PEER 4 - Engineered Alternatives Cost/Benefit Study
Peer Review

ENGINEERED ALTERNATIVES COST/BENEFIT STUDY

PEER REVIEW REPORT

CAO PLAN
Carlsbad Area Office

Title: Engineered Alternatives Cost/Benefit Study Peer Review Plan

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(Assistant Manager, Office of Regulatory Compliance, Carlsbad Area Office) Date: 5/7/96

1.0 Introduction

This Engineered Alternatives Cost/Benefit Study Peer Review Plan describes the peer review process and the documentation requirements the Department of Energy (DOE) Carlsbad Area Office (CAO) will use to ensure that the processes used in the Engineered Alternatives Cost/Benefit Study (EACBS) are appropriate for use in the demonstration of compliance.

1.1 Background

The Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance With the 40 CFR 191 Disposal Regulations, require an analysis of engineered barriers to be performed. This analysis will become background information in the selection or rejection of engineered barriers for use in the disposal system design. The DOE has generated the Engineered Alternatives Cost/Benefit Study (EACBS) to fulfill this requirement. This Peer Review Plan details the requirements, methods and procedures to be used to perform the peer review of the EACBS.

1.2 Purpose

The purpose of the peer review of the EACBS is to satisfy the requirements of 40 CFR 194.27. The rule requires DOE to conduct peer reviews of three specific elements of the WIPP program, one of which is the EACBS.

The Department of Energy initiated the EACBS to provide a technical basis for the selection and rejection of Engineered Alternatives (EAs) for the WIPP should it be determined that additional barriers are needed for assurance purposes. *(Engineered Alternatives: Engineered barriers that are technically feasible processes, technologies, methods, repository designs, or waste form modifications which make a positive impact on the disposal system in terms of uncertainty in performance calculations or improving long-term performance.)* This study includes a qualitative assessment of estimated costs, potential risks, benefits, and relative repository performance impacts resulting from the implementations of EAs. Although the EACBS does not directly supply input data to the performance assessment (PA), decisions resulting from the EACBS final report may influence PA parameters such as solubility, permeability, and waste strength.

This peer review is not intended to assess the validity of the requirement to perform the EACBS, nor the validity of the 40 CFR 194.44 analysis requirements. The peer review is only to assess the validity of the assumptions and the technical approach used in the EACBS.

1.3 Scope

This Peer Review Plan describes the process that the Carlsbad Area Office (CAO) will utilize for the review of the EACBS. The peer review will be an in-depth critique of assumptions, alternate interpretations, methodologies and acceptance criteria employed, and of the conclusions drawn in the original work. This EACBS Peer Review Plan defines the approach, methods, criteria, schedules, deliverables and the resources required to perform the review.

2.0 Peer Review Planning and Implementation

2.1 Approach

The DOE-CAO has prepared the "Office of Regulatory Compliance (ORC) Team Procedure for Peer Review" (TP 10.5) to document the approach for conducting the peer review process. The EACBS Peer Review Panel will conduct the peer review activities in accordance with NUREG-1297, TP 10.5 and this Plan.

The EACBS Peer Review Panel will develop procedures in accordance with guidelines set forth in NUREG-1297 *and* TP 10.5. *Specifically, the EACBS Peer Review Panel will:*

- Administer and document QA aspects of the peer review process, including preparation, logging and archiving of written minutes. In the QA process, the EACBS Peer Review Panel's Manager will ensure that all aspects of the peer review conform to NUREG-1297 and TP 10.5
- *Communicate interim peer review finding in hardcopy to the ORC Peer Review Coordinator*
- Produce a type written report and include a disk copy in WordPerfect compatible format

2.2 Composition of Peer Review Panel

The Peer Review Panel *will consist of approximately 10 national, academic and industrial experts.* The Peer Review Panel will have the following areas of expertise:

1. Waste Management
2. Waste Processing
3. *Transportation* Risk Assessment
4. Industrial Hygiene
5. Probabilistic Risk Assessment and Statistical Assessment
6. Mine Engineering
7. Radiation Risk Assessment
8. *Cost and Schedule*
9. Radionuclide Movement and Solubility
10. Public Relations

The rationale for selection of members of the Peer Review Panel shall be documented in accordance with the *requirements of* TP 10.5 *and maintained as a* QA *record.*

2.3 Peer Review Panel Member duties

Each Peer Review Panel member shall:

- Complete and document the necessary training prior to the start of the Peer Review process at a minimum to include:
  - 40 CFR Part 191, as amended on December 20, 1993
  - 40 CFR Part 194 dated February 9, 1996
  - NUREG-1297, *Peer Review for High-Level Nuclear Waste Repositories,* published February 1988
  - CAO Quality Assurance Program Description (QAPD) CAO-94-1012, latest revision
  - CAO Procedure 10.5, Revision 0, Office of Regulatory Compliance (ORC) Team Procedure for Peer Review
  - *This Peer Review Plan*
  - The EACBS Executive Summary, Chapters 1 & 2, and Appendix D
- Perform an in-depth critique of the EACBS documented assumptions, calculations, extrapolations; alternate interpretations, methodologies, and acceptance criteria employed; and of conclusions drawn in the original work in accordance with approved technical and quality assurance *requirements, and the applicable Peer Review Plan(s)*

- Interact with other Peer Review Panel members to ensure that sufficient consideration is given to interdisciplinary and coupled data and information
- Prepare Peer Review Report(s) on those specific areas reviewed
- Sign the Peer Review Final Report to show concurrence

3.0 Peer Review Process

The Peer Review shall be conducted in accordance with TP 10.5. The Peer Review process shall consist of an in-depth critique of documented assumptions, calculations, extrapolations, alternate interpretations, methodologies, and acceptance criteria employed, and of conclusions drawn in the original work in accordance with approved technical and quality assurance requirements.

A trained facilitator will aid in the direction of Panel meetings by maintaining "flip chart" records of the major issues, comments, etc. Two technical people will also be available to take more detailed minutes of the meetings. These daily records of meetings, deliberations, and activities will be the basis for developing the final report, and will become part of the QA record.

3.1 Evaluation Criteria

The Peer Review Panel shall evaluate the EACBS and report on:

- Adequacy of requirements and criteria
- Validity of assumptions
- Alternate interpretations
- Uncertainty of results and consequences if wrong
- Appropriateness and limitations of methodology and procedures
- Adequacy of application
- Accuracy of calculations
- Validity of conclusions

Full and frank discussions between the Peer Reviewers and the original performers of the work are encouraged.

3.2 Schedule and Deliverables

Attachment A contains a schedule of EACBS Peer Review activities and milestones. This schedule will serve as the baseline schedule from which requested schedule deviations will be evaluated and approved, if appropriate. Revisions to the baseline schedule will not require revision to this plan, but will be attached to the plan by reference.

3.3 Evaluation Format

The Peer Review Panel activities will follow the format of the EACBS. The EACBS was performed in three phases:

- Compile EAs, screen and optimize
- Analyze optimized EAs through an eight factor analysis
- Report analysis results in a practical format that compares the EAs performance against the repository baseline design performance.

The peer review will be performed on each of these phases and may review the analysis of EAs through the entire EACBS analysis to validate the approach. The Peer Review Panel shall perform their review in the same areas and order as listed above.

4.0 Meetings and Peer Review Activities

Meetings of the Peer Review Panel are scheduled for May 7-10 in Carlsbad, and May 29-31, and July 8-10, in Albuquerque, New Mexico. The initial meeting in Carlsbad, New Mexico is for the orientation and training of the Peer Review Panel, in accordance with TP 10.5, and to tour the WIPP site. Written minutes, including graphic or calculated materials utilized in the meetings, shall be prepared for meetings, deliberations, and other activities of the Peer Review Panel.

4.1 Observer Protocol

Observer protocol shall be conducted in accordance with TP 10.5 Attachment V. Additional protocol for the Peer Review process will meet the following conditions:

1. Internal observers are WIPP project participants, i.e., CAO, CTAC, WID and Sandia National Laboratories employees. External observers, such as employees of the U.S. Environmental Protection Agency, State of New Mexico, etc. are considered guests of the CAO.
2. International Technology, Inc. (IT), will act as the point of contact between the work originator observers and the Peer Review Panel. IT will help respond to questions regarding work performed for the EACBS raised by the Peer Review Panel.
3. Peer Review meeting minutes shall be compiled and transmitted to the Peer Review Coordinator after each meeting has taken place.

4.2 Preliminary Peer Review Meeting Agenda

May 8-10, Carlsbad, New Mexico (three days): The Peer Review Panel will receive a three-day orientation in Carlsbad on the scope, screening process, and subject matter to be covered during the performance of the EACBS peer review. The orientation will include:

- A presentation on WIPP
- Background information on the EACBS
- Formation of the peer review panel groups and assignment of EACBS appendices to be reviewed by each group
- Identification of the IT Corporation to serve the role as the work originator point-of-contact and provide clarification/input to the experts on techniques used to compile the report *(Note: Other observers are allowed, but they are strictly considered non-participants and will follow the observers rules and regulations identified by NUREG-1297 and TP 10.5)*
- Duties and responsibilities of each Panel member
- Tour of the WIPP site (half-day trip)

The remainder of the first meeting will be spent on the review of the original EACBS and how it was conducted, including coverage of the EA screening process and the initial eight factors used to rank the technologies.

May 29-31, Albuquerque, New Mexico (three days): The Peer Review Panel will convene to complete the initial EACBS review and experts from each of the ten areas identified previously, will discuss their concerns, agreements and disagreements. The agenda for this meeting will be determined after the May 7-10 orientation and submitted to the ORC Peer Review Coordinator.

July 8-10, Albuquerque, New Mexico (three days): The Peer Review Panel will have a conclusion meeting to discuss drafting the final report, due on July 19. The discussion will focus on Panel consensus, differences and final conclusions.

Specific dates of the Peer Review Panel meetings may vary slightly, depending on the availability of the Panel members.

4.3 Peer Review Daily Caucus

When Peer Review activities are conducted, the Peer Review Panel Leader shall schedule and conduct daily caucuses of the Peer Review Panel to address issues, concerns, questions or conflicts. The Peer Review Panel Leader shall resolve caucus issues, concerns, etc., as they arise.

4.4 Peer Review Report

The Peer Review Report shall as a minimum:

- Be signed by each Peer Review Panel member individually
- Describe the work or issue that was reviewed
- Describe the conclusions reached by the Peer Review Panel
- Provide individual statements by the Peer Review Panel members reflecting dissenting views or additional comments as appropriate
- List the Peer Review Panel members and provide acceptability information (i.e., technical qualifications and independence) for each member, including potential technical, and/or organizational partiality.

The Peer Review final report will be a documented, in-depth report of the proceedings and findings of the Peer Review Panel. It will be prepared under the direction of the chairperson of the Peer Review Panel and signed by each member of the Panel individually. It will clearly state the work and issues that were peer reviewed and the conclusions reached by the peer review process. The report will include individual statements by the Peer Review Panel members reflecting dissenting views or additional comments as appropriate. A preliminary outline is shown in Attachment B.

5.0 Quality Assurance Records

QA records shall be processed and maintained in accordance with the requirements of CAO Management Procedure MP 4.5, *Records Management*, Revision 0. QA records shall be maintained by the Peer Review Manager until completion of the peer review process. Duplicate records shall be generated and maintained at separate facilities. Upon completion of the peer review process the QA records shall be delivered to CAO for retention.

References

Carlsbad Area Office Team Procedure 10.5, *Peer Review*, Revision 0, March 1996.

Engineered Alternatives Cost/Benefit Study Final Report for the Waste Isolation Pilot Plant, U.S. Department of Energy. WIPP/WID 95-2135, Rev. 0. September 1995.

NUREG-1297, Peer Review for High-Level Nuclear Waste Repositories, Generic Technical Position. U.S. Nuclear Regulatory Commission. February 1988.

ATTACHMENT A

Preliminary Schedule for the EACBS Peer Review

May 7-10: Orientation, Training, and tour of the WIPP Facility

May 29-31: Peer Review Panel Meetings (Albuquerque, N.M.)
- Subcommittee Meetings

June 11: Panel Members Begin Draft Final Report Review

June 21: Preliminary Panel Member Comments on Draft Final Report Due

July 8-10: Peer Review Panel Meetings (Albuquerque, N.M.)
- Discuss Outstanding Issues
- Editorial Review of Final Report
- Panel Members Sign Final Report

July 19: Final Report Submitted to the ORC Peer Review Coordinator

ATTACHMENT B

PEER REVIEW REPORT OUTLINE

Executive Summary

1. Introduction

2. Purpose

3. Description of Work Performed

4. Evaluation Work Performed
   - A. Adequacy of Requirements and Criteria
   - B. Validity of Assumptions
   - C. Alternate Interpretations
   - D. Uncertainty of Results and Consequences if Wrong
   - E. Appropriateness and Limitations of Methodology and Procedures
   - F. Adequacy of Application
   - G. Accuracy of Calculations
   - H. Validity of Conclusions

5. Conclusions

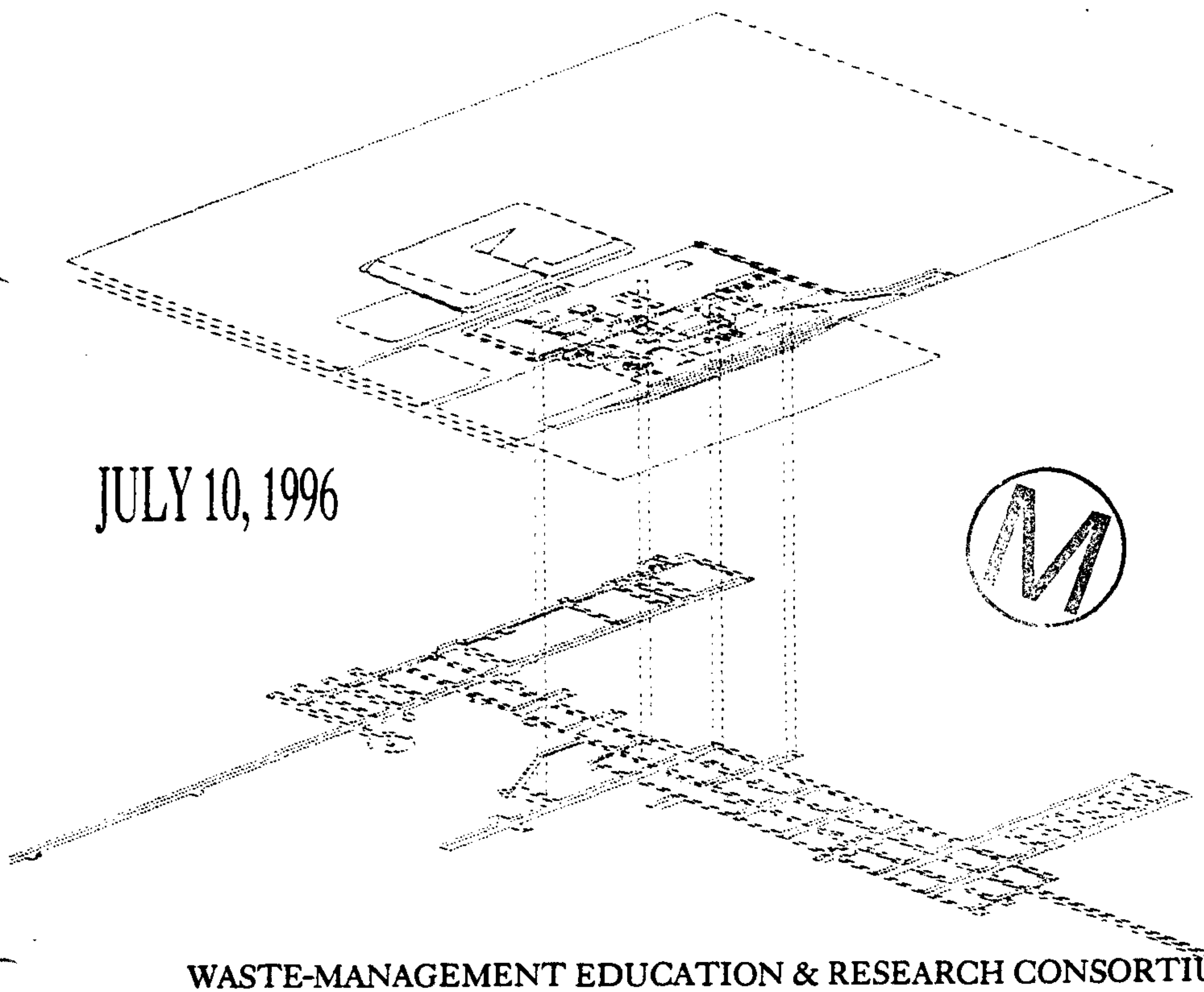
6. Dissenting Views

7. Summary

8. Signatures

9. Peer Review Members and Acceptability

INDEPENDENT PEER REVIEW
of the
U.S. DEPARTMENT OF ENERGY
WASTE ISOLATION PILOT PLANT
ENGINEERED ALTERNATIVES
COST/BENEFIT STUDY FINAL REPORT



JULY 10, 1996

WASTE-MANAGEMENT EDUCATION & RESEARCH CONSORTIUM

INDEPENDENT PEER REVIEW

OF THE

U.S. DEPARTMENT OF ENERGY

WASTE ISOLATION PILOT PLANT

ENGINEERED ALTERNATIVES COST/BENEFIT STUDY

FINAL REPORT

JULY 10, 1996

Prepared by an independent Peer Review Panel organized by the Waste-management Education and Research Consortium for Westinghouse Waste Isolation Division, the operating contractor for the U.S. Department of Energy's Waste Isolation Pilot Plant

ACKNOWLEDGEMENTS

The Waste-management Education and Research Consortium wishes to thank the following for their contribution: panel members C.T. Aimone-Martin, R.K. Bhada, A. Duran, D.J. Kuhns, C.R. Lewis, J.D. Navratil, J. Rostami, D.M. Smith, and K.K. Wahi; peer review staff A. Ghassemi, L.E. Cummins, T.J. Carlson; and M.R. Nolen; G.K. Perkins (WERC) for word processing; International Environmental Training and Consulting, Inc. for contract administration and management for peer panel members; presenters of information on the EACBS report: S.W. Wagner (Westinghouse), J. Myers (IT Corp.), M.E. Crawley (IT Corp.), and J.H. Maes (DOE-CAO).

AGREEMENT OF REPORT CONTENTS

The panel members who performed the peer review for the U.S. Department of Energy's Waste Isolation Pilot Plant Engineering Alternatives Cost Benefit Study have read in the entirety this peer review report dated July 1996 and concur with the contents herein. This peer review was conducted in May, June, and July 1996.

Rohinton K. Bhada (peer panel chair)	July 10, 1996 date
Catherine T. Aimone-Martin	July 10, 1996 date
Arturo Duran	July 10, 1996 date
Douglass J. Kuhns	July 10, 1996 date
Cindy R. Lewis	7/10/96 date
James D. Navratil	July 10, 1996 date
Jamal Rostami	July 10, 1996 date
Dennis M. Smith	July 10, 1996 date
Krishan K. Wahi	July 10, 1996 date

EXECUTIVE SUMMARY

An independent peer review committee assembled by the Waste-management Education & Research Consortium (WERC) has provided to the U.S. Department of Energy (DOE) this review of the Waste Isolation Pilot Plant's (WIPP) Engineered Alternatives Cost/Benefit Study (EACBS) Final Report (DOE, 1995a). This study and the peer review are requirements of the U.S. Environmental Protection Agency (EPA) as part of the compliance application for the permitting of WIPP to receive and dispose transuranic waste. The DOE initiated the EACBS, required by EPA regulation Title 40 U.S. Code of Federal Regulations Part 194 (40 CFR 194; *Criteria for the Certification and Re-certification of the Waste Isolation Pilot Plant's compliance with the 40 CFR Part 191 Disposal Regulations;* EPA, 1996), to provide a technical basis for the selection or rejection of engineered alternatives (EAs) for the WIPP should it be determined that additional barriers are needed to satisfy the assurance requirements of 40 CFR 191. EAs are defined as technically feasible processes, technologies, methods, repository designs, or waste modifications which make a significant positive impact on the WIPP disposal system in terms of uncertainty in performance calculations or improving long-term performance. The EACBS includes a qualitative and to a limited extent quantitative assessment of estimated costs, potential risks, public acceptance, benefits, and relative repository performance impacts resulting from the implementation of engineered alternatives.

The peer review of the EACBS was conducted during May, June, and July 1996 in accordance with the U.S. Nuclear Regulatory Commission *NUREG-1297 Peer Review for High-level Nuclear Waste Repositories* (NRC, 1988) and the DOE Carlsbad Area Office *Peer Review Procedure* TP 10.5 (DOE, 1996). The objective of the peer review was to assess the validity of the assumptions and the technical approach used in the EACBS, and to evaluate the adequacy of the work. It was not to assess the validity of the WIPP project, the requirement to perform the EACBS, 40 CFR Part 194 analysis requirements, nor the ability of the WIPP to meet compliance standards. The review focused on determining the reasonableness of the report's conclusions.

The panel reviewed several parts of the study. However, to provide in-depth review of major factors, the peer panel divided itself into three subcommittees to address certain areas of the study. Subcommittees were established for reviewing the eight different EA evaluation factors identified under 40 CFR 194.44 with reviewers divided by expertise that was most appropriate for each set of factors. Eventually, all subcommittee findings were reviewed by the entire peer panel.

Based on presentations by the EACBS authors, discussions with the authors and DOE staff, and review of the EACBS and supporting documents, the overall conclusions of the peer review panel are:

- the information presented within the EACBS is of high quality,
- the approach taken is valid,

- the conclusions drawn are reasonable, and
- the analysis was conducted in accordance with 40 CFR 194.44 requirements.

The peer review panel also notes the following observations:

- The screening process for identifying EAs and the EA analysis itself was not iterative. After the screening was completed, it was not reevaluated with regard to the detailed alternative evaluation criteria. For example, if waste removal or costs were considered by DOE to be a major factor for decision-making, then several alternatives that did not pass the EA screening process should be reevaluated. The review committee feels that this is acceptable because of additional costs that would have to be incurred by repeated iterations and the conclusions would probably not change significantly.

- The EACBS report is ambiguous about the significance of early intrusion with respect to the relative benefits of the EAs. The Measure of Relative Effectiveness (MREs) for some alternatives do show a dependence on time of intrusion, particularly when the releases are solubility-limited.

- Creep closure modeling did not consider uncertainty in creep parameters nor did it incorporate important advances in creep modeling. Different time periods for closure would have likely resulted which may have changed the relative ratings of the EAs, but the conclusions will probably not change.

- The effectiveness of EAs with clay backfill or treated by vitrification was underestimated because the enhanced immobilization of actinides within these matrices was not assumed.

- The relative nature of the alternatives comparison decreases the chance that uncertainties in assumptions used in the evaluation process would have an impact on the evaluation results; e.g., if costs are consistently high by 50%, the relative importance of the cost estimates will not change.

- Waste removal assumptions do not include a short-term removal scenario from the regulatory closure of the repository to the geological closure of the rooms. Had short-term removal been considered in the analysis, the inter-EA comparisons may be different.

- Public confidence could have benefited from involvement of the public from states neighboring New Mexico and possibly from states which intend to ship waste to WIPP. Although this involvement was not evident in the EACBS, it was not felt to be a significant issue that would have altered the results and conclusions.

- With respect to the adequacy of requirements and criteria, panel members agreed that these were prescribed by regulation for most of the factors and was therefore beyond the scope of their review.

- The EACBS focused on evaluating measures that exceed compliance and are added assurance of performance beyond the baseline requirements. The major consequence of implementing an alternative based on a slightly incorrect evaluation is probably the expenditure of greater dollars than necessary and the addition of more time to implement the alternative. Safety is not impaired.

- As described in the EACBS, the identification/screening process is not clearly documented. There is also confusion in some of the terminology used (e.g., "screening," "optimization," "prioritization"). In order that the process is well understood, it is recommended that clarification be added to the report, particularly to describe how the alternatives list went from the 54 recommended by the Engineered Alternatives Screening Working Group to the 18 evaluated in the EACBS report.

- Remote-handled waste was not considered. This issue may have implications to the compliance application.

- We believe that the DOE would gain better insight by considering the post-closure performance separately (as distinct from pre-closure activities) to fully appreciate the benefits (or detriments) of a given EA.

Results of the EACBS peer review evaluation are summarized in Table ES-1.

