PEER 25 - Technical Support Group Review

TECHNICAL SUPPORT GROUP REVIEW OF EXPERIMENTAL PLAN FOR TRACER-TESTING IN THE CULEBRA DOLOMITE

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February 22, 1993

Mr. W. John Arthur, III
Project Director
WIPP Project Integration Office
6501 Americas Parkway, Suite 903
Albuquerque, NM 87110

M

Attn: Patrick Higgins, WPIO
Mark Matthews, WPIO
Ravi Batra, WPSO

Re: Transmittal of the Technical Support Groups' Report of Findings on Culebra Tracer Testing

Dear Mr. Arthur:

The Technical Support Group (TSG) was tasked to provide the WPIO Configuration Control Board with recommendations that could facilitate a decision on funding of the SNL proposed Experimental Plan for Tracer Testing in the Culebra Dolomite at the WIPP Site, dated October 15, 1992. Enclosed are four copies of the Technical Support Group Report on Culebra Tracer Testing.

The report is specific to the questions that were asked of the TSG. However, there are several significant issues that were identified during the course of the TSG's analysis of the proposed test plan that are of concern to the TSG. In the interest of expediting the subject report, the TSG will prepare a separate follow on letter report that addresses the additional concerns. The letter report will be to you by the end of February.

The recommendations from the TSG are:

1. The types of tests outlined in the reviewed test plan are helpful in resolving the hydrogeologic characterization of the Culebra. However, the test plan should be augmented to present a program that addresses a broader set of issues than the preliminary version does. This augmented plan should also address cost and schedule optimization for the program outlined in the revised plan. The "final" test plan is currently scheduled for completion in September 1993. The TSG recommends the technical questions listed below, at a minimum, be addressed in the final plan.

   A. How will the tests discriminate among candidate conceptual flow models and serve to validate the appropriate choice or combination of choices for the Culebra?

   B. How will the question of "scale-up" of the field flow results to a grid size that matches the grid utilized in performance assessment be approached?

   C. What is the basis for location of the test site(s) and, if preliminary drilling is deemed advantageous, where precisely will it be done and why was that site chosen?

   D. Is it desirable to incorporate existing pumping test data that may not have been analyzed or that require additional interpretation to better define the flow field? If so, what is required to incorporate those data into current analysis?

   E. What drilling procedures will be used to ensure that core and water samples can be obtained that are suitable for laboratory analysis?

   F. How are the laboratory retardation results to be scaled-up and correlated with field retardation results? How will the results be further scaled-up to the performance assessment grid size?

   G. How will all the results be incorporated into performance assessment and how does the experimental schedule mesh with performance assessment schedule commitments?

H. What is the relative importance of each of the experimental objectives (e.g., rank them); and how do each of these objectives contribute to compliance demonstration?

I. How will the experimental data be used to draw conclusions that are valid for the entire regulatory period (10,000 years)?

J. What is the statistical basis for selecting samples utilized in determining the values for the coefficients (elements) of retardation? How will the mechanisms creating retardation be established? Why is the range of geochemistries investigated adequate to bound the conditions that might occur throughout the regulatory period?

K. What tests and methodology will be utilized to resolve the effect of the numerous wells to the south of the site on the present and long term flow field?

2. The apparent disconnect between performance assessment and the experimental program must be resolved. DOE will be judged on the conceptual model, data supporting that model, and resulting calculations. Two specific suggestions for improvement are:

A. Formal procedures could be developed to ensure that the experimental program supports performance assessment data needs and that the performance assessment model reflects experimental understanding. One implication here is that the experimentalist may develop a much greater interest in participating in finalization of the performance assessment conceptual and mathematical models. A question to be considered is who is responsible for defending the results presented by the performance assessment group?

B. SNL should consider instituting some process that ensures communication between the data generation groups and Performance Assessment. A major objective of the process would be to define the data and model elements necessary to provide sufficient resolution of the regional hydrology to support a preferred baseline case for describing the present hydrological condition.

Please do not hesitate to contact me at (505) 845-6321 or Dave Lechel at (505) 845-6290 with any questions you may have concerning this report.

Sincerely,

Kelly M. Peil

for John A. Thies
Project Manager

cc:
G. Hanson
D. Lechel
B. Root
D. Sala
B. Farrell

Technical Support Groups'
Report of Findings
on
Culebra Tracer Testing

Issue

The WIPP Project Integration Office (WPIO) Change Control Board (CCB) requested the Technical Support Group (TSG) to provide recommendations in support of a decision on partial funding of an $8 million plan for a new set of tracer tests in the Culebra Dolomite Member of the Rustler Formation.

Importance

Human intrusion scenarios, which presume future inadvertent drilling activity intercepts an underlying pressurized brine reservoir and/or the repository, have focused on the Culebra Member of the Rustler Formation as the final barrier in the potential pathway to the 40 CFR 191 Subpart B subsurface compliance boundary. A determination of the effectiveness of the Culebra as a geologic barrier to radionuclide transport is therefore important in demonstrating compliance with this regulation. A sound technical position must be prepared if the U. S. Environmental Protection Agency (EPA) is to accept a U. S. Department of Energy (DOE) position that the Culebra is a natural geologic barrier to the release of radionuclides. The data to be collected from the proposed Culebra Tracer Tests will provide additional information that will be useful in demonstrating the effectiveness of the Culebra barrier. The unresolved issue is whether the proposed additional tests will lead to a successful defense of the radionuclide transport retardation affects included in the performance assessment (PA) model. The objectives of the test program should align with the reduction in uncertainty necessary for validation of the conceptual model, mathematical model and sensitive parameter ranges utilized to predict radionuclide transport.

Scope of Evaluation

The questions to be answered are as follows:
(1) Are additional experiments for fluid flow and transport characterization of the Culebra necessary? If additional testing is necessary, (2) will the planned Culebra Tracer Tests, as described in the proposed test plan, provide a final additional set of data that can be used to establish that the Culebra retards radionuclide transport to the degree necessary to demonstrate the Culebra is an effective geologic barrier? This report is specific to resolving these questions.

Conclusions

In response to the two questions stated above. the TSG concludes that additional characterization of the Culebra is necessary but that the preliminary "Experimental Plan for Tracer Testing in the Culebra Dolomite at the WIPP Site", dated October 15, 1992, will not provide a final (comprehensive) set of data. The experimental plan needs substantive modification and refinement. Revisions to this plan (and/or a governing experimental plan of which this specific test plan is a subset) should support an objective of developing a comprehensive set of data that will fulfill all the data requirements for model selection and validation. An important consideration is that the National Academy of Sciences (NAS) has cautioned, in the September and December 1992 meetings, that the proposed Culebra Tracer Tests may not substantially contribute to the overall reduction of an already high uncertainty level. The task confronting the WIPP Project is to define an integrated experimental program that will reduce the uncertainty to acceptable levels or, at least, quickly identify critical performance assessment parameters whose uncertainties will not be reduced to acceptable levels by the planned experiments. Specific TSG conclusions with brief supporting rationale follow:

1. Retardation in the Culebra: Experimentally derived fluid flow velocities indicate fairly rapid movement of fluid to the compliance boundary relative to the regulatory period. Therefore, the Culebra cannot be assumed to be a major barrier to radionuclide transport if retardation is not demonstrated to the satisfaction of the regulatory agencies. An experimental determination of chemical (primarily) and physical retardation is vital to establishing robust evidence that the Culebra is an effective geologic barrier. This must be done in the laboratory with corroboration in the field.

   Summary Rationale: Experimental determination of distribution coefficients (K_d's) is required to establish a conservative range of values for each element of retardation. In fact, DOE has agreed with the State of New Mexico in the Consultation and Cooperation Agreement that, "in the absence of experimentally justifiable values, K_d will equal zero, e.g., no credit for retardation will be taken in the performance assessment calculations". Current field experimental data support estimated fluid flow velocities in the range of 1 meter per day to 1 meter per year. In meetings with the TSG, Sandia National Laboratory (SNL) scientists agreed that the estimated flow velocities, when integrated over the general flow path from the storage panel area to the vertical compliance boundary, translate to fluid arrival times at the subsurface compliance boundary that generally range from 100 to 1,000 years. This is an indication that flow time alone cannot be relied upon to ensure compliance. However, additional phenomena act to reduce the concentrations of radionuclides reaching the boundary. These concentrations will be diluted (at least initially) by chemical and pressure gradient diffusion into the relatively static fluid volume (currently assumed to be about 100 times larger than the dynamic fluid volume) contained in the nonconductive pores of the rock matrix. This dilution, or physical retardation, delays the time it takes to accumulate a total release that may exceed the 40 CFR 191 Subpart B standard, although the delay in some scenarios may be substantial. Compliance may be assumed if very long-term or permanent chemical retention of the radionuclides in the rock matrix can be shown. Chemical bonding with the host rock and/or filler materials (generally clay) would ensure long-term retention. However, the degree to which this chemical retention occurs has not been established experimentally, which remains as a potential breach of the previous agreement with the State until these experiments are completed.

