporting capabilities. The mass balance errors occurred in the implementation of the code, not in the transport solution. Therefore, mass balance reporting capabilities were subsequently added to the code in Version 1.32. The differences between Version 1.32 and Version 1.30 are: (1) the addition of mass balance reporting; and (2) the option to output history variables at specified time step intervals (added in Version 1.31). Both changes to the code only affect the way results are reported. Neither change alters the transport solution in any way.

An analysis of SECOTP2D (Version 1.30) mass balance errors in the Culebra transport calculations has been completed using Version 1.32 and is attached. The mass balance errors were found to exist in all but two of the 600 transport simulations based on comparison with a one-dimensional analytical solution. However, the mass balance errors did not result in errors in the calculation of the containment CCDF reported in the CCA. In the original CCA calculations, two (of 600 total) vectors for which transport across the Land Withdrawal Act Boundary was indicated, were treated correctly (by modifying the time steps used to resolve the calculation during the PA). The analytical solution confirmed the results for these potential off-site releases. The analytical solutions also confirmed those vectors for which transport did not reach the accessible environment (the remaining 598), even though their transport calculations contained mass balance errors (none reached the boundary even when mass is conserved).

In summary, results from the analytical solution confirmed those reported in the CCA, i.e., zero discharge at the land withdrawal boundary in all but two of the transport simulations. The mass balance errors for these two particular CCA runs have been shown to be insignificant. Consequently, there is no impact on the CCA performance calculations from mass balance errors in the Culebra transport calculations.

Attachment 1 - "Expedited CCA Activity: Test of mass

balance of SECOTP " WPO# 44700, Revision 0, dated April 30, 1997.

Attachment not available.

EPA Comment 6 - Enclosure 1, page 2 - 194.23(a)(3)(iv)

Text of Comment

194.23(a)(3)(iv)

Section 194.23(a)(3)(iv) states that computer models must accurately implement the numerical models; i.e., computer codes are free of coding errors and produce stable solutions.

(3) Potential errors have been found in the computer codes.

DOE needs to identify errors that have been found in the computer codes since the PA calculations were run for the 10/29/96 CCA submission. DOE needs to describe the impact of those errors on the results of PA.

DOE Response

As requested in the comment, DOE has identified eleven errors in the computer codes since the PA calculations were run for the 10/29/96 CCA submission. Of these errors, eight had either a very minor, or no impact on the results of CCA performance assessment calculations:

MINOR or NO IMPACT

- 5 in BRAGFLO
- 1 in SUMMARIZE
- 1 in PRESECOTP2D
- 1 in CCDFGF

The remaining three errors included one in CCDFGF, and two in NUTS. A breif look at the impacts of these errors originally assessed them as having either no impact or possible major impact. These errors were further analyzed to determine their true impact.

CODE ERROR IMPACTS

- CCDFGF

  The CCDFGF error resulted in minor impacts to calculated spallings and blowout releases. Cuttings releases were slightly underestimated, while spallings and blowout releases were slightly overestimated.

- NUTS

  1. The first NUTS code error regarding solubilities, and therefore releases, has been corrected with the new information included in the NUTS/PANEL analysis package. The impact to CCA performance assessment calculations was small and releases through the Culebra were unaffected since NUTS results were not needed for the these calculations.

  2. The impact to CCA performance assessment calculations from the second NUTS code error identified in March 1997 regarding solubilities (and therefore releases) has been determined to be insignificant. Although releases to the Culebra may increase slightly, there is no effect on CCA performance assessment calculations since NUTS results were not needed for these calculations. The sensitivity analysis results will also be affected because they are based on NUTS runs with this error.

A synopsis of the software problem reports describing these errors and impacts are attached.

Software Problem 96-006

Code Name/Version:	PRESECOTP2D	1.20
Software Problem Report # and Date:	96-006	06/27/96
Software Problem Report Class:	Minor	

Description of Error:

The error involved coding in PRESECOTP2D code which led to an error in the source term for ^{230}Th. The error had the effect of reducing the cumulative mass of

^{230}Th that is injected by a factor 256. Consequently, only 1/256 kg of ^{230}Th was injected over a 50 year period. The error had no ramifications on the remaining isotopes or on the daughter product ^{230}Th solution. Also, because the integrated discharge of injected ^{230}Th was exceptionally low in all simulations, the error in the integrated discharge is not detectable in the single precision format which is used by the code to output results. Therefore, the error is considered to have no impact on the primary deliverable "isotope integrated discharge".

Description of Impact:

The error had the effect of reducing the amount of source that was used for transport for one (^{230}Th) of the five isotopes that were transported by a factor of 256. (Four of the five isotopes are correct.) The effect of the error is minimal as there was no discharge for this isotope in any of the vectors for all three replicates.

Software Problem 96-007

Code Name/Version:	SUMMARIZE	2.10
Software Problem Report # and Date:	96-007	07/18/96
Software Problem Report Class:	Minor	

Description of Error:

The file descriptor for NUCPLOT mistakenly omitted a single line necessary for NUCPLOT to read this common file format. The line contains the vector number, probability (always 1.0 output), and the summation (not used, outputs 1.0). These three values (two of which are dummies) require no computation.

Description of Impact:

This transfer file was not utilized in the CCA until after the corrected version of SUMMARIZE was available. NUCPLOT would not run with the old formats so no errant results were generated are possible. The format change was compared and confirmed by hand editing the old file format by adding the above line and running NUCPLOT.

Software Problem 96-008

Code Name/Version:	CCDFGF	1.00

Software Problem Report # and Date:	96-008	09/11/96
Software Problem Report Class:	Minor	

Description of Error:

When RH waste stream #1 was randomly drawn in the LHS sample, the activity loading for CH waste stream #1 was used instead. If the first intrusion was an E1 event with a subsequent E2 event following the E1 event, the E1 waste panel index (the number of waste panel that was intruded 1 to 10) was incorrectly set to the E2 waste panel index. The E1 waste panel index should have remained the initial E1 waste panel index.

Description of Impact:

Cuttings releases were underestimated by 1.2% or less compared to the total release. Spallings releases were overestimated by 0.6% or less (usually 0.0%) when compared to total release. Blowout releases were overestimated by 0.3% (usually 0.0%) when compared to the total release. This error had a negligible impact on the final CCA release amount.

Software Problem 96-012

Code Name/Version:	NUTS	2.02
Software Problem Report # and Date:	96-012	10/04/96
Software Problem Report Class:	Major	

Description of Error:

The outer index of the “DO loop” which reads the element’s solubility from the CDB was # of isotopes instead of # of elements. This resulted in the use of the Pu solubility for U and the U solubility for Th, which over-estimated each solubility, and therefore, the releases for both ^{234}U and ^{230}Th by two orders of magnitude.