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Table ES-1. *Summary of the Peer Review of the EACBS Evaluation Factors and Criteria*

Engineered Alternatives Evaluation Factors	A. Adequacy of Requirements and Criteria	B. Validity of Assumptions	C. Alternative Interpretations	D. Uncertainty of Results and Consequences if Wrong	E. Appropriateness and Limitations of Methodology and Procedures	F. Adequacy of Application	G. Accuracy of Calculations	H. Validity of Conclusions
Evaluation of the EA Screening Process	Generally considered to be adequate, although some other potential EAs could have been added.	Evaluation was qualitative and was to assess assurance, not compliance. This assumption was prescribed by law and was therefore considered valid.	None.	The screening process was conservative in nature and was thus more inclusive than exclusive.	The screening process was considered to be appropriate. A better description of the process would have enhanced the report.	The sequence of comparing, scoring, prioritizing, etc. was adequate to achieve the results.	The use of algorithms and professional judgement were deemed appropriate.	The final list of EAs selected for further analysis was reasonable.
1. Long Term Repository Performance	Adequate	Broad Level: Appropriate. Detailed Level: Intrusion scenarios assumed to occur at 5,000 years; and actinide solubility assumptions were conservative.	Different creep closure models or model coefficients may affect the relative benefits of EAs; and the effects of future mining nearby could have been considered as an additional human intrusion scenario.	Uncertainty will result due to the uncertainty of input parameters; however, no severe consequences if wrong; conservative parameter estimates were used.	Use of the DAM model to predict performance was appropriate; however, important advances in creep modeling were not used. Model did not (and cannot) consider stratigraphy (e.g., anhydrite layers) in the mechanical response calculations.	Compressive strengths of waste/backfill EAs is misleading; and intrusion before creep closure not adequately analyzed.	Creep rate calculations checked and qualitatively agree.	Effectiveness of some EAs may have been underestimated due to simultaneous consideration of pre-closure and post-closure risks.
2. Uncertainty in Compliance Assessment		Broad Level: Appropriate; Detailed Level: Uncertainty in creep parameters was not considered. Differences in creep closure estimates could affect the quantity and rates of release; early intrusion could result in significantly different releases; and EAs with plasma processing or clay backfill were not credited with enhanced Pu immobilization.		Relative nature of analysis allows meaningful conclusions to be drawn. Discussion of uncertainty in the results does not fully reflect the uncertainty analysis that was in fact carried out.		Methods used are completely applicable for comparative screening process		
3. Worker and Public Risk	Adequate	Risk assumptions are conservative, conventional, and adequate for the work performed.	None.	Uncertainties err on the side of safety and risks are likely overstated.	Methodology did not account for risks inherent in current waste handling methods. For example, relative risks could have been different for these EAs having long development/processing time.	Methods are applicable for the comparative screening process.	Calculations are reasonable and consistent.	Risk conclusions for CH waste appear valid. Risk conclusions for RH waste are absent.
4. Impact on Waste Removal	200 year period for waste removal requires justification; different time frames have a major impact on the methods used for retrieval.	Assumed excavation technology is appropriate, but the data used in the calculations is not state-of-the-art. For long term retrieval, assumptions and methodology used for mining rate and time estimates are correct; quantitative studies are needed. Short term retrieval method, rate, and schedule not addressed.	Alternative methods for recovery based on different time frames could have been performed.	Uncertainty associated with the compressive strength of the EAs is not critical to the relative comparison of EAs. The waste is removable with today's technology and the decisions made based on the EACBS are not irreversible.	Methodology was appropriate to estimate time required for long-term removal; however, some of the assumptions, data, and terminology were not suitable for the application.	Time of waste removal was not adequately addressed.	Overall, calculations could not be checked for accuracy; there is no reference to machine type, specifications, and utilization.	Although the quantitative results of the analysis can not be directly used for assessment of the EAs, the general conclusions based on a qualitative comparison with the baseline are valid and acceptable for long-term removal. Consideration of short-term removal could change the results.

Table ES-1 (continued). Summary of the Peer Review of the EACBS Evaluation Factors and Criteria

Engineered Alternatives Evaluation Factors	A. Adequacy of Requirements and Criteria	B. Validity of Assumptions	C. Alternative Interpretations	D. Uncertainty of Results and Consequences if Wrong	E. Appropriateness and Limitations of Methodology and Procedures	F. Adequacy of Application	G. Accuracy of Calculations	H. Validity of Conclusions
5. Transportation Risk	Adequate	Risk analysis assumes 20 year active life, yet the WIPP operational window is for 33 to 35 years. Transportation is by truck only, no explanation why rail is not evaluated. Overall, however, risk assumptions are conservative, reasonable and well within contemporary transportation risk analysis.	There is no reasonable alternative interpretation.	Population densities will be different if the period of transportation and disposal is greater than 20 years. An added risk could occur for those EAs which have a longer time frame.	The methodologies were considered to be generally appropriate. Limitations include addressing only CH waste, a "bounding" accident not being evaluated, and lack of justification for selected values. The limitations should not compromise the EA evaluation so long as the 20 versus 35 year issue is recognized.	Methods used are applicable for comparative screening process	Calculations appear to be reasonable and consistent with the methodology.	The conclusions drawn for purposes of a qualitative comparison of the transportation risks of the various EAs appears valid.
6. Public Confidence in the Performance of the Disposal System	Adequate	Assumptions regarding the public's concerns as to content, categorization, timeliness, and affected in-state population are reasonable. Although out of state populations were not addressed, this is not considered to be a major deficiency.	Slightly different interpretations are possible, but would not affect the conclusions of the study.	Uncertainty is low regarding the public's position on the EAs and slight misinterpretations are not considered serious.	The methodology used to assess public confidence was appropriate. A limitation is the lack of opportunity for out of state public comment.	Application of the methodology was considered proper.	Categorization of public comments was checked and determined to be relatively accurate with only minor discrepancies.	The conclusions appear appropriate.
7. System Cost and Schedule	Adequate	Cost and schedule assumptions are considered to be valid with uncertainty of approximately 30 percent associated with the uncertainty of the waste inventories.	A few alternate interpretations may originate from the guidance documents. However, they would have little effect on the study's results.	The estimated costs and schedules were reasonable.	The methodology for cost and schedule evaluation is considered appropriate.	Methodologies were appropriately applied.	Spot checks determined that calculations were performed according to accepted methods and procedures.	In general, the conclusions are valid.
8. Impact on Other Disposal Systems	Adequate	The assumptions of waste type and volume have uncertainties associated with them that may impact other disposal systems. The assumptions used appear reasonable.	The uncertainties associated with waste volume can be interpreted in different ways. Some interpretations will result in higher volumes while others will result in lower volumes.	Uncertainty of results are +10% to -25% based on waste volume uncertainty. No serious negative consequences should occur because of this uncertainty.	Procedures used are technically defensible. A limitation of the methodology is the reliance on the accuracy of waste volume.	The techniques used were adequate to meet the intended goal.	The basis of calculations was not provided in the EACBS; however, using reasonable assumptions, data spot checks were found to be accurate.	The conclusions reached are valid and support the end use of the report.

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1.0 INTRODUCTION

In March 1996 the U.S. Department of Energy (DOE) Carlsbad Area Office (CAO) requested through its operating contractor, Westinghouse - Waste Isolation Division, that the Waste-management Education & Research Consortium (WERC) provide a peer review of the Waste Isolation Pilot Plant (WIPP) Engineered Alternatives Cost/Benefit Study (EACBS) Final Report (DOE, 1995a). The WIPP is a DOE project designed to provide for the safe disposal of transuranic (TRU) waste in deep, geologic, bedded salt. As required by U.S. Environmental Protection Agency (EPA) regulations promulgated under Title 40 Code of Federal Regulations 191 (40 CFR Part 191: *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-level and Transuranic Radioactive Wastes;* EPA, 1985) DOE was required to examine additional engineered barriers beyond the salt itself to provide added assurance against waste migration. The DOE initiated the EACBS, required by EPA regulation 40 CFR 194 (*Criteria for the Certification and Re-certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations;* EPA, 1996), to provide a technical basis for the selection and rejection of engineered alternatives (EAs) for the WIPP should it be determined that additional barriers are needed to satisfy the assurance requirements of 40 CFR 191. EAs are defined as technically feasible processes, technologies, methods, repository designs, or waste modifications which make a significant positive impact on the disposal system in terms of reducing uncertainty in performance calculations or improving long-term performance. The EACBS includes a qualitative assessment of estimated costs, potential risks and benefits, and relative repository performance impacts resulting from the implementation of engineered alternatives. The EACBS was conducted as required by Section 194.44 of 40 CFR 194. Additionally, for purposes of convenience, the nine evaluation factors prescribed in 40 CFR 194 were rolled up into eight equivalent factors.

2.0 PURPOSE

The purpose of the peer review of the EACBS is to satisfy quality assurance requirements of 40 CFR 194. This final rule requires DOE to conduct a peer review of three specific elements of the WIPP program, one of which is engineered barriers. Because of the potential uncertainty in most geotechnical data and their analyses, the need to make projections over thousands of years, the lack of unanimity among experts, and the first-of-a-kind nature of geologic repository technical issues, expert judgement will need to be utilized in assessing the adequacy of work. Peer reviews are a mechanism by which these judgements may be made.

WERC (a consortium consisting of New Mexico State University, University of New Mexico, New Mexico Institute of Mining and Technology, Navajo Community College, Los Alamos

National Laboratory, and Sandia National Laboratory) was selected to organize this peer review because of its ability to assemble a panel of experts from diverse academic and industrial settings.

Background of the WIPP EACBS: The deep, geologic, bedded salt repository known as the WIPP is the United States' proposed permanent solution for disposal of TRU waste currently stored and generated by DOE. The WIPP repository is located in the Northern Delaware Basin in southeastern New Mexico (Figure 1) at a depth of approximately 2,150 feet below surface in a bedded salt (halite) formation. A cut-away view of the planned WIPP repository is shown in Figure 2. (See EACBS for greater detail concerning the geology and layout of the WIPP.) TRU waste identified for disposal is generated from DOE defense-related activities, including weapons production, research, and development and are stored at various DOE sites across the country. The majority of TRU waste is material contaminated with alpha emitting radionuclides (e.g., plutonium-239) with half lives greater than 20 years and activities greater than 100 nanocuries per gram of waste. Once salt is excavated to form disposal rooms, natural closure due to creep (plastic flow) of the surrounding salt formation on the order of a few inches per year occurs. In time, complete consolidation of the waste within the host rock occurs.

Under the *Waste Isolation Pilot Plant Land Withdrawl Act* (U.S. Congress, 1992) the 16 square mile area at the WIPP site has been withdrawn from public use and has been set aside for use in the safe disposal of TRU waste. Also by law, disposal of TRU waste must comply with rules and regulations promulgated by the EPA. The disposal system design consists of multiple barriers, both natural and man-made, located in the geologic salt deposit. These barriers were selected because of their ability to permanently isolate the waste from the accessible environment as required to comply with Subparts B and C of 40 CFR 191. As a part of the assurance requirements, 40 CFR 191.14 requires that barriers of different types shall be used to isolate the waste. The WIPP design uses both geologic (natural) and engineered barriers for waste isolation as specified by these regulations. However, to provide additional confidence in performance assessment calculations used to demonstrate compliance with the containment requirements, EAs could be used to provide additional assurance measures beyond those used to meet the containment requirements. These engineered alternatives, if used, function as barriers to the release of radioactive material.

The DOE initiated the EACBS to evaluate EAs for potential use as assurance measures. The EACBS evaluated these EAs using the following assumptions and guidance

- The baseline design (as defined in 1995) of the disposal system and its predicted performance meet the containment requirements of 40 CFR 191 without additional EAs. The baseline does not include waste processing above that required by the WIPP Waste Acceptance Criteria and does not include backfill around the containers of waste as an option.

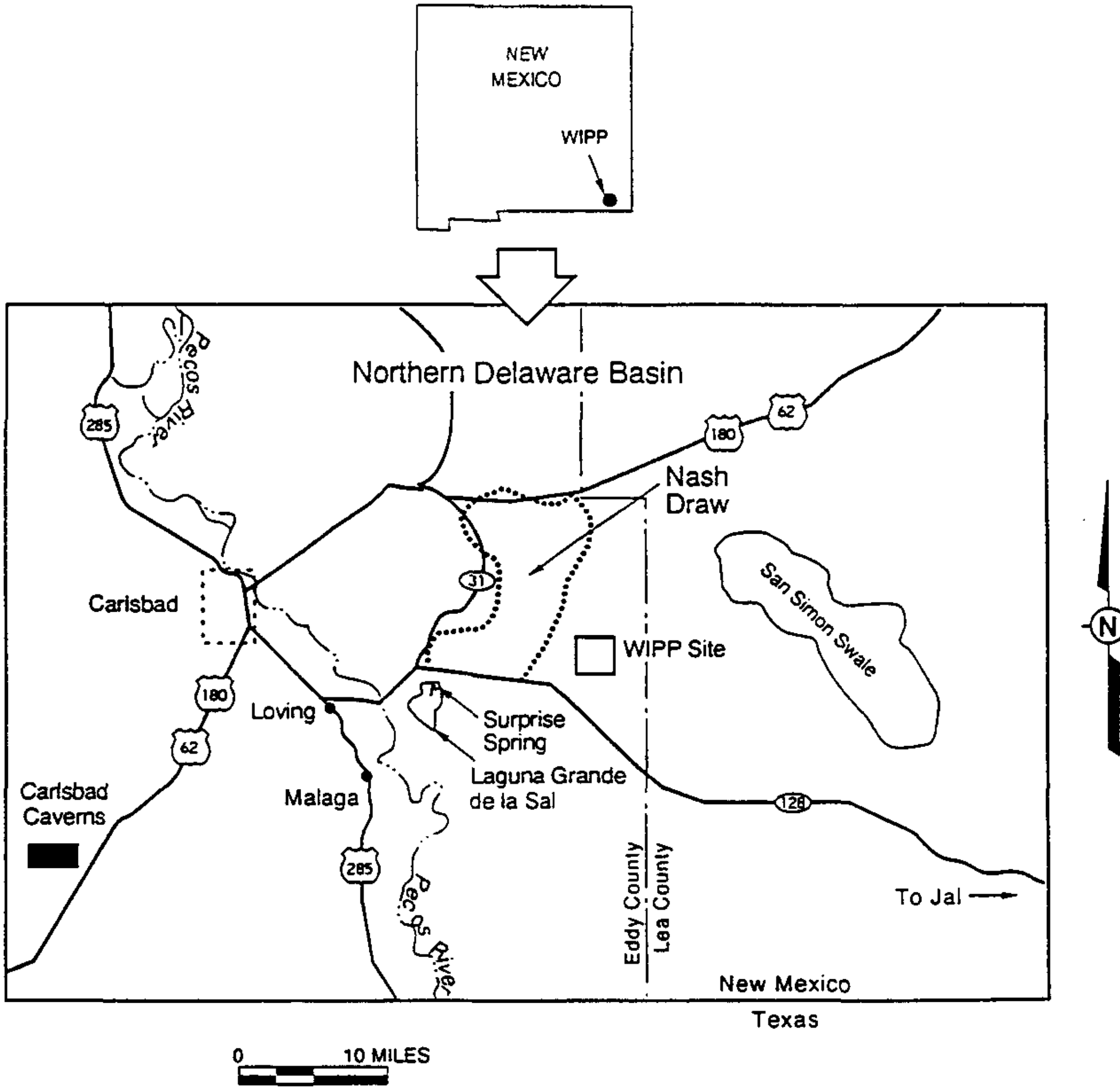

Figure 1
The WIPP Location in Southeastern New Mexico

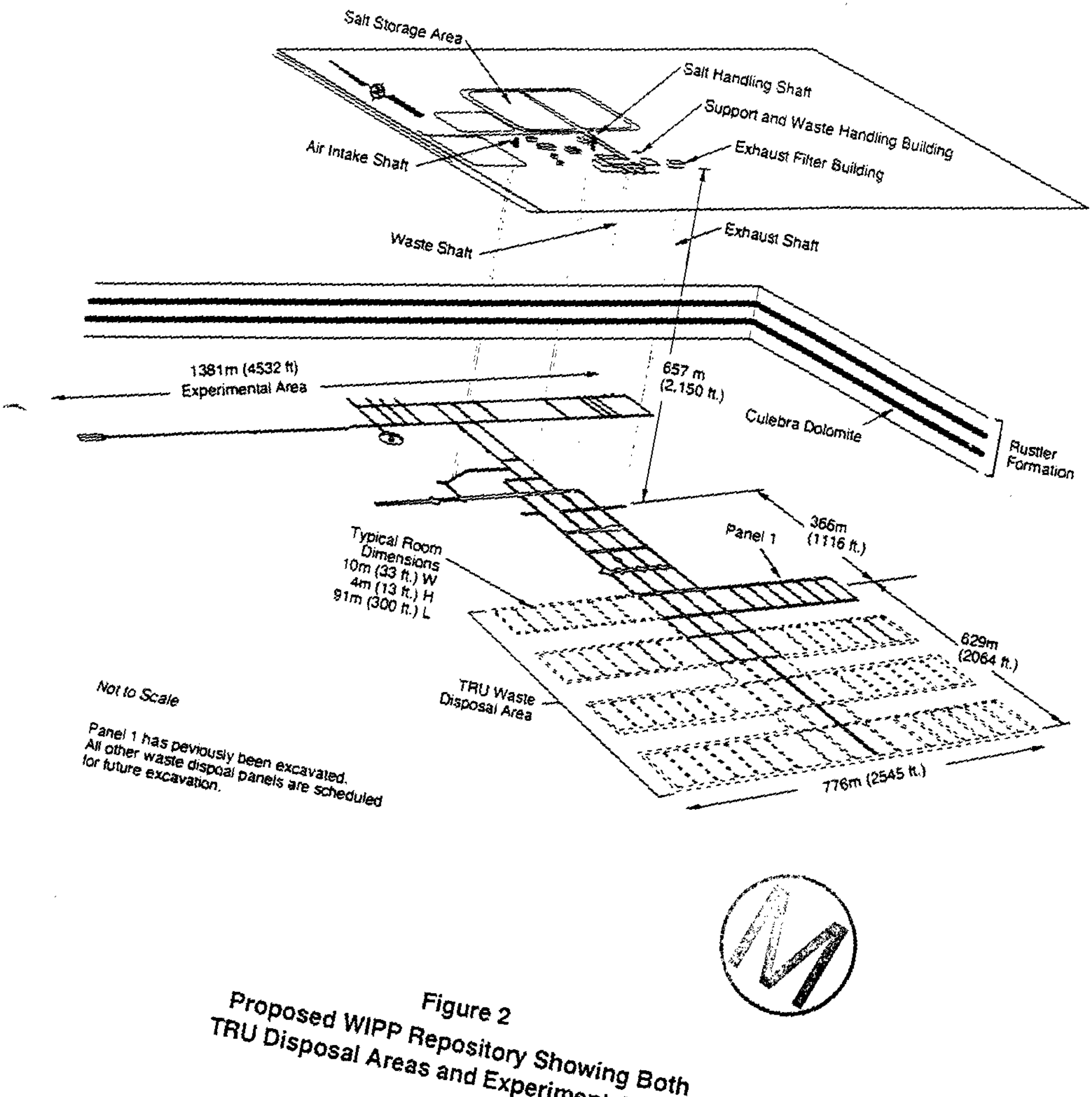

Figure 2
Proposed WIPP Repository Showing Both
TRU Disposal Areas and Experimental Areas

- The information presented in the EACBS is to be used to select or reject EAs for assurance purposes only and is not for demonstrating compliance with the containment requirements.

- The results of the EACBS analysis are qualitative. However, both qualitative and quantitative methods are used to generate the output information.

- The output of the EACBS compares the results of the EAs analysis with the baseline and not to each other. Numerical ranking of EAs is not provided.

- The EAs analysis uses a multi-factor approach that evaluates the cost, the risk (both incidental and accidental), and the benefit and schedule impacts that could be expected from the implementation of each individual EA. The factors are not ranked or weighted.

- TRU waste destined for WIPP can be grouped into three basic waste forms: sludges, solid organics, and solid inorganic materials.

- All waste shipped to WIPP will meet the Waste Acceptance Criteria. These requirements reflect any necessary waste treatment or processing requirements to safely transport and emplace the waste.

3.0 PEER REVIEW PROCESS

The peer review of the EACBS was conducted in accordance with the U.S. Nuclear Regulatory Commission NUREG-1297 *Peer Review for High-level Nuclear Waste Repositories* (NRC, 1988), and the DOE Carlsbad Area Office *Peer Review Procedure* TP 10.5 (DOE, 1996). Peer review panel members and their affiliations are:

Ron K. Bhada (peer panel leader)	WERC and New Mexico State University
Catherine T. Aimone-Martin	New Mexico Institute of Mining and Technology
Arturo Duran	Environmental Consulting and Engineering
Douglass J. Kuhns	Lockheed Martin Idaho Technologies Company
Cindy R. Lewis	Parsons Engineering Science
James D. Navratil	Rust Federal Services
Jamal Rostami	Colorado School of Mines
Dennis M. Smith	Technical & Management Systems & Services, Inc.
Krishan K.Wahi	Geologic Repository Assessment Methodologies, Inc.

The peer review management team members are:

Abbas Ghassemi (project manager)	New Mexico State University/WERC
Tim Carlson	Rust Federal Services, Inc.
Laura Cummins	Rust Federal Services, Inc.
Mark Nolen	New Mexico State University

Biographic sketches of the panel members and the management staff used to generate the peer review report are included in Appendix A. Meetings of the peer panel were held on April 29, 30 and May 1 in Carlsbad, and May 29-31, and July 8-10, in Albuquerque, New Mexico. The initial meeting in Carlsbad, NM, was for orientation and training of the peer review panel, and to tour the WIPP site. The review of the initial screening process also was performed at this time by the Peer Review Committee. 40 CFR 194.27 prescribes that the peer review shall be conducted in a manner compatible with NUREG-1297. Panel members performed their evaluation of the EACBS based on the following criteria prescribed in 40 CFR 194:

- validity of assumptions
- alternate interpretations
- uncertainty of results and consequences if wrong
- appropriateness and limitations of methodology and procedures
- adequacy of application
- accuracy of calculations
- validity of conclusions
- adequacy of requirements and criteria

Agendas for all three meetings are presented in Appendix B. During these meetings, full and frank discussions between the peer reviewers and the original performers of the work occurred. The intent of the peer review was to assess the validity of the assumptions and the technical approach used in the EACBS, and to confirm the adequacy of the work. It was not to assess the validity of the WIPP project, the requirement to perform the EACBS, the 40 CFR 194 analysis requirements, nor the ability of the WIPP to meet compliance standards. The review conducted was a high-level analysis, focused on determining the reasonableness of conclusions reached in the EACBS. The intent of the review was not to reproduce the calculations and results of the report in great detail.

In the EACBS report, each alternative considered was analyzed with respect to eight different factors specified in 40 CFR 194 (the regulation actually specifies nine factors, two of which were combined for the EACBS[1]). Those factors are as follows:

- Factor 1 Long term repository performance
- Factor 2 Uncertainty in compliance assessment
- Factor 3 Impact on public and worker exposure
- Factor 4 Impact on waste removal
- Factor 5 Transportation risk
- Factor 6 Public confidence
- Factor 7 Impact on system cost and schedule
- Factor 8 Impact on other disposal systems

The EACBS relies heavily upon previously published documents for backup of the identification and evaluation of the EAs. These include the *Evaluation of the Effectiveness and Feasibility of the Waste Isolation Pilot Plant Engineered Alternatives: Final Report of the Engineered Alternatives Task Force* (DOE, 1991a), *Office of Environmental Management Programmatic Environmental Impact Statement* (DOE, 1994a), *Interim Mixed Waste Inventory Report: Waste Streams, Treatment Capacities and Technologies* (DOE, 1993), *Waste Isolation Pilot Plant Transuranic Waste Baseline Inventory Report* (DOE, 1995b), *Comparative Study of Waste Isolation Pilot Plant Transportation Alternatives* (DOE, 1995c), *Waste Acceptance Criteria for the Waste Isolation Pilot Plant* (DOE, 1991b), *Final Supplement Environmental Impact Statement, Waste Isolation Pilot Plant* (DOE, 1990), and the *Final Environmental Impact Statement, Waste Isolation Pilot Plant* (DOE, 1980). Because the EACBS is not a stand alone document for peer review purposes, the peer panel also reviewed relevant portions of these documents.