2. Flow in the Culebra: Additional characterization of the Culebra will enhance the basis for establishing a representative hydrologic model. Selection of a model type that adequately represents all the observations is an important element of compliance demonstration. Care should be exercised to not bias the approach for differentiating between flow model types, especially in light of the strongly held view that dual porosity is the correct model type.

   Summary Rationale: In addition to the retardation, uncertainties still exist with other fundamental issues. These issues include identification of the physical characteristics of the pathways (e.g., layers, channels, fractures, connection of fractures with matrix porosity). For example, there is general agreement within SNL that the Culebra is a layered member, but layering has not been directly incorporated into the model. In another example, INTRAVAL has suggested a conceptual flow model based entirely on channeling also will produce an acceptable fit to the current data; but current modeling utilizes a dual porosity concept instead. The implication is that if only channel flow is occurring the retardation will be considerably reduced. The inability to convincingly answer such questions indicates an incomplete understanding of the flow regime. A well characterized flow regime is necessary to the establishment of acceptable retardation values.

3. Integration of the Performance Assessment and Experimental Programs: As an addendum to these technical conclusions, the TSG notes a lack of integration of the experimental program and the performance assessment group. This is a concern in that it affects the Project's chances of reaching a sound scientific basis for compliance. Finding ways of fostering closer integration, or at least more effective cooperation, would greatly enhance the quality and defensibility of the resulting performance assessment; and therefore is an integral part of rectifying the technical issues addressed in this report.

Recommendations

The TSG review of the "preliminary" Culebra Tracer Test Plan and meetings with SNL staff culminated in the following recommendations. These recommendations will aid in promoting both a comprehensive experimental test program and a broad-based compliance strategy.

1. The types of tests outlined in the reviewed experimental plan are helpful in resolving the hydrogeologic characterization of the Culebra. However, the plan should be augmented to present a program that addresses a broader set of issues than the preliminary version. This augmented plan should also address cost and schedule optimization for the program outlined in the revised plan. This "final" test plan is currently scheduled for completion in September 1993. The TSG recommends the technical questions listed below, at a minimum, be addressed in the final plan.

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A. How will the tests discriminate among candidate conceptual flow models and serve to validate the appropriate choice or combination of choices for the Culebra?

B. How will the question of "scale-up" of the field flow results to a grid size that matches the grid utilized in performance assessment be approached?

C. What is the basis for location of the test site(s) and, if preliminary drilling is deemed advantageous, where precisely will it be done and why was that site chosen?

D. Is it desirable to incorporate existing pumping test data that may not have been analyzed or that require additional interpretation to better define the flow field? If so, what is required to incorporate those data into current analysis?

E. What drilling procedures will be used to ensure that core and water samples can be obtained that are suitable for laboratory analysis?

F. How are the laboratory retardation results to be scaled-up and correlated with field retardation results? How will the results be further scaled-up to the performance assessment grid size?

G. How will all the results be incorporated into performance assessment; and how does the experimental schedule mesh with performance assessment schedule commitments?

H. What is the relative importance of each of the experimental objectives (e.g., rank them); and how do each of these objectives contribute to compliance demonstration?

I. How will the experimental data be used to draw conclusions that are valid for the entire regulatory period (10,000 years)?

J. What is the statistical basis for selecting samples utilized in determining the values for the coefficients (elements) of retardation? How will the mechanisms creating retardation be established? Why the range of geochemistries investigated is adequate to bound the conditions that might occur throughout the regulatory period?

K. What tests and methodology will be utilized to resolve the effect of the numerous wells to the south of the site on the present and long term flow field?

The term "comprehensive" could be substituted for the term "final" used in this report to describe the desired status for the data to be generated from the proposed test program. The important message is that reactionary experimental testing often leads to additional unplanned testing programs. DOE can not afford to be dependent on a test plan that does not address all of the issues or potential issues related to validating a representative flow model. Within the bounds of current knowledge, this test plan must encompass collection of all the data that will be required for validation. In this sense "final" means there is a high level of certainty that unplanned tests will not be required after the proposed tests are concluded.

2. The apparent disconnect between performance assessment and the experimental program must be resolved. DOE will be judged on the conceptual model, data supporting that model, and resulting calculations. Two specific recommendations for improvement are:

   A. Formal procedures should be developed to ensure that the experimental program supports performance assessment data needs and that the performance assessment model reflects experimental understanding. One implication here is that the experimentalist may develop a much greater interest in participating in finalization of the performance assessment conceptual and mathematical models. A question to be considered is who is responsible for defending the results presented by the performance assessment group?

   B. SNL should consider forming a hydrogeology intergroup team or instituting some other process that ensures communication between groups. A major objective of this interactive team would be to define the data and model elements necessary to provide sufficient resolution of the regional hydrology to support a preferred baseline case for describing the present hydrological condition.

Background Observations and Analysis

During this review process, the importance of the national and international scientific interchange sponsored by SNL has become apparent. This interchange has resulted in the identification of issues that need to be addressed by the experimental and performance assessment programs. The SNL initiative to institute the proposed Culebra testing seems to be partially in response to this influential scientific community.

In a joint meeting with SNL performance assessment and experimental program staff, agreement was reached that estimated water flow rates within the WIPP site are bounded by a range of 1 meter per day to 1 meter per year. This estimated range is based on fracture flow. It is generally agreed that the flow over the storage panels will be in an south-easterly direction until it intersects a much higher transmissivity zone with flow to the site boundary in a southerly direction. In a later meeting with the experimental program group, there was agreement that the integration of these variations in flow rates from the storage panels to the site boundary will not exceed an aggregate flow time of 1,000 years and could be as low as 100 years. This conclusion is in apparent disagreement with travel times published in the working draft 1992 Performance Assessment Report (9,000 to 14,000 years).

Features of the present flow system in the Culebra suggest a possible relationship with the oil and gas wells located south of the WIPP site. These features include (1) an anomalous flow direction (south) which is not the direction of the slope of the topography as is the usual case, (2) closed potentiometric depressions to the south that suggest vertical loss of water, and (3) low hydraulic head in the Culebra with respect to the Magenta above the Rustler-Salado Residuum below. The features could be explained by depletion of hydraulic head in the Culebra in the vicinity of the oil and gas wells resulting from vertical leakage between the Culebra and pressure-depleted petroleum production horizons. Consequently, the flow system may change after oil and gas production cease.

The SNL performance assessment report for 1991 discusses recharge and discharge in Volume 1, pages 5-32 to 5-34. This discussion states that "There is no direct evidence for the location of either recharge to or discharge from the Culebra Dolomite" and that "small amounts of inflow may also occur as leakage from overlying units throughout the region." Quantifying this vertical leakage is important because it may have a substantial effect on dilution of any contaminant that enters the Culebra. Note that Figures 5-13 and 5-14 show a hydraulic head difference between the Magenta and Culebra of 45 feet (959-914 at the southeast corner of the WIPP site). These units are separated by the Tamarisk, which has an average thickness of 118 feet at the WIPP (p. 5-16). Thus the vertical hydraulic gradient is about 0.38 ft/ft. If the vertical hydraulic conductivity of the Tamarisk were 10^{-12} m/s (which seems possible), crude Darcy calculations show that most of the flow in the Culebra would be coming from vertical seepage. Furthermore, the head in the Rustler-Salado Residuum is also considerably higher than the head in the Culebra, suggesting the possibility of upward flow as well. These considerations do not prove that vertical recharge to the Culebra is significant, but suggest that it might be and that it is worthy of investigation. Also note that the low head in the Culebra relative to units above and below is consistent with depletion of head in the Culebra by leakage around oil and gas well casings to the south. If the oil and gas wells are affecting head in the Culebra, vertical leakage may change in the future if the effect of the wells changes.