Description of Impact:

Table 8-1 in Chapter 8 of the CCA, which documented releases through the marker bed, was affected (Table 7.5 herein). This table was redone and is included herein as Table 7.6 and in the NUTS/PANEL analysis package. The releases, which were already small, became even smaller after this error was corrected. Releases through the Culebra were unaffected because the NUTS results were not needed for this calculation. The sensitivity analysis results are unaffected because they are based on NUTS runs with this error corrected. The impact on the dose calculations documented in Chapter 8 of the CCA are negligible.

Table 7.5 Concentrations of Radionuclides Within the Salado Interbeds at the Disposal System Boundary at 10,000 years reported in CCA Table 8-1.

Realization No	Vector No.	Maximum Concentration (Curies/liter) [1(4)]				
		^{241}Am	^{239}Pu	^{238}Pu	^{234}U	^{230}Th
1	R1V046	1.36×10^{-17}	4.33×10^{-12}	N	5.82×10^{-13}	2.10×10^{-1}
2	R2V016	N	5.13×10^{-14}	N	6.77×10^{-15}	1.89×10^{-1}
3	R2V025	N	1.35×10^{-15}	N	1.65×10^{-16}	7.00×10^{-1}
4	R2V033	1.32×10^{-17}	7.18×10^{-14}	N	9.76×10^{-15}	9.36×10^{-1}
5	R2V081	N	6.23×10^{-18}	N	N	N
6	R2V090	N	5.20×10^{-16}	N	7.40×10^{-17}	N
7	R3V003	3.50×10^{-18}	3.08×10^{-13}	N	4.32×10^{-14}	1.07×10^{-1}
8	R3V060	5.98×10^{-17}	7.41×10^{-14}	N	9.09×10^{-15}	2.30×10^{-1}
9	R3V064	5.42×10^{-17}	5.85×10^{-12}	N	7.61×10^{-13}	4.68×10^{-1}
10-300	-	N	N	N	N	N

Table 7.6 Concentrations of Radionuclides Within the Salado Interbeds at the Disposal System Boundary at 10000 years (Table AD-1 of Rahal et. al. 1996).

Realization No.	Vector No.	Maximum Concentration (Curies/liter) 1(5)				
		^{241}Am	^{239}Pu	^{238}Pu	^{234}U	^{230}Th
1	R1V046	N	1.3×10^{-13}	N	2.8×10^{-15}	7.4×10^{-1}
2	R2V016	N	1.6×10^{-15}	N	1.0×10^{-18}	2.3×10^{-1}
3	R2V025	N	4.2×10^{-17}	N	N	2.4×10^{-1}
4	R2V033	N	2.2×10^{-15}	N	1.2×10^{-16}	2.7×10^{-1}
5	R2V081	N	N	N	N	N
6	R2V090	N	1.6×10^{-17}	N	N	N
7	R3V003	N	9.5×10^{-15}	N	7.4×10^{-18}	4.4×10^{-1}
8	R3V060	N	2.3×10^{-15}	N	2.8×10^{-16}	2.9×10^{-1}
9	R3V064	1.7×10^{-18}	1.8×10^{-13}	N	6.7×10^{-16}	4.4×10^{-1}
10-300	-	N	N	N	N	N

Software Problem 97-002

Code Name/Version: BRAGFLO 4.00 and 4.01
Software Problem Report # and Date: 97-002 01/29/97
Software Problem Report Class: Minor

Description of Error:

In 2- or 3-dimensional simulations, the gas interblock flows in the 2nd and 3rd directions are not calculated at the I=1 row of grid cells. For Example, in a 2-D simulation such as a WIPP CCA calculation, the vertical gas flows, QGBLOCKJ, at I=1 (in the left column of grid cells) will always remain unchanged at zero.

Description of Impact:

There is no impact on the CCA calculations. In the CCA, no gas reached the south (left, or I=1) boundary, thus QGBLOCKJ should correctly remain zero. Furthermore, gas flows at the boundaries were of no concern in the CCA, so values of QGBLOCKJ were not output. Vertical gas flows at the boundaries were also of no concern in any other calculations done by WIPP PA.

The error has a minor impact on Direct Brine Release (DBR) calculations. Gas flows were output for the entire mesh; however, the only gas flows that were examined quantitatively were for grid cells in the interior of the mesh. The erroneous boundary gas flow values were used only in vector plots as part of a qualitative description of the gas flow patterns in the DBR scenario

Software Problem 97-003

Code Name/Version:	BRAGFLO 4.00 and 4.01	
Software Problem Report # and Date:	97-003	01/29/97
Software Problem Report Class:	Minor	

Description of Error:

Mass balance equations were incorrectly written with a gravity potential term in the form grad[P+density*g*elevation]. The correct form is [grad(P)+density*g*grad(elevation)]. In effect, BRAGFLO adds a term g*elevation*grad(density) to the fluxes in the mass balances.

Description of Impact:

The error is small and has no discernible effect on the results of the CCA calculations. Plots of the results from a test run on a CCA realization implementing recommended corrections to BRAGFLO overlay plots of the original CCA results, indicating that any differences are minor.

Software Problem 97-004

Code Name/Version:	NUTS	2.03
Software Problem Report # and Date:	97-004	03/25/97
Software Problem Report Class:	Major	

Description of Error:

The total mass in the system is treated as the sum of dissolved and precipitated masses. In NUTS version 2.03 and earlier versions, the solution algorithm for the dissolved portion is fully implicit while the solution for the precipitated portion is explicit. The dissolved concentration is evaluated first and compared with the solubility limit. If the solubility limit is exceeded the additional mass is removed as precipitate. If the computed concentration is less than the solubility limit, NUTS will dissolve additional mass from the precipitate sufficient to maintain the solubility limit. This numerical implementation for calculating precipitated mass may, in some intrusion scenarios, result in underestimates of the releases to the Salado/Culebra interface. This would happen because the computational nodes in the wellbore may not have precipitate available for most cases, therefore (1) it can not be adjusted back to the solubility limit the way it is computed in the neighboring grid points that have precipitate, and (2) during the numerical matrix inversion, the computational node is coupled with a neighboring computed concentration which is different from the solubility limit. Note that the concentration is adjusted after the solution is computed (in constrained solution).

Description of Impact:

The impact of the explicit precipitation/dissolution algorithm on the CCA results is insignificant. This conclusion is based on comparisons between the CCA results and new results obtained using a revised version of NUTS that implements an implicit precipitation/dissolution algorithm. New results show that the majority of vectors now produce smaller radionuclide releases as opposed to larger releases. In addition, in those vectors where releases are increased, increases are not significant.