To review the large amount of information provided in the EACBS, the peer panel divided itself into three subcommittees to address specific factors of the study. Subcommittees were established for reviewing the eight different EA evaluation factors identified in 40 CFR 194 with reviewers divided by expertise that was most appropriate for each set of factors. The subcommittees were composed of the following:

- Group 1 - Factors 1 and 2 - Cathy Aimone-Martin, Jim Navratil, and Krishan Wahi.
- Group 2 - Factors 3, 4, and 5 - Cindy Lewis, Jamal Rostami, and Dennis Smith.
- Group 3 - Factors 6, 7, and 8 - Ron Bhada, Arturo Duran, and Doug Kuhns.

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[1] Two of the original factors were combined into Factor 1. Those factors were: (1) the ability of the engineered barrier to prevent or substantially delay the movement of water or waste toward the accessible environment, and (2) the effects on mitigating the consequences of human intrusion.

The subcommittee reports (presented in Appendix C) represent the principal observations/conclusions drawn by the peer panel in accordance with the 8 evaluation criteria specified previously in this section. Highlights of these reports are contained in Section 4.0 and are summarized in Section 5.0. The entire peer review panel agrees with the substance of this peer review report.

4.0 EVALUATION OF WORK PERFORMED

The evaluation of the alternative identification/screening process was completed by the peer review panel as a whole. Detailed evaluation of the eight factors used to perform the EACBS was completed by subcommittees of the peer panel; these evaluations were subsequently reviewed by the entire panel. This section of the report summarizes the results of the evaluation process conducted by the peer review panel members. Subcommittee reports, with results organized by individual evaluation criteria, can be found in Appendix C. The major findings of those reports are presented here. Subcommittee reports are summarized in Table 1 in Section 5 of this report. The discussion in this section covers only the main points identified in the evaluation process.

For the most part, panel members focused their evaluation on discretionary issues that were under the control of the report preparers, rather than those that were prescribed by regulation. In addition, it was recognized that the EACBS report is one of many other studies that have been completed or are ongoing for the WIPP facility. Other assumptions, standards, etc., may have been established in previous work that also feed into the EACBS report. A critique of prior work was beyond the scope of this review.

4.1 Results of the Engineered Alternatives Identification/Screening Process

In general, the peer panel members thought that the identification/screening process was adequate. However, members felt that the EACBS report was not very clear on the description of the screening process to clearly understand the steps and criteria involved. Only after presentations by and discussions with those involved in the identification/screening process did the members come to a mutual understanding of how the process was carried out. Among the findings of the panel are the following:

- Clarification is needed in the text of the report on the steps involved in the identification/screening process, including steps that occurred after the Engineered Alternatives Task Force performed their initial evaluation. Better define what is meant by "screening," "optimization," and "prioritization." Clearly state the criteria used for each stage of the process.

- Some concern was expressed that the screening process was conducted independent of a consideration of the eight factors used in evaluating the EAs. If the screening process and evaluation of EAs according to the eight factors had been iterative, the list of EAs analyzed as well as the results of both the screening process and the evaluation of the EAs may have been different. However, this would probably be an endless process of iterations and not justified because of cost and time involved.

- Remote-handled waste was not considered. This issue may have implications to the compliance application.

4.2 Evaluation of Factors 1 and 2: Impacts on Long-term Repository Performance and Uncertainty in Compliance Assessment

These factors focused primarily on the analyses performed with the Design Analysis Model (DAM) computer simulation program. This program was used to predict the future performance of the repository with different engineered alternatives given three different human intrusion scenarios. Values for several parameters are required as input to the model. Many input parameters were treated as being uncertain; i.e., ranges and distributions were assigned to such parameters. Other parameters were given constant (single point) values. The panel members checked many of these parameters, as well as quality assurance documentation for the computer simulation itself. No major discrepancies or errors were noted. It was noted that much of the information used in the model was selected to be consistent with the Performance Assessment (PA) being conducted by Sandia National Laboratories (SNL).

Among the findings of the evaluation of factors 1 and 2 are the following:

- The simplifying assumptions used in the model are valid given that the results are to be used in a relative, not absolute, manner. Actual calculated releases of radionuclides, although not absolute, are acceptable for comparison purposes.

- Creep closure modeling did not consider uncertainty in creep parameters nor did it incorporate important advances in creep modeling. Different time periods for closure would have likely resulted which may have changed the relative ratings of the EAs, but the conclusions will probably not change.

- The EACBS report assessed the effect of human intrusion at 5000 years as well as additional simulations for the baseline and nine selected alternatives at 200, 2000, and 7000 years. This assessment concluded that the Measures of Relative Effectiveness (MREs) are insensitive to the time of intrusion once the physical properties (density and permeability) of the composite material in the room reaches a steady-state condition. This occurs some time between 200 and 2000 years. One exception is the MREs at 200 years which differ by several percent from the MREs at later years because the composite material in the rooms at 200 years is still in the process of consolidating from creep closure, and this consolidation occurs at different rates for each alternative. Consolidation of the composite material is complete by 2000 years, so the MREs remain constant thereafter. Had the analysis included radionuclide transport within the Culebra, it is likely that the results would have shown a stronger sensitivity to the time of intrusion (e.g., within a few hundred years).

- The uncertainty analysis in the EACBS report focused on uncertainty associated with input parameters. Uncertainty associated with the model itself and with the future state of the disposal system were not considered.

- Because the study focuses on potential benefits of EAs beyond the baseline design, consequences of reaching a wrong conclusion are not expected to be severe.

- Lack of a user's manual for the DAM code makes it difficult to independently verify calculations in the EACBS report.

- The comparative, unweighted approach used for evaluating alternatives results leads to an inevitable trade-off between long-term performance and short-term risk. The DOE can avoid this pitfall by separately evaluating the merits of each EA in the post-closure phase only. Specifically, by comparing only the first two columns of results in Figure E-4 (of the EACBS report), one can more clearly see the long-term benefits offered by each EA.

- The effectiveness of EAs with clay backfill or vitrification treatment was underestimated because the enhanced immobilization of actinides within these matrices was not assumed.

4.3 Evaluation of Factor 3: Impact of Engineered Alternatives on Worker and Public Risk

Review of Factor 3 indicated that the methodology used for assessing alternatives for worker and public risk was consistent with accepted, conservative techniques. Methods and assumptions used are defensible. Major concerns expressed are as follows:

- An evaluation of risks associated with processing of remote-handled (RH) waste is absent. It would be useful to include a discussion of the possible relative comparison between the risks associated with contact-handled (CH) and RH waste. For example, one can draw conclusions based on radionuclide difference, radionuclide mobility, potential for release, transport mechanisms, and exposure scenarios associated with both waste processing and long-term performance.

- Many of the assumptions used in assessing worker and public risk appear to be borrowed from the Draft Waste Management Programmatic Environmental Impact Statement (WMPEIS; DOE, 1995d). While these assumptions may be valid, additional discussion of them in the text of the EACBS would provide further clarification.

- Additional risks posed by allowing the waste to remain above ground for longer time periods necessitated by some of the EAs were not evaluated. This could underestimate risks associated with those EAs.

4.4 Evaluation of Factor 4: Waste Removal Impact

The evaluation of Factor 4 was conducted in the context of the 40 CFR 194.44, assuming that the removal of the emplaced waste and backfill (after the regulatory closure) is possible. The factor considers the impact of EAs on waste removal after 200 years with no justification. The methodology used and the conclusions made based on a qualitative comparison using the volume and the time required for removal is acceptable. However, the following issues were raised with respect to this factor:

- Short-term removal of the waste and backfill (from regulatory closure of the repository to geological closure of the rooms) was not considered. Had the short term removal scenarios been considered, the results of relative comparison may be different.

- If waste removal had been one of the evaluation criteria, different alternatives may have reached the detailed evaluation stage (e.g., the EAs which passed through each screening process may have included one or more additional alternatives than the EAs contained in the final list).

- The results of implementing any of the EAs would not be irreversible and waste could be removed after disposal, using current technology.

- The assumptions and conclusions should be used for comparative purposes only. Some assumptions used for quantitative calculations were inappropriate for the circumstances but serve the purpose for a comparative study.

4.5 Evaluation of Factor 5: Impact of the Engineered Alternatives on Transportation Risk

Generally, the evaluation of transportation risk was conducted according to standard, accepted practices, particularly for radionuclides. Standard risk calculation methods were used and were determined to be conservative, conventional, and appropriate. The major points raised through the peer review are as follows:

- The "worst case" accident considered in the reference document for the EACBS (the Final Supplement Environmental Impact Statement; DOE, 1990) appears to have been eliminated from consideration in the EACBS with no justification. RADTRAN accounts for accident severity categories within its code. Therefore modeling of an additional worst-case accident would not provide substantive additional information.

- For chemical hazards, risks are calculated solely on a consideration of wasteform characteristics. Transportation-related aspects of the scenario (e.g., mileage, population density) were not included; an accidental release was simply assumed. This full range of transportation impacts cannot, therefore, be evaluated.

- The analysis in the EACBS relied heavily on previous work done for the WIPP Final Environmental Impact Statement (FEIS) and Final Supplement Environmental Impact Statement (FSEIS). However, methods used in these previous reports varied; information was not provided in the EACBS to indicate which methods came from original documents and what the justification was for using the methods selected in the EACBS.

- The risk analysis assumes a 20-year active life for transportation and disposal of waste; however, the operational window for WIPP is approximately 35 years. Additional population densities might affect the impact analysis of alternatives that require treatment and greater than 20 years to complete transportation and disposal. The panel members do not feel that the apparent discontinuity in this assumption is limiting to the assessment of transportation-related risks.

4.6 Evaluation of Factor 6: Impact of Engineered Alternatives on Public Confidence

Public confidence was assessed by conducting general and focused public meetings over a six-year period (not all meetings were specific to receiving input on EAs). Input received by members of the public through this process indicates that the majority of public sentiment is not directly related to any specific EA, but is mostly related to an overall perception of the Department of Energy's credibility. Methods used to collect and analyze information were deemed to be appropriate, though subject to interpretation. The conclusions of the EACBS report are appropriate and reasonable. The only issue raised was the lack of public input from New Mexico's neighboring states. However, because of the diverse nature of the public input, no significant impact on the conclusions of the EACBS report is expected.

4.7 Evaluation of Factor 7: Total System Costs and Schedule Estimates

The evaluation of this factor focused largely on the assumptions and methodologies used and the results of their application. The assumptions, methodologies and results were divided into five separate categories for review: (1) waste processing, (2) transportation, (3) backfill emplacement, (4) waste emplacement handling, and (5) schedule. Overall, the panel members found no significant flaws in the estimates for costs and schedules. Standard references were used to compile this information along with experience gained through work on other comparable DOE projects. The panel members agreed that development of the schedule and cost estimates was appropriate, reasonable, and defensible. They also concurred with the observation made in the EACBS that none of the EAs presents significant benefits over the baseline with regard to cost or schedule considerations. Finally, they agreed that when looking at the schedules alone for each of the alternatives, no alternative presents significant detriments relative to the baseline for the closure of WIPP.

4.8 Evaluation of Factor 8: Impact on Other Waste Disposal Programs

This factor is defined in the EACBS as the determination of major impacts an EA will have on other waste disposal and processing programs, including low-level and mixed low-level waste. Therefore, the focus in evaluating this factor was on volumes of waste generated through the implementation of the EAs considered in the EACBS report. It was acknowledged that a great deal of uncertainty is involved in estimating waste volumes that will require disposition; however, the panel members determined that estimates were based on the best available information at the time. It is recommended that these volume estimates be updated as more accurate information becomes available to ensure adequate facilities and resources for disposal. Other findings from a review of data related to this factor are as follows:

- Except for plasma arc, all other EAs that include treatment are assumed to result in waste volumes similar to cementation processes used at Rocky Flats (an increase of 75%). An additional 30% (of the total waste volume) of secondary waste is anticipated to be generated, resulting in a total of 2.275 drums from the treatment of a single drum.

- The EACBS report for this factor is difficult to follow at times and could benefit from clarification and the use of examples to show how waste volume estimates were made.

- It is not clear by reading the EACBS report how the volumes of waste destined for WIPP are factored in to the report. A best estimate of waste to be disposed should be provided for WIPP operations personnel.

- Percentages of secondary waste generated vary widely with respect to the type of EA implemented. However, the report uses a 50% figure for both low-level and low-level mixed secondary waste. The use of the actual average percentages would provide a more accurate estimate of waste volumes generated.

- The actual waste that may be generated by implementing an EA may be as much as 10% higher or 25% lower than estimated volumes after treatment, which are provided in the EACBS. This uncertainty is acceptable at this time, as no definitive information is available to provide a more accurate estimate. These estimates should be revisited and revised as more information becomes available.

- The report could benefit by a discussion of other possible impacts on the different DOE disposal systems, not just waste generation.

5.0 SUMMARY OF PEER REVIEW RESULTS

The panel, as a whole, evaluated the reasonableness of the alternatives identification/screening process. The EACBS peer review panel was then divided into three separate subcommittees to assess the validity and reasonableness of the alternatives with respect to the eight factors prescribed in 40 CFR 194. Each factor was evaluated using eight evaluation criteria established in NUREG-1297. This review was based on information provided by the authors of the report and the DOE Carlsbad Area Office; detailed review of the EACBS and supporting documents; and follow-up interviews with the authors of the report. While time did not allow a total evaluation of all the details embodied within the EACBS (e.g., all calculations were not checked), the peer review panel did establish an overall understanding of the process by which it was generated and the fundamental philosophy for its development. The results of this evaluation are summarized in Table 1 and reflect the overall assessment of the EACBS by the peer review panel.

Table 1. Summary of the Peer Review of the EACBS Evaluation Factors and Criteria

Engineered Alternatives Evaluation Factors	A. Adequacy of Requirements and Criteria	B. Validity of Assumptions	C. Alternative Interpretations	D. Uncertainty of Results and Consequences if Wrong	E. Appropriateness and Limitations of Methodology and Procedures	F. Adequacy of Application	G. Accuracy of Calculations	H. Validity of Conclusions
Evaluation of the EA Screening Process	Generally considered to be adequate, although some other potential EAs could have been added.	Evaluation was qualitative and was to assess assurance, not compliance. This assumption was prescribed by law and was therefore considered valid.	None.	The screening process was conservative in nature and was thus more inclusive than exclusive.	The screening process was considered to be appropriate. A better description of the process would have enhanced the report.	The sequence of comparing, scoring, prioritizing, etc. was adequate to achieve the results.	The use of algorithms and professional judgement were deemed appropriate.	The final list of EAs selected for further analysis was reasonable.
1. Long Term Repository Performance	Adequate	Broad Level: Appropriate. Detailed Level: Intrusion scenarios assumed to occur at 5,000 years; and actinide solubility assumptions were conservative.	Different creep closure models or model coefficients may affect the relative benefits of EAs; and the effects of future mining nearby could have been considered as an additional human intrusion scenario.	Uncertainty will result due to the uncertainty of input parameters; however, no severe consequences if wrong; conservative parameter estimates were used.	Use of the DAM model to predict performance was appropriate; however, important advances in creep modeling were not used. Model did not (and cannot) consider stratigraphy (e.g., anhydrite layers) in the mechanical response calculations.	Compressive strengths of waste/backfill EAs is misleading; and intrusion before creep closure not adequately analyzed.	Creep rate calculations checked and qualitatively agree.	Effectiveness of some EAs may have been underestimated due to simultaneous consideration of pre-closure and post-closure risks.
2. Uncertainty in Compliance Assessment		Broad Level: Appropriate; Detailed Level: Uncertainty in creep parameters was not considered. Differences in creep closure estimates could affect the quantity and rates of release; early intrusion could result in significantly different releases; and EAs with plasma processing or clay backfill were not credited with enhanced Pu immobilization.		Relative nature of analysis allows meaningful conclusions to be drawn. Discussion of uncertainty in the results does not fully reflect the uncertainty analysis that was in fact carried out.		Methods used are completely applicable for comparative screening process		
3. Worker and Public Risk	Adequate	Risk assumptions are conservative, conventional, and adequate for the work performed.	None.	Uncertainties err on the side of safety and risks are likely overstated.	Methodology did not account for risks inherent in current waste handling methods. For example, relative risks could have been different for these EAs having long development/processing time.	Methods are applicable for the comparative screening process.	Calculations are reasonable and consistent.	Risk conclusions for CH waste appear valid. Risk conclusions for RH waste are absent.
4. Impact on Waste Removal	200 year period for waste removal requires justification; different time frames have a major impact on the methods used for retrieval.	Assumed excavation technology is appropriate, but the data used in the calculations is not state-of-the-art. For long term retrieval, assumptions and methodology used for mining rate and time estimates are correct; quantitative studies are needed. Short term retrieval method, rate, and schedule not addressed.	Alternative methods for recovery based on different time frames could have been performed.	Uncertainty associated with the compressive strength of the EAs is not critical to the relative comparison of EAs. The waste is removable with today's technology and the decisions made based on the EACBS are not irreversible.	Methodology was appropriate to estimate time required for long-term removal; however, some of the assumptions, data, and terminology were not suitable for the application.	Time of waste removal was not adequately addressed.	Overall, calculations could not be checked for accuracy; there is no reference to machine type, specifications, and utilization.	Although the quantitative results of the analysis can not be directly used for assessment of the EAs, the general conclusions based on a qualitative comparison with the baseline are valid and acceptable for long-term removal. Consideration of short-term removal could change the results.

Table 1 (continued). Summary of the Peer Review of the EACBS Evaluation Factors and Criteria

Engineered Alternatives Evaluation Factors	A. Adequacy of Requirements and Criteria	B. Validity of Assumptions	C. Alternative Interpretations	D. Uncertainty of Results and Consequences if Wrong	E. Appropriateness and Limitations of Methodology and Procedures	F. Adequacy of Application	G. Accuracy of Calculations	H. Validity of Conclusions
5. Transportation Risk	Adequate	Risk analysis assumes 20 year active life, yet the WIPP operational window is for 33 to 35 years. Transportation is by truck only, no explanation why rail is not evaluated. Overall, however, risk assumptions are conservative, reasonable and well within contemporary transportation risk analysis.	There is no reasonable alternative interpretation.	Population densities will be different if the period of transportation and disposal is greater than 20 years. An added risk could occur for those EAs which have a longer time frame.	The methodologies were considered to be generally appropriate. Limitations include addressing only CH waste, a "bounding" accident not being evaluated, and lack of justification for selected values. The limitations should not compromise the EA evaluation so long as the 20 versus 35 year issue is recognized.	Methods used are applicable for comparative screening process	Calculations appear to be reasonable and consistent with the methodology.	The conclusions drawn for purposes of a qualitative comparison of the transportation risks of the various EAs appears valid.
6. Public Confidence in the Performance of the Disposal System	Adequate	Assumptions regarding the public's concerns as to content, categorization, timeliness, and affected in-state population are reasonable. Although out of state populations were not addressed, this is not considered to be a major deficiency.	Slightly different interpretations are possible, but would not affect the conclusions of the study.	Uncertainty is low regarding the public's position on the EAs and slight misinterpretations are not considered serious.	The methodology used to assess public confidence was appropriate. A limitation is the lack of opportunity for out of state public comment.	Application of the methodology was considered proper.	Categorization of public comments was checked and determined to be relatively accurate with only minor discrepancies.	The conclusions appear appropriate.
7. System Cost and Schedule	Adequate	Cost and schedule assumptions are considered to be valid with uncertainty of approximately 30 percent associated with the uncertainty of the waste inventories.	A few alternate interpretations may originate from the guidance documents. However, they would have little effect on the study's results.	The estimated costs and schedules were reasonable.	The methodology for cost and schedule evaluation is considered appropriate.	Methodologies were appropriately applied.	Spot checks determined that calculations were performed according to accepted methods and procedures.	In general, the conclusions are valid.
8. Impact on Other Disposal Systems	Adequate	The assumptions of waste type and volume have uncertainties associated with them that may impact other disposal systems. The assumptions used appear reasonable.	The uncertainties associated with waste volume can be interpreted in different ways. Some interpretations will result in higher volumes while others will result in lower volumes.	Uncertainty of results are +10% to -25% based on waste volume uncertainty. No serious negative consequences should occur because of this uncertainty.	Procedures used are technically defensible. A limitation of the methodology is the reliance on the accuracy of waste volume.	The techniques used were adequate to meet the intended goal.	The basis of calculations was not provided in the EACBS; however, using reasonable assumptions, data spot checks were found to be accurate.	The conclusions reached are valid and support the end use of the report.

6.0 OBSERVATIONS AND CONCLUSIONS

In its deliberations during May, June, and July 1996 the peer panel identified that much of the information presented within the EACBS is of high quality and the approach taken is valid with conclusions drawn being reasonable. The peer review panel also noted the following observations and conclusions associated with the EACBS:

- The EA identification/screening process used a multiple step approach that included not only technical considerations, but also a consideration of regulatory constraints and professional judgement. The screening process, although not iterative, was considered to be appropriate.

- The screening process could be designed to be iterative with the factor analysis by including some EAs that could have major impact on results of specific factors (i.e., EAs using different container material such as ceramics/glass could have major impact on waste removal although they did not pass the screening process).

- Had the analysis included radionuclide transport within the Culebra, it is likely that the results would have shown a stronger sensitivity to the time of intrusion (e.g., within a few hundred years).

- Creep closure modeling did not consider uncertainty in creep parameters nor did it incorporate important advances in creep modeling. Different time periods for closure would have likely resulted from such considerations which may have changed the relative ratings of the EAs.

- The effectiveness of EAs with clay backfill or vitrification treatment were underestimated because the enhanced immobilization of actinides within these matrices was not assumed.

- The methodology did not account for risks inherent in current waste handling methods. For example, relative risks could have been different for those EAs having longer development/processing times.

- The costs and schedules identified in the EACBS are adequate and are based on data typically used for similar studies. As cost and schedule information is refined, these data can be revised to reflect current knowledge.

- Uncertainty in waste inventory requires a reexamination as new information becomes available that could influence the decision making process.

- The relative nature of the alternatives comparison decreases the chance that uncertainties in assumptions used in the evaluation process would have an impact on the evaluation results.

- Short-term removal of the waste and backfill (from regulatory closure of the repository to geological closure of the rooms) was not considered. Had short-term removal scenarios been considered, the results of relative comparison could have been different.

- Public confidence could have benefited from involvement of the public from states neighboring New Mexico and those that plan to ship waste to WIPP. Although this involvement was not evident in the EACBS, it was not felt to be a significant issue that would have substantially altered the results.

- With respect to the adequacy of requirements and criteria, the panel members agreed that these were prescribed by regulation for most of the factors and was, therefore, beyond the scope of their review.

- The EACBS focused on evaluating measures that exceed compliance and are added assurance of performance beyond the baseline requirements. The major consequence of implementing an alternative based on a slightly incorrect evaluation is probably the expenditure of greater dollars than necessary and the addition of more time to implement the alternative. Safety is not impaired.

- To maximize the usefulness of the EACBS it will either need to be revised or certain sections (such as waste volume information) will need to be updated. This document can assist all DOE sites with their planning so it will be helpful to share the report across the complex.

- Some discrepancies are noted regarding waste volumes and the methodology used to evaluate Factor 8 (impact on other disposal systems). This confusion should be resolved in the future.

- Factor 8 only analyzed the impacts on other waste disposal programs. It would be beneficial to consider the DOE complex as a whole where additional impacts may be felt.

- Remote-handled waste was not considered. This issue may have implications to the compliance application.