INTRAVAL has suggested that a channel flow model be considered as an alternative to the dual porosity model now used to describe the Culebra. This channel model could possibly result in much less matrix contribution to retardation than is currently assumed. Either the existence of channel flow needs to be shown to be minimal (on the scale of the performance assessment model) or it needs to be shown that the channel flow and matrix retardation are both occurring and not mutually exclusive. It is unlikely that the system operates as a single porosity system because it is already known from examination of the cores that the matrix is porous and has interconnecting fractures. It is reasonable to attempt to demonstrate by field testing that the system is dual porosity and to quantify the effect of clay fracture linings in answer to the INTRAVAL suggestion. Otherwise, the regulatory agencies may require testing at a late stage of the permitting process.

There are large zones within the regional hydrologic model that have not been well characterized with data, but only modeled by Kriging techniques. An example is the zone south of the repository along the most direct geometric path to the vertical compliance boundary. The Environmental Evaluation Group (EEG) has suggested that a well be placed in this zone. The NAS WIPP panel made the same observation in the December 1992, meeting in Albuquerque. The TSG adds emphasis by reaching the same conclusion. A final set of data should include tests (even if simple) to obtain hydrologic parameters in one or more of the regions that have not been investigated.

There is a prevailing view within SNL that the probabilistic analysis currently used in performance assessment to define the range of possible transport paths and transport times adequately bound the hydrogeologic regime over the range of time required (10,000 years). That may not be true because of scale dependencies not yet accounted for and differences in hydrologic and chemical behavior not yet explained.

Several clauses in the "1988 Modification to the Working Agreement of the Consultation and Cooperation Between Department of Energy and the State of New Mexico on the Waste Isolation Pilot Plant" have special relevance to the hydrological mapping of the Culebra and to the determination of transport retardation factors. Quotes from one clause are "Development of a generalized three-dimensional regional flow model extending from the ground surface to the Bell Canyon Formation. Care will be taken that, over the long term, geologic and modeling expertise and interpretations developed as part of WIPP site-characterization activities are included in such modeling." Quotes from a second clause are "DOE recognizes that radionuclide retardation within the Culebra remains to be proven experimentally and remains committed to demonstrate experimentally the actual range of K_d's to be expected for transport within the Culebra. It is unlikely that transport will involve a single set of K_d values, and performance assessment likely must consider a range of values for each element. DOE will select, after consultation with the State, a range of values to be conservative, but reasonable, based on the lowest reasonable values experimentally obtained. In the absence of experimentally justifiable values, K_d will equal zero, i.e., no credit for retardation will be taken in the performance assessment calculations."

One of the major objectives of the Culebra Tracer Tests is to collect enough retardation data to satisfy the Consultation and Cooperation Agreement with the State of New Mexico. This agreement stipulates, as stated above, that the flow model's radionuclide distribution coefficients must be set to zero until a defensible value has been established experimentally. The planned tests (including the laboratory phase) can provide a valuable set of data. However, additional data from other zones will probably be required.

Despite the uncertainty in the overall model, SNL experimental staff state that physical and chemical retardation of the radionuclides will occur and will provide a very large reduction to total release. This opinion contrasts with some NAS WIPP panel members' comments in the quarterly meetings with WIPP that DOE will not be able to take credit for chemical retardation ("You will have to set the K_d coefficients to zero").

Assuming chemical retardation is important, the hydrogeology over the storage panels should be known with a greater degree of certainty than the higher transmissivity zones to the east. If retardation is demonstrated, most of the retardation should occur in the region above the repository since this is the first region to be exposed. Also the low transmissivity of this region means the brine resides in this region much longer than in the faster flow zones to the east. The TSG designated this region as the "local zone" in our internal discussions because of the relative importance this zone attains if retardation is necessary to demonstrate compliance. Current plans do not include additional characterization of this zone.

The objectives of the Tracer Tests, as described by the SNL staff planning them, are to provide evidence for a matrix retardation component and to further characterize the flow regime in the highest known conductivity path to the boundary. These objectives are important and will contribute to a final resolution. The printed objective of proving or disproving channel flow, although directly related to these real objectives and interesting from a scientific view, is not the basic objective. The basic objective should be to establish a modeling approach that provides a representative description of the Culebra flow.

An important aspect of the proposed field testing is to provide high quality core and fluid samples for laboratory testing. This aspect has not been fully stated and incorporated into the experimental plan.

A recurring question is whether or not credit for physical or chemical retardation of radionuclide transport within the Culebra is even necessary to compliance arguments because compliance might be proven without reliance on the retardation provided by the Culebra. Dr. Wendell Weart pointed out to the TSG that viewing the Culebra, as an additional potential geologic barrier, serves an important role of increasing the confidence in demonstration of regulatory compliance. Even if the additional barrier is not needed or an exact value cannot be put on the effect of the barrier, this is a compelling argument. Dr. Weart's point is valid even if radionuclide retardation within the Culebra aquifer is not needed to demonstrate compliance.

Future changes in the hydrogeology that are a result of climate changes, etc. do not appear to be sufficiently developed in current performance assessment analysis. A major focus has been to predict transport pathways and transport times based on best-fit transmissivity zones that satisfy the observed hydrological response in existing wells. This means that possible future conditions have to be applied to a maze of best fit transmissivity zones since the baseline definition consists of multiple best fit cases.

№ 5077 –

WTAC

Waste Isolation Pilot Plant
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December 22, 1993

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WPIO

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

Attn: Patrick J. Higgins, Branch Chief, EPB, CAO/AL

Re: Technical Support Group's Report of Findings for the Performance Assessment Parameter List

Dear Mr. Dials:

I am pleased to submit the Technical Support Group's (TSG) Report of Findings for the Performance Assessment (PA) Parameter List. The TSG has conducted a detailed review of many of the parameters that form the basis for the PA calculations for the WIPP Project. This effort emphasized the key 49 PA parameters that were sampled in the 1992 PA calculations, and, as time permitted, included a preliminary review of an additional 80 parameters. Data type, data quality, data interpretation, and source documentation were evaluated and each reviewer categorized the data based on their professional judgment. A database called PERFORM was developed to help in the management of the reviews.

The results indicate that the documentation is inadequate for many parameters and a considerable effort will be needed to assemble the documentation necessary to defend the PA parameters. To that end, the TSG recommends that the TSG work with Sandia National Laboratories (SNL/NM) to revise, update, and document as necessary the key 49 PA parameters. The TSG also recommends that it review, revise, and update the remaining PA parameters. The PERFORM database has been very useful in conducting the reviews and the TSG recommends that it continue to be used to manage the large amount of information involved in the review process.

If you have any questions or comments regarding this review, please contact me at 845-6321 or Steve Alcorn at 845-5918.

Sincerely,

Marilyn Baich

John A. Thies
Project Manager

Enclosure

cc w/enclosure:
G. Dials, CAO
J. Coffey, CAO/AL
D. Ofte, WTAC
J. Schatz, WTAC
P. Drez, WTAC
R. Root, WTAC
D. Lechel, WTAC
J. Kircher, WTAC
D. Bretzke, WTAC
TSG Files (2)(to R. Root)
CAO/AL RRA
WTAC-ABQ r/f

cc w/o enclosure:
S. Alcorn, WTAC
L. Eriksson, WTAC
D. Dunn, WTAC/ASI-DN
R. Zeiler, WTAC/ASI-DN
D. Dennison, WTAC/ASI-DN
P. Cloke, WTAC/SAIC
WTAC-CBD r/f
WTAC r/f

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THE TECHNICAL SUPPORT GROUP'S

REPORT OF FINDINGS

FOR THE

PERFORMANCE ASSESSMENT PARAMETER LIST

December 1993

TSG Approval:

Paul E. Drez

John F. Schatz

Steve R. Alcorn

Robert A. Root

THE TECHNICAL SUPPORT GROUP'S REPORT OF FINDINGS FOR THE PERFORMANCE ASSESSMENT PARAMETER LIST

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Issue

More than 300 parameters have been used by Sandia National Laboratories, New Mexico (SNL/NM) for Waste Isolation Pilot Plant (WIPP) performance assessment (PA) calculations. In the most recent 1992 PA calculations, the distributions of the key 49 PA parameters were sampled for use in PA and the remaining were used as constants. Documentation of the sources of these parameter values, their ranges, and their distribution types has been assembled in Preliminary Performance Assessment for the Waste Isolation Pilot Plant, December 1992 Volume 3: Model Parameters (SNL/NM, 1992). In anticipation of eventual regulatory evaluation, there is a need to confirm the quality and completeness of source data and interpretation through an independent review of the PA parameters. The purpose of the Technical Support Group (TSG) review is to ensure that all PA parameters have been adequately documented and are suitable for use in the WIPP PA.