Software Problem 97-005

Code Name/Version:	CCDFGF	2.01
Software Problem Report # and Date:	97-005	03/20/97
Software Problem Report Class:	Major	

Description of Error:

Spallings releases and blowout (direct brine) releases used the incorrect waste panel index (the number of waste panel that was intruded 1 to 10) for first E1 intrusion after one or several E2 intrusions. CCDFGF was using the E1 waste panel index on the original E1 spallings and blowout release calculations when it should have used the initial E2 waste panel index. The initial E1 intrusion after a singular or series of E2 intrusions should continue using the initial E2 waste panel index. Subsequent E1 intrusions should use the initial E1 waste panel index.

Description of Impact:

Spallings releases were unchanged except for less than 1% of the observations in the CCA analysis where the spallings releases were underestimated by less than 0.2%. Blowout (Direct Brine) releases were overestimated by 36% or less relative to previously calculated blowout releases and from 6% or less (for most realizations less than 0.01%) relative to previously calculated total releases.

Software Problem 97-006

Code Name/Version: SECOTP2D 1.30 and 1.31
Software Problem Report # and Date: 97-006 05/01/97
Software Problem Report Class: Minor

Description of Error:

The source term algorithm in SECOTP2D was incorrectly implemented. The total mass injected was, at a minimum, ½ of the correct amount using one year time steps and 95% for 0.1 year time steps. Therefore, the magnitude of the error is dependent on the time step taken and the duration of the source function.

Description of Impact:

The overall impact of this error on the CCA performance calculations is minor. Impact analysis results showed no discernible change in the final CCDF. For the time step size and source function used in the CCA, the magnitude of the error is small, 0.98667 kg vs. 1.0 kg.

Software Problem 97-007

Code Name/Version: BRAGFLO 4.00 and 4.01
Software Problem Report # and Date: 97-007 04/11/97
Software Problem Report Class: Minor

Description of Error:

1) In subroutine CONSOL, array PHI(I,J,K) is being used outside of any DO-loop where (I,J,K) are defined. 2) In subroutine CONSOL, waste porosity surface #4 porosity is being incorrectly converted when waste permeability varies with porosity. 3) In subroutine RXGAST, (I,J,K) arrays are being used outside any DO-loop where (I,J,K) are defined. 4) In subroutine READFILES, CHARACTER*128 variables BF2_UIF$INPUT, etc., are declared but unused. 5) In subroutines READFILES and QABGNL, PREBRAG QA information at top of input file is not saved (i.e., not written to output files) when keyword 'PREBRAG' is followed by a nonblank character, which occurs when PREBRAG has been run under SCMS.

Description of Impact:

There is no impact on the CCA performance calculations. Subroutine CONSOL was not accessed in CCA calculations; instead, the single-grid-block version, CONSOL1, was used. Subroutine RXGAST is part of the "reaction path" model, which has never been used. Declaration of variables in READFILES that are not used has no effect on results, but does unnecessarily clutter certain diagnostic analysis (e.g., FLINT). The absence of PREBRAG QA record in output files does not impact traceability of CCA calculations because all calculations were done in SCMS.

Software Problem 97-008

Code Name/Version:	BRAGFLO 4.00 and 4.01	
Software Problem Report # and Date:	97-008	04/18/97
Software Problem Report Class:		Minor

Description of Error:

In subroutine CUMULGEN, when Dirichlet conditions are specified to hold the pressure and saturation constant in a grid cell, the flows of gas and brine into or out of the cell, needed to maintain the specified conditions, are computed as if an injection or production well were present. These "well inflow" values can be output for use in other codes or analysis, such as NUTS. The signs on the rates and cumulative inflows were reversed, which would cause errors if the inflow values were used in NUTS. The sign error has no effect on other BRAGFLO results.

Description of Impact:

There is no impact on the CCA performance calculations. Well inflows were not reported in the BRAGFLO CCA runs and were not used in NUTS CCA runs. Well inflows are computed solely for output purposes and have no effect on the solution that BRAGFLO computes.

Software Problem 97-009

Code Name/Version:	BRAGFLO 4.00 and 4.01	
Software Problem Report # and Date:	97-009	04/22/97
Software Problem Report Class:	Minor	

Description of Error:

When every grid cell in a BRAGFLO simulation is fully brine-saturated, BRAGFLO will eventually abort. This is caused by two factors. First, because the gas saturation is zero, the algorithm in subroutine TIMESTEP that determines time step sizes does not allow the time step to change from the minimum value specified in the input file. Typically, this input value is small enough to enable BRAGFLO to get through difficult transients, but is far too small to complete a realistic simulation. Second, when well inflows are integrated in subroutine CUMULGEN, a division by zero occurs when the cumulative inflows are divided by the initial gas content of the mesh, which has been assigned a value of zero. An additional, non-fatal error occurs even when the mesh is not fully brine-saturated - the cumulative brine inflow is calculated incorrectly in grid cells for which Dirichlet conditions are specified.

Description of Impact:

There is no impact on the CCA performance calculations. Because of the problems described above, BRAGFLO has never been run with the entire mesh fully brine-saturated. The error in the cumulative brine inflow using Dirichlet conditions has not been a problem. It is an additional calculation done solely to manipulate BRAGFLO results into a form that may be useful in some analysis and can be output for use in subsequent analysis. It has no effect on any other BRAGFLO results. Brine inflows using Dirichlet conditions are not used in subsequent analysis.

EPA Comment 7 - Enclosure 1, page 2 - 194.23(a)(3)(iv)

Text of Comment

194.23(a)(3)(iv)

(4) While the type of testing for the SECO3D code appears to be appropriate, the most relevant tests (listed in Record 25, WPO 43367) are only briefly described, and test results are not presented.

The tests mentioned in Record 25 need to be fully described and the results provided.

DOE Response

The requested additional testing documentation is attached and provides descriptions of the SECOFL3D tests, and the test results. These tests listed in Records Item 25 of the record package, Development and Testing of SECOFL3D (WPO# 43367) were performed on October 11, 1995, using SECOFL3D, Version 1.9. The attached document provides a test description, objectives, setup, and results of analysis for each of the 14 tests performed. Also attached is the User's Guide for SECOFL3D, Version 1.9. The input and output files are included in the appropriate records package (WPO# 45099, *Testing of SECOFL3D, version 1.9*).

Attachment 1 - User's Guide and Test Documentation for SECOFL3D, Version 1.9.

Attachment not available.