APPENDIX A

M

Biographic Sketches of

Peer Panel Members

and Staff

APPENDIX A

SHORT BIOGRAPHICAL SKETCH OF PEER PANEL MEMBERS AND STAFF

D.1 Peer Panel Members

AIMONE-MARTIN, Catherine T. - Dr. Aimone-Martin received her BS degree in Geological Engineering from Michigan Tech and a PhD from Northwestern University in Mineral Resources Engineering and Management and Civil (Geotechnical) Engineering. She is currently Associate Professor and Department Chair of the Mineral and Environmental Engineering Department at New Mexico Institute of Mining and Technology in Socorro, New Mexico. Prior to joining New Mexico Tech in 1981, Dr. Aimone-Martin worked in the Canadian mining industry as a geological engineer evaluating ore reserves and mine planning options for an Ontario iron ore mine and a British Columbian copper mine. She further worked as a Geotechnical Engineer for Golder Associates in Seattle on geophysical exploration projects involving uranium and coal in South America. While working for STS, Ltd. in Chicago, she assisted project managers in foundation design and analysis and field quality control for large construction projects. While at New Mexico Tech, she was co-founder and Research Engineer of the Center for Explosives Technology Research. Dr. Aimone-Martin worked with Los Alamos National Labs, as a Lab Affiliate on shock attenuation experiments and seismic wave analysis (1983-1994). She served as Director of the State Mining and Mineral Resource Research Institute (1989-1994) and is currently a member of the U.S. National Committee for Rock Mechanics with the National Academy of Sciences. She instructs in the areas of laboratory and field assessment of rock and soil properties and behavior, instrumentation, applied mechanics and design of earth structures, geochemical evaluation of ore deposits, and numerical methods. She has co-authored numerous publications and has made presentations in the areas of rock mechanics, explosives engineering and structural response to blasting vibrations.

BHADA, Rohinton (Ron) - Dr. Bhada received his BS, MS and PhD degrees in Chemical Engineering from the University of Michigan and earned an MBA in Management from the University of Akron. He joined New Mexico State University as Department Head of Chemical Engineering in 1988 and currently holds the academic title of Associate Dean of Engineering at NMSU. He also directs the Waste-management Education and Research Consortium (WERC). For the 29 years before joining NMSU, Dr. Bhada held various positions at the Babcock and Wilcox Company and worked primarily in the areas of pollution control and energy conversion. In the early years of his career, his work was directly in research related to the above areas and resulted in many publications and new inventions, including a patent in the remediation area. In the later years at Babcock and Wilcox, he managed the New Products and Advanced Technologies Department. His professional activities include active work for the American Institute of Chemical Engineers, the American Academy of Environmental Engineers, the

American Society of Engineering Education and the National Society of Professional Engineers. Dr. Bhada is a registered professional engineer and was recently awarded the title of Diplomate of the American Association of Environmental Engineers. He is the author of over 100 papers and publications in the fields of energy conversion, thermodynamics and environmental engineering. He is also the co-editor or contributor to several textbooks in the area of environmental management and technology transfer.

DURAN, Arturo - Mr. Duran received his MS and BS degrees in Chemical Engineering from the New Mexico State University located in Las Cruces, NM. Mr. Duran has seven years of environmental professional experience as a private consultant and as a project manager with the Environmental Protection Agency (EPA). Mr. Duran's environmental expertise includes environmental management, environmental regulations, soil and ground water remediation, mixed waste treatment and disposal, hazardous waste management, and waste water engineering. Mr. Duran has worked as a project manager on more than 50 environmental projects including site investigations, feasibility studies, landfill closure, remedial design, construction and operation of groundwater and soil treatment systems and permitted RCRA storage, treatment and disposal facilities. Mr. Duran served as a member of the mixed-waste working group for the Western Governors' Development of On-Site Innovative Technologies (DOIT) Initiative. Mr. Duran has also participated in several expert panels regarding risk management and mixed waste treatment and disposal. Mr. Duran is coauthor of publications on Ion Exchange and Adsorption Processes.

KUHNS, Douglass J. - Mr. Kuhns received his BS degree in Geology and MS degree in Safety Science from the Indiana University of Pennsylvania. He is currently an advisory scientist/engineer for the Lockheed-Martin Idaho Technologies Corporation at the Idaho National Engineering Laboratory, which he joined in 1989. At the Idaho National Engineering Laboratory Mr. Kuhns has held a number of various positions in the environmental restoration/waste management arena. Some of his most interesting projects include the intrusive characterization and assessment of a mixed waste liquid disposal pit; an evaluation and recommendation concerning reported significant quantities of buried mercury; considerable effort on the assessment, treatment, storage, disposal, waste management, and characterization of buried mixed waste; preparation of a comprehensive plan to assess and remediate buried mixed waste tanks; a variety of remedial actions ranging from soil vapor extraction to landfill capping; and substantial effort with the Department of Energy's Technology Development office. He is also frequently involved in strategic planning initiatives designed to prepare the environmental restoration program for the future. Mr. Kuhns currently holds the Associate Safety Professional designation and is a member of the American Society of Safety Engineers. He is responsible for providing program and project management expertise, technical direction, supervision, leadership, and guidance for a number of environmental restoration projects where he frequently interacts with state and federal agencies.

LEWIS, Cindy - Ms. Lewis received her BS in Chemical Engineering from the University of Maryland. She is certified in Comprehensive Practice by the American Board of Industrial Hygienists. She is currently acting as a Chemical Engineer and Risk Assessment Specialist in the Mobile, Alabama office of Parsons Engineering Science, Inc. She previously managed the Environmental Safety and Health Department for Smith Environmental Technologies Corporation and acted as Risk Assessor under subcontract to the Department of Energy at the Grand Junction Project Office. Ms. Lewis has provided guidance and technical support for risk assessments conducted as part of environmental restoration efforts conducted under authority of RCRA and CERCLA for DOE (INEL and Savannah River) and DOD (Westover AFB, Plant PJKS, O'Hare AFB, Plant 36, and Redstone Arsenal). In addition, Ms. Lewis has developed methods and conducted occupational exposure risk assessments for a variety of industrial applications.

NAVRATIL, James D. - Dr. Navratil received his BA, MS and PhD degrees in Chemistry from the University of Colorado, Boulder, CO. He is Chief Scientist with Rust Federal Services and has more than 25 years of waste management and waste treatment experience. He has extensive experience with radioactive, hazardous and mixed wastes, actinide chemistry and radionuclide solubilities. His experience was mainly acquired at the US Department of Energy's Rocky Flats Plant, but he has also spent significant time with the International Atomic Energy Agency, DOE's Energy Technology Engineering Center and Chemical Waste Management's Geneva Research Center. Dr. Navratil taught chemical engineering and extractive metallurgy subjects at The University of New South Wales, Australia from 1987 to 1990. He has more than 200 publications, including several patents and 20 books, to his credit. He is a member of the American Chemical Society, the American Institute of Chemical Engineers and Sigma Xi, a Fellow of The Royal Australian Chemical Institute and of the American Association for the Advancement of Science.

ROSTAMI, Jamal - Mr. Rostami received his BS in Mining Engineering from faculty of engineering of the University of Tehran in 1987. He received his MS in the department of Mining Engineering of the Colorado School of Mines (CSM) in 1991. He is currently a senior research associate at the Earth Mechanics Institute (EMI) while preparing to defend his PhD thesis in the Department of Mining Engineering. He joined CSM in 1989 and started working at EMI in 1990. Prior to joining CSM, he worked at various capacities in Iranian Institute of Mineral Research and Application in the field of mineral processing. He has affiliations with several professional societies in the field of mining and tunneling. Presently, he is chairman of publication of mechanical mining unit committee of the Society of Mining Engineers (SME). His area of interest and expertise includes mechanical excavation, machine design and selection, cutterhead layout and design optimization, performance prediction and analysis, mechanized mining, underground mining of coal, industrial mineral, and hard metallic rock, micro-tunneling and trench-less technology, geotechnical testing and exploration, feasibility study, and surface mining. He has made several presentations, given many lectures, and taught in several short courses. He has been project manager and principle investigator on several projects and has a number of reports, as well as several papers, in conference publications and journals.

SMITH, Dennis, M. - Mr. Smith received his BS degree in Environmental Health from Colorado State University (1976) and his MS in Environmental Chemical Hazard Analysis (1990) from the University of Pittsburgh. Completion of his ME in Engineering Management from the University of Colorado is expected in 1997. He is currently president of Technical & Management Systems & Services Inc,. an environmental management consulting firm in Littleton, Colorado. Mr. Smith's background includes nearly 20 years of progressive environmental science and engineering highlighted by 13 years in the hazardous waste industry. For three years (1990 - 1993) Mr. Smith was manager of risk and remedial action analysis for the DOE's environmental restoration program at Rocky Flats. In that position he was responsible for overall risk assessment and risk management activities for environmental remediation programs. In addition, he has spent nearly 11 years in the environmental consulting industry. Mr Smith is a board certified industrial hygienist with extensive experience in the fields of occupational safety and health, and radiation protection. Major areas of Mr. Smith's expertise include: human and ecological risk analysis, cost-benefit evaluation, remedial action assessment and strategic regulatory consulting. Mr. Smith has participated in third party reviews, technical and managerial oversight, and independent consulting for numerous clients.

WAHI, Krishan K. - Dr. Wahi received his BS, MS and PhD in Mechanical Engineering from the University of Washington. After completing his PhD in 1974, he joined Physics International Company as a Senior Physicist and participated in hydrodynamic code development and simulation of ground motion due to thermonuclear blasts and projectile penetration. From 1975 until 1986, he worked as a Senior Engineer and a manager at Science Application International Corporation. Since February, 1986, Dr. Wahi has been the President/Owner of GRAM, Inc., providing waste management and environmental restoration consulting and support services. He has 20 years of experience in nuclear waste management, specializing in geomechanics, numerical modeling, performance assessment of geological repositories and coupled processes. He has served on several expert panels on topics related to the management of nuclear waste. His PhD work focused on mechanics of head injuries and fragility of brain tissue. Dr. Wahi's past work includes development and application of salt creep models, performance assessment methodologies, thermomechanical response, and dynamic structural response calculations. He is a member of the American Society of Mechanical Engineers, International Society for Rock Mechanics, and Sigma Xi, and serves on the advisory board of Waste-management Education and Research Consortium. He is the author or co-author of more than fifty technical papers, book articles, and reports. He was a 1996 nominee for the New Mexico "Small Business Person of the Year" award.

D.2 Peer Review Staff

CARLSON, Timothy J. - Mr. Carlson received his BS in Civil Engineering and MS in Environmental Engineering at Arizona State University and is a registered Professional Engineer in Colorado. He has more than twenty years experience in the environmental cleanup arena working in the private sector with various states, EPA regions, and Federal agencies (DOE, DOD, Corps of Engineers, and the National Park Service). Mr. Carlson's projects have included the planning, design, construction management, and operation assistance for numerous waste treatment systems under the regulatory authority of the Clean Water Act and CERCLA. As a Principal Scientist for RUST Geotech Inc. at the Grand Junction Projects Office, work on DOE projects has included several CERCLA actions that have lead to Records of Decisions; DOE Headquarters support on the identification of needs for the Environmental Restoration Program and the relationship of technology efforts to meeting those needs; and the development and coordination of a comprehensive implementation program for several innovative treatment technologies. Another aspect of Mr. Carlson's capabilities has been the organization and performance of high level peer reviews of environmental technologies. These included an overall assessment of existing technologies for DOE's radioactive and mixed-waste problems, molten salt oxidation for the treatment of organic wastes, and a proprietary Russian technology for the separation of cesium and strontium from high-level wastes. Mr. Carlson has participated on two peer panels which evaluated the technology options for treating mixed waste at Los Alamos National Laboratory and at the Savannah River Site.

CUMMINS, Laura E. - Dr. Cummins received her MS and BS degrees in Geology from Bowling Green State University and her PhD at Florida State University in Geology. She is a registered professional geologist in the State of Florida and a member of the Geological Society of America. Dr. Cummins is currently a Principal Scientist for a Department of Energy contractor in Grand Junction, CO. In her work for DOE she has served in a key role on a number of projects related to furthering the use of innovative environmental technologies. She has been involved in the development of publications, databases, videotapes, and other types of information dissemination mechanism. Dr. Cummins worked for several years in a technical support/oversight role for the environmental restoration program at the Idaho National Engineering Laboratory. Prior to her work for the DOE, Dr. Cummins served as a hazardous waste cleanup project manager for the State of Florida where she was responsible for cleanup of Superfund and state-funded sites. In addition, she worked as a project manager in Florida's underground storage tank cleanup program. Dr. Cummins' experience also includes two years as an assistant professor of geology at Angelo State University in San Angelo, TX, where she was responsible for teaching upper level undergraduate courses in mineralogy, structural geology, petrology, and optical mineralogy.

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GHASSEMI, Abbas - Dr. Ghassemi received his BS from the University of Oklahoma and his MS and PhD in Chemical Engineering from New Mexico State University in Las Cruces, NM. He has more than 15 years of industrial, academic, chemical, and environmental hands-on engineering experience. Dr. Ghassemi is an Associate Professor Chemical Engineering and is the Liaison Technology Officer and Associate Director of the Waste-management Education and Research Consortium (WERC). Over the past four years, Dr. Ghassemi has been responsible for managing the following WERC programs: Industrial Affiliates, Summer Environmental Design Institute, International Environmental Design Contest, outreach, technology transfer and demonstration, new business development and new technology development programs. Prior to joining NMSU, Dr. Ghassemi compiled extensive experience in technical and marketing management, process control, process operation and optimization by more than ten years of employment at Fisher Controls International and Monsanto Company. He has extensive experience in the environmental field including pollution prevention, waste management, environmental remediation, and technology identification. He has served as technical expert in several environmental litigation cases as well as technical peer review panels and international training projects in the environmental health and risk assement fields. He is the author of more than 75 papers and publications in the fields of process control, thermodynamics, environmental engineering and education. He is also co-editor and contributor to several textbooks in the area of environmental technology and management.

NOLEN, Mark R. - Mr. Nolan received his BBA degree in accounting and his MBA in planning and policy from the University of New Mexico, Albuquerque, NM. He is currently a fourth-year doctoral student studying management at New Mexico State University , Las Cruces, NM. Mr. Nolan's facilitation experience includes training and coordinator roles in the installation of financial management information systems in healthcare, state government, and electric utility industries. He has been a part-time instructor at the University of Phoenix, Albuquerque, NM and Santa Teresa, NM campuses for eight years in the areas of strategic management and business research. As a doctoral graduate assistant, he teaches introductory management and human relations courses.

APPENDIX B

Peer Review Meeting

Minutes

Meeting Minutes
WIPP EACBS Peer Review
Session 1, May 7-10, 1996

M

<u>May 7, 1996</u>

Introduction of peer panel members, EACBS staff who participated in the production of the report, and the WERC peer review management staff (see attached list).

Review of agenda (attached)

Orientation and training consisted of:

- Scope of the peer review; what is intended to be accomplish and what it is not intended to be a part of the process
- Duties of the peer panel
- Roles of the performers of the work
- Roles of observers
- Roles of the peer review management
- *CAO EACBS Peer Review Plan*
- Collection of *Peer Review Panel Member Independence Forms*
- Collection of *Peer Review Panel Member Verification of Education/Employment Forms*
- Collection of *Peer Review Panel Training Forms*
- James Maes, CAO/DOE, provided an introduction of the WIPP EACBS and the peer review process.
- Jonathan Myers, IT Corporation, presented information on the
  - History of the Waste Isolation Pilot Plant
  - Regulations
  - WIPP Waste Inventory
  - Engineered Alternatives Task Force
- Steve Wagner, Westinghouse - Waste Isolation Division, presented information on
  the WIPP facility description

<u>May 8, 1996</u>

Orientation and training continued with

- Mark Crawley, IT Corporation, providing information on
  - Extent <u>of</u> drilling activities
  - Geophysical surveys
  - Hydrologic investigations
  - Isotope studies
  - Resources evaluation
  - Environmental monitoring activities

Changes amended to meeting minutes
underlined in red.

May 8, 1996 continued

- Steve Wagner, Westinghouse, presented information on
  - EACBS technical approach
- Jonathan Myers, IT Corporation, presented information on
  - Design analysis model
- James Maes, DOE/CAO, wrapped up the orientation and training session.

Following the orientation and training portion of the peer review, discussion centered on the process for identifying engineered alternatives and the screening process for reducing the original number from 111 to 18 found in the EACBS. Issues raised by the peer review panel included a need for the EACBS to better clarify the process for (1) how the initial alternatives were identified, (2) how they were subsequently reduced to 53, (3) how Westinghouse narrowed the list to 14, and (4) how DOE finalized the list at 18. The peer panel was not in disagreement that the process likely resulted in a good range of alternatives, but rather felt that the EA Task Force might have been in a better position to reduce the list from 53 to 14. James Maes, DOE/CAO, provided additional clarification of how the screening process worked which helped the panel members better understand the process.

James Maes, DOE/CAO, identified that the RCRA application includes the use of MgO as the preferred engineered alternative. Although MgO was not included in the EACBS, DOE considers the engineered alternatives using CaO as representative of a classification of stabilization alternatives. The peer panel suggested that any revision to the EACBS include this specific alternative since it is the preferred choice. James Maes indicated that DOE/CAO would be willing to amend the EACBS to reflect recommendations of the peer review panel.

May 9, 1996

James Maes, DOE/CAO, presented an overview of each of the 8 evaluation factors used in the EACBS.

Discussions lead by Ron Bhada, peer panel leader, centered on the format for the peer review report as described in the *CAO EACBS Peer Review Plan*. It was agreed that subcommittee reports should closely follow this same format. Subcommittees were established for reviewing the 8 different evaluation factors with reviewers divided by expertise that appeared most appropriate for each set of factors. The subcommittee are:

- Long term repository performance and uncertainty in compliance acceptance - Jim Navratil, Krishan Wahi, and Cathy Aimone-Martin.

- Worker and public risk, impact on waste removal, and transportation risk - Jamal Rostami, Cindy Lewis, and Dennis Smith.

- Public confidence, system cost and schedule, and impact on other disposal systems - Arturo Duran, Doug Kuhns, and Ron Bhada.

Subcommittees broke up into their separate groups, reviewed specific areas of responsibility, and

May 9, 1996 continued

the approach they intend to take. Following these discussions, the peer panel reconvened and discussed the process they are proceeding with. Two of the evaluation criteria were further discussed with the following general guidance agreed upon:

- Adequacy of Requirements and Criteria - Requirements are generally prescribed by 40CFR194 and other requirements for the peer review under NUREG1297. As such, these requirements cannot be evaluated and will be so stated.

- Accuracy of calculations - It was apparent that there is insufficient time to check all calculations; therefore, calculations will be checked for accuracy by performing spot checks on selected calculations, determining if computer models and codes were verified, determining if QA was performed, and checking results for order of magnitude variability. Subcommittees will identify which areas of the EACBS require additional explanations by DOE or its contractors for the next peer review meeting.

An additional evaluation criteria (General Comments) may be used by the subcommittees to document concerns/issues that the prescribed criteria do not cover.

The agendas for the next two meetings was agreed upon (attached).

May 10, 1996

A tour of the WIPP facilities was provided by DOE.

Peer Review Session 1
END

Approval of minutes as amended

[illegible] 5-30-96

[illegible] 5-30-96

[illegible] 5-30-96

[illegible] 5-30-96

[illegible] 5-30-96

[illegible] 5-30-96

James D. Navratil 5-30-96

[illegible] 5-30-96

[illegible] 5/30-96

MINUTES - WIPP EACBS PEER REVIEW MEETING; MAY 29-31, 1996

Wednesday, May 29

All peer review panel members were in attendance at this meeting, as were representatives from IT, Westinghouse-WIPP, and DOE-CAO. In addition, several observers were present. The meeting began with introductions and brief review of observer protocol. Panel members were asked if there were any general issues that needed discussion. It was noted that some of the terminology used in describing the screening process might be misleading. The term "optimization" was said to be particularly misleading in that it was conducted using many of the same criteria as the initial screening.

Following general discussion, each subcommittee reported on where it stood in terms of the review process. Some general concerns were also noted at this time. In general, all groups felt that they had made good progress since the orientation meeting and that they could have a substantially complete report prepared by the end of the present working meetings. All subcommittees reported the need to seek additional clarification and information from the report preparers.

Each subcommittee provided an overview of the general findings of its evaluation to date. The subcommittees are designated as follows:

- Group 1 - Factors 1 and 2. Cathy Aimone-Martin, Krishan Wahi, James Navratil
- Group 2 - Factors 3, 4, 5. Jamal Rostami, Cindy Lewis, Dennis Smith
- Group 3 - Factors 6, 7, 8. Ron Bhada, Arturo Duran, Doug Kuhns

Some issues raised by Group 1 included

- The adequacy of requirements and criteria are largely prescribed and are essentially a non issue in the evaluation of the EAs. The other subcommittees agreed on this point.
- There is some question about what level of detail to use in determining validity of assumptions. The group has both higher level and more detailed information. They will try to take a systems approach in their evaluation. IT noted that some of the assumptions made were selected to be consistent with the performance assessment being conducted by Sandia National Laboratory in Albuquerque and that those assumptions were external to their control. The suggestion was made to concentrate on assumptions made internal to EACBS preparers.
- The question was raised about how to deal with requirements of 40 CFR 194, which were not in place at the time the EACBS was in preparation (e.g., the waste retrieval scenario). A supplement to the report will probably be recommended to deal with these issues.
- The group felt that the relative comparison of alternatives in the report appears to be valid. However, some items need clarification. The group will focus on those during the working session this week.

Group 2 also felt that the report was generally done according to acceptable protocols. It was felt that the risk assessment portions of the report were conservative and health-protective. Among the concerns raised by this group were

- 40 CFR 194 requires that waste retrieval be evaluated. The concern was expressed that all the EAs involve disposal of wastes in steel drums. The statement was made that the evaluation of the retrieval scenario would be much different if the EACBS had included alternatives that used material other than steel for the waste drums.
- The point was made that evaluation of chemical transportation risks were dependent strictly on wasteform and that transportation probability issues (e.g., miles travelled) were not considered.

Group 3 distributed preliminary drafts of its evaluation results. In general the group felt that reasonable, accepted methods were used in assembling information on factors 6, 7, and 8. Some points that were made during this group's discussion include

- The fact that the EACBS uses a relative comparison of alternatives, not an absolute evaluation, reduces the effect that uncertainty in the evaluation process might otherwise have.
- The focus of the group was on major assumptions, not the more numerous smaller ones.
- The EACBS contains much detail. It would be easier to use if some "big picture" tables were used to summarize the information in an easy manner.
- The report used the best available information. Some of this information will change, however, and provision should be made to take this into consideration up until a decision regarding the use of EAs is made.

The peer panel broke into subcommittees to continue work on their reports.

The committee reconvened at the end of the day for general discussion. Points raised included:

- the distinction between EAs that focus on pre-closure versus post-closure measures
- the role of remote-handled waste in the evaluation of performance (IT explained that RH waste makes up only 7% by volume of total and that after a few 100 years, it would decay sufficiently to be indistinguishable from contact-handled wastes)
- If groups need more time to prepare their reports, it can be worked into the schedule. A quality product will not be sacrificed just to meet an interim deadline.

Minutes of the first peer review meeting were distributed for review by the panel members. Sucommittees were each requested to prepare brief subcommittee minutes to document their working meetings.

<u>Thursday, May 30</u>

The group met as a whole to review the previous meetings minutes. Changes were noted. The panel review leader, Ron Bhada, noted that subcommittees would probably come across things in their review that were notable, but beyond the scope of their task. He suggested listing these separately from the subcommittee report; these items will be submitted to DOE in a separate letter report.

The panel broke into subcommittees to work on their reports.

In the afternoon caucus session, the issue of dissenting opinions was raised. It was determined that the dissenting opinions would be based on the review of the report in its entirely; discussion regarding dissenting opinions would therefore take place during the next panel meeting in July.

Friday, May 31

Groups continued to meet to produce draft reports. The entire committee was convened for a final time to bring up any final points. A question was raised as to whether any subcommittee had identified issues that might affect other subcommittees. IT made the point that waste inventory and volume reduction figures probably figure into all groups and that this might be something to consider in review of the peer review report. The issue was also raised about whether there should have been some interaction between the screening process and the evaluation of alternatives against the eight factors. The opinion was expressed that this might have had an impact on the selection of alternatives for detailed analysis. IT noted that an attempt was made to include alternatives that spanned the range of variables involved and that they tried to be as inclusive as possible, considering the time and money allotted.

Each subcommittee turned in a draft report before departing the meeting.

QA Surveillance

Surveillance of the peer review process was conducted by representatives of DOE's Quality Assurance Office, the USEPA, and EEG. Minor findings were noted and corrective action taken.

July 9, 1996
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July 9, 1996

MINUTES - WIPP EACBS PEER REVIEW MEETING; JULY 8-10, 1996

Monday, July 8

The objective of this three day session was to finalize the Peer Review document with approval by all panel members of the final report on July 10, 1996. The meeting centered on additional comments provided by the peer panel members on the June 26th version of the report (Rev. 1). This report had received an earlier review by the peer members that was sent to them as a June 7 version (Rev. 0). Following receipt of comments the report was revised for further comment.