Significance of Issue

The robustness of the PA parameters is crucial because they are used as input to the PA calculations, which are used to assess the long-term performance of the repository. Project records must be adequate to defend the pedigree of each parameter, which means that the source of each parameter must be either solidly anchored in the scientific literature or that the basis for the parameter must be established through experimental data or some other justifiable means.

Approach

An informal check of PA parameter information revealed several gaps in the availability of source data and inconsistencies in interpretations. This check convinced the TSG that some parameter information is not adequate to defend the PA parameters during a regulatory evaluation. Therefore, work was undertaken to provide a new and concise parameter database and associated investigations of parameter values, ranges, and distributions for data quality, interpretation quality, and documentation completeness. The results of that work are reported here. The effort to date has emphasized the key 49 parameters sampled in 1992 PA calculations. In addition, other parameters have undergone a preliminary review.

Several guidelines applied to this work: (1) to review PA parameters only, and not the computational models in which they are used; (2) to avoid reviewer bias by having each reviewer evaluate and draw conclusions independently; (3) to gather information from and interact directly with SNL/NM; (4) to avoid duplication of effort by interacting with the U.S.

Department of Energy (DOE) Headquarters (HQ) Performance Assessment Review Team (PART); and (5) to focus on providing recommendations that further the attainment of regulatory compliance.

A database, called PERFORM, was developed as a management tool to facilitate the organization of the parameters and to document reviewer comments. The PERFORM database was designed to be user friendly and provide an easy way to find the name, value, range, distribution, and pertinent documentation of each parameter as well as to record reviewer comments.

Reviewers with relevant expertise (see Appendix for names, affiliations, and areas of expertise) evaluated the PA parameter values, ranges, and distributions for quality and completeness of data, interpretation, and documentation. Summary judgments and review comments were entered directly into the database. Each reviewer was asked to assume the role of a hypothetical regulator, with emphasis on the following:

- Values, ranges, or distributions that are incompletely documented.
- Data or interpretations that are considered of low or questionable quality.
- Data that are not sufficiently relevant to WIPP.

Where difficulties with the data were found, reviewers were asked to provide suggestions for resolution.

Scope of Evaluation

For this review, the report by SNL/NM (1992), which describes the PA model parameters, was used as the primary source of information on parameters, and it was assumed that this report contained all of the values, ranges, and distributions used in the 1992 PA calculations. This report also served as the basis for further literature searches, and all references cited in it were reviewed. Only published sources of information such as SNL/NM reports, articles in professional journals, and published meeting proceedings were used for this evaluation. All documents used by the reviewers are listed in the PERFORM database.

Table 1 lists the key 49 PA parameters that were reviewed. These parameters were sampled and used in 1992 PA (SNL/NM, 1992). Table 2 lists reviewed parameters that were used in the 1992 PA as constants. The review results for non-sampled parameters are preliminary, but are included to provide useful general information. The parameter names used in this report are taken from an SNL/NM internal database called REF_TRACK, which was compiled for the purpose of finding possible errors in references (Rechard, 1993). In cases where these names are different from those in SNL/NM (1992), the equivalent name can be found by referring to the document page given in the PERFORM database.

Reviewers examined the available PA parameter information for compliance determination suitability from the perspective of a regulatory agency. However, this review was not intended to replace or update the information and expertise originally used by SNL/NM to develop and implement the PA parameters. Instead, the reviewers were tasked to find problems in quality or documentation based solely on what was found in the documentation and references cited and to suggest approaches to solving these problems.

Each reviewer was directed to do the following:

1. **Review parameters within their field(s) of expertise.**
   Reviewers were to read the relevant documentation for each parameter chosen. Emphasis was to be placed on the key 49 parameters sampled in 1992, and, as time allowed, other parameters that are closely related to those sampled were to be reviewed.

2. **Assign each parameter to judgment categories.**
   Reviewers were to assign each parameter to the judgment categories provided in the areas of Data Type, Data Quality, Data Interpretation, and Source Documentation. Examples are "acceptable," "unacceptable," and "needs work." These categories are introduced and explained below.

3. **Explain judgments and make recommendations.**
   Reviewers were to explain judgments and recommend specific solutions in the areas of parameter values, ranges, and distributions. Reviewer comments were to be documented on a signed/dated hard copy of their comments. An example of signed-off reviewer comments is presented on Figure 1.

Reviewers were instructed to act independently. That is, each reviewer was to work alone in forming their judgments, except where help was required in locating source materials.

The use of parameter judgment categories allowed a succinct summary of all reviewers' work to be entered into the database. A definition of each judgment category is presented in Table 3. Comments supporting reviewers' judgments are documented in the database in the categories of Parameter Value, Parameter Range, Parameter Distribution, and General Comments.

Summary of Findings

Each of the key 49 parameters sampled in the 1992 PA documentation was reviewed, 46 of them by two or more reviewers. Eighty non-sampled parameters were also reviewed, 40 of these by two or more reviewers. Results for the key 49 sampled parameters are presented in Table 4; results for the non-sampled parameters are presented in Table 5.

The column labelled "Overall Standing" on these tables provides an assessment of the completeness of the documentation for each parameter. Each parameter is rated as either excellent, needs some work, or needs significant work. The overall standing is a subjective rating determined by John Schatz, the principal author of this Report of Findings. The ratings indicate which parameters appear to be defendable in a regulatory setting (rated "excellent") and the degree of work anticipated to bring the others up to a rating of "excellent."

Data Type. Table 6 summarizes the results for Data Type for the key 49 parameters and for all the parameters reviewed (key 49 parameters + 80 additional parameters). The results indicate that only 20 of the key 49 parameters were judged to be based on an "unjustified assumption" or have an "unknown source" by one or more reviewer. For 5 of the key 49 parameters, two or more reviewers concurred on this judgment. However, this low level of agreement suggests that some of the "unjustified assumption" listings can be fixed by better identification of information sources.

Data Quality. For Data Quality, 24 of the key 49 parameters were found to be "unacceptable" by one or more reviewer; however, two or more reviewers concurred on 10 of the key 49 parameters. Concurrence by reviewers on this unfavorable category occurs more frequently for Data Quality than for Data Type. Where reviewers failed to concur, generally one reviewer chose "unacceptable," while another chose "needs work," reflecting a difference of opinion regarding unacceptability for this category.

Data Interpretation. For Data Interpretation, 18 of the key 49 parameters were found to be "unacceptable" by one or more reviewer. Two or more reviewers concurred on only one parameter. This low level of concurrence indicates considerable overlap between the "unacceptable" and "needs work" categories, a stronger difference of opinion among reviewers than for the other categories.

Source Documentation. For Source Documentation, 32 of the key 49 parameters were found to be "incomplete" by one or more reviewer. For 27 of the key 49 parameters, two or more reviewers concurred. Concurrence occurs for Source Documentation more frequently than for any of the other categories, indicating general agreement among reviewers in cases where documentation could not be found.

Overall Standing. For Overall Standing of the key 49 parameters, 32 were "needs significant work," 13 were "needs some work," and 4 were "excellent."

Conclusions and Recommendations

Results of the TSG review of PA parameters indicate that improvement is needed in areas of Data Quality, Data Interpretation, and Source Documentation. It is the opinion of the TSG that this needs to be accomplished to ensure regulatory compliance.