EPA Comment 8 - Enclosure 1, page 2-3 - 194.23(c)(2)

Text of Comment

194.23(c)(2)

Section 194.23(c)(2) requires that the CCA include detailed instructions for executing the computer codes, including hardware and software requirements, input and output formats, listings of input and output files from a sample computer run, etc.

NUTS Validation Document, page 1205: EPA commented in the December 1996 letter that there is no obvious physical reason for oscillations in the concentration profile and there are concerns about the adequacy of the testing. DOE responded that the "apparent oscillations" are actually concentration accumulations due to the velocity field and coarse grid that was used. DOE also stated that no attempt was made to actually solve the problem described in the test, but instead, the purpose was to determine whether NUTS could track the results computed by an independent technique (i.e., MT3D) given the velocity field. This may be true, although it raises two issues: (1) Since MT3D is known to have problems producing accurate solutions, an essentially perfect match of the NUTS results to these inaccuracies does not produce confidence that the NUTS code is providing accurate solutions; and (2) the fact that the same degree of grid coarseness leads to exactly the same level of inaccuracy in both codes is unusual behavior for two independently formulated codes.

DOE should use the computer code SWIFT to benchmark NUTS for the same problem, with the exception that the grid be made fine enough to provide an accurate solution.

DOE Response

A comparison was made between the flow/transport code suites BRAGFLO/NUTS, SWIFT, SWIFT/NUTS, and MODFLOW/MT3D on a heterogeneous flow and transport problem. This request stems from the results of the NUTS Test Case #11 in the Software Quality Assurance (SQA) Requirements Document/ Verification and Validation Plan (RD/VVP, WPO# 42618) - Validation Document (VD, WPO# 42619) which shows a “spiky” behavior rather than the expected behavior. This “spiky” behavior was first thought to be an instability or a mass conservation problem in

NUTS. However, this investigation shows that the “spiky” behavior resulted from the fact that only four digits of the velocity field were provided, which is all of the digits that were available at the time. In order to avoid the problem of having too few digits, it was decided to transfer the information via a CDB file to NUTS in the same manner as is used in the Compliance Certification Application (CCA) calculations. SWIFT computes its own velocity field and simultaneously solves the transport equation. In addition to the results for SWIFT, the results from an advection - finite difference MODFLOW/MT3D (McDonald and Harbaugh, 1988/Zheng, 1992) calculation have also been included. Moreover, the results from a calculation which extracts the steady-state velocity field from SWIFT and then uses NUTS for the transport calculations (SWIFT/NUTS) have been included as well.

When the concentration contour plots were overlaid, no discernible differences were observed. Good agreement was also found between the flow codes when the head (pressure) and velocity fields were examined. The results indicate that for this heterogeneous flow and transport problem, any of the code suites would give comparable results. Attached is a copy of the report, “Flow and Transport Comparison”, Revision 1, WPO# 44598.

Attachment 1 - "Expedited CCA Activity: Flow and transport comparison" WPO#44598, Revision 1, dated May 12, 1997.

Attachment not available.

EPA Comment 11 - Enclosure 1, page 4 - 194.23(c)(4)

Text of Comment

194.23(c)(4)

Section 194.23(c)(4) states that detailed descriptions of data collection procedures, sources of data, data reduction and analysis, and code input parameter development must be documented in the CCA.

(3) "Legacy" parameters were developed and used in the 1992 PA calculation in the CCA PA calculations without alternation. Current parameter packages simply reference "Legacy" parameters without explaining how they are developed or providing traceability to source documents.

DOE needs to document the development of "Legacy" parameters to show traceability.

DOE Response

The comment requests documentation to provide traceability of the development of "Legacy" parameters. Attached is a Memo of Record from M.A. Martell, February 27, 1997 which provides additional traceability for the “Legacy” and “Placeholder” parameters. The memo of record is an addendum to the original “Legacy” memorandum (Tierney and Vaughn to File, dated June 17, 1996, WPO# 38568). This memo is also attached for your convenience. Subsequent to the issuance of the original memo, WIPP Data Entry Forms (Form 464) have been prepared for the “Legacy” parameters. Form 464, a product of a QAP 9-2 activity, includes the parameter ID, material, model, category, distribution, source and interpretation of the “Legacy” parameters. An updated list of the “Legacy” and “Placeholder” parameters that includes the WPO numbers and page numbers of the PA Analysis QA Package are included in the attached memo as well.

Completed form 464s which contain information regarding sources have been generated for all legacy parameters. Legacy parameters, as a class, now include all parameters that did not change from their previous value for the CCA Calculation. Therefore, all "Legacy" parameters have data entry dates prior to 1996. A "placeholder parameter" is a parameter whose value is not used, but remains in the database to facilitate the correct reading of all parameters for BRAGFLO from SCMS files.

Attachment 1 - Memorandum frpm M. Martell, dated February 27, 1997 - Addenda to WPO# 38568 SNL Internal memo: M.

Tierney and P. Vaughn, dated June 17, 1996, "Designation of 'Legacy Parameters' and 'Placeholders' in the WIPP Parameter Database".

Attachment not available.

EPA Comment 20 - Enclosure 1, Page 7 - 194.32(c)

Text of Comment

194.32(c)

Section 194.32(c) specifically requires that the PA include an analysis of the effects on the disposal system of any activities that occur in the vicinity of the disposal system prior to disposal and are expected to occur in the vicinity of the disposal system soon after disposal system. These activities include boreholes and leases that may be used for fluid injection activities.

The process for solution mining for extraction of brine is distinctly different from other resource extraction techniques. The fluid injection activities used in solution mining can potentially induce alterations, which may not be limited to subsidence and caving, in the host rock (Salado).

DOE needs to consider in the PA existing boreholes in which solution mining can reasonably be expected to occur in the near future.

EPA Comment 22 - Enclosure 1, Page 8 - 194.32(e), Part 2

Text of Comment

194.32(e)

(2) DOE has not analyzed (screened) the potential effects of solution mining of halite in the CCA. Section 194.32(c) requires that performance assessments include an analysis of the effects on the disposal system of such

activities in its vicinity prior to disposal or that can reasonable be expected soon after disposal.

DOE needs to provide an analysis of the effects of solution mining for halite. Since the mining of the halite is associated with the production of oil, the time frame for the modeling study may be limited to the potential life of oil production around WIPP (i.e., 150 years).

Synopsis of Comments

Comments concern the effects of solution mining in the vicinity of the WIPP disposal system.

DOE Response

Statement of Issue

The 40 CFR Part 194 criteria require that performance assessments for the Waste Isolation Pilot Plant (WIPP) Compliance Certification Application (CCA) include an analysis of the effects on the disposal system of any activities that occur in the vicinity of the disposal system prior to disposal or are reasonably expected to occur in the vicinity of the disposal system soon after disposal.