Tuesday, July 9

The panel members received and reviewed the Rev. 2 version of the peer review report (July 8) and made additional comments. These comments were subsequently incorporated into the report as Rev. 3 on July 9.

The panel members discussed a letter received from the EEG concerning the EACBS and the peer review. The panel members determined that it would be appropriate for Dr. Bhada, the panel chair, to write a written response explaining that the contents of the letter from EEG were beyond the scope of work that the peer panel was directed to perform. The issues raised are more appropriately directed to the regulatory agencies responsible for permitting the WIPP facilities.

Wednesday, July 10

Final comments to the Draft Peer Review report (Rev. 3, July 9) were made by the peer members and incorporated into the final document. The final document was completed and signed by the peer panel members as being complete and accurate.

[illegible] July 10, 1996
[illegible] 7-10-96
[illegible] 7-10-96
R.K. Bhada 7-10-96
[illegible] 7/10/96
[illegible] 7/10/96
[illegible] 7/10/96
James O. Navratil July 10, 1996
[illegible] July 10, 1996

APPENDIX C

Committee/Subcommittee

Reports

APPENDIX C-1

PANEL REPORT ON EVALUATION OF THE SCREENING PROCESS

C-1.1 Description of the Identification/Screening Process

The first task of the EACBS peer review panel was to evaluate the identification and screening process that was used in generating the list of 111 initial engineered alternatives (EAs) and in reducing these potential alternatives down to the 18 that were considered for detailed evaluation. The identification of initial EAs was drawn from a consideration of multiple sources. The initial list of 111 comprises

- 64 individual EAs from the 1991 Engineered Alternatives Task Force Final Report
- 14 combination and 1 baseline from the 1991 Engineered Alternatives Task Force Final Report (DOE, 1991a)
- 20 EAs considered by Sandia National Laboratories for System Prioritization Method
- 10 EAs listed by the EPA in 40 CFR 194, section 194.44(b)
- 2 EAs added during the subsequent screening process

The screening was conducted using a multiple-step process that included not only technical considerations, but also a consideration of regulatory constraints and professional judgement. In the initial screening phase each alternative was evaluated to determine if it met the definition of an "engineered alternative" as defined by 40 CFR 191. Additionally, EAs were compared against two "must satisfy" criteria —regulatory compliance and technical feasibility —to determine if these criteria could be met. EAs failing to meet the definition or the must satisfy criteria were dropped from further evaluation. The evaluation process was conducted by an independent Engineered Alternatives Screening Working Group (EASWG); the EASWG reduced the initial 111 alternatives to a total of 53.

In the next phase of the screening process, a small number of WIPP Westinghouse engineers "optimized" and "prioritized" the remaining 53 EAs based on the following:

- effectiveness for specific factors (gas generation, solubility, permeability, human intrusion consequences)
- overall effectiveness
- feasibility for each factor
- "technological merit"
- overall feasibility

This evaluation was made using the results compiled by the EASWG in their scoring of the alternatives for feasibility and effectiveness along with some of the same evaluation criteria used in the initial screening process. This part of the screening process also involved the use of professional judgement. The process was limited by constraints on time and funding available. Some of the 53 EAs were combined to form a subset of the final EAs. Of the 53 alternatives entering the process, 14 EAs were submitted to DOE-CAO and recommended for continued evaluation.

DOE-CAO further refined the Westinghouse recommendations based on the following:

- the most important performance parameters (gas generation was no longer considered critical)
- feasibility of implementation
- addressing all EPA technologies specified in 40 CFR 194
- conflicts with other permit applications and positions

Using these considerations, the DOE dropped some of the EAs and added several others. Upon conclusion of the screening process, 18 EAs remained for a cost/benefit evaluation, that was conducted in the EACBS.

C-1.2 Description of the Peer Review Panel Screening Process Evaluation

In preparation for review of the screening process, members of the peer review panel read the section of the EACBS report that detailed this process (section 2.0). Authors of the EACBS report and other participants in the screening process made presentations to the panel on how the process was conducted. The panel understands that a supplement to the EACBS will be prepared by the DOE that will also provide additional information on the screening process. Discussions between the presenters and panel members followed until everyone adequately understood how the screening process was carried out. Results of the peer panel review are listed below according to the review criteria.

C-1.3 Adequacy of Requirements and Criteria

- Panel members agreed that use of the definition of an EA and technical/regulatory acceptability were reasonable for the initial screening to reduce the 111 EAs to 53.

- Panel members were in agreement that the additional performance criteria applied to the 53 EAs to reduce them to 14 was reasonable. Use of EASWG evaluation results was appropriate.

- Panel members agreed that DOE used appropriate criteria to modify the 14 EAs to the final 18. They felt it was justified for DOE to use additional non-technical criteria, such as conflicts with other permits, in this process. It was also appropriate to ensure that all technologies specified by EPA in 40 CFR 194 were included. As a general note, for the

DOE-CAO part of the screening process, it was felt that "other permit applications and positions" could be better explained in the EACBS report.

- Panel members agree that criteria used in identifying the initial 111 EAs were appropriate.

C-1.4 Validity of Assumptions

- The evaluation was designed to be qualitative and was to assess assurance, not compliance. These conditions were prescribed by law; as such, the panel members agreed that they were valid.

C-1.5 Alternate Interpretations

- The panel members did not identify a reasonable alternate interpretation that could have been developed through the screening process.

C-1.6 Uncertainty of Results and Consequences if Wrong

- During the screening process, a conscious attempt was made to ensure that the final list of EAs spanned the range of possible options based on technology types represented, implementation costs, and other pertinent factors. Having a diversity of alternatives for final evaluation decreases the amount of uncertainty associated with the screening process and ensures that the impact of any error made through the process has a minimal impact on the overall results. The process, in fact, turned out to be a conservative one. After final evaluation of the 18 EAs, some alternatives that had appeared to be promising turned out to be unsatisfactory. Thus the process was more inclusive than exclusive. Therefore negative consequences were not a significant concern.

C-1.7 Appropriateness and Limitations of Methodology and Procedures

- The panel agreed that the process of screening the 111 to 53 EAs was appropriate, using a multidisciplinary EASWG. Panel members felt that members of the EASWG were qualified to perform the analysis. It was felt that the application of the screening criteria and the scoring process was also appropriate.

- In screening EAs from 53 to 14, the panel generally felt that the process used was appropriate (using additional performance criteria and combining alternatives). While qualified individuals conducted this part of the screening, the panel thought that it might have been more appropriate if this screening has been done by the EASWG.

- The panel felt that it was appropriate for the DOE to modify the recommended 14 alternatives to the final 18. The DOE had specific insight and knowledge of other factors (than those used in initial screening phases) to adjust the final list accordingly.

- As a general note, the panel felt that the screening process was not clearly spelled out in the EACBS report and that the description of this process could benefit from some additional clarification and modification.

C-1.8 Adequacy of Application

- The panel felt that the application of criteria used in the screening process was appropriate for each phase of the process. The sequence of comparing, scoring, prioritizing, etc., was adequate to achieve the desired results (i.e., a list of suitable alternatives for further evaluation).

C-1.9 Accuracy of Calculations

- Part of the process required the use of algorithms that appeared to be adequate for the process objectives. Part of the process was based on professional judgement rather than quantitative techniques; the panel deemed this to be appropriate.

C-1.10 Validity of Conclusions

- There was general agreement among panel members that the final list of EAs selected for further analysis was reasonable. No obviously feasible alternatives were omitted and no clearly inferior alternatives were retained. While panel members admitted that the initial starting list of EAs was not all-inclusive, there were no signficant misgivings about the final results.

C-1.11 General Note

As described in the EACBS, the identification/screening process is not clearly documented. There is also confusion in some of the terminology used (e.g., "screening," "optimization," "prioritization"). In order that the process is well understood, it is recommended that clarification be added to the report, particularly to describe how the EAs list went from the 53 recommended by the EASWG to the 18 evaluated in the EACBS report.

APPENDIX C-2

REPORT OF SUBCOMMITTEE 1

FACTOR 1 - LONG TERM REPOSITORY PERFORMANCE

FACTOR 2 - UNCERTAINTY IN COMPLIANCE ASSESSMENT

C-2.1 Scope and Tasks of Subcommittee

The subcommittee was assigned the tasks of evaluating the EACBS using the criteria specified in 40 CFR 194 for the study of Factors 1 and 2. Factor 1 analysis involved the long-term performance of the disposal system for selected Engineered Alternatives (EAs) relative to the baseline performance. The Design Analysis Model (DAM) computer simulation program was used to predict the changes in performance in terms of a measure of impact that each EA had on the release of radionuclides into the surface and groundwater environments for three human intrusion scenarios. Factor 2 analysis dealt with the consideration of uncertainties of the DAM input parameters as well as the propagation of uncertainties in the results. Engineered alternatives that were considered consisted primarily of combinations of various waste processing and backfill types. One series of alternatives (Alternatives 77a through 77d) also considered a variation of the emplacement room height. The DAM code considered coupled processes of creep closure, brine inflow, gas generation and the migration of radionuclides. Parameters considered in the DAM for each alternative further included the porosity and permeability of the waste/backfill, rates of brine inflow, waste/backfill shear strength, and radionuclide solubility.

The three scenarios of human intrusion included drilling a borehole through the repository into a pressurized brine pocket (E1), drilling a borehole to the base of the repository (E2), and a combination of E1 and E2 scenarios (E1E2). The same three scenarios have been considered in SNL's performance assessment.

Radionuclide releases were computed for each case and the impact was expressed in terms of a "Measure of Relative Effectiveness" (MRE) which represents each EA's impact relative to the baseline. This MRE is a measure of the magnitude of the reduction or increase in releases for the three intrusion scenarios with respect to the baseline disposal system design.

Members of the Subcommittee reviewed the EACBS and related documents pertaining to the methodology, procedures, assumptions and the results of their collective application made in the preparation of the Study. Further, members conducted discussions with representatives of Westinghouse, DOE, International Technology (IT) Corporation and others to interpret and clarify points made in the document.

This report summarizes the review conducted by the Subcommittee with regard to the assumptions, methodologies and procedures, applications, interpretations, results and consequences and validity of conclusions of the study.

C-2.2 Adequacy of Requirements and Criteria

The requirements and criteria for the study are prescribed by regulations and, as such, judging their adequacy is beyond the scope of this review. The requirements set forth by 40 CFR 194 specify that the applicant must consider EAs for the purpose of providing additional assurance in the performance of the waste disposal system. Specifically, Section 194.44, "Engineered Barriers," states that in selecting any engineered barrier(s) for the disposal system, the DOE shall evaluate the benefit and detriment of engineered barrier alternatives. The study was performed in strict conformance with criteria and requirements (as prescribed) and satisfies the objective of the regulation.

C-2.3 Validity of Assumptions

The Subcommittee considered assumptions of the analysis on two levels. On one level, assumptions were evaluated from a broad perspective and involved the processes considered in the model and the performance measure for representing and comparing radionuclide releases. The second level involved specific details used in computations such as ranges and distributions of input parameters to the model.

C.2.3.1 Broad Level, Factor 1

The subcommittee felt that the approach taken to parallel the Sandia National Laboratories (SNL) Performance Assessment (PA) was appropriate. The advantage of this approach is that the results are expected to be on the same scale as, and comparable to, the PA. Similarities are drawn in the conceptual models, input parameters, and to the human intrusion scenarios. The primary differences between this study and the SNL PA approach are:

- In the EACBS, radionuclide releases are predicted as flux into the Culebra Formation, and transport within the Culebra is not modeled. By contrast, the SNL PA considered transport within the Culebra and predicted integrated releases at the accessible environment.
- The SNL PA only dealt with the baseline design and did not consider engineered alternatives. Further, the DAM processes that were simulated are "coupled". These processes include gas generation, brine inflow, radionuclide migration and creep closure.

- Representation of processes and repository geometry are considerably more simplified in the EACBS when compared to the SNL PA.

Simplifying assumptions made in the analysis of many processes (e.g., modeling creep with a function fit to empirical creep data and excavation geometry) are valid within the context of the EACBS report in that relative, not absolute, performance is used to compare alternatives. Such simplifications may not be valid when used to measure the (absolute) releases of radioactive materials into the accessible environment. Performance was assessed using an approach required by EPA to demonstrate compliance by computing a normalized integrated release (Q value) into the environment.

C.2.3.2 Broad Level, Factor 2

The general approach taken in dealing with uncertainties by treating variabilities in the DAM input parameter adheres to 40 CFR 191 and 40 CFR 194 compliance assessment requirements. However, a complete description of the uncertainty analysis is not made in the EACBS; e.g., Complementary Cumulative Distribution Functions (CCDFs) are not presented or analyzed although the model results contain the necessary raw data. Therefore, it is difficult to assess: (1) the approach taken in calculating the statistics for Factor 2 analysis, (2) the interpretation of results, and (3) how these data should be used in comparison with the data for Factor 1 analysis.

C.2.3.3 Detailed Level, Factors 1 and 2

Specific details that are deemed important in the creep modeling process include the following:

- lack of stratigraphy in the deformation model may affect the closure rates, therefore a measure of uncertainty about creep closure is introduced;
- the assumption of a constant effective stress in the vicinity of the room can result in inaccurate creep closure estimates (also see Item C-2.8);
- uncertainly in creep parameters was not considered. Had uncertainty been included for the creep parameters, room closure times could have been different (e.g., creep closure could have taken place over a longer period of time instead of 200 years). Sensitivity/uncertainty analysis of the creep parameters may have been left out because the SNL PA did not consider it. This could be a significant weakness of the analysis because creep closure response directly affects the permeability in the vicinity of the waste and, hence, quantity and rates of release of radionuclides.

The EACBS performed a detailed analysis of the intrusion scenarios, with intrusion occurring at a time of 5,000 years. Additional simulations for the baseline and nine selected alternatives were performed at intrusion times of 200, 2,000, and 7,000 years. The study concluded that, in general, the MREs are insensitive to the time of intrusion once the density and permeability of the composite material (waste, backfill, host rock) reaches a steady-state condition. Notwithstanding that conclusion, this subcommittee maintains that an earlier intrusion time (say, before complete closure) could result in significantly different releases than those predicted by any current scenario. Section 194.33, "Consideration of drilling events in performance assessments," requires that drilling events be assumed to occur in the Delaware Basin at random intervals in time and space during the regulatory time frame. This random occurrence was not modeled.

The model used the most recent conservative actinide solubility data. For example, for plutonium (the most abundant radioisotope present in the long term), the highest solubility of all the oxidation states (trivalent state) was used. The presence of organic complexing agents was also considered, but not all possible organics, e.g. tributyl phosphate and its hydrolysis products; these complexes may be stable over long periods of time and could be more mobile than aqueous complexes of Pu(III).

The study also assumed solubility-limited source terms in the model. This would tend to underrate the performance for high-fired plutonium dioxide which would be the species present in the plasma processing option. For example, the leaching and solubilization of high-fired PuO_2 in a glass matrix would be much slower than PuF_4 coated on paper and plastic waste.

Adsorption of actinides on clays was not considered in the model since no K_D (distribution coefficient) data were available on the uptake of actinides in brine by these materials. The strong adsorption of plutonium species on clay materials is well known; in fact, adsorbed plutonium cannot be eluted or removed with brine solution. Thus the advantage of clays in immobilizing plutonium and other radionuclides was not credited in EAs using clay.

C-2.4 Alternate Interpretations

There are alternative interpretations that could have been made with respect to the repository phenomena, undisturbed performance and intrusion scenarios. Consideration of these alternatives may affect the conclusions of the relative benefit of a given engineered alternative. For instance, a more sophisticated analysis would include the WIPP site stratigraphy and radionuclide transport within the Culebra dolomite as is the case with the SNL PA. Because the EACBS descends from the EATF study and strives to parallel the SNL PA with respect to intrusion scenarios, consideration of alternate interpretations was precluded to a large extent. Note, however, that prior to deciding which conceptual models best represent the WIPP repository system, SNL had considered many alternatives, compared and benchmarked state-of-the-art computer codes, and used expert judgement in selecting the basis of its PA analysis. Even today, the PA methodology is amenable to other conceptual models that might increase the confidence level in the predictive calculations.

C-2.4.1 Models Affecting the Coupled Response

Other simulation techniques and/or numerical models could have been used. Although the report claims a fully coupled approach, the DAM code processes are only weakly coupled (i.e., the equations are not coupled or solved simultaneously) in that relevant effects of one process are sequentially passed on as an incremental change in one of the parameters to the next process solved. The objectives of this study are not compromised despite the simplifications and the empirical approach of the DAM code.

C-2.4.2 Intrusion Scenarios

At the time this study was conducted, 40 CFR 194 had not yet been finalized. Section 194.32 of the final rule contains a requirement for DOE to consider the effects of excavation mining, allowing assessments to be limited to changes in the hydraulic conductivity of the hydrogeologic units of the disposal system from excavation mining for natural resources. Note that the EACBS did not consider effects of mining within the land withdrawal boundary.

C-2.5 Uncertainty of Results and Consequences if Wrong

Data and parameter uncertainty was addressed and was an "inherent" part of quantifying "relative" measures/benefits. Accordingly, the results contain uncertainty due to the uncertainty in input parameters. Other types of uncertainty such as model uncertainty and uncertainty in the future states of the disposal system are not addressed.

Because this study is investigating potential benefits of engineered alternatives (and not revisions to the baseline design), the consequences of reaching wrong conclusions (based on wrong results) are not severe. At worst, an engineered alternative may be underrated or overrated due to a faulty analysis. The relative nature of the performance measure (i.e., MRE) allows meaningful conclusions to be drawn even if some of the modeling details are not accurate in the absolute sense.

C-2.6 Appropriateness and Limitations of Methodology and Procedures

Use of EPA's sum rule to compute and compare the releases for each EA relative to the baseline is appropriate. Use of a simplified model (e.g., DAM) is also appropriate and consistent with other analyses where a Monte Carlo approach is utilized to treat uncertainty.

The coupling of the processes contributing to the release measures as modeled in the DAM code is appropriate based on the nature of the complex interactions of these processes. However, there is no user's manual for the DAM code. As such, members of the Subcommittee felt that a lack of a user's manual limits the ability to independently verify calculations and somewhat diminishes the ability to assess the quality assurance of the associated results.

Representatives from IT Corp. did provide access to QA records and documentation of changes made to the DAM code since the EATF study. Procedures followed in the execution of calculations are comparable to other modeling efforts in that input data files and output files were reviewed by independent personnel.

The subcommittee notes that Appendix S (Factor-Specific Quality Assurance) of the EACBS does not identify Factor 1 as one for which specific QA measures were taken. However, the intent on the part of IT Corp. personnel was to lump Factors 1 and 2 together for the purpose of addressing issues presented in Appendix S.

The DAM model uses a fixed state of stress in and around the openings and does not recompute (or update) the deviatoric stress, σ_{ϵ}. Other more sophisticated mechanical models (such as SNL's SANCHO code) perform continuous updates of the state of stress in the host rock at every computational cycle. It is not known whether the simplifications in the DAM materially affect the final results. Hypothetically, one would expect complete closure of the emplacement room at a different time when a variable state of stress is used in the model. Whereas the need for simplicity is recognized, the use of a modified Chabannes' equation to represent creep deformation ignores important advances in creep modeling.

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C-2.7 Adequacy of application

The following comments are made with respect to the adequacy of application:

- In the Executive summary, Table E-3 lists input values for the compressive strength of what it calls the waste/backfill. Values are listed for the baseline case (no backfill) and all EAs considered. Since the baseline case has no backfill, the 25 megaPascals (MPa) value assigned to it seems high, especially because it is the highest value listed. After consultation with the authors of the report, it was determined that the strength value is, in fact, that for an equivalent room volume of a composite mixture of waste, backfill (if any) and host rock (i.e., the salt that has closed in around the waste) following room closure. For the baseline case as well as for several EAs, the compressive strength of the composite is dominated by the salt properties. Whereas, for EAs when backfill is added, the strength value is more representative of the consolidated backfill.

- Data Bases from International Atomic Energy Agency (IAEA) and International Union of Pure and Applied Chemistry (IUPAC) were not considered. These data bases include selected solubility values for several actinide compounds compiled by experts in the field. However, the solubility data used in the model are conservative and are similar to selected values in the IAEA and IUPAC computations.

- Section C-2.3.3 above alluded to the possiblility of complete closure due to creep taking place over a longer period of time than predicted in the EACBS. It is conceivable that human intrusion could take place before complete closure. If that were the case, the porosity in the vicinity of the waste would be higher, and one or more of the EAs may be more effective in a relative sense.

- By definition, an alternate repository design is one of the ways in which the requirement to evaluate engineered alternatives is met. Indeed, one series of engineered alternatives (EA 77a through 77d) considers a modified repository design by using a room height of 6 ft, instead of the baseline design of 13 ft. It would have been very useful to also model EA 77 with a room height of 13 ft to isolate the effects of a different repository design to assess the sensitivity of a different room design. This, however, was not done in the EACBS.

C-2.8 Accuracy of Calculations

Calculations related to Factors 1 and 2 are extensive and form the foundation for the analyses of these factors. Because creep closure is a major driving force contributing to the measure of relative performance, members of this review panel performed a check of the creep calculations by independently solving the creep equation used in the DAM. Using representative values of stress and emplacement room dimensions as input, early time creep closures predicted by our independent calculation were in good agreement with the DAM code predictions identified in the report.

It is assumed that QA procedures were followed as stated in the report by performing hand calculations of the subroutines models used in the DAM code. QA files and spreadsheet calculations were reviewed by members of the subcommittee. Selected items were checked for accuracy and consistency between the data files and the values in the EACBS Report. MRE values extracted from the DAM output for various alternatives, and each scenario, were tabulated. These tables are available in IT Corp.'s QA records. Model output values of MRE for Scenario E1 (integrated release at 10,000 years via groundwater flow path) were compared with the values reported in Table E-3 of EACBS and were found to match to the accuracy in Table E-3.

Selected subroutines of the DAM code were examined for programming errors, and none were found. Two new subroutines, SATURATION and GASGENERATE, were added to the EATF version of the DAM in addition to a few other model refinements. QA file F058 documents these changes in the form of revised flow charts and accompanying text. The data input files for various EAs were scanned and spot checked for accuracy. Several input files showed hand-corrected numbers. For example, EA 94f data file shows a printed value of 3.42E8 for MOLCAOH2, and a hand-written value of 4.66E7. QA file F047 notes that Alternatives 77d, 83, and 94f had input errors for the number of moles of portlandite (MOLCAOH2). These computer runs were not repeated with correct input. The analysts contend that, "the error would not significantly affect the final scoring."

C-2.9 Validity of Conclusions

The effectiveness of some of the EAs appears to have been undermined by the comparison technique used in the EACBS (see Figure E-4). Specifically, by choosing not to assign relative significance (i.e., weights) to individual factors, the study ends up with trade-offs between long-term performance enhancement (or reduction of uncertainty) and short-term risks that could be mitigated.

There may be possible contradictions regarding conclusions drawn upon the results of this study in the Executive Summary in that conclusions are offered on p. xvi. In the first paragraph, EAs 1, 6, and 10 are compared to the Baseline and are found to present short-term disadvantages. In the paragraph under the second bullet, the last sentence concludes the backfill alternatives improve long-term disposal system performance. This is not evident in Figure E-4, which is on the following page.

C-2.10 Other Observations/Issues

The following observations and issues were identified during the review of Factors 1 and 2:

- Many of the statements in Section 3.2, "Uncertainty in Compliance Assessment" are not completely correct. Some of the discussion related to treatment of uncertainty is very difficult to follow and contains conclusive remarks that do not logically fall out of the discussion that preceded.

- The distinction between, and the need for, two separate calculations of the 95th percentile values of MRE is not adequately explained (see columns 5 and 7 in Table 3-5, p. 3-26). Section 3.2.1 states, "Because the largest improvement in assurance that adequate containment will be achieved derives from reducing the spread of large releases (which are closest to the EPA limit), the second measure calculates an MRE based on the factor by which the 95th percentiles of value of radionuclide transport are reduced by each EA." Apparently the objective of the second 95th percentile value is to quantify the shift in the median as well as the narrowing (or broadening) of the output distribution relative to the baseline.

- The quantity MRU, "Measure of Relative Uncertainty," is defined as a performance measure in Table E-2 of the Executive Summary but is never used in Section 3.2 in discussing the results of the uncertainty analysis.