One or more of the six reviewers who participated placed approximately 50 percent of the key 49 parameters in the unfavorable categories of "unjustified assumption," "unknown source," "unacceptable," or "incomplete" in various areas. Two or more reviewers concurred in these unfavorable categorizations for 22 percent of the parameters. Concurrence values are lower than individual values primarily because of a difference in opinion in placement in categories such as "incomplete" and "needs work." There were few disagreements among reviewers where, for example, one chose "unacceptable" and another chose "acceptable." When a parameter was judged to have a problem, most reviewers agreed, differing only in their judgment of the magnitude of the problem.

Documentation that DOE is likely to submit to the U.S. Environmental Protection Agency (EPA) in support of compliance (e.g., the supporting data for the 300-plus PA parameters) will need to be comprehensive in scope and yet concise and accurate in detail to help EPA understand the need for the data, data sources and quality, and to trace their interpretation and use. This level of detail does not currently exist in the PA documents and needs to be achieved prior to any submission of a PA compliance statement to the EPA.

The TSG recommends the following:

1. **Revise and update the key 49 PA parameters.** The quality and completeness of data, interpretation and documentation for each PA parameter must be improved. SNL/NM should provide additional, up-to-date information, as available, for the key 49 parameters, with emphasis on the problem areas identified in this report. This information should be incorporated into the PERFORM database. A reasonable first goal is to upgrade the parameters in the "needs some work" category.

   The TSG recently obtained a list of additional documentation from SNL/NM to be used to further clarify the status some of the key 49 parameters. This information needs to be transmitted to the original reviewers for consideration in updating their evaluation of these parameters.

   A periodic status report should be prepared that summarizes the state of the PA parameter list and provides recommendations on how to revise and update it.

2. **Review, revise, and update the remaining 300-plus additional PA parameters.** The TSG should conduct a similar review on the remaining 300-plus PA parameters. Following the review, the TSG and SNL/NM should implement the actions recommended above.

3. **Continue to use the PERFORM database to manage the PA parameters.** It is recommended that the PERFORM database be maintained in the future to manage the PA parameters list. The PERFORM database is a useful management tool which can help DOE and others track the data and its use, especially the document trail to the origin of information.

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Table 1. Key 49 PA Parameters Sampled in 1992

Parameters for Scenario Probability Models

- Areal Extent of Brine Reser fraction
- Index for Drilling Intensity Functions

Parameter of Global Materials and Agents Acting on Disposal System

- Bulk Storativity, Castile Brine Reservoir
- Index for computing recharge amplitude factor
- Intrusion Drill Bit Diameter
- Permeability, Final, BOR H Fill Prop.
- Pressure, Initial, Castile Brine Reser

Engineered Barrier and Source Term

- Anoxic Iron Corrosion Stoichiometry
- Brine Saturation, initial (Waste)
- Gas Generation, Stoichiom. Micro
- Gas Production Rate, Corro Humid
- Gas Production Rate, Corro Inundated
- Gas Production Rate, Micro. Inundated
- Gas Production Rate, Microbial Humid
- Solubility (Am)
- Solubility (Np+5)
- Solubility (Pu+4)
- Solubility (Ra)
- Solubility (Th)
- Solubility (U+6)
- Volume Fraction-IDB, Combustibles
- Volume Fraction-IDB, Metals/Glass

Geologic Barrier

Salado

- Brooks & Corey Exponent (Halite)
- Brooks & Corey Weight Factor
- Index for Computing DRZ Porosity (Salado)
- Permeability, Undist (Anhydrite)
- Permeability, Undisturbed (Halite)
- Pore Pressure at Repos Lev (Anhydrite)
- Porosity, Undisturbed (Anhydrite)
- Residual Gas Saturation (Halite)
- Residual Wetting Phase Saturation (Halite)

Culebra

- Clay Filling Fraction, Culebra
- Fracture Porosity, Culebra
- Fracture Spacing, Culebra
- Index for Culebra Transmissivity Fields
- Matrix Porosity, Culebra
- Partition Coeff. (Cul Fracture) (Am)
- Partition Coeff. (Cul Fracture) (Np)
- Partition Coeff. (Cul Fracture) (Pu)
- Partition Coeff. (Cul Fracture) (Ra)
- Partition Coeff. (Cul Fracture) (Th)
- Partition Coeff. (Cul Fracture) (U)
- Partition Coeff. (Cul Matrix) (Am)
- Partition Coeff. (Cul Matrix) (Np)
- Partition Coeff. (Cul Matrix) (Pu)
- Partition Coeff. (Cul Matrix) (Ra)
- Partition Coeff. (Cul Matrix) (Th)
- Partition Coeff. (Cul Matrix)-(U)
- Porosity of Clay (Culebra)

Table 2. Additional PA Parameters Reviewed

Parameter of Global Materials and Agents Acting on Disposal System

- Amplitude Factor, Precipitation Variation
- Bulk Density (Salado Halite-Borehole Fill)
- Compressibility (Salado Brine)
- Density (Salado Brine, 300K)
- Density, Avg. Storage (Borehole Fill)
- Density, Mud
- Drilling Rate Function—Rate Const. in Poisson Drilling Model
- Elevation of Top, Castile Brine Reservoir
- Glacial Fluctuation, Precipitation
- Historical Drill Bit Diameters
- Mean Annual Precipitation, Regional
- Porosity (Borehole Fill Prop.)
- Recharge Amplitude Factor, Culebra
- Short-Term Precipitation Fluctuation Frequency
- Viscosity (Salado Brine)
- Viscosity, Mud

Engineered Barrier and Source Term

- Absolute Roughness of Waste
- Effective Shear Strength Erosional Unmod.
- Eh-pH Conditions
- Halflife (Ac 227)
- Halflife (Ac 225)
- Halflife (Ac 228)
- Permeability, Combustibles, Final
- Permeability, Metals/Glass, Final
- Permeability, Sludge, Final
- Porosity, Combustibles, Final
- Porosity, Metals/Glass, Final
- Porosity, Sludge, Final
- Solubility (Cm) Log

Geologic Barrier

Salado

- Base of Anhydrite III Elevation above Mean Sea Level @ ERDA-9
- Brooks & Corey Exponent, Anhydrite
- Capillary Pressure, Anhydrite
- Density, Average (Near Field Salado)
- Density, Bulk (Halite)
- Density, Grain (Anhydrite)
- Density, Grain (Halite in Salado)
- Density, Grain (Polyhalite in Salado)
- Dispersivity, Longitudinal (Anhydrite)
- Dispersivity, Long./Trans. Ratio (Anhydrite)

Geologic Barrier, continued

Salado, continued

- Dispersivity, Long./Trans. Ratio (Halite in Salado)
- Dispersivity, Longitudinal (Halite and Polyhalite)
- Log Permeability, Disturbed (Anhydrite)
- Log Permeability, Disturbed (Halite)
- MB139 Thickness (Anhydrite)
- Partition Coefficient (Anhydrite) (Am)
- Partition Coefficient (Anhydrite) (Np)
- Partition Coefficient (Anhydrite) (Pb)
- Partition Coefficient (Anhydrite) (Pb)
- Partition Coefficient (Anhydrite) (Pu)
- Partition Coefficient (Anhydrite) (Ra)
- Partition Coefficient (Anhydrite) (Th)
- Partition Coefficient (Anhydrite) (U)
- Partition Coefficient (Halite and Polyhalite)
- Pore Pressure (Halite)
- Porosity, Disturbed (Anhydrite)
- Porosity, Disturbed (Halite)
- Porosity, Undisturbed (Halite)
- Residual Wetting Phase Saturation (Anhydrite)
- Residual Gas Saturation (Anhydrite)
- Specific Storage (Anhydrite)
- Specific Storage (Halite)
- Top of Bell Canyon Elevation above Mean Sea Level @ ERDA-9
- Tortuosity (Anhydrite)
- Tortuosity (Halite)
- Threshold Displacement Pressure (Salado)
- Threshold Displacement Pressure (Anhydrite)

Culebra

- Density, Bulk Clay (Culebra)
- Dispersivity, Longitudinal (Culebra)
- Dispersivity Ratio (Culebra)
- Head, Freshwater (Culebra)
- Hydraulic Conductivity—5k (Culebra)
- Hydrogen Viscosity @ 27°C
- Matrix Tortuosity, Culebra.
- Partition Coefficient (Cul Fracture) (Cm)
- Partition Coefficient (Cul Fracture) (Pb)
- Partition Coefficient (Cul Matrix) (Cm)
- Partition Coefficient (Cul Matrix) (Pb)
- Storage Coefficient (Culebra)
- Thickness, Dolomite (Culebra)
- Tortuosity in Clay Lining (Culebra)

Table 3. Judgment Categories Used to Evaluate PA Parameters

Data Type

Assumption-Unjustified. The original documentation for the parameter value, range, or distribution is found, but no supporting explanation is given for the choice. An example of this would be the use of only the phrase "PA analyst's choice" to describe the source of a parameter value, with no additional documentation, but where other alternatives apparently exist.