40 CFR Part 194 also states that performance assessments should assume future drilling practices and technology will remain consistent with practices in the Delaware Basin[1(6)] at the time a compliance application is prepared. A survey of activities in the Delaware Basin has shown that there are a number of boreholes used for the solution mining of halite, to recover brine for use in drilling oil and gas boreholes.

Solution mining involves the injection of freshwater and the recovery of brine, which results in the formation of cavities at depth. If these cavities become sufficiently large, subsidence may take place in overlying strata. Losses from leaking boreholes could affect the hydrogeology of units overlying the halite and could change the geochemical environment in these units. Subsidence, changes in hydrogeology, and changes in the geochemical environment could all have an effect on the performance of the disposal system if solution mining occurs in the vicinity of the WIPP.

Hicks (1997) discussed solution mining and presented screening arguments for eliminating it from performance assessment calculations. The screening arguments were based on the solution mining operations in the New Mexico portion of the Delaware Basin. The DOE has recently reviewed solution mining operations in the remainder of the Delaware Basin, and additional material has been added to the following screening argument.

Summary of Screening Decision

Historical and current solution mining has been eliminated from performance assessment calculations on the basis of low consequence to the performance of the disposal system. Near-future solution mining has been eliminated from performance assessment calculations on the basis of low probability. Future solution mining has been eliminated from performance assessment calculations on regulatory grounds.

Basis for Screening Decision

Solution Mining in the Delaware Basin

Purpose

Oil and gas reserves in the Delaware Basin are located in structures within the Delaware Mountain Group and lower stratigraphic units. Boreholes drilled to reach these horizons pass through the Salado and Castile Formations which comprise thick halite and other evaporite units. In order to avoid dissolution of the halite units during drilling and prior to casing of the borehole, the fluid used for lubrication, rotating the drilling-bit cutters, and transporting cuttings (drilling mud) must be saturated with respect to halite. Most oil- and gas-field drilling operations in the Delaware Basin therefore use saturated brine (10 to 10.5 pounds per gallon) as a drilling fluid until reaching the Bell Canyon Formation, where intermediate casing is set.

One method of providing saturated brine for drilling operations is solution mining, whereby fresh water is pumped into the Salado Formation, allowed to reach saturation with respect to halite and then recovered. This operation may be performed in the vicinity of the drilling operation or remotely. In the latter case, the brine is transported by tanker or pipeline to the drilling site.

Techniques

Two principal techniques are used for solution mining; single-borehole operations, and doublet or two-borehole operations.

In single-borehole operations, a borehole is drilled into the upper part of the halite unit. After casing and cementing this portion of the borehole, the borehole is extended, uncased into the halite formation. An inner pipe is installed from the surface to the base of this uncased portion of the borehole. During operation, fresh water is pumped down the annulus of the borehole. This dissolves halite over the uncased portion of the borehole, and saturated brine is forced up the inner tube to the surface.

In doublet operations, a pair of boreholes are drilled, cased and cemented into the upper part of the halite unit. The base of the production well is set some feet below the base of the injection well. In the absence of natural fractures or other connections between the boreholes, hydrofracturing is used to induce fractures around the injection well. During operation, fresh water is pumped down the injection well. This initially dissolves halite from the walls of the fractures and is then pumped from the production well. After a period of operation a cavity develops between the boreholes as the halite between fractures is removed. Because of its lower density, fresh water injected into this cavity will rise to the top and dissolve halite from the roof of the cavity. As the brine density increases it sinks within the cavern and saturated brine is extracted from the production well.

Distribution

The DOE has conducted a survey of boreholes drilled within the Delaware Basin. This survey has identified eleven operating solution mining operations (Table 1). The distribution of these operations in New Mexico and Texas are shown on the accompanying map (Figure 1). Three active wells were identified within 4 miles (6.4 kilometers) of Carlsbad. These are all more than 20 miles (32 kilometers) from the WIPP site. In addition, there is one inactive, temporarily abandoned well near Carlsbad, and a permit has been filed to drill a brine well in Lea County (Section 32, Township 23 South, Range 33 East), about 14 miles (22 kilometers) southeast of the WIPP site. However, no drilling has yet taken place at this latter site. The permit is only valid until January 12, 1999, and the operator has indicated that the well will likely not be drilled. There are no pending applications for brine solution wells in Eddy or Lea County.

Table 1

ACTIVE BRINE WELLS IN THE DELAWARE BASIN			
Facility	**Operator**	**County/Location Description**	**BR Numbe**
Carlsbad	I & W	Eddy, 22S, 27E, Sec 24	BR 006
Carlsbad	Rowland Trucking	Eddy, 22S, 26E, Sec 36	BR 019
Carlsbad	Scurlock Permian Corp.	Eddy, 22S, 27E, Sec 23	BR 027
Orla	West Texas Water System	Loving/Blk 56, Twp 1, Sec. 30	BR 50030
Mentone	Herricks & Son	Loving/Blk 1	BR 50046
Barstow	Permian Brine Sales	Ward/Blk 34, NE of Barstow	BR 50022
Coyanosa	Permian Brine Sales	Reeves/Blk 7, Section 21	BR 50023
N. Pecos	Permian Brine Sales	Reeves/Blk 4	BR 50028
Peyote	Permian Brine Sales	Ward/Blk 16, Section 29	BR 50032
E. Mentone	Permian Brine Sales	Loving	BR 50062
N. Mentone	Permian Bine Sales	Loving	BR 50063

Figure 1 *(Not available).(7)*

Constraints

There are several constraints on the development of a solution mining operation:

(i) Availability of halite in sufficient amounts for economic extraction.

(ii) Availability of fresh water or dilute brine of appropriate quality and in sufficient quantities.

(iii) Convenient location with respect to drilling operations requiring brine, and to a suitable distribution network.

(iv) Absence of more valuable resources that would be damaged or otherwise lowered in value by solution mining.

The first of these constraints is satisfied throughout much of the Delaware Basin, where there are thick Permian evaporite deposits. In the region of the WIPP, the Salado and Castile Formations are both potential sources of halite.

The accompanying map of solution mining operations shows the importance of the second constraint. The majority of operations are situated along the Pecos River valley where shallow aquifers yield sufficient quantities of fresh water.

Oil and gas drilling operations in the Delaware Basin that are close to a suitable water supply are assumed to use locally-derived brine. Drilling operations remote from a suitable water source have two possible approaches to obtaining brine:

- Transport fresh water by tanker or pipeline to the site for solution mining.
- Transport brine by tanker or pipeline to the site for use in drilling muds.

