See Pocket for encl.

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WM-RES
WM Record File D1004 EI

WM Project 10,11,16
Docket No.
PDR ✓
LPDR ✓ (B,N,S)

Distribution:
Buckley

(Return to WM, 623-SS)

12 September 1984
Ref. No. 1148-003
Letter No. 053
Federal Express No. 844729922

High Level Waste Technical Development Branch
Division of Waste Management
U. S. Nuclear Regulatory Commission
7915 Eastern Avenue
Silver Spring, MD 20910

'84 SEP 13 P2:35
WM DOCKET CONTROL CENTER

Attention: Mr. John Buckley, Mail Stop 623-SS

Subject: Second Transmittal of Partial Comments on the 4th Draft Environmental Assessments (EAs) for Salt Repositories. Contract No. NRC-02-84-002, Task Order No. 003

Dear Mr. Buckley:

Per your request, please find attached our further comments on the subject EAs. These consist of EI comments on the Swisher County EA and comments by our subcontractor A. Brown on the Lavender Canyon EA. We are forwarding these comments without final review by EI for their scope and content, so as to avoid further delay in your receipt and use of this material.

We hope to complete and formalize our draft comments on the Swisher, Lavender Canyon, and Cypress Creek EAs shortly. We would welcome your reaction to this work and your guidance as to future EA review effort.

Sincerely,

ENGINEERS INTERNATIONAL, INC.

Robert A. Cummings

Robert A. Cummings
Project Engineer

RAC/bt

Enclosure

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1485

ADRIAN BROWN
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RECEIVED
SEP 12 1984
ENGINEERS INTERNATIONAL, INC.
WESTMONT, ILLINOIS 60559

September 11, 1984

Engineers International Inc
98 East Naperville Road
Westmont, Illinois 60559

Attention: Mr. R. Cummings

Re: REVIEW OF ENVIRONMENTAL ASSESSMENT OF LAVENDER CANYON EA
CONTRACT NRC-02-84-002

Dear Robert:

Please find attached my review of the above captioned Environmental Assessment. This review was initiated by a visit to Westmont early in August, and completed in Denver this week.

I trust that this report meets your needs at this time. Please do not hesitate to call if there are any questions.

Respectfully submitted,

Adrian Brown

Adrian Brown, P.E.

Att.

1.0 INTRODUCTION

This review of the Fourth Draft of the Lavender Canyon Environmental Assessment (the EA) has been prepared for the NRC by Adrian Brown, under subcontract to Engineers International. It covers sections of Chapters 3, 4, 5, and 6, as selected by the NRC. The author also read the entire text of those chapters in order to ensure that the review was performed in context.

The review presented here concentrates on the evaluation of the geohydrological information of the text. Where other earth science issues are addressed, the author has commented on those items that are within his area of expertise.

Review comments are offered in two sections, as requested. The first section addresses general comments on the text material as a whole, in general providing comments on material presented in the EA that appears to the reviewer to be of significance to a future licensing action. The second section presents details of a variety of apparent factual, logical, and other errors, and identifies areas where the reviewer believes that more information is required to enable a review to be conducted.

No evaluation was performed as to the relative merits of the Lavender Canyon site when compared to other sites, nor was the acceptability of the performace addressed. The review was limited to evaluation of the data which would appear to be used in a licensing action, and the inferences developed from the data which appear to have licensing significance.

Specific references to the EA text are made by chapter, page number and paragraph, in the following format: (chapter-page/paragraph). For this purpose the opening paragraph is counted as paragrah #1, regardless of whether it is complete or carries over from the previous page. In addition, lists in the center or at the end of paragraphs are included in the paragraphs.

2.0 COMMENTS ON THE TEXT AS A WHOLE

2.1 CONTENTS OF THE CHAPTERS REVIEWED

Chapter 3 contains information about the site. The subsurface information is based largely on the results of the drilling of corehole GD-1, some 4 miles to the north of the candidate site. This information is supported by limited regional data from various oil wells and other coreholes. This material has been available for some time, and in general all of the data presented has been reviewed by the reviewer prior to the preparation of the EA draft.

Chapter 4 contains information on the impacts of the investigations needed to complete the characterization of the site. This is of interest in a licensing context as it provides an early view of the proposed investigation strategy.

Chapter 5 provides an evaluation of the likely effects of locating a repository at the site. For the purposes of this review this chapter is of value in providing details of the proposed repository design and the activities associated with its construction.

Chapter 6 provides an evaluation of the suitability of the site for site characterization. This invloves a series of comparisons of conditions at the site with favorable and adverse conditions set out in 10 CFR 60 and 10 CFR 960, and a series of performance evaluations of a repository at the site.