Unknown Source. No source is found for the parameter information.

Judgment

Field Data. Parameter information is derived from WIPP-specific field data, but judgment is used, rather than the data only, to arrive at results. Typically, this would be done if the field data are incomplete or not fully representative. In many cases, judgment is used out of necessity.

Lab Data. Parameter information is derived from WIPP-specific laboratory data, but judgment is used, rather than the data only, to arrive at results. Typically, this would be done if the laboratory data are incomplete or not fully representative.

Generic Data. Parameter information is derived from generic data found in the literature, but judgment is used, rather than the data only, to arrive at results. Typically, this would be done to adapt non-WIPP data for use at WIPP.

Measurement

Field Data. Parameter information is derived entirely from WIPP-specific field data, even if an interpretive model must be used to derive the values.

Lab Data. Parameter information is derived entirely from WIPP-specific laboratory data, even if an interpretive model must be used to derive the values.

Handbook Data. Parameter information is derived from handbook data that are deemed specifically applicable to WIPP.

Data Quality

Acceptable. Data quality appears acceptable at this time for compliance justification.

Needs Work. Data quality is lacking, but apparently can be remedied by ongoing or planned work. Reviewer's comments provide further explanation.

Unacceptable. Data quality is severely deficient due to poorly documented sources, non-physically realistic values, lack of clear explanation, apparent lack of quality control, or other reasons as stated in the reviewers' comments.

No Data. No data could be found on which to base a judgment.

Data Interpretation

Acceptable. Data interpretation appears acceptable at this time for compliance justification.

Needs Work. Data interpretation is lacking only in ways that can apparently be remedied by ongoing or planned work. Reviewer's comments provide further explanation.

Unacceptable. Data interpretation is erroneous, unclear, undocumented, or severely deficient in some way, as stated in the reviewer's comments.

No Data. No data could be found on which to base a judgment.

Source Documentation

Complete. All parameter information (even if found unacceptable or needing work in some way) is fully documented.

Incomplete. Some important aspect of the required parameter information is undocumented. Reviewer's comments provide further explanation.

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Table 4. Results for the Key 49 PA Parameters Sampled in 1992

PA Parameter	Data Type	Data Quality	Data Interpretation	Source Document	Overall Standing
Parameters for Scenario Probability Models					
Areal Extent of Brine Reservoir Fraction	JF, JF	A, NW	A, NW	C, C	⁙
Index for Drilling Intensity Functions	JG, JG	ND, ND	A, A	C, C	⁙
Parameter of Global Materials and Agents Acting on Disposal System					
Bulk Storativity, Castile Brine Reservoir	MF, MF	A, A	NW, NW	C, C	■
Index for Computing Recharge Amplitude Factor	UA, JG	U, ND	NW, NW	I, I	□
Intrusion Drill Bit Diameter	JF, JG	A, A	A, NW	C, C	■
Permeability, Final, BOR H Fill Prop.	JG, JG	A, A	NW, NW	C, C	⁙
Pressure, Initial, Castile Brine Reservoir	JL, JF	A, A	NW, A	C, C	■
Engineered Barrier and Source Term					
Anoxic Iron Corrosion Stoichiometry	JG, UA	NW, ND	A, U	I, I	□
Brine Saturation, Initial (Waste)	UA, UA	NW, U	NW, U	I, I	□
Gas Generation, Stoichiometry Microbial	JG, JG	A, A	A, A	C, C	■
Gas Production Rate, Corro Humid	UA, JL	U, U	NW, U	I, I	□
Gas Production Rate, Corro Inundated	ML, ML	NW, NW	NW, U	C, I	⁙
Gas Production Rate, Microbial Inundated	JL, ML	NW, NW	NW, NW	C, I	⁙
Gas Production Rate, Microbial Humid	UA, UA	U, U	U, U	I, I	□
Solubility (Am)	US, JG	U, NW	U, NW	I, I	□
Solubility (Np+5)	US, JG	U, NW	U, NW	I, I	□
Solubility (Pu+4)	US, JG	U, NW	U, NW	I, I	□
Solubility (Ra)	US, JG	U, NW	U, NW	I, I	□
Solubility (Th)	US, JG	U, NW	U, NW	I, I	□
Solubility (U+6)	US, JG	U, NW	U, NW	I, I	□

Data Type		Data Quality/ Data Interpretation		Source Documentation		Overall Standing	
JF	Judgment Field Data	A	Acceptable	C	Complete	■	Excellent
JG	Judgment Generic Data	NW	Needs Work	I	Incomplete	⁙	Needs Some Work
JL	Judgment Lab Data	U	Unacceptable			□	Needs Significant Work
MF	Measurement Field Data	ND	No Data				
MH	Measurement Handbook Data						
ML	Measurement Lab Data						
UA	Unjustified Assumption						
US	Unknown Source						

Table 4. Results for the Key 49 PA Parameters Sampled in 1992 (continued)

PA Parameter	Data Type	Data Quality	Data Interpretation	Source Document	Overall Standing
Volume Fraction-IDB, Combustibles	JG	NW	U	I	□
Volume Fraction-IDB, Metals/Glass	JG	NW	U	I	□
Geologic Barrier					
<u>Salado</u>					
Brooks & Corey Exponent (Halite)	JG, JG	NW, NW	NW, NW	I, I	□
Brooks & Corey Weight Factor	UA	NW	NW	C	□
Index for Computing DRZ Porosity (Salado)	UA, UA	NW, ND	NW, NW	C, C	□
Permeability, Undisturbed (Anhydrite)	JF, MF	NW, A	U, NW	I, I	□
Permeability, Undisturbed (Halite)	JF, MF	NW, NW	NW, NW	C, C	⁙
Pore Pressure at Repository Level (Anhydrite)	JF, MF	A, A	U, A	I, I	⁙
Porosity, Undisturbed (Anhydrite)	UA, UA	ND, ND	NW, NW	I, I	□
Residual Gas Saturation (Halite)	JG, JG	NW, NW	NW, NW	C, C	⁙
Residual Wetting Phase Saturation (Halite)	JG, JG	NW, NW	NW, NW	C, C	⁙
<u>Culebra</u>					
Clay Filling Fraction, Culebra	JF, UA, UA, UA	NW, NW, ND, ND	NW, NW, NW, U	C, C, C, C	□
Fracture Porosity, Culebra	MF, JF, JF	NW, NW, A	NW, NW, U	C, C, C	⁙
Fracture Spacing, Culebra	JF, JF, JF	NW, NW, A	NW, NW, A	C, C, C	⁙
Index for Culebra Transmissivity Fields	US, MF, MF	A, A, NW	NW, NW, NW	C, C, C	⁙
Matrix Porosity, Culebra	ML, ML, ML	A, A, U	NW, NW, A	C, C, C	⁙
Partition Coefficient (Culebra Fracture) (Am)	UA, JG, JL	U, U, NW	NW, NW, NW	I, I, C	□
Partition Coefficient (Culebra Fracture) (Np)	UA, JG, JL	U, U, NW	NW, NW, NW	I, I, C	□
Partition Coefficient (Culebra Fracture) (Pu)	JL, JL, JG	NW, NW, U	NW, NW, NW	I, I, C	□
Partition Coefficient (Culebra Fracture) (Ra)	UA, JG, JL	U, U, NW	NW, NW, NW	I, I, C	□

<u>Data Type</u>

- JF Judgment Field Data
- JG Judgment Generic Data
- JL Judgment Lab Data
- MF Measurement Field Data
- MH Measurement Handbook Data
- ML Measurement Lab Data
- UA Unjustified Assumption
- US Unknown Source