The topography of the Delaware Basin is such that there are no major natural obstacles to transport either by road, rail, or pipeline. The decision on whether to transport fresh water or brine will depend on the relative economics of these approaches. Transport costs for fresh water and for brine are comparable on a mile by mile basis, so that the principal difference will be in the costs of solution mining. A specialized operation that can supply a large number of drilling operations will, in general, be more economic than a localized operation developed to service only a small group of wells. The majority of oil- and gas-drilling operations in the Delaware Basin obtain brine from specialized suppliers. Such specialized solution mining companies site their operations near suitable water supplies in order to reduce their transport, storage and development costs.

Surface drainage in the region of the WIPP is intermittent, and is expected to remain so even under conditions of increased precipitation. The nearest perennial stream is the Pecos River, 12 miles (19 kilometers) southwest of the WIPP site boundary. Shallow aquifers along the Pecos River valley provide sources of abundant fresh water for solution mining, and no changes in the distribution of these aquifers is expected. Specialized solution mining operations are therefore unlikely to be sited close to the WIPP site.

With respect to the constraint imposed by other resources, there are several places in the Delaware Basin where potash resources are found within formations that might otherwise be used for solution mining. Because of the value of these resources[2(8)], there are restrictions on the type of drilling activities that may be conducted within the potash enclaves. These restrictions apply to oil- and gas-drilling that is targeted at deeper formations. Solution mining in support of oil and gas drilling could remove or render unminable large volumes of potash above or alongside a solution cavity and would also be restricted while potash reserves remain.

Consequences of Solution Mining

Subsidence

Regardless of whether the single-borehole or two-borehole technique is used for solution mining, the result is a sub-surface cavity which could collapse and lead to subsidence of overlying strata. Gray (1991) quoted earlier analyses that show cavity stability is relatively high if the cavity has at least 50 feet of overburden per million cubic feet of cavity volume (26.9 meters per fifty thousand cubic meters). There are two studies - discussed below - of the size of solution mining cavities in the Carlsbad region. These studies concern the Carlsbad Eugenie Brine Wells and the Carlsbad Brine Well and show that neither of these cavities are currently close to this critical ratio, but that subsidence in the future, given continued brine extraction, is a possibility.

Hickerson (1991) considered the potential for subsidence resulting from operation of the Carlsbad Eugenie Brine wells, where fresh water is injected into a salt section at a depth of 583 feet (178 meters) and brine is recovered through a borehole at a depth of 587 feet (179 meters). The boreholes are 327 feet (100 meters) apart. Hickerson noted that the fresh water, being less dense than brine, tends to move upwards, causing the dissolution cavern to grow preferentially upwards. Thus, the dissolution cavern at the Carlsbad Eugenie Brine wells is approximately triangular in cross-section, being bounded by the top of the salt section and larger near the injection well. Hickerson estimated that brine production from 1979 until 1991 had created a cavern of about 3.4×10^6 cubic feet (9.6×10^4 cubic meters). The size of this cavern was estimated as 350 feet (107 meters) by 153 feet (47 meters) at the upper surface of the cavern with a depth of 127 feet (39 meters).

Gray (1991) investigated the potential for collapse and subsidence at the Carlsbad Brine Well. Based on estimated production rates between 1976 and 1991, approximately 3.4×10^6 cubic feet (9.6×10^4 cubic meters) of salt has been dissolved at this site. The well depth is 710 feet (216 meters) and thus there are about 210 feet of overburden per million cubic feet of capacity (112 meters of overburden per fifty thousand cubic meters of capacity).

Gray (1991) also estimated the time required for the cavity at the Carlsbad Brine Well to reach the critical ratio. At an average cavity growth rate of 2.25×10^5 cubic feet per year (6.4×10^3 cubic meters per year), a further 50 years of operation would be required before cavity stability was reduced to levels of concern. A similar calculation for the Carlsbad Eugenie Brine well, based on an overburden of 460 feet (140 meters) and an estimated average cavity growth rate of 2.8×10^5 cubic feet per year (7.9×10^3 cubic meters per year), shows that a further 15 years of operation is required before the cavity reaches the critical ratio.

Hydrogeological effects

In regions where solution mining takes place, the hydrogeology could be affected in a number ways:

- Subsidence above a large dissolution cavity could change the vertical and lateral hydraulic conductivity of overlying units.
- Extraction of fresh water from aquifers for solution mining could cause local changes in pressure gradients.
- Loss of injected fresh water or extracted brine to overlying units could cause local changes in pressure gradients.

The potential for subsidence to take place above solution mining operations in the region of Carlsbad is discussed above. Some subsidence could occur in the future if brine operations continue at existing wells. Resulting fracturing may change permeabilities locally in overlying formations. However, because of the restricted scale of the solution mining at a particular site, and the distances between such wells, such fracturing will have no significant effect on hydrogeology near the WIPP.

Solution mining operations in the Delaware Basin extract water from shallow aquifers so that, even if large drawdowns are permitted, the effects on the hydrogeology will be limited to a relatively small area around the operation. Since all the active operations are more than 20 miles from the WIPP, there will be no significant effects on the hydrogeology near the WIPP.

Discharge plans for solution mining operations typically include provision for annual mechanical integrity tests at one and one-half the normal operating pressure for four hours (OCD, 1994). Thus, the potential for loss of integrity and consequent leakage of freshwater or brine to overlying formations is low. If, despite these annual tests, large water losses did take place, from either injection or production wells, the result would be low brine yields and remedial actions would most likely be taken by the operators.

Geochemical effects

Solution mining operations could affect the geochemistry of surface or sub-surface water near the operation if there were brine leakage from storage tanks or production wells. Discharge plans for solution mining operations specify the measures to be taken to prevent leakage and to mitigate the effects of any that do take place. These measures include berms around tanks and annual mechanical integrity testing of wells (OCD, 1994). The potential for changes in geochemistry is therefore low, and any brine losses that did take place would be limited by remedial actions taken by the operator. In the event of leakage from a production well, the effect on geochemistry of overlying formation waters would be localized and, given the distance of such wells from the WIPP site, such leakage would have no significant effect on geochemistry near the WIPP.

Screening Analysis

Low probability

Brine production through solution mining has not taken place near the WIPP site, and there are no plans for wells in this area in the near future[3(9)]. The constraints upon the location of solution mining operations imposed by the availability of water indicate that there is a low probability of brine production through solution mining near the WIPP site in the near future.

Brine production through solution mining near the WIPP site can be eliminated from performance assessment calculations on the basis of low probability of occurrence in the vicinity of the disposal system.

Low consequence

Brine production through solution mining takes place in the Delaware Basin, and the DOE assumes it will continue in the near future.