- The screening process description is unduly cumbersome. It appears that some of the steps have different labels but, in effect, have significant overlap with other steps.

- The fact that some of the EAs actually provide a reduction in uncertainty (because a sensitive input parameter's uncertainty is lower) is not clearly communicated by the report. For example, at the top of p. ix of the Executive Summary there are confusing statements about the treatment of uncertainty without taking sufficient credit for the ability of certain EAs to reduce uncertainty in the results. A quick study of the figures in Appendix J reveals how, for example, EA 10 lowers the uncertainty for the parameter RADFAC.

- The juxtaposition of results for all eight factors in Figure E-4, and other similar figures, tends to downplay the substantial benefit provided by several EAs (e.g., EA 10) with respect to Factors 1 and 2. The report, likewise, tends to look at the net outcome based on a collective assessment for Factors 1 through 8 in judging the merit of a given EA. Interestingly, in this study an EA that improves the long-term performance, or increases compliance confidence, tends to increase the operational phase risk. However, DOE can mitigate the higher short-term risks but has no control over risk once the WIPP facility is decommissioned. We feel that the spirit of 40 CFR 194 was to focus on long-term benefits or detriments of EAs.

- The Engineered Alternative Task Force (EATF) study predicts improvements of one to four orders of magnitude for selected EAs. Comparable EAs in the EACBS do not appear to provide the same magnitude of improvement. The reasons for this discrepancy are not clear.

APPENDIX C-3

REPORT OF SUBCOMMITTEE 2

FACTOR 3 - IMPACT ON PUBLIC AND WORKER EXPOSURE

C-3.1 Scope and Tasks of Subcommittee

The task of this subcommittee is to review the study conducted by Westinghouse and the DOE of the relative impact on worker and public risk of the different engineered alternatives (EA). This was accomplished by reviewing Section 3.3 and Appendix K of the EACBS, as well specific portions of the 1995 Draft Waste Management Programmatic Environmental Impact Statement (WMPEIS, DOE, 1995d).

This section summarizes the review of the subcommittee, including a review of the requirements and criteria, assumptions, results and inferred consequences, methods and procedures used, and validity of the conclusions.

C-3.2 Adequacy of Requirements and Criteria

The requirements of the study conducted by Westinghouse and DOE are specified in 40 CFR 191 and 40 CFR 194. The specific criteria, as used in this study adequately satisfy the intent of the requirements set forth by the regulation.

C-3.3 Validity of Assumptions

The principal assumptions underlying the assessment of worker and public risks associated with implementation of the various engineering alternatives, as identified by the subcommittee are:

- Methods used for computing risks, doses, and hazard indices are appropriate, and they effectively express the actual worker and public risks associated with exposure stemming from each EA. A review of the methods, through inspection of the referenced documents (i.e., WMPEIS; DOE, 1995d), indicates that the methods come from the EPA, the International Committee on Radiation Protection, and the American Conference of Governmental Industrial Hygienists guidance. These methods in and of themselves are based on conservative assumptions, they are conventional, are commonly used in assessments such as the EACBS, and are extensively documented in the literature.

- Application of the methods in the EACBS relies heavily on the assumption that the human receptor exposure scenarios for workers and the public, developed for the WMPEIS, are sufficiently similar to those pertaining to the current situation that they can be amended and applied to this case. That assumption was not evaluated by Westinghouse and the

DOE as part of this EACBS; however, our review suggests that the assumption is appropriate and defensible.

- It was clearly acknowledged that waste consolidation in the DOE complex, and process configurations used in the WMPEIS do not exactly match those described in the EACBS. It was assumed that the differences were minor and that scaling factors (identified below) could adequately accommodate the modification of WMPEIS risk estimates to the EACBS. The subcommittee's review of the WMPEIS indicates that the WMPEIS scenarios are reasonably similar to those used in the EACBS (except for the "worst case" accident for Factor 5).

- It is assumed that the operating life of the WIPP is 20 years, but does not document the basis for this assumption. In other places in the EACBS, reference is made to a 33 to 35 year operational period. Therefore, the validity is somewhat questionable. However, most of the risk computations were based on waste throughput - not time, and waste throughput was assumed to be the maximum WIPP capacity. Two important aspects embodied in this approach are: 1) the assumed time frame (e.g. 20 to 35 years) can be accommodated by a single human generation, and 2) it encompasses processing the entire inventory of waste destined for WIPP. Consequently, in concept, a single human receptor could receive the maximum exposure to the waste stream processed through a given facility regardless of the exact processing period (so long as it is reasonably within this envelope). Dose, risk and exposures computed on this basis, therefore, constitute a conservative assumption which tends to override the uncertainty in the time-frame assumption.

- In order to convert estimated WMPEIS risks to estimated EACBS risk, and to accommodate differences in throughput, scaling factors were developed based on an assumed full WIPP capacity. It was assumed that these scaling factors adequately reflect the anticipated EACBS risk and that the WIPP would be loaded to full capacity. In light of the suppositional nature of a future risk scenario, these assumptions appear reasonable and adequate.
- Overall, the founding assumptions of the assessment are regarded as conservative, yet reasonable within the realm of contemporary risk analysis practice.

C-3.3 Alternate Interpretations

The methods used are widely recognized in the risk assessment field and, in light of the needs to assess risks quantitatively in a defensible manner, there are no reasonable alternative interpretations.

C-3.4 Uncertainty of Results and Consequences if Wrong

The nature of the uncertainties is addressed in the EACBS which states that the uncertainties inherent in the WMPEIS assumptions are also applicable to this report, but do not specify what they are or what the impact might be (i.e., the uncertainties cascade). The WMPEIS addressed uncertainties in a semi-qualitative fashion and pointed out that, for purposes of making relative comparisons between alternatives, systematic bias does not compromise the comparison process because the same type and degree of uncertainty will be embodied in each estimation. A limited uncertainty evaluation in the WMPEIS, based on sensitivity analysis of key input parameters, suggests that uncertainties are not unreasonable for the type analysis performed. Uncertainties in scaling factors were not addressed, but may be within the range of uncertainty in the original assessment. Notwithstanding this issue, based on the methods used in the WMPEIS and in the EACBS, there is a systematic bias to err on the side of safety which means that the risks are likely to be overstated. Thus, uncertainties are controlled so that the consequences are to report risks in a manner that would lead to a health protective action, possibly at the expense of managerial efficiency.

C-3.5 Appropriateness & Limitations of Methodology and Procedures

The subcommittee found the methods to be appropriate and within the bounds of convention. One limitation noted was that effects of EAs were only assessed for contact-handled (CH) waste, not for remote handled (RH) waste. Presumably the impact to worker health from processing RH waste could be significant. While, in general RH waste processing was not a variable, the subcommittee felt that the impacts of its handling could have been addressed by considering its "risk" as a constant which could have been added to the CH risk thereby introducing more realism to the evaluation. No significant compromise is introduced in the comparative analysis through omitting the RH waste contribution to worker and public risk.

The method for assessing risk did not address the inherent risks associated with mishaps occurring during interim storage of TRU wastes at the various DOE facilities over differing EA time intervals. The probability of a mishap resulting in a release and subsequent worker or public exposure during interim storage is low (e.g., container spill and release, failure resulting in leakage, occurrence of natural event [e.g., earthquake]). Nonetheless, if an EA has a significantly longer waste processing implementation period thereby increasing the probability of events (e.g., fork lift puncture of a drum) , and/or if extended processing is scheduled to occur at a facility more prone to natural disasters (e.g., prone to tornadoes) then qualitatively considering the waste processing period in inter-EA comparison could be beneficial. Neglecting this component of risk could result in understating the relative risks associated with the EAs that require significant development time (e.g., Plasma Arc and Supercompaction). Appendix K does not appear to address the method used to estimate emplacement impact, although it is referred to in that discussion.

C-3.6 Accuracy of Calculations

They appear to be reasonable and consistent with the methodology. The example scaling equation provided in Appendix L appeared to be accurate. The subcommittee did not check the fundamental computations referenced in the WMPEIS. The subcommittee's familiarity with the source of those computations and their description in the WMPEIS implies computational integrity.

C-3.7 Validity of Conclusions:

The subcommittee did not see anything that would invalidate the conclusions drawn for CH waste, but does question the absence of an evaluation of risks associated with processing RH waste. Overall, the subcommittee believes that the results can be used with confidence for the relative comparison of the impacts on worker and human health between EAs.`

C-3.8 General/Documentation

The discussion in the body of the text was weakened by the lack of a discussion of the scenarios depicted in the WMPEIS, upon which so much of this evaluation rests. Appendix K's introduction does not track with the rest of the section.

APPENDIX C-4

REPORT OF SUBCOMMITTEE 2

FACTOR 4 - IMPACT ON WASTE REMOVAL

C-4.1 Introduction

This section explains the review of Factor 4 of the EACBS, the Impact of Engineering Alternatives (EAs) on Waste Removal. The EACBS is the study performed in compliance with Section 194.44 of the 40-CFR-194. The study of the ease and the impact of EAs on waste removal is specifically mentioned in the Sec. 194.44 part C-1-iii, which was also referred to in Section 194.46.

C-4.2 Scope and Task of Subcommittee

The task of this subcommittee is to review the study conducted by Westinghouse and the DOE of the relative impact of the EAs on waste removal. This was accomplished by reviewing section 3.4 of the EACBS.

This section summarizes the review by the subcommittee, including a review of the requirements and criteria, results, and inferred consequences, methods and procedures used, and validity of the conclusions.

C-4.3 Adequacy of Requirements and Criteria

The study performed under Factor 4 for qualitative comparison of the impact of various EAs on waste removal was required under Section 194.44 and 194.46 of the 40-CFR-194. In these sections, no reference to a particular time frame was made. Factor 4 was mainly structured to satisfy 194.44 which refers to waste removal within the context of an overall multi-parameter qualitative study of the EAs and their impact on the performance of repository. This factor is designed on the basis that "no provisions are made with any of the EAs that specifically facilitate removal. Such provisions are not required by the disposal standard" (P 3-72, line 23).

The ease of removal, the rate and hence time required for removal is related to the physical properties and strength of the material and the volume of the waste plus the surrounding area to be removed. The factor addresses these issues along with the occupational hazards and accidents associated with underground mining for waste removal. This satisfies the overall objective of the factor, which is to provide a qualitative measure to compare the EAs (including Baseline).

The underlying value used for the comparison purposes was mining time and related accident rates. The objective of the study and the degree of importance of these parameters are not very clear (i.e., minimization of accidents, minimization of time, cost etc.).

C-4.4 Validity of Assumptions

The factor was based on the criteria that the waste removal operation will be resumed 200 years after emplacement and disposal. This parameter, "time", has a major impact on the condition of the waste and the methods to be used for removal. Considering that the waste in all forms (Baseline or the EAs) is contained in steel drums, the time frame for the retrieval must be considered in three distinct phases, including: (1) from disposal to complete closure of the rooms (by creep), (2) room closure to deterioration and corrosion of the drums, and (3) long-term removal scenario (after corrosion of steel drum). Waste retrieval, which refers to retrieval during the operational life of the repository was not considered in the EACBS, and according to this definintion (given by Westinghouse) it was not required by 40 CFR Section 194.44.

Any analysis of the waste removal must be performed with respect to the prospective time frame. The 200 years period, even though it is not related to the aforementioned phases, can be considered to address the third phase. Therefore, Factor 4 seems to be based on the long term retrieval scenario. Some clarification to that effect and the justification of a 200-year time frame needs to be made.

The conceptual approach to the problem is, in general, acceptable. In other words, the mining rate being a function of specific energy of excavation (specific energy being a function of strength, and strength being a function of compaction etc.) will satisfy the basic requirements for the estimates in the lack of actual measurements and field data from waste removal operation. Yet the specific values and terminology used for the calculation has to be applied more cautiously. The assumptions made to evaluate the impact of EAs on waste removal within this factor and their validity are subject to discussion.

The direct use of the cited data for strength, specific energy, and mining rate calculation, specially with the consideration of the recent advancement in excavation technology, is not justified. Besides, utilizing data from disc cutter application for excavation of the waste in the forms identified in the EACBS alternatives is not suitable. Also, the mining rate calculations had to be repeated and new performance curves established with respect to the specification of a given machine (i.e., the mining equipment presently used at the WIPP) to be used for this purpose at WIPP. The use of the mining rate achieved in the WIPP to date would be more suitable as the basis for the calculations, which could be factored to account for different expected material properties.

Altogether, the assumptions made for the conceptual mining method (for long term retrieval) and the methodology used for mining rate and time estimates is correct but the quantitative measures need to be reexamined more thoroughly in a more detailed study. No reference has been made to the short term retrieval methods, rate, schedule, or the removal of RH waste. The results of the study (comparing the EAs) will be the same based on the volumetric approach and will not be affected by the values used in the calculations.

C-4.5 Alternative Interpretations

The analysis could have been based on alternative methods for recovery and removal of the waste depending on the time frames discussed earlier. However, since the study is a qualitative comparison of the EAs, the alternative methodologies do not seem to have a major impact on the results. Briefly, the interpretations made based on the current methodology are not very sensitive to the variation of the waste processing or disposal method.

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C-4.6 Uncertainty of Results and Consequences If Wrong

In this factor, the percent porosity is used to estimate the unconfined compressive strength (UCS) of the material. There is some uncertainty involved with this assumption since the chemical bonding between the grains and the intrinsic characteristics of the material have more impact than the porosity alone. The extent of chemical interaction between the material (waste or backfill) is controlled also by the presence of fluids, which for the most part is inaccessible or very restricted except for wet backfills. In addition, UCS is used to estimate the specific energy requirements and that in turn is used as a basis for mining rate and other analysis. It is noteworthy that the UCS is dominant, but not the only parameter controlling the specific energy. The calculations following this stage using specific energy are straight forward and are not prone to uncertainties.

However, in either case, the impact of these uncertainties is not crucial in waste retrieval since the material can be removed by the current state of technology. The different materials anticipated to be encountered in the retrieval operations can be cut even if their strength is higher than the estimated UCS (Table 3-29) by a large margin. The difference will obviously change the mining rate, time, and the human exposure to hazardous environment that must be accounted for in the calculations.

The outcome and result of the analysis done in factor 4 and its impact on the selection of the EAs is not irreversible. Finally, since the study is a qualitative comparison and the volume of waste to be removed is used for estimation of the time and accidents, the impact of the errors are not prohibitive and the consequences is not very severe.

C-4.7 Appropriateness and Limitations of Methodology and Procedures

The subcommittee found the methodology used in this factor to be, in general, appropriate and within the bounds of convention. This refers to the use of rock strength, specific energy, and mining rate to estimate the time required for removal and accident rates. However, some of the assumptions, procedures, data, and terminology used in the analysis were not suitable for this application.

C-4.8 Adequacy of Applications

This parameter was discussed in more detail in the section about the assumptions and criteria (see Section C-4.4).

C-4.9 Accuracy of Calculations

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The accuracy of the calculations cannot be checked since the rates quoted are based on the continuous mining of the material without any reference to the machine specifications and power. Back calculation of the machine power from the figure 3-9 using a 50% efficiency and 6 Megajoule per cubic meter (MJ/m^3) specific energy results in the assumption of using a machine with a cutterhead power of 80 Kilowatts (KW). This is below the installed power of the machines used to excavate the rooms at the site. More powerful machines are currently available in the market that can increase the rate even further. Also, the daily advance rates are based on the mining rate and the utilization, which is not mentioned in the text. Back calculation from the graphs shows that a utilization of 75% might have been used, but it is not clear.

Overall, the relationship in Figure 3-8 is not given and cannot be checked beyond visual inspection of the curve. Also, since no reference was cited, it could be concluded that the graph was made for this study (the graph was directly adopted from one of the reference articles but it is not mentioned in the report). In any case, the scale used (0-350 MPa) in the graph is well beyond the range of anticipated strengths. Figure 3-9 also seems incorrect from the basic theory of a cutting point of view unless some other assumptions were made in the calculations which were not mentioned in the text or tables. Likewise, the graph in Figure 3-10, provides no reference to the machine parameters and utilization.

The calculation for 77 series EAs must be reconsidered based on the selection of the excavation machine. Most machines (i.e., Dosco and Marrieta machines used at WIPP) cannot practically work in rooms below 6 ft height unless special provisions and set ups are made. The advance rates (for either size rooms) could be estimated from the volume per linear meter since the calculations are based on the volumetric excavation.

Overall, with the amount of information available, checking the calculations was not possible.

This does not necessarily imply that the calculations are invalid or the estimated daily advance rates are inaccurate. Nonetheless, the direct use of data from the sources for the calculations is not justified. However, since the calculated figures are used in a relative comparison, the outcome of the study could still be valid.

C-4.10 Validity of Conclusions

The result of the analysis and especially the numerical output of Factor 4 can not be directly used for assessment of the EAs. It must be emphasized that the mining method perceived for application in the waste removal (continuous mining) is considered only for long-term operation of the repository and removal of the waste. The conclusions made based on the results of the Factor 4 analysis must address the time frame more clearly. Had the short-term removal of waste and backfill been studied, the final results could have been different.

The general conclusions based on relationship between the volume of material to be removed and the time required for mining and, thus, the human exposure and accident is acceptable and valid. In other words, for the purpose of comparison (impacts and difficulty of removing the waste) between the EAs and the baseline, it is reasonable to favor EAs with super-compact (77 EAs) or reduced waste volume. The conclusion made by the analysis (that the difference between the other alternatives and the baseline is marginal) is also acceptable. The quantitative comparison should only be considered indicative, leading to distinction of the EAs.

C-4.11 General/Documentation

Factor 4 is designed to evaluate the impact(s) of the various Engineered Alternatives (EAs) on waste removal and their comparison with the baseline design. The method of waste removal selected was the same as the method for excavation of the rooms in the repository, which is continuous mining. Due to some uncertainties, especially with respect to cutting of the steel drums, different mining methods may need to be considered for this purpose to account for the effects of time on the waste containers. The assumptions made with respect to the mining procedure and cuttability of the material(s) needs some further investigation for the same reason. Therefore, the calculation of the specific energy, mining rate, and time required to excavate the waste is uncertain. This issue must be examined more thoroughly and mining rates estimated based on a mining method which is more appropriate for this type of conditions.

Overall, the impact of the selected EAs for final evaluation on the waste removal compared to the baseline design seems to be marginal. The underlying conclusion of the analysis with respect to the increased time and accidents with the increase in the volume of waste is reasonable. This is irrespective of the material to be removed. The exact impact of the EAs on the schedule and actual method used for the removal is dependent on the time. The alternative approaches do not change the outcome of the analysis significantly. The quantitative comparison should only be considered indicative and used for the comparison, but not for further calculations of time, schedule, or cost.

Had Factor 4 been considered in the screening process, EAs using different container material (i.e., EA 64) such as ceramic/glass could be considered for further evaluation. The process could be designed to be interactive with the factors in such way that if there was an EA which could significantly impact the results of a factor, it could be included in the studies. This does not imply that all 54 EAs had to be studied at the final level with all factors, rather it refers to a quick/rough review of the EAs with respect to the general scope of each factor.

APPENDIX C-5

REPORT OF SUBCOMMITTEE 2

FACTOR 5 - TRANSPORTATION RISK

C-5.1 Scope and Tasks of Subcommittee

The task of this subcommittee is to review the study conducted by Westinghouse and the DOE of the relative impact on transportation risk of the different engineered alternatives (EA). This was accomplished by reviewing Section 3.5 and Appendix L of the Engineered Alternatives Cost Benefit Study (EACBS) as well as specific portions of the RADTRAN4 Users Guide (Rodgers Engineering, 1994), the Comparative Study of Waste Isolation Pilot Plant Transportation Alternatives (DOE, 1995c) and the Final Supplement Environmental Impact Statement (DOE, 1990). Additionally, the subcommittee spent time discussing technical features of the work with the principal authors.

This section summarizes the review of the subcommittee, including a review of the requirements and criteria, assumptions, results and inferred consequences, methods and procedures used, and validity of the conclusions.

C-5.2 Adequacy of Requirements and Criteria

The requirements of the study conducted by Westinghouse and DOE are specified in 40 CFR Part 191 and 40 CFR Part 194. The specific criteria, as used in this study adequately satisfy the intent of the requirements set forth by the regulation.

C-5.3 Validity of Assumptions

- The methods used for computing risks, doses and hazard indices, and hazard quotients are appropriate, and they effectively express the worker and public risks associated with exposure stemming from each traffic accident associated with each EA. Additionally, several "off-the-shelf" transportation accident projection codes (e.g., RADTRAN) were used. A review of the methods, through inspection of the referenced documents (i.e., the FSEIS) indicates that the methods come from EPA, the International Committee on Radiation Protection, the American Conference of Governmental Industrial Hygienists guidance and the US Nuclear Regulatory Commission. These methods in and of themselves are based on conservative assumptions, they are conventional, are commonly used for this type of application, and are extensively documented in the literature.

- The report assumes current population densities and 20 year active life, with no documentation. Elsewhere in the Report, the WIPP operational window is stated to be 33 to 35 years. It is possible that population dynamics may change over the period of performance, thereby affecting population impacts. However, the subcommittee does not feel that the apparent discrepancy in assumptions is limiting to the assessment of transportation related risks. This is because of other conservative assumptions as will be discussed below.

- Exclusion of RH waste overall is questionable from an absolute perspective (Table 3-33 provides information for baseline and decentralized configurations, but Traffic Index (TI) values are only provided for baseline conditions. Effectively, it was assumed that RH waste was not a variable in the EACBS because the individual EAs addressed only the handling of CH waste. Overall, this is a valid assumption for the inter-EA comparisons because the RH related risks become a constant across all EAs. Therefore, negating the additive impacts of RH waste does not compromise the inter-EA comparison process.

  Results are provided for RH waste, but details of the derivation are not provided in either the EACBS or the FSEIS.

- The EACBS assumes only truck transport with no explanation. The subcommittee understands that it is possible that rail transportation could be used, though truck transportation will be the dominant mode of transport. The subcommittee cannot determine whether this assumption is valid. However, considering the magnitude of the projected risks, omission of rail risks does not compromise the inter-EA comparisons of transportation risks.

- It was assumed that the total overland inventory was equal to the WIPP design capacity. However, currently, the estimated inventory of TRU waste is roughly one-half the WIPP capacity. Thus, the total number of highway miles traveled, the number of incidents, their effects, and doses from non-incident travel are overestimated. This conservative assumption is justified and typical of the type of conservatism embodied in contemporary risk analysis.

- Other assumptions appear to be reasonable. Overall, the basic assumptions of the assessment are regarded as reasonable and well within the envelope of contemporary transportation risk assessment practice.

C-5.4 Alternate Interpretations

If the operating life of the WIPP significantly exceeds 20 years, the population densities could vary significantly. However, this variation is not a limiting factor. The methods used are widely recognized in the risk assessment field and, in light of the need to assess risks quantitatively in a defensible manner, there are no reasonable alternative interpretation.

C-5.5 Uncertainty of Results and Consequences if Wrong

Understating population densities would underestimate cumulative risks between EAs. This is because the variation in highway miles and population density between EAs (i.e., persons at risk is a function of linear miles and population density along the linear miles) This could produce a higher estimate of risk on a inter-EA comparison basis because the different configurations (i.e., central vs regional processing options) have varying linear miles and population densities. The effect of this subtlety are not easily quantifiable at this point.

The nature of the uncertainties is addressed in the report. However, the authors do not address the effect on their analysis of the consequences of errors stemming from uncertainties. The subcommittee feels that, overall, there would be little effect on an inter-EA comparison basis.

C-5.6 Appropriateness and Limitations of Methodology and Procedures

The subcommittee's review indicates that the methods used were generally appropriate. However, several imitations were noted as discussed below. The underlying document, the FSEIS, evaluates risks from a "bounding" accident (being the absolute worst case). This appears to have been eliminated from the EACBS evaluation, with no justification. For chemical hazards, calculated worst case airborne concentrations resulting from a category VIII accident were compared with the relevant Emergency Response Planning Guidance (ERPG) value. When the calculated values were less than the ERPG, no excess risk was assumed. This method evaluates individual risk only and is, therefore, based solely on waste form characteristics. Impacts on cumulative human health risks from transportation (mileage, population density, etc.) of the processed wastes is not considered.