Data Quality/ <u>Data Interpretation</u>

- A Acceptable
- NW Needs Work
- U Unacceptable
- ND No Data

Source <u>Documentation</u>

- C Complete
- I Incomplete

Overall <u>Standing</u>

- ■ Excellent
- ⁙ Needs Some Work
- □ Needs Significant Work

Table 4. Results for the Key 49 PA Parameters Sampled in 1992 (continued)

PA Parameter	Data Type	Data Quality	Data Interpretation	Source Document	Overall Standing
Partition Coefficient (Culebra Fracture) (Th)	JL, JL, JG	U, U, NW	NW, NW, NW	I, I, C	□
Partition Coefficient (Culebra Fracture) (U)	JL, JL, JG	A, U, NW	NW, NW, NW	I, I, C	□
Partition Coefficient (Culebra Matrix) (Am)	JL, JL, JL	NW, NW, U	NW, NW, NW	I, I, C	□
Partition Coefficient (Culebra Matrix) (Np)	UA, JL, JL	U, U, NW	NW, NW, NW	I, I, C	□
Partition Coefficient (Culebra Matrix) (Pu)	JL, JL, JL	A, U, NW	NW, NW, NW	I, I, C	□
Partition Coefficient (Culebra Matrix) (Ra)	JL, JL, JG	U, U, NW	NW, NW, NW	I, I, C	□
Partition Coefficient (Culebra Matrix) (Th)	JG, JL, JL	U, U, NW	NW, NW, NW	I, I, C	□
Partition Coefficient (Culebra Fracture) (U)	JL, JL, JL	U, U, NW	NW, NW, NW	I, I, C	□
Porosity of Clay (Culebra)	JG, JG, JG	NW, NW, U	NW, NW, U	C, C, I	□

Data Type

- JF Judgment Field Data
- JG Judgment Generic Data
- JL Judgment Lab Data
- MF Measurement Field Data
- MH Measurement Handbook Data
- ML Measurement Lab Data
- UA Unjustified Assumption
- US Unknown Source

Data Quality/ Data Interpretation

- A Acceptable
- NW Needs Work
- U Unacceptable
- ND No Data

Source Documentation

- C Complete
- I Incomplete

Overall Standing

- ■ Excellent
- ⠿ Needs Some Work
- □ Needs Significant Work

Table 5. Results of Additional Parameters Reviewed

PA Parameter	Data Type	Data Quality	Data Interpretation	Source Document	Overall Standing
Parameter of Global Materials and Agents Acting on Disposal System					
Amplitude Factor, Precipitation Variation	JG, JG	NW, A	NW, NW	I, C	□
Bulk Density (Salado Halite-Borehole Fill)	UA	NW	NW	I	□
Compressibility (Salado Brine)	ML	A	NW	C	■
Density (Salado Brine, 300K)	ML	A	A	C	■
Density, Avg. Storage (Borehole Fill)	UA	NW	A	I	□
Density, Mud	JG	NW	A	I	□
Drilling Rate Function—Rate Const. in Poisson Drilling Model	___[1]	ND	NW	C	□
Elevation of Top, Castile Brine Reservoir	JF, JF	A, A	NW, A	I, I	⁝⁝⁝
Glacial Fluctuation, Precipitation	JF	A	NW	C	⁝⁝⁝
Historical Drill Bit Diameters	MH	A	NW	C	⁝⁝⁝
Mean Annual Precipitation, Regional	MF	A	NW	C	⁝⁝⁝
Porosity (Borehole Fill Prop.)	JG	A	NW	C	⁝⁝⁝
Recharge Amplitude Factors, Culebra	UA	NW	NW	I	□
Short-Term Precipitation Fluctuation Frequency	JF	A	NW	C	⁝⁝⁝
Viscosity (Salado Brine)	MH	A	NW	C	⁝⁝⁝
Viscosity, Mud	JG	NW	A	I	□
Engineered Barrier and Source Term					
Absolute Roughness of Waste	JG	A	NW	C	⁝⁝⁝
Effective Shear Strength Erosional Unmod.	JG	A	NW	C	⁝⁝⁝
Eh-pH Conditions	UA	U	U	I	□
Halflife (Ac 225)	MH	A	A	C	■
Halflife (Ac 227)	MH	A	A	C	■
Halflife (Ac 228)	MH	A	A	C	■

1 No Reviewer Results for this category. (Judgement dropped out of "Overall Stabding" rating system.)

Data Type

- JF Judgment Field Data
- JG Judgment Generic Data
- JL Judgment Lab Data
- MF Measurement Field Data
- MH Measurement Handbook Data
- ML Measurement Lab Data
- UA Unjustified Assumption
- US Unknown Source

Data Quality/ Data Interpretation

- A Acceptable
- NW Needs Work
- U Unacceptable
- ND No Data

Source Documentation

- C Complete
- I Incomplete

Overall Standing

- ■ Excellent
- ⁝⁝⁝ Needs Some Work
- □ Needs Significant Work

Table 5. Results of Additional Parameters Reviewed (continued)

PA Parameter	Data Type	Data Quality	Data Interpretation	Source Document	Overall Standing
Permeability, Combustibles, Final	JG	NW	NW	C	⠿
Permeability, Metals/Glass, Final	JG	NW	NW	C	⠿
Permeability, Sludge, Final	JG	NW	NW	C	⠿
Porosity, Combustibles, Final	ML	A	A	C	■
Porosity, Metals/Glass, Final	ML	A	A	C	■
Porosity, Sludge, Final	ML	A	A	C	■
Solubility (Cm) Log	JG	NW	NW	I	□
Geologic Barrier					
<u>Salado</u>					
Base of Anhydrite III Elevation above Mean Sea Level @ ERDA-9	JF	NW	A	C	⠿
Brooks & Corey Exponent, Anhydrite	JG, JG	NW, NW	NW, NW	I, I	□
Capillary Pressure, Anhydrite	—[1]	—[1]	—[1]	C	—[2]
Density, Average (Near Field Salado)	JG, JF	A, ND	NW,A	C, I	⠿
Density, Bulk (Halite)	US, MF	U, ND	U, A	I, I	□
Density, Grain (Anhydrite)	MH, MH	NW, A	NW, A	C, C	⠿
Density, Grain (Halite in Salado)	MH, MH	A, A	A, A	C, C	■
Density, Grain (Polyhalite in Salado)	MH, MH	A, A	A, A	C, C	■
Dispersivity, Longitudinal (Anhydrite)	UA, JG	NW, ND	NW, NW	I, I	□
Dispersivity, Long./Trans. Ratio (Anhydrite)	UA, JG	NW, ND	NW, A	I, I	□
Dispersivity, Long/Trans. Ratio (Halite in Salado)	JG, JG	NW, ND	NW, A	I, I	□
Dispersivity, Longitudinal (Halite and Polyhalite)	UA, JG	NW, ND	NW, NW	I, I	□
Log Permeability, Disturbed (Anhydrite)	UA	U	A	I	□
Log Permeability, Disturbed (Halite)	JF, MF	NW, NW	U, A	C, C	□

1 Source Documentation is the only category with reviewer results.
2 Not enough information available from reviewer to develop overall standing.