Despite oil and gas exploration and production taking place in the vicinity of the WIPP site, the nearest operating solution mine is more than 20 miles from the WIPP site. The nearest permitted site is 14 miles from the WIPP site, but the operator has indicated that there are no plans to proceed with drilling at this site. These locations are too far from the WIPP site for any changes in hydrogeology or geochemistry, from subsidence or fresh water or brine leakage, to affect the performance of the disposal system. Thus, the effects of historical, current, and near-future solution mining in the Delaware Basin can be eliminated from performance assessment calculations on the basis of low consequence to the performance of the disposal system.

Consistent with 40 CFR §194.33(d) performance assessments need not analyze the effects of techniques used for resource recovery subsequent to the drilling of a borehole in the future[4(10)]. Therefore, future brine production from within and outside the controlled area has been eliminated from performance assessment calculations on regulatory grounds.

References

Gray, J.L., 1991. "Carlsbad Brine Well Collapse and Subsidence Investigation, Simon Environmental Services Project No. 502-939-01". Letter from J.L. Gray (Simon Environmental Services, Norman, Oklahoma) to W. Price (Unichem International Inc., Hobbs, New Mexico).

Hickerson, A.L., 1991. Letter from A.L. Hickerson (Odessa, Texas) to V. Pierce (B&E Inc., Carlsbad, New Mexico), April 12, 1991.

Hicks, T.W., 1997. "Solution Mining for Brine". Memo from T.W. Hicks (Galson Sciences Ltd., Oakham, UK) to P.N. Swift (Sandia National Laboratories, Albuquerque, New Mexico), March 7, 1997. Filed at II-H-24.

OCD, 1994 "Attachment to Discharge Plan BW-26 Approval Salado Brine Sales No. 3 Brine Facility Discharge Plan Requirements". Attachment to letter from W.J. LeMay, (Oil Conservation Division, Santa Fe, New Mexico) to W.H. Brininstool (Salado Brine Sales, Jal, New Mexico), January 12, 1994.

II-I-33: Performance Assessment parameter values identified in EPA letters to DOE dated April 17 and 25, 1997 - 6 June, 1997

To: Docket A-93-02

From: Mary Kruger

Re: Performance Assessment Parameter Values Identified in EPA Letters, Dated April 17 and.25, 1997, to DOE

In letters dated April 17 and 25, 1997(11), EPA informed the Department of Energy (DOE) of certain parameter values which must be incorporated in the EPA-mandated performance assessment test to be conducted by the Department. EPA has identified certain information in the April 17 letter that requires clarification. Also, in response to the April 25 letter, DOE has provided additional information regarding certain parameters. This note updates and clarifies the information provided in the April 17 and 25, 1997 letters, and, where pertinent, supersedes the information in those letters.

April 17, 1997 Letter

Enclosure 2 of the April 17 letter identifies the distribution type of parameter numbers 198 and 3184 as log uniform. Because the values provided in the letter are already in log units, the distribution should be uniform. The minimum and maximum values identified for these parameters remain the same; however, the median values for parameters 198 and 3184 should be changed to - 15.95 and - 13.65, respectively. EPA staff have informed DOE of this revision.

April 25, 1997 Letter

In response to the April 25, 1997 letter, DOE provided additional experimental data and calculations[1(12)]. Also, DOE/Sandia National Laboratories conducted additional calculations[2(13)]. EPA has reviewed these additional data and calculations and determined that, coupled with the original basis used by DOE to establish the CCA parameter values[3(14)], the values included in the October 29, 1996 Compliance Certification Application (CCA) for parameters 3405 and 3409 are considered to be representative.

In the April 25, 1997 letter, it was the Agency's intent to change the waste permeability parameter within the repository system. Changing parameter 3259 (BLOWOUT, APORO), a waste permeability parameter, was intended to accomplish this; however, parameter 3259 was not used in the performance assessment calculations. Instead, the waste permeability is incorporated via parameters 663 (WAS_ AREA, PRMX_ LOG) and 2131 (REPOSIT, PRMX_LOG). EPA staff have informed DOE that the values for parameters 663 and 2131 must be changed to 2.4 E-13 m^2, which is the value listed for parameter 3259 in the April 25, 1997 letter.

Based on information provided to EPA subsequent to the April 25, 1997 letter, the Agency has determined that it is appropriate to use the CCA value for the lower bound of the TAUFAIL parameter. In addition, the results of the expert panel on particle diameter should be used for creating and applying the remainder of the TAUFAIL distribution as indicated in the April 25 letter.

II-I-36:DOE response to EPA March 19, 1997 request for additional information about water flooding - 17 June, 1997

Department of Energy
Carlsbad Area Office
P.O. Box 3090
Carlsbad. New Mexico 88221
June 17, 1997
Mr. Larry Weinstock

U. S. Environmental Protection Agency
Office of Radiation and Indoor Air
401 M Street SW
Washington DC 20460

Subject: DOE Response to EPA Request for Additional Information about Water Flooding Dated March 19, 1997

Dear Mr. Weinstock:

The March 19, 1997 Environmental Protection Agency (EPA) letter (Trovato to Dials) requested additional information concerning. the Department of Energy (DOE) Compliance Certification Application (CCA). One of the requests specified that DOE perform additional analyses of the effect of near-future water flooding operations (conducted by the oil and gas industry) on the Waste Isolation Pilot Plant (WIPP) long-term performance.

DOE has recently completed these analyses and is transmitting the attached reports. As detailed in the accompanying analyses, DOE has concluded that water flooding should remain "screened out" of the Performance Assessment calculations.

The DOE believes that the attached will help EPA as it begins drafting. the proposed rule to certify the Waste Isolation Pilot Plant. If you have any questions about these responses, please contact me at (-505) 234-7300.

Sincerely,

George E. Dials
Manager

Attachment
cc: Mary Kruger

EPA Comment 21 - Enclosure 1, page 7 - 194.32(c)

Text of Comment

194.32(c)

Section 194.32(e) states that compliance application(s) shall include information which: (1) identifies all potential processes, events or sequences and combinations of processes and events that may occur during the regulatory time frame and may affect the disposal system: (2) identifies the processes, events or sequences and combinations of processes and events included in performance assessments; and (3) Documents why any processes. events or sequences and combinations of processes and events identified pursuant to paragraph (e)(1) of this section were not included in performance assessment results provided in any compliance application.

(1) The Stoelzel and O'Brien features, events and processes (FEP) analysis (Reference 61 1) provides information on how fluid injection may effect the disposal system. This approach does not appropriately model this event.

DOE needs to:

(a) Use a 150-year period as the period of simulation.