The full range of transportation impacts cannot, therefore, be evaluated. The respirable release fractions calculated in the DSEIS were modified to account for variations in the waste form caused by the various engineered alternatives. This procedure is appropriate. However, the text does not provide adequate justification for the selected values of release fraction. For instance, Page 3-107 states that "the fraction of material released from failed containers was reduced by one third ... reflecting greater crush resistance of the drums..." Similar statements are included for each of the processing options (i.e., "fraction of material entrained to the environment was reduced by an order of magnitude..."). The bases of these modifications should be addressed. Not withstanding these limitations, the subcommittee found the methods to be appropriate and within the bounds of convention. The limitations, while notable, should not compromise the use of the assessment for inter-EA comparisons, so long as the issue of the 20 versus 35 year time schedule and an EA significantly encroaching into the margin (e.g., the later 15 years) is not overlooked.

C-5.7 Accuracy of Calculations

The calculations appear to be reasonable and consistent with the methodology. The subcommittee did not check the computations referenced in the SEIS. They appear to be reasonable and the subcommittee's familiarity with the source of those computations and their description in the WMPEIS implies computational integrity.

C-5.8 Validity of Conclusions

The subcommittee's review did not uncover issues that would invalidate the conclusions drawn for the purposes of comparing transportation risk associated with the different EAs. Unfortunately, the reliance on "individual" chemical risk evaluations versus "cumulative" risk evaluations for radiation impairs the comparability (between chemical and radiological risks) of the conclusions somewhat. As is the case with radiation risk, the impacts to human health risk from transportation of hazardous chemicals is also a function of distance traveled, population density, as well as waste form. While these methodology discrepancies are inherent in the techniques used, they do not significantly impact the overall inter-EA evaluation.

Overall, the subcommittee believes that the results can be used with confidence for the relative comparison of the impacts on worker and human health between EAs.

C-5.9 General/documentation

Section 3.5.2 states that the analyses were conducted similarly to assessments included in the WIPP FEIS and FSEIS. However, the FSEIS explicitly states that the methodology used in that document differs from that in the FEIS, and provides justification for that difference. The EACBS should identify which methods were taken from what original documents, and state the reasons for the selection. Also, it would be helpful if the general procedures were summarized in this document (i.e., reliance on accident frequency/severity probabilities rather than on risks associated with individual accidents.)

APPENDIX C-6

REPORT OF SUBCOMMITTEE 3

FACTOR 6 - IMPACT ON PUBLIC CONFIDENCE

FACTOR 7 - IMPACT ON SYSTEM COST AND SCHEDULE

FACTOR 8 - IMPACT ON OTHER DISPOSAL SYSTEMS

C-6.1 Factor 6: Impact on Public Confidence in the Performance of the Disposal System.

C-6.1.1 Scope and Tasks of Subcommittee

The task of this subcommittee is to review the study conducted by Westinghouse and the Department of Energy relative to the impact of engineered alternatives on public confidence in performance of the disposal system at WIPP. Specifically, the subcommittee reviewed Section 3 of the study conducted by Westinghouse, DOE, and its subcontractors on identifying and understanding public concern about real or perceived risks associated with WIPP in its post-closure state that can assist DOE in:

- planning and executing sound engineered alternatives as needed to address public concerns
- providing credible scientific basis and data to assist the public in understanding risk as related to possible concerns and comments
- actively involving the general public to insure a two-way flow of information

This section summarizes the review of the subcommittee, including a review of the requirements and criteria, assumptions, results and consequences, methodology and procedure, and validity of conclusions.

C-6.1.2 Adequacy of Requirements and Criteria

The requirements of the study conducted by Westinghouse and the DOE are set forth by EPA rules 40 CFR Part 191 and 40 CFR Part 194 with reference to public participation. The specific criteria, as used in this study and as noted above in the Scope and Task, adequately satisfy the intent of the requirements set forth by the regulations.

C-6.1.3 Validity of Assumptions

The major assumptions associated with this section of the study are that 1) the public's concerns (questions and input) can be understood by comments from regulatory review meetings and focus group programs and 2) these concerns can be categorized to evaluate how well the engineered alternatives address the public concerns. These assumptions were made in order that not every engineered alternative needs to be specifically addressed by the public. A review of the opinions, questions and concerns obtained at the public meetings and focus group meetings lead us to agree that these assumptions are reasonable since these opinions and concerns do apply to the alternatives. (There are also some technical assumptions that are available to the public.)

Another assumption, in this study, is that public concerns that were voiced during meetings relative to 40 CFR part 191 and 40 CFR part 194 and the 1990 Final Supplement Environmental Impact Statement (FSEIS) reviews are still valid. This is also reasonable since these meetings were held within the last six years and the opinions appear to be applicable today.

An additional assumption is that focus group meetings that were held in three primary cities—Albuquerque, Carlsbad, and Santa Fe, NM—would be valid for other geographic areas affected by the WIPP site. This too seems reasonable since these cities are the primary population areas in New Mexico. The only possible suggestion here from the subcommittee is that concerns should also have been obtained from some of the neighboring states (e.g., Texas) so that if different concerns are voiced by citizens of the neighboring states these could have been considered in the study of the engineered alternatives. In any case, communication with the other states might have been beneficial. Similarly, the DOE sites that plan to ship waste to WIPP could also have been surveyed for public opinions. However, we feel these are minor concerns and not worth repeating for the study.

C-6.1.4 Alternate Interpretations

The comments were analyzed qualitatively from Phase I and quantitatively from Phase II. The application of the comments to the engineered alternatives could be interpreted in slightly different ways, but our judgement is that this would not affect the conclusions of the study.

C-6.1.5 Uncertainty of Results and Consequences if Wrong

There may be some misinterpretation since generalized comments were applied to specific engineered alternatives. However, this uncertainty is low and the consequences of slight misinterpretation are not serious since the majority of the comments (greater than 60%) were comments relative to trust in DOE rather than on impact of engineered alternatives. The other comments on engineered alternatives are straightforward and of minimum impact because most of them also apply equally to the baseline technology.

Tests of statistical significance were not utilized. However, the method used is adequate, given the qualitative nature of the comments and the tenuous connection of public confidence to costs/benefits.

C-6.1.6 Appropriateness of Methodology and Procedures

As noted previously, the methodology used was to first analyze public comments that were made in the past six years relative to 40 CFR 191, 40 CFR 194, and the Final Supplement Environmental Impact Statement (DOE, 1990). This Phase I analysis covered several conditions, as well as siting and design factors. This was followed by a specific Phase II study conducted in three major population areas of New Mexico with focus group comments which covered several additional factors specific to the engineered alternatives. These public concerns were then analyzed in depth and applied to each of the engineered alternatives.

This methodology is quite appropriate, although one could argue that every engineered alternative could have been posed to the focus group and comments obtained. This is, however, unrealistic and in our opinion would not be a prudent use of taxpayers time and money since the comments made by the focus groups are easily applicable to the engineered alternatives. The focus groups would have had to spend an inordinately large amount of time addressing every alternative and would still probably provide comments similar to what they have already done.

The primary suggestion we can make is that, in order to provide greater confidence, one engineered alternative could have been taken and studied specifically with a focus group as a validation of the analysis. This would have required getting the focus group together again and would have taken additional time; the benefits would not be worth the cost. Another limitation might be that the study of focus groups could also have taken place in other states as pointed out previously (e.g., Texas). Again, it is doubtful that any signficant new results would have been obtained. Therefore, this subcommittee concludes that the methodology and procedure was appropriate.

C-6.1.7 Adequacy of Application

Having studied the methodology and other material, as well as the analysis, we feel that the application was proper in using the public concerns to understand the impact of engineered alternatives on the public. Specifically:

- The process used by the moderators is appropriate.
- The cities are representative of those most affected by WIPP in the State of New Mexico and, therefore, are appropriate.
- The sample represented adequately those with significant interest in WIPP.

C-6.1.8 Accuracy of Calculations

The only calculations involved are those of grouping the concerns together into major categories relative to the performance of WIPP. These categories were chosen to evaluate performance, i.e. human health, waste characteristics, waste repository technology, etc. We have spot-checked these calculations for developing groupings and feel that these are accurate with minor discrepancies within the interpretation of the comments. Different interpretations might have led to slightly different percentages in the grouping, but this would have been a small change and would not create any critical limitations.

C-6.1.9 Validity of Conclusions

The major conclusion from the study is that the overall spread of results does not lend itself to signficant differentiation. Therefore, all engineered alternatives are indicated as unchanged from the baseline for the impact element (i.e., the public views the alternatives performance to be approximately the same as the baseline performance). Although some may make an argument that selected EA performance is somewhat better, rather than the same as baseline, this is marginal at best and the EACBS conclusion is appropriate in view of the review that we have conducted.

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C-6.2 FACTOR 7: IMPACT ON SYSTEM COST AND SCHEDULE

6.2.1 Scope and Tasks of Subcommittee

Factor 7 is defined as the determination of the impacts each EA will have on cost and schedule where cost is composed of waste processing, transportation, repository backfill and emplacement handling costs for the different EAs in different configurations. Schedule impacts look at the length of time an EA will require to be implemented and consequently the EA's desireability. The scope and tasks of the Peer Review Subcommittee regarding this factor was to conduct an assessment of the validity of the assumptions and the technical approach used in the work performed. This included an in-depth critique of assumptions, alternate interpretations, methodologies and acceptance criteria employed, and of the conclusions drawn.

C-6.2.2 Adequacy of Requirements and Criteria

This peer review was conducted to satisfy quality assurance (QA) requirements of 40 CFR Part 194, Criteria for the Certification and Re-certification; and NUREG-1297 of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 194 Disposal Regulations. The evaluation of the PRS was not intended to assess the validity of the requirement to perform this work, nor the validity of the 40 CFR 194.44 analysis requirements.

C-6.2.3 Validity of Assumptions

The subcommittee conducted the evaluation of the assumptions utilizing a two-tiered approach. The first tier consisted of grouping the assumptions in the following five categories: 1) waste processing cost assumptions; 2) transportation cost assumptions; 3) backfill emplacement costs assumptions; 4) waste emplacement handling costs assumptions and 5) schedule assumptions. The second tier consisted of conducting a qualitative analysis of the assumptions in light of their completeness, appropriateness, and uncertainty associated with all calculated costs and schedule duration for each of the engineering alternatives.

A list of the assumptions based on the five categories mentioned above is included in Attachment A. The following sections describe the results of the subcommittee qualitative analysis of the validity of the assumptions.

C-6.2.3.1 Validity of Waste Processing Cost Assumptions — The subcommittee evaluated the completeness of the assumptions based on the information necessary to carry out the waste processing cost methodology. The subcommittee determined that the following information was necessary to calculate the waste processing costs: 1) waste mass and volumes rates: 2) processing period; 3) percent of inventory of waste requiring retrieval; 4) percent of stored wastes requiring re-grouting; and 5) qualitative cost comparison information of similar waste processing engineering alternatives. During the review of the assumptions, the subcommittee determined that the list of assumptions included in Attachment A encompassed all the above information. Therefore, the subcommittee concluded that the assumptions were complete. The subcommittee also evaluated the unstated assumption that no new treatment facilities will be constructed after the initial facility has been constructed (i.e., a treatment facility is expected to remain operational for the 20 year processing period.) This assumption is considered to be acceptable given the 30 percent maintenance cost addition discussed in the EACBS.

The evaluation of the appropriateness of the assumptions was focused on the assumptions made to calculate the mass and volumes rates which have the greatest impact on the overall processing cost. The mass and volume throughput were calculated using data from the Waste Isolation Pilot Plant Baseline Inventory Report (WIPP BIR) (DOE, 1995e) which assumed a 20 year processing period and 4,032 working hours a year. The subcommittee evaluated the processing period of 20 years based on the expected 35 years operational life for WIPP. The subcommittee considered the 10 years estimated period to start up processing operations and the additional time for emplacement of waste at WIPP, and determined that the 20 years processing period will be consistent with the expected 35 years operational life for WIPP. The 4,032 working hours were calculated assuming 240 working days a year, and three working shifts a day at 70 percent availability. The 240 working days a year appeared to be appropriate to the PRS. Also, the subcommittee considered that three working shifts a day will be an effective waste processing operation because it will avoid unnecessary shut down of the systems. In looking at the 70 percent availability the subcommittee considered it a little low. Usually, the operational availability of processing systems is assumed to be about 85 percent. However, after the subcommittee considered that the processing alternatives in this report were innovative technologies, the subcommittee determined that this 70 percent availability may be appropriate because of potential problems associated with the operation of these innovative processing systems. Therefore, the subcommittee concluded that the assumptions were appropriate. In regards to the uncertainty associated with the assumptions, the subcommittee agreed that the probable accuracy of the estimate is plus or minus 30% (Peters et al., 1991).

C-6.2.3.2 Validity of Transportation Cost Assumptions — The transportation costs assumptions were derived primarily by specific waste density and waste containment shipment requirements. The subcommittee analyzed the assumptions, and found them consistent with packaging and transportation requirements. Therefore, the subcommittee concluded that the assumptions were complete and appropriate. The subcommittee concluded that the assumptions are valid.

C-6.2.3.3 Validity of Backfill Emplacement Costs Assumptions —The assumptions were developed based on the proposed backfill emplacement method. The subcommittee evaluated the proposed backfill emplacement method, and found it to be effective because it avoids interruption to waste emplacement activities. Therefore, the subcommittee determined that the assumptions were complete and appropriate. Assumptions are valid as long as the batch method for backfill emplacement is implemented at WIPP.

C-6.2.3.4 Validity of WIPP Waste Operations Emplacement Cost Assumptions — The subcommittee evaluated the assumptions based on their consistency with the estimated 35 years operational life for WIPP and the estimated quantities of waste to be sent to WIPP. The subcommittee reviewed the estimated waste inventories and waste operation's rates at WIPP, and determined that the assumptions were consistent with the 35 years operational life for WIPP. Therefore, the Subcommittee found these assumptions to be complete and appropriate.

The waste operations costs are mainly driven by the estimated quantities of waste to be sent to WIPP. Therefore, the subcommittee concluded that the assumptions are valid based on their consistencies with waste inventories.

C-6.2.3.5 Validity of Schedule Assumptions — The subcommittee assessed the completeness and appropriateness of the schedule assumptions based on their consistency with the broad spectrum of engineering alternatives and the expected 35 years operational life for WIPP. The subcommittee found the schedule assumptions consistent with the type of engineering alternatives (waste processing and backfill) and the 35 years operations at WIPP. Therefore, the subcommittee determined that the schedule assumptions were complete and appropriate.

In regards to the uncertainty associated with the assumptions, the subcommittee noted that the schedule assumptions were very generic in nature and had insignificant effect on the actual development of the schedule duration for each of the engineering alternatives. Therefore, The subcommittee concluded that there was little uncertainty associated with any of the schedule assumptions.

C-6.2.4 Alternate Interpretations

The subcommittee evaluation of the costs and schedules was performed based on the input of information and methodologies used in this comparative analysis. A great amount of the information and methodologies were adopted from other source documents. Although there may be a few alternate interpretations originated from the guidance documents, the subcommittee determined that they will have an insignificant effect on the results of the study.

C-6.2.5 Uncertainty of Results and Consequences if Wrong

The subcommittee performed a qualitative evaluation of the results to ensure that there were no significant flaws or shortcomings with the calculations. At first, the subcommittee was concerned that the estimated costs were based on 1994 cost data and did not account for any cost increases in the future. Also, the subcommittee was concerned that the life cycle cost methodology did not consider any costs associated with the need to further develop a specific engineered alternative. However, in looking at these potential cost increases, the subcommittee determined that they will have an insignificant effect in the overall cost for each engineered alternative. Therefore, the subcommittee concluded that the estimated costs and schedules provided a reasonable approximation of the actual costs and schedule duration for each engineering alternative. A detailed discussion of the evaluation of the results is presented in the following sections.

C-6.2.5.1 Evaluation of Processing Cost Results — The subcommittee performed a comparison between similar processing schemes for each of the engineered alternatives in order to verify similar processing costs and agreed with the following results: alternatives 33, 35(a&b), 83, and 111 should be identical to the baseline; alternative 77 (a-d) should be identical to alternative 1.

The subcommittee also conducted a comparison of the processing costs among centralized, regionalized and decentralized processing facilities. Based on this comparison, the subcommittee agreed that centralized facilities resulted in the lowest cost and decentralized facilities in the highest cost. This conclusion was justified due to lower operation and maintenance costs being applied to a smaller number of facilities (1 for centralized vs. 10 for decentralized.)

The subcommittee also agreed that the baseline alternative was the least expensive due to less throughput values for the treatment modules. The cost of alternative 10 - (Plasma) was lower than the cost of alternative 94 (a-f) - Enhanced Cementation - because full-scale Plasma facilities are planned to soon exist at the Idaho National Engineering Laboratory. Therefore, the subcommittee determined that alternative 94 (a-f) - Enhanced Cementation was the most costly because of the need to construct new facilities.

In regards to the uncertainty of the results, the subcommittee agreed that the uncertainty should be the same as the level of uncertainty associated with the information utilized in the calculations. For the purpose of this comparative analysis, the subcommittee concluded that the process cost uncertainty will not change the results because the same level of uncertainty exists for all of the alternatives.

C-6.2.5.2 Evaluation of TRU Waste Transportation Cost Estimation Results — The subcommittee evaluated the results based on the following two factors which have the greatest impact on the transportation cost calculations: 1) certain waste processing alternatives increase the density of the waste making it mass limited; and 2) the cost of transportation is directly proportional to the waste volume/weight and required number of trips.

Looking at factor 1 above, the subcommittee agreed that the increase of density of the waste offsets the benefits of the waste treatment resulting in volume reduction because of waste volume transportation restrictions for high density waste.

Based on factor 2 above, the subcommittee determined that the transportation cost calculations were a straightforward analysis and found no issues with the calculations.

C-6.2.5.3 Evaluation of Backfill Emplacement Cost Results — The subcommittee reviewed the calculations of the backfill emplacement costs. Specifically, the subcommittee evaluated the estimated volumes, materials type, and associated cost of backfill materials.

The subcommittee determined that the estimated volumes of backfill and associated cost were reasonable. Also, in regards to the cost of backfill materials, the subcommittee determined that the overall cost evaluation was conducted properly because the costs accounted for the utilization of mined materials where backfill material consisting of salt was to be used.

C-6.2.5.4 Evaluation of WIPP Waste Operations Emplacement Cost Results — The subcommittee determined that the following factors were directly proportional to the waste operations emplacement costs: 1) period of operations for each alternative; 2) crew configuration; and 3) size of the crew.

Based on these factors, the subcommittee agreed with the results showing that alternative 10 - Plasma and 1 - Supercompaction provided the highest handling savings due to a 25 years operations rather than 35 years.

C-6.2.5.5 Evaluation of Schedule Results —The subcommittee evaluated the estimated schedule duration for each engineered alternative. During the evaluation, the subcommittee agreed that the duration of the National Environmental Policy Act process and permitting process should be longer for processing alternatives such as Plasma and Supercompaction due to public and regulatory agency concerns with these alternatives. Therefore, the subcommittee determined that the implementation schedules were justified for Plasma (36 years) and Supercompaction (35.5 years).

In regards to implementation schedules for alternatives where facilities currently exist, the subcommittee considered it reasonable that waste would be available for emplacement at WIPP by 1998. The subcommittee also considered that the processing start up period of 11 to 12 years was reasonable for alternatives that require new facilities.

Finally, looking at the schedules alone for each of the alternatives, the subcommittee also agreed that no alternative presents significant benefits or detriments relative to the baseline.

C-6.2.6 Appropriateness and Limitations of Methodology and Procedures

The subcommittee conducted a thorough evaluation of the methodologies and procedures used to develop the cost and schedule estimates. Detailed discussion of this evaluation is included in the following sections.

C-6.2.6.1 Evaluation of the Processing Cost Methodology — The Subcommittee assessed the cost methodology used in light of its ability and appropriateness to estimate the costs without having to perform a conceptual design and detailed cost estimate for each of the process configurations. During this evaluation, the Subcommittee determined that the cost approach provided an effective mechanism to calculate the costs associated with each of the process configurations. Specifically, the Subcommittee considered it appropriate to segment waste management facilities into discrete modules based on various waste management functions. This will allow flexibility in the costing methodology to consider existing facilities into the overall processing cost. Finally, the subcommittee determined that the cost methodology was appropriate because it was designed to consider the life cycle cost for each process configuration.

C-6.2.6.2 Evaluation of the TRU Waste Transportation Cost Estimation Methodology — The subcommittee considered the transportation cost methodology a straightforward analysis. Specifically, the subcommittee determined the following costing approach to be appropriate for this comparative analysis: 1) the cost per loaded mile (CPLM) have to be calculated considering carrier costs and hardware costs; 2) the costs are derived from the number of shipments which are applied to the CPLM and the round-trip mileage; and 3) the fixed costs are added to calculate the total cost.

The subcommittee examined that the uncertainty of the methodology was not an issue. The subcommittee determined that any uncertainty with the calculated costs will be originated from any uncertainty associated with the information used on waste inventory and other documents used as guidance.

C-6.2.6.3 Evaluation of Backfill Emplacement Costs Estimation Methodology — The subcommittee's evaluation of the methodology consisted of the assessment of the appropriateness of the following factors: capital costs, working rate of backfill emplacement operations, and maintenance costs.

The capital costs were given by the actual costs of the equipment needs. The equipment needs were identified considering the tons per day of emplacement capacity based on the number of TRUPAC-IIs per day. The subcommittee found the capital costs to be acceptable for the required backfill emplacement operations.

The subcommittee evaluated the appropriateness of the working rate of backfill emplacement operations based on the method of emplacement. The method of emplacement consisted of a batch operation in order to avoid waste emplacement interruptions. For batch operations, the subcommittee considered the assumed working rate of 960 hours a year acceptable. However, the working rate may need to be modified if the method of emplacement is changed in the future.

The maintenance cost was assumed to be 30 percent of the capital equipment costs. The subcommittee considered this a standard practice for estimating maintenance costs. Therefore, the subcommittee determined that the estimated maintenance cost was appropriate.

The methodology used included a 25 percent contingency in all costs including the baseline. The subcommittee determined that this was appropriate due to the level of uncertainty of plus or minus 30 percent resulting from the cost information provided in the Society of Mining Engineering Handbook (Hartman, 1992). In addition, the overall backfill emplacement cost for each alternative is about 1 to 2 percent of the total cost associated with each alternative, thus this cost is a minor component of the entire cost picture.

Overall, the subcommittee concluded that the methodology used was applicable and appropriate to estimate the backfill emplacement operation cost.

C-6.2.6.4 Evaluation of the Waste Emplacement Operations Cost Estimation Methodology — The subcommittee evaluation of the appropriateness of the cost methodology was based on the following two cost factors: throughput rate, and man power requirements for handling operations.

The subcommittee considered it acceptable to estimate the throughput rate by dividing the number of waste shipments by the operational period of WIPP. Also, the subcommittee considered that two working shifts a day will be acceptable to perform the waste handling operations at WIPP. Since the cost of waste emplacement operations is based primarily on the two factors mentioned above, the subcommittee determined that the methodology used was acceptable.

C-6.2.6.5 Evaluation of the Schedule Methodology — The information of schedule duration applied to the methodology was based on the duration of similar activities at DOE sites. This schedule duration was the main factor impacting the overall schedule for each engineering alternative. Based on professional judgment, the Subcommittee determined that it was reasonable to use information based on past schedule duration of similar activities in order to develop more realistic schedules. Also, the Subcommittee performed a spot check of selected schedules and they look reasonable.

In general, the Subcommittee determined that the schedule methodology considered the necessary implementation activities associated with each engineering alternative. Also, the schedules developed were consistent with the estimated 35 years operational life for WIPP. Therefore, the Subcommittee determined that the schedule methodology was adequate.

C-6.2.7 Adequacy of Application

Based on the review and evaluation of the assumptions, and methodologies used to estimate the overall cost and implementation schedule for each engineered alternative, the subcommittee determined that all the assumptions and methodologies were adequately applied to the work performed.

C-6.2.8 Accuracy of Calculations

On May 16, 1996, the subcommittee attended a meeting in Albuquerque, New Mexico to discuss the accuracy of the calculations performed in this Engineered Alternative Cost/Benefit Study Final Report (EACBS). The primary authors of the EACBS were available at the meeting (in person and by teleconference). At this meeting, the subcommittee asked several questions regarding the cost methodologies and assumptions used to calculate the overall costs and schedules for each engineering alternative. The primary authors provided satisfactory answers and clarification on each of the issues raised by the subcommittee.