<u>Data Type</u>		Data Quality/ <u>Data Interpretation</u>		Source <u>Documentation</u>		Overall <u>Standing</u>	
JF	Judgment Field Data	A	Acceptable	C	Complete	■	Excellent
JG	Judgment Generic Data	NW	Needs Work	I	Incomplete	⠿	Needs Some Work
JL	Judgment Lab Data	U	Unacceptable			□	Needs Significant Work
MF	Measurement Field Data	ND	No Data				
MH	Measurement Handbook Data						
ML	Measurement Lab Data						
UA	Unjustified Assumption						
US	Unknown Source						

Table 5. Results of Additional Parameters Reviewed (continued)

PA Parameter	Data Type	Data Quality	Data Interpretation	Source Document	Overall Standing
MB139 Thickness (Anhydrite)	MF, MF	NW, NW	NW, NW	I, I	□
Partition Coefficient (Anhydrite) (Am)	JG, JL	U, NW	NW, NW	C, I	□
Partition Coefficient, (Anhydrite) (Np)	JG, JL	U, NW	NW, NW	C, I	□
Partition Coefficient (Anhydrite) (Pb)	JG, JL	U, NW	NW, NW	C, I	□
Partition Coefficient (Anhydrite) (Pu)	JG, JG	U, NW	NW, NW	C, I	□
Partition Coefficient (Anhydrite) (Ra)	JG, JL	U, NW	NW, NW	C, I	□
Partition Coefficient (Anhydrite) (Th)	JG, JL	U, NW	NW, NW	C, I	□
Partition Coefficient (Anhydrite) (U)	JG, JG	U, NW	NW, NW	C, I	□
Partition Coefficient, Halite and Polyhalite	UA	NW	A	I	□
Pore Pressure (Halite)	JF, MF	U, U	NW, U	C, C	□
Porosity, Disturbed (Anhydrite)	UA, UA	ND, ND	U, NW	I, I	□
Porosity, Disturbed, (Halite)	UA, UA	U, ND	U, NW	C, I	□
Porosity, Undisturbed (Halite)	UA, JF	ND, A	U, NW	I, C	□
Residual Wetting Phase Saturation (Anhydrite)	JG, JG	NW, NW	NW, NW	C, C	⁙
Residual Gas Saturation (Anhydrite)	JG, JG	NW, NW	NW, NW	C, C	⁙
Specific Storage, Anhydrite	US, ML	NW, A	NW, NW	I, I	□
Specific Storage (Halite)	US, ML	A, NW	NW, NW	I, C	⁙
Top of Bell Canyon Elevation above Mean Sea Level @ ERDA-9	JF	NW	NW	C	⁙
Tortuosity (Anhydrite)	UA	NW	NW	C	□
Tortuosity (Halite)	UA, JG	NW, ND	NW, NW	C, C	□
Threshold Displacement Pressure (Salado)	JG, JF	NW, A	NW, A	I, C	□
Threshold Displacement Pressure (Anhydrite)	JG, JG	NW, A	NW, A	I, C	□
<u>Culebra</u>					
Density, Bulk Clay, Culebra	US, US, UA	ND, ND, U	NW, NW, NW	I, I, I	□
Dispersivity, Longitudinal (Culebra)	JG, JG, JG	NW, NW, ND	U, NW, NW	I, I, I	□

Data Type

- JF Judgment Field Data
- JG Judgment Generic Data
- JL Judgment Lab Data
- MF Measurement Field Data
- MH Measurement Handbook Data
- ML Measurement Lab Data
- UA Unjustified Assumption
- US Unknown Source

Data Quality/ Data Interpretation

- A Acceptable
- NW Needs Work
- U Unacceptable
- ND No Data

Source Documentation

- C Complete
- I Incomplete

Overall Standing

- ■ Excellent
- ⁙ Needs Some Work
- □ Needs Significant Work

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Table 5. Results of Additional Parameters Reviewed (continued)

PA Parameter	Data Type	Data Quality	Data Interpretation	Source Document	Overall Standing
Dispersivity Ratio (Culebra)	JG, JG, JG	NW, NW, ND	NW, NW, NW	I, C, I	⁙
Head, Freshwater (Culebra)	MF	A	A	C	■
Hydraulic Conducting—5k (Culebra)	US, US	NW, ND	U ___[1]	I, I	□
Hydrogen Viscosity @ 27°C	MH	A	NW	___[1]	⁙
Matrix Tortuosity, Culebra	ML, ML, ML	A, A, A	NW, A, NW	C, C, C	■
Partition Coefficient (Cul Fracture) (Cm)	JG, JL	U, NW	NW, NW	C, I	□
Partition Coefficient (Cul Fracture) (Pb)	JG, JL	U, NW	NW, NW	C, I	□
Partition Coefficient (Cul Matrix) (Cm)	JL, JL	U, NW	NW, NW	C, I	□
Partition Coefficient (Cul Matrix) (Pb)	JG, JL	U, NW	NW, NW	C, I	□
Storage Coefficient, Culebra	MF, JF, MF	A, A, A	NW, A, A	C, C, C	■
Thickness, Dolomite, Culebra	MF, MF, MF, MF	A, A, A, A	NW, A, NW, A	C, C, C, C	■
Tortuosity in Clay Lining, Culebra	UA, UA, JG	ND, ND, ND	NW, NW, NW	C, I, C	□

1 No review results for this category.

Data Type

JF Judgment Field Data
JG Judgment Generic Data
JL Judgment Lab Data
MF Measurement Field Data
MH Measurement Handbook Data
ML Measurement Lab Data
UA Unjustified Assumption
US Unknown Source

Data Quality/ Data Interpretation

A Acceptable
NW Needs Work
U Unacceptable
ND No Data

Source Documentation

C Complete
I Incomplete

Overall Standing

■ Excellent
⁙ Needs Some Work
□ Needs Significant Work

Table 6. Summary of Results

	Key 49 PA Parameters		All 129 PA Parameters	
	≥ 1 reviewer	≥ 2 reviewers	≥ 1 reviewer	≥ 2 reviewers
Data Type				
Judgement (all)	39	23	82	46
Measurement (all)	9	4	34	11
Assumption-Unjustified or Unknown Source	20	5	40	10
Data Quality				
Acceptable	13	10	45	14
Needs Work	37	12	80	19
Unacceptable	24	8	41	11
No Data	6	3	21	6
Data Interpretation				
Acceptable	9	2	37	6
Needs Work	42	28	100	58
Unacceptable	18	1	27	1
Documentation				
Complete	32	17	88	29
Incomplete	32	27	74	41

Figure 1. Example of Signedoff Reviewer Comments

PARAMETER: Elevation of Top, Castile Brine Reser
INDEX NUMBER: 006

Data Type	Source Documentation	Data Quality	Interpretation
JUDGEMENT - FIELD DATA	INCOMPLETE	ACCEPTABLE	NEEDS WORK

PARAMETER VALUE:
The value given is stated as the elevation (with respect to sea level) of the point at which brine production began in the well WIPP-12. This is certainly acceptable. It is NOT discussed in Table 3-19 of SAND89-0462, as the reference states. Checking other references, the value appears to be correct, but the reference should be fixed. What is it?

PARAMETER RANGE:
The range chosen corresponds to the top and bottom of the Castile over the area of the WIPP site. It is also incorrectly referenced, but appears to a correct value. This range apparently means that the thickness of the brine reservoir can range from zero to the entire Castile thickness, but it is not directly stated as such.

DISTRIBUTION TYPE:
The distribution heavily weights the observed 170 m depth, but with no stated and clear justification. If there is any sensitivity to this parameter, the distribution may be brought into question and needs to be explicitly justified.

OTHER CONCERNS:

Signature

12/6/93
Date

REFERENCES

Rechard, R.P., 1993. "Personal Communication," June 22, 1993, Sandia National Laboratories, Albuquerque, NM.

SNL/NM, see Sandia National Laboratories/New Mexico

Sandia National Laboratories/New Mexico, 1992. Preliminary Performance Assessment for the Waste Isolation Pilot Plant, December 1992, Volume 3: Model Parameters, SAND92-0700/3, Sandia National Laboratories, Albuquerque, NM.

APPENDIX: PA PARAMETER REVIEW TEAM

The Technical Support Group (TSG) core member expert and reviewer was Paul Drez. John Schatz, a specialist in rock properties analysis and testing, lead the technical effort and provided the initial input of expert comments used for fine-tuning of the database system. He guided the entry, evaluation, and reporting of other expert input. TSG ad hoc reviewers Paul Cloke, Darrel Dunn, Rose Zeiler, and David Dennison provided technical input in the areas of hydrology, geochemistry, and waste package performance. The resumes for all reviewers are in the WIPP Project files. In addition to the review team, several individuals contributed to database support. Jody Cruse and Mark David provided the database organization and programming support, as well as results compilation. D'Ann Bretzke provided database management.

A complete list of reviewers, their affiliations, and their areas of expertise is presented below.

Participant	Affiliation	Area(s) of Expertise
Paul Drez	TSG Core Member	• Waste Characterization • (Geochemistry)*
John Schatz	Consultant	• Geomechanics • (Hydrology)*
Paul Cloke	SAIC-Nevada	• Geochemistry
Darrel Dunn	ASI-Denver	• Hydrology
Rose Zeiler	ASI-Denver	• Hydrology
David Dennison	ASI-Denver	• Geochemistry

* Secondary area of expertise

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