(b) Identify the extent to which the initial conditions (i.e., conditions before an intrusion Event) of the repository could change with the longer period of fluid injection.

(c) Analyze the effects of a human intrusion event subsequent to fluid reaching the repository via a fluid injection event.

(d) Increase the transmissivity of Bell Canyon to allow higher volumes of brine to be injected.

(e) Reduce, by one-half, the DRZ volume.

(f) Estimate the frequency of fluid injection wells that have failed or appear to have jailed.

(g) Substantiate why a two-dimensional cross-sectional modeling approach is appropriate for this analysis.

DOE Response

Two reports are attached that address the concerns raised in this comment. DOE (1997) presents a detailed description of current fluid injection practice in the WIPP region. Stoelzel and Swift (1997) document modeling studies of the effects of salt water disposal and waterflooding on the WIPP. These modeling studies supplement the analyses by Stoelzel and O'Brien (1996) that formed the basis for the screening decision used in the CCA.

DOE (1997) and Stoelzel and Swift (1997) address each of the specific concerns raised by the EPA in their comment. The EPA comments are repeated here, with a summary of how they have been addressed.

(a) Use a 150-year period as the period of simulation.

Analyses reported by Stoelzel and Swift simulate 10,000-year flow resulting from both 50- and 150-year periods of fluid injection.

(b) Identify the extent to which the initial conditions (i.e., conditions before an intrusion event of the repository could change with the longer period of fluid injection.

Analyses reported by Stoelzel and Swift show that conditions in the undisturbed repository are not affected by the longer period of fluid injection.

(c) Analyze the effects of a human intrusion event subsequent to fluid reaching the repository via a fluid injection event.

Analyses reported by Stoelzel and Swift show that, because conditions in the undisturbed repository are not affected by the longer period of fluid injection, the consequences of human intrusion into the repository will be the same with and without fluid injection.

(d) Increase the transmissivity of Bell Canyon to allow higher volumes of brine to be injected.

Stoelzel and Swift report results from model cases in which the permeability of the Bell Canyon Formation was increased by one order of magnitude. This change results in less leakage from the injection well reaching the Salado Formation, and Stoelzel and Swift therefore chose to base their conclusions on analyses using the same value of permeability used by Stoelzel and O'Brien (1996).

(e) Reduce, by one-half, the DRZ volume.

The cross-sectional model used by Stoelzel and Swift has a DR7- with approximately one- half the volume of the DRZ included in the Stoelzel and O'Brien (1996) model.

(f) Estimate the frequency of wells that have failed or appear to have failed.

The report by the DOE (1 997) on current fluid injection practice documents the frequency of injection well failure in the New Mexico portion of the Delaware Basin over the past 15 years.

(g) Substantiate why a two-dimensional cross-sectional modeling approach is appropriate for this analysis.

Stoelzel and Swift use both a cross-sectional model and an axisymmetric radial borehole model in their analysis. Brine flow away from the injection borehole in the Salado anhydrites is similar for both models.

References

DOE, 1997. "Injection Methods: Current Practices and Failure Rates in the Delaware Basin". DOE/WIPP97-2240, United States Department of Energy, Carlsbad Area Office. Carlsbad, NM. (Copy attached)

Stoelzel, D.M., and D.G. O'Brien. 1996. "The Effects of Salt Water Disposal and Water. flooding on WIPP", Summary Memo of Record for FEP NS-7a. Sandia

National Laboratories, Albuquerque, NM. WPO 40837. CCA Reference # 611.

Stoelzel, D.M., and P.N. Swift. 1997. "Supplementary Analyses of the Effects of Salt Water Disposal and Waterflooding on the WIPP", Sandia National Laboratories, Albuquerque, NM. WPO 44158. (Copy attached)

Attachment 1 - "Injection Methods: Current Practices and Failure Rates in the Delaware Basin". DOE/WIPP97-2240, June, 1997.

Text not available. Filed at II-G-25.

Attachment 2 - Technical Review by Swift et al. of "The HARTMAN Scenario: Implications for the WIPP" by J. Bredehoeft" - June 13, 1997 (includes "Supplementary Analyses of the Effects of Salt Water Disposal and Waterflooding on the WIPP" by D.M. Stoelzel and P.N. Swift.

Text not available. Filed at II-G-25.

II-G-25: Expedited CCA Activity: Supplementary Analyses of the Effects of Salt Water Disposal and Waterflooding on the WIPP - June, 1997

Text not available.

Endnotes

1 (Popup - Popup)

The DOE's initial response to this request at II-I-24 was subsequently revised at II-I-28.

2 (Popup - Popup)

The DOE's initial response to this request at II-I-24 was subsequently revised at II-I-28.

3 (Popup - Table/Figure)

An electronic version of this table or figure is not available.

4 (Popup - Table7-5/6-Note1)

1. Values less than 10^{-18} curies per liter were considered to be negligible relative to the other values and were not reported.

5 (Popup - Table7-5/6-Note1)

1. Values less than 10^{-18} curies per liter were considered to be negligible relative to the other values and were not reported.

6 (Popup - Popup)

[1] In 40 CFR Part 194, the Delaware Basin means those surface and subsurface features which lie inside the boundary formed to the north, east and west of the disposal system by the innermost edge of the Capitan Reef, and formed, to the south, by a straight line drawn from the southeastern point of the Davis Mountains to the most southwestern point of the Glass Mountains.

7 (Popup - Popup)

An electronic version of this figure is not available.

8 (Popup - Popup)

[2] Potash mining in Eddy and Lea Counties, New Mexico produced 83 percent of the nation's domestic potash in 1992

9 (Popup - Popup)

[3] Near-future human activities are those activities that may be expected to occur based on existing plans and leases. The DOE assumes that all such activities will occur and will continue until their completion, potentially at some time after disposal.

10 (Popup - Popup)

[4] Future human activities are those that occur within or outside the controlled area subsequent to repository closure, for which there are no existing plans and leases.

11 (Popup - April 17 and 25)

Letter dated April 17, 1997

Letter dated April 25, 1997

12 (Popup - Popup)

[1] WPO44625, *Actinide Stability/Solubility in Simulated WIPP Brines,* Reed, Donald T. and David G. Wygmans , 3/21/97 Interim Report.

13 (Popup - Popup)

[2] WPO451 1 *5, U(V1) Solubility Calculation, Performance of Uranium (VI) Solubility Predictions for EPA*, Bynum, R.V., and Y. Wang, 5/6/97.

14 (Popup - Popup)

[3] WPO36488, *Analysis of Uranium (V1) Solubility Data for WIPP Performance Assessment: Implementation of Analysis Plan AP-028,* Hobart, D. E. and R. C. Moore.