Based on the meeting discussions, the subcommittee conducted a spot check of the calculations and determined that the calculations were performed in accordance with widely accepted methodologies and procedures. Therefore, the subcommittee determined that any uncertainty associated with the calculations were derived from uncertainty associated with input information such as waste inventories and other information gathered from guidance documents. The subcommittee finally concluded that this uncertainty should not impact the accuracy of the results of this comparative analysis.

C-6.2.9 Validity of Conclusions

The subcommittee agreed with the main body of the report which states that when looking at the schedules alone for each of the alternatives, no alternative presents significant benefits or detriments relative to the baseline for the closure of WIPP. However, Figure 5-4 shows that the schedule for alternatives involving waste processing was significantly worse than the corresponding baseline schedule. This is correct for the required schedule to send first waste to WIPP, but is not correct for the life cycle of WIPP or at WIPP closure. In order to avoid confusion, the Subcommittee suggests that Figure 5-4 makes this clarification.

In general, other than what is noted above in this section, the subcommittee concluded that the conclusions of this comparative analysis are valid.

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ATTACHMENT A
COST AND SCHEDULE ASSUMPTIONS

Waste Processing Cost Assumptions

1. Mass and volume rates are calculated using a 20-year processing period and a 4,032-hour working year.
2. Mass and volume changes occur during certain processing activities.
3. The mass of unknown wastes is assumed to be zero because no information is available regarding the density of this waste and the volume of this waste is small compared to the total volume of waste destined for WIPP.
4. Thirty percent of stored waste at Los Alamos National Laboratory, Savannah River Site, Argonne National Laboratory-West, and Handford requires retrieval.
5. Twenty-five percent of stored sludges at Los Alamos and Idaho requires re-grouting and all of the stored sludges at Oak Ridge require grouting.
6. All waste within a major waste form category ((i.e., sludges, solid organic, solid inorganic) can be treated using a specified technology.
7. The supercompaction module does not include shredding.
8. Cost for a vitrification unit are considered adequate for the costs for a plasma melter.
9. Costs for enhanced cementation processing are identical to costs for grouting except for material costs.
10. Costs for shredding and adding clay are identical to costs for grouding except for material costs.
11. Costs for shredding and compacting are analyzed as a modified cost module for supercompaction.
12. Start up processing operations will take 10 years.

Transportation Cost Assumptions

1. It is assumed that all CH TRU waste will be shipped by truck in TRUPACT-II containers, which have mass, volume, and radionuclide restrictions that limit the amount of waste transported in one shipment.
2. Shipments may include as many as 42 drums of low density waste or as little as 14 drums of high density waste.

Backfill Cost Assumptions

1. The backfill is emplaced daily as a batch and will not interrupt the waste emplacement activites.
2. The working rate for backfill emplacement is assumed to be 960 hours per year for 35 years.

WIPP Waste Operations Emplacement Cost Assumptions

1. The waste emplacement operations at WIPP consist of two eight hour shift operations five days a week
2. Waste emplacement is dependent upon the number of TRUPACT-IIs received per day.
3. The cost estimation for the impacts associated with the WIPP operations only analyzed the incremental costs to the actual activities associated with waste handling and emplacement.

Schedule Assumptions

1. Treatment units would be capital projects.
2. The operational life of WIPP would be 35 years.
3. Funding is unconstrained for the purposes of developing the schedules.
4. The Baseline and Shred and Compact scenarios are assumed to have the shortest schedules because they employ the simplest technologies, followed in order of complexity by Shred and Compact, Enhanced Cement, Supercompact and Plasma.
5. Durations for the Resource Conservation and Recovery Act permitting and National Environmental Policy Act documentations increase for the Plasma melter because of the likelihood of significant public and agency comments.

C-6.3 FACTOR 8: IMPACT ON OTHER WASTE DISPOSAL PROGRAMS

C-6.3.1 Scope and Tasks of Subcommittee

This factor is defined in the EACBS as the determination of the major impacts an Engineered Alternative (EA) will have on other waste disposal and processing programs, including low level and mixed low level waste. Major impacts were assessed based on additional waste generated by TRU waste processing EAs in accordance with the guidance outlined in 40 CFR 194 Section 194.44(c)(1)(viii) Engineered Barriers which stated: "In conducting the evaluation of engineered barriers alternatives, the following shall be considered, to the extent practicable: The impact, if any, on other waste disposal programs from the incorporation of engineered barriers (e.g. the extent to which the incorporation of engineered barriers affects the volume of waste.)" Non-processing or backfill-type EAs did not impact the assessment.

C-6.3.2 Adequacy of Requirements and Criteria:

40 CFR 194 specifies the 8 factors required to be evaluated in this EACBS. As such the adequacy of the requirements and criteria governing the conduct of this work are considered to be fixed and are not subject to modification as a result of this peer review. Other requirements which relate to this study are found in 40 CFR 191.

C-6.3.3 Validity of Assumptions:

A large number of assumptions are utilized, some inherent and others explicit, in the evaluation of Factor 8. Each of these key assumptions is listed and discussed in the following section:

- Treatment processes evaluated, other than plasma processing which assumes no secondary waste generation, are assumed to generate waste volumes similar to cementation processes currently in use at the Rocky Flats Plant. Further it is assumed that any new cementation processes at other DOE facilities will generate similar volumes. The EACBS used a volume increase factor of 1:2.5 which results in 0.75 drums of secondary waste generated per drum of input waste. Further, the report uses an average of 0.3 drums of secondary waste generated per drum of output cemented waste. Types of secondary waste include: oil, glovebox gloves, glovebox filters, line metal, non-line wet combustibles, line wet combustibles, non-line metal, plastic, personal protective equipment (PPE), dry combustibles, laboratory waste, cement, empty bottles, sludge, filtrate, insulation, glass, etc.

  Assuming the calculations to support the volume increases are accurate (and there is no reason to believe they are not accurate because they make sense intuitively and spot checks verified some of the calculations), this is a safe and conservative assumption, one that is key when determining life-cycle cost, schedule, and scope for a project. It would be a great help to the reader and for the EACBS to clearly show where and how these volumes were derived, and to provide an example. This assumption may over-estimate the volumes of secondary waste to be processed, handled, and disposed, but this over-estimation is not expected to be significant in the overall waste handling and disposal process. One key area where this assumption may have a larger impact in the future is during the actual waste emplacement process. Based on this assumption, one can safely assume WIPP operations will plan for the appropriate amount of storage space. If this amount is greatly overestimated it will not have significant impacts because well before the additional space has been mined, these estimates will be refined. Further, waste estimates from DOE sites are typically highly variable and are subject to change as each site learns more about its waste inventory and as regulatory requirements change. Thus, this assumption is valid in the context of EACBS but should be revisited periodically to determine the implications of the new knowledge each site will gain with respect to their waste inventory volumes. The text of the report does not clearly state it, but the volumes of waste exiting the different treatment processes do change based on the type of treatment the waste undergoes (e.g., cementation produces the largest volume of secondary waste and compaction produces a smaller volume.)

These sections of the report (3.8 and Appendix R) are difficult to follow at times. The subcommittee recommends these sections be revised to clearly show the rationale for and an example of all volumes (before, during and after treatment). It is not clear in reading the report the tie between the fractional increases (0.3 and 0.75) in waste volume, including whether these percentages are additive or mutually exclusive. The subcommittee further recommends this revision not take place until sometime in the future when the document will be revised for other purposes (i.e., the subcommittee's request is not sufficient justification to revise the document until there are other reasons to modify the report.) It is important to note that in talking with the authors of the EACBS telephonically and in person, subcommittee 3 gained an understanding of the basis used in the EACBS. The following information shows the relation of the changes in volume discussed above which has led to some confusion.

> 1 drum ——> treatment (this process adds 0.75 drums [based on the worst case scenario] additional waste per drum input waste) = 1.75 drums ——> secondary waste which increases by as much as 0.3 drums waste per drum of the previously treated waste (this process can add as much as 0.525 drums because the volume of secondary waste is based on the output volume of the treated waste [i.e. 1.75 X 0.3 = 0.525 drums secondary waste generated as a maximum]) ——> which means that as much as 2.275 drums of waste may be generated from the initial 1 drum of input waste (1.75 + 0.525 = 2.275 drums of waste potentially generated per drum of input waste.)

This maximum volume increase only relates to those EAs with the highest treatment volume increase (i.e., cementation) and the largest number of applicable modules that generate secondary waste (e.g., characterization). Other EAs will have volumes ranging between the minimum and maximum and these differing volumes are so indicated in Table R-6.

- The waste characterization step, which is key in some aspects of the waste shipping process, is assumed to generate secondary low level waste at the same rate as the input treatment processes. This volume of waste has only been calculated for the volume of waste estimated to be in need of characterization, which amounts to approximately 30% of stored waste and 10% of projected waste. This volume of secondary waste generated is the same for the baseline and all alternatives because this step is required independent of the EA that may be implemented.

All of the applicable waste is expected to undergo the same waste characterization processing regardless of the EA chosen, thus the estimated volume of characterization waste (21,848 cubic meters) is the same regardless of the alternative (i.e. the generation of this waste is independent of the EA, therefore the assumed volume is acceptable). Also, the assumption that the generation rate is the same as the input treatment process is reasonable. It would be beneficial to describe the characterization process envisioned, in detail, to ensure a complete understanding of the processes involved. This is especially important when one realizes that non-intrusive characterization methods will be employed to the maximum extent possible to minimize waste (i.e. maximizing the use of non-intrusive methods will reduce the volumes of waste generated).

- All secondary waste characterized as TRU or low level is assumed to be low level and all secondary waste characterized as TRU mixed, hazardous, or low level mixed is assumed to be low level mixed.

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This assumption conservatively estimates the volumes of these waste types the DOE complex low level waste programs will have to account for in their processes and plans. It is not clear by reading the report, however, how the volumes of waste destined for WIPP are factored in to the report (i.e. if the entire volume of secondary wastes are going to low-level waste disposal, then does the report count this waste twice?) It should be clarified for the WIPP operations personnel what the best estimate of the volume of waste they will be required to dispose of is.

- When a treatment process listed a generation rate as "variable" or "insufficient data" the EACBS used a generation rate based on similar processes or wastes.

In spot checking the areas where the authors of the EACBS made assumptions concerning these generation rates, it was determined by the subcommittee that the author(s)' assumptions are valid and are applicable within the context they are used.

- When a generation rate was not identified based on volume, it was calculated using assumed densities based on Rocky Flats data and/or the Baseline Inventory Report (DOE, 1995b).

  This assumption is technically appropriate although it is difficult to follow the steps listed in the assumption in Appendix R where the volumes have been detailed. It would be a great assistance to the reader and end-user of this document to clarify the tie between the Baseline Inventory Report, the Rocky Flats data, the densities, the initial mass, Section 3.8 and Appendix R of the EACBS. Subcommittee 3 spot checked some of the specific rates that were derived from densities. The assumed rates are considered to be appropriate based on this review.

- The non-cementation EAs are assumed to generate similar volumes of secondary waste relative to the cementation EAs, on an input basis, other than plasma which is estimated to have no secondary waste.

  This assumption is adequate and considered to be conservative on the high side in estimating volumes. Cementation is well known for increasing waste volumes, sometimes significantly. Thus, the volumes estimated in the EACBS for the non-cementation EAs are expected to be higher than will actually be seen when the waste processing begins. Even in the worst case, secondary waste volumes from other (non-cementation) processes will not exceed the volume from cementation.

- The percentages of low level and mixed low level secondary waste generation varied considerably with respect to the type of processes evaluated in the report. Based on this variability the author(s) assumed 50 percent of the generated waste is low level and 50 percent is mixed low level.

  These estimates (50% for each waste type) are based on the calculated averages of 56% low level and 44% mixed low level waste generated from the processes evaluated. It is unclear from the report why 50% of each waste type was used in these calculations instead of the actual averages calculated. A suggestion is to add the information based on the calculated averages to the report which is not a difficult task but will provide the "best guess" of these waste volumes. When the individual DOE sites begin using the information contained in the report, a more accurate estimate will be desireable for planning purposes. Once again though, this information will be refined in the future and it is not critical for these values to be precise at this time. In fact these values cannot be precisely predicted at this time because the actual technologies that may ultimately be used have not yet been determined. The EACBS or similar report must be a living document that will be periodically updated as new information comes to light.

- The author(s) used two primary reports for total DOE waste inventories and projections, the 1993 Integrated Data Base Report (DOE, 1993) and the 1994 Mixed Waste Inventory

Report (DOE, 1994b). The inherent assumption in the use of these reports is they are accurate and represent each sites best estimate of their inventories.

These reports are widely used in the DOE community to estimate waste volumes. The data in the reports are by no means 100% accurate but they are the best information available at any one time. Significant effort goes into the preparation of the reports so it is not appropriate to second guess the data contained therein. It is critical to understand that projected waste volume data is a moving target and as additional data is learned at a particular DOE site, the volumes will be refined. In addition, site-specific agreements across the country will further determine the amount of waste generated, retrieved, and ultimately shipped to WIPP. Changing the volumes identified in the reports would be purely arbitrary at this time and would not provide DOE with a better basis in the EACBS. It is recommended, however, that the data in these reports can be reviewed in the future to determine if there have been any signficant changes that may impact the WIPP.

C-6.3.4 Alternate Interpretations:

There are several alternate interpretations that can be made with respect to the volume of secondary waste generated when the processes outlined in the EACBS are implemented. The majority of these alternative interpretations are a direct function of the assumptions made and thus they are no more correct than those identified in the report. Some of the specific modifications other than what has been discussed above include but are not limited to:

- Significant work is underway across the nation to minimize the volumes of waste generated in any and all waste treatment processes. As these technologies mature there will be new and potentially better techniques which can be used to reduce the volumes of waste the DOE complex must deal with. Consequently it is expected the processes used as the basis for the estimates found in the EACBS will be improved upon. Assuming this is true, the volumes identified in the EACBS will be on the conservative (high) side.

- DOE sites are actively working to refine non-intrusive characterization techniques such as real time radiography, integrity testing, drum venting, gas sampling, and passive/active neutron assay systems. Assuming these technologies prove to be successful, (and they are presently widely used and have been accepted by most individuals) the volumes of characterization waste will be reduced beyond what is described in the report.

- Estimates of secondary waste volumes after compaction could be better defined by contacting private industry and other organizations that perform this function. There are several companies involved in this process that can provide additional estimating information. Using the assumption that compaction will generate similar volumes in comparison to the other treatment processes results in an overestimation of the total waste generated. Consequently this number can be refined.

- The most significant alternate interpretation is that the EACBS only evaluated the impacts of secondary waste generation on other waste disposal and processing programs. As discussed above, 40 CFR 194 Section 194.44(c)(1)(viii) explicitly requires this information to be evaluated. However, the regulation does not specify this is the only impact that should be evaluated. It merely provides the effects of the EAs on waste volume as an example. Since this report is a cost/benefit study the subcommittee expected to see a clear and concise description of the costs and benefits of the EAs.

  Other impacts that could be assessed in this report include:

  - The life-cycle cost and schedule impacts on the waste generation sites as well as to WIPP. Although cost/schedule information is included in Section 3.7 of this report, a clear tie needs to be made between Sections 3.7 and 3.8. The subcommittee envisions a high level table with a textual description that can be added to Section 3.8 to describe this tie. This information is critical to maximize the usefulness of the EACBS to the DOE community and the public but is not expected to be incorporated into the report until other reasons dictate a revision or addendum is necessary.

  - DOE programs across the nation struggle with the question of "where do we ship our waste"? Consequently as more information is learned and waste quantities are further defined, the question provided in Factor 8 must be reconsidered. A specific example relates to buried waste which has not yet been accepted for disposal at WIPP. If this waste does eventually get shipped, there is a definite need to revise this section of the report with respect to the new volume data.

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C-6.3.5 Uncertainty of Results and Consequences if They are Wrong:

It can be clearly stated that the results presented in the report are not accurate with respect to the volumes of waste that will be generated by the waste processing EAs and that they have a confidence interval associated with them. This confidence interval is qualitatively estimated by the subcommittee to be +10% to -25% (i.e., the volumes may be as much as 10% higher or 25% lower than estimated in the report). However, since there is no way to definitively know the volumes of waste that will be generated, there is no need to quantify the associated waste volumes at this time. There are presently no serious negative consequences if the results are erroneous because the fact of the matter is the volumes identified in this report are based on the best available data and the methods used to determine the volumes are defensible.

C-6.3.6 Appropriateness and Limitations of Methodology and Procedures:

The procedures used to estimate the volumes are technically defensible and have sound justification. There are some limitations inherent in the approach used in the report including:

1. The basis for the volume estimates assumes the data provided in existing references is accurate. Although the information in these documents is not totally accurate, it is the best data available. The limitation is that all of this data is subject to change which can ultimately impact the results of this study. The results of the EACBS must be viewed as the first step. As the DOE complex clearly defines the processes they will use as they relate to this study, the volumes of secondary waste generated will also be better defined.

2. The methods used to estimate the volumes also have uncertainty built into them. The assumptions used however are defensible and are therefore considered to be acceptable.

C-6.3.7 Adequacy of Application:

The methods applied to the estimation of the volumes of waste generated have been discussed above. It is felt the techniques used were adequate to meet the intended goal of the EACBS report.

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C-6.3.8 Accuracy of Calculations:

There are few calculations required to be conducted to support this section of the report, but the bases for the calculations necessary are not detailed in either Section 3.8 or Appendix R. As such it is not possible to definitively determine the accuracy of the calculations used (i.e. the tables simply show the results of the calculations and the text explains how the tables were developed.) It would assist the reader to add a minimum of one example showing how the data were derived. This will also support any future activities which will be necessary when a revision to the report or data contained in the report is required.

Based on the textual description of the techniques used to estimate the volumes however, the process used appears to be appropriate according to the end use of the data. The subcommittee did perform spot checks on the data that are presented in the tables (such as averages) and found these to be accurate.

During some of the subcommittee's spot checks it was noted that the report had slightly different values in comparison with the input data received from the authors of the report. These differences were minor and will not affect the results of the EACBS. During spot checks of the data found in Appendix O with the Baseline Inventory Report, several discrepancies were noted with respect to waste volumes (e.g., Table O-6 of Appendix O of the EACBS is not consistent with Table 6-1 of the Baseline Inventory Report). Although inconsistent, the data erred on the conservative side, once again. The subcommittee recommends that these data be quality checked during the next revision to the EACBS. The changes that result must be accounted for in the analysis of several of the other factors.

C-6.3.9 Validity of Conclusions:

The conclusions reached in Section 3.8 are valid and support the end use of the report. Once again, it is important to explain that the data described in Section 3.8 must be revisited as more information is learned regarding the processes that will be used at the WIPP as well as the rest of the DOE complex.

APPENDIX D

References

APPENDIX D

REFERENCES

Hartman, H.L., 1992, Society of Mining Engineers, *Mining Engineering Handbook*, 2nd Ed., Society of Mining Engineers.

Peters, M.S., and K.D. Timmerhaus, 1991, *Plant Design and Economics for Chemical Engineers*, 4th ed., McGraw Hill, Inc., New York, New York.

U.S. Congress, October 30, 1992, *Waste Isolation Pilot Plant Land Withdrawal Act*, Public Law 102-579.

U.S. Department of Energy, 1980, *Final Environmental Impact Statement, Waste Isolation Pilot Plant*, DOE/EIS-0026.

U.S. Department of Energy, 1990, *Final Supplement Environmental Impact Statement, Waste Isolation Pilot Plant*, DOE/EIS-0026-FS, Office of Environmental Restoration and Waste Management.

U.S. Department of Energy, 1991a, *Evaluation of the Effectiveness and Feasibility of the Waste Isolation Pilot Plant Engineered Alternatives: Final Report of the Engineered Alternatives Task Force*, DOE/WIPP 91-007, Revision 0, Waste Isolation Pilot Plant, Carlsbad, New Mexico.

U.S. Department of Energy, 1991b, *Waste Acceptance Criteria for the Waste Isolation Pilot Plant*, WIPP-DOE-069, Revision 4, Carlsbad, New Mexico.

U.S. Department of Energy, 1993, *Interim Mixed Waste Inventory Report: Waste Streams, Treatment Capacities and Technologies*, DOE/NBM-1100, WIPP Project Integration Office, Albuquerque, New Mexico.

U.S. Department of Energy, 1994a, *Office of Environmental Management Programmatic Environmental Impact Statement*, DOE/EIS-0200.

U.S. Department of Energy, 1994b, *National Data Base System for the Final Mixed Waste Inventory Report, Draft User's Guide*.

U.S. Department of Energy, 1995a, *Engineered Alternatives Cost/Benefit Study Final Report*, DOE/WIPP 95-2135, Revision 0, Waste Isolation Pilot Plant, Carlsbad, New Mexico.

U.S. Department of Energy, 1995b, *Waste Isolation Pilot Plant Transuranic Waste Baseline Inventory Report*, CAO-94-1005, Revision 1, Carlsbad, New Mexico.

U.S. Department of Energy, 1995c, *Comparative Study of Waste Isolation Plant Transportation Alternatives*, DOE/WIPP 93-058, Carlsbad, New Mexico.

U.S. Department of Energy, 1995d, *Draft Waste Management Programmatic Environmental Impact Statement*, DOE/EIS-0200-D.

U.S. Department of Energy, 1996, *Peer Review Procedure*, TP10.5, Carlsbad Area Office.

U.S. Environmental Protection Agency, 1985, *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-level and Transuranic Radioactive Waste*, Title 40 U.S. Code of Federal Regulations Part 191, (40 CFR 191).

U.S. Environmental Protection Agency, 1996, *Criteria for the Certification and Re-certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations*, Title 40 U.S. Code of Federal Regulations Part 194, (40 CFR 194).

U.S. Nuclear Regulatory Commission, 1988, *Peer Review for High-level Nuclear Waste Repositories*, NUREG-1297.

APPENDIX E

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Acronyms and Initialisms

ACRONYMS and INITIALISMS

CAO	Carlsbad Area Office
CCDF	complementary cumulative distribution function
CFR	Code of Federal Regulations
CH	contact-handled
CPLM	cost per loaded mile
DAM	Design Analysis Model
DOE	U.S. Department of Energy
DSEIS	Draft Supplement Environmental Impact Statement
EA	Engineered Alternative
EACBS	Engineered Alternatives Cost/Benefit Study
EAs	Engineered Alternatives
EASWG	Engineered Alternatives Screening Working Group
EATF	Engineered Alternatives Task Force
EMPEIS	Environmental Management Programmatic Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ERPG	Emergency Response Planning Guidance
FEIS	Final Environmental Impact Statement
FSEIS	Final Supplement Environmental Impact Statement
FTE	Full Time Equivalents
IAEA	International Atomic Energy Agency
IUPAC	International Union of Pure and Applied Chemistry
K_d	distribution coefficient
KW	kilowatts
MJ/m^3	mega joules per cubic meter
MPa	megaPascals
MRE	Measure of Relative Effectiveness
MRU	Measure of Relative Uncertainty
NUREG-1297	U.S. Nuclear Regulatory Commission *Peer Review for High-level Nuclear Waste Repositories*
PA	Performance Assessment
QA	Quality Assurance
RH	remote-handled
SNL	Sandia National Laboratories
TRU	Transuranic
UCS	unconfined compressive strength
WERC	Waste-management Education & Research Consortium
WIPP	Waste Isolation Pilot Plant
WMPEIS	Waste Management Programmatic Environmental Impact Statement

WASTE-MANAGEMENT EDUCATION & RESEARCH CONSORTIUM
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MEMORANDUM

Date: August 29, 1996

To: James Mass; DOE-CAO
Steve Wagner; Westinghouse-WID

From: Abbas Ghassemi, Peer Review Manager

Re: Peer Review Panel response to DOE comments

Gentlemen;

The peer review of the EACBS was conducted in accordance with the U. S. Nuclear Regulatory Commission *NUREG-1297 Peer Review for High-level Nuclear Waste Repositories* (NRC,1988) and the DOE Carlsbad Area *Office Peer Review Procedure TP 10.5*(DOE, 1996).

One key component of the TP 10.5 is the formal verification of the independence of each peer review panel member, which was completed as a part of the EACBS peer review process. The documentation and the evidence for this process can be found in the records package of the EACBS peer review. If there are any questions, please do not hesitate to contact me at (505) 646-1719.

cc: Peer Review Panel Members