2.2 GENERAL COMMENTS ON SELECTED ISSUES

2.2.1 Reliance on GD-1

The evaluation presented in this EA depends heavily on the results obtained from GD-1, the major corehole drilled in the Paradox Basin by the DOE. This hole is over two miles from the Lavender Canyon site, and use of this information must be considered in light of the following:

1. There is little geological and hydrogeological data to allow interpolation from GD-1 to the site;

2. Little unambiguous in situ hydrological or hydrogeochemical information was obtained from GD-1 for the entire Paradox unit, which includes more than 1000 feet above and below the proposed repository horizon.

As a result, it is the opinion of the reviewer that there should be a single, clear statement of the uncertainties associated with this data, and its relocation to the site. A large number of comments are made in the entire text on this matter, but they are often inconsistent and occasionally wrong (see detailed comments below).

2.2.2 Head gradients in the Paradox unit

The hydrogeological tests of the Paradox unit were in general terminated before approaching pressure equilibrium. This is a result of the nature of the materials being tested (creeep-prone and very low permeability). Test analysis is very conjectural (see for example the differences between the results in ONWI-388 and ONWI-491). Static heads (and also permeabilities) in the Paradox are therefore still considered by the reviewer to be largely unknown.

The EA contains many references to vertical head gradients in the Cycle 6 Salt, and other parts of the Paradox Unit, particularly in analysis of the Darcy flow release of radionuclides. In general the assumption is made that the gradient in the salt is equal to the gross gradient between the upper and lower hydrostratigraphic unit. This gradient is fairly strongly downward, which is a positive factor with respect to containment. It appears to the reviewer that it is possible that the pressure of groundwater in an inclusion in a low permeability plastic material might approach the lithostatic pressure at that point. This would suggest head gradients away from the repository horizon in either direction.

In any event, the complexities of this question, and the evaluation of the data available to resolve them, appear to be to some extent ignored in the EA. It would appear necessary for these matters to be more exhaustively addressed for licensing purposes.

2.2.3 Flow in salt

The nature of the flow of water in salt is exhaustively addressed in the EA. There seems little doubt that the mass flux of water through a salt medium is small, even under the most extreme conditions of thermal and pressure gradients. This issue is in general well addressed in the EA, with an assumption of Darcy flow taken where this is conservative, and other assumptions (brine migration, diffusion) taken where it is not.

There seems, however, to be some confusion over the nature of porosity in salt, and its relationship to permeability. In general the porosity and permeability are considered in the report to close off together. However the total porosity of the salt is generally reported to be 0.5% even under stress, which is significantly above zero. The reviewer believes that a single,

detailed statement on the nature of flow in salt, and on the way that this is influenced by stress and creep, would clear up the considerable remaining uncertainty about the way in which this matter is handled by the salt program.

2.2.4 Future program

The future program laid out in the EA comprises the following elements:

1. Drilling of a principal deep borehole at the Lavender Canyon site, primarily for "...determining the geotechnical characteristics of the stratigraphic sections penetrated by the borehole..." (4-9/2). Little hydrological or geochemical testing is anticipated in the hole, except to perform further tests of the type performed in GD-1.

2. Drilling of four monitoring wells close to the shaft site. These wells would all stop short of the Paradox Formation.

3. Drilling and testing of sixteen wells into the upper hydrostratigraphic unit, for testing and monitoring of the effects of shaft sinking.

4. Drilling of fifteen wells into the lower hydrostratigraphic unit within 16 kilometers of the site.

Some additional geophysical and shallow geotechnical work would also be performed.

The second major part of the site characterization activities would be the installation of a drilled test shaft, and excavation of an in situ test facility in the proposed repository horizon. No hydrogeolodical or hydrogeochemical testing is anticipated as part of this activity.

The identified data gaps in the EA include the lack of adequate information about the hydrogeology and hydrogeochemistry of the Paradox Unit in general, and the emplacement horizon in particular. It would appear that the program outlined in the EA will not address these matters. This appears to have significant importance for licensing.

2.2.5 Retrievability

The engineering description of the project activities does not appear to address the required retrievability of the waste cannisters after emplacement (10 CFR 60.111(b)). The report describes the emplacement activities, and indicates that the emplacement holes will close onto the cannisters in less than a year (6-265/3). It is stated that the problems which are expected to

be associated with retrievability are as yet unresolved (6-208/2). This is an important issue for licensing.

2.2.6 Creep effects and hydrology

There are numerous references to the effects of salt creep on the hydrology of the containment system. As noted above, the DOE expects creep to return the permeability of all disturbed materials to zero. In addition, creep is expected to provide a water-tight seal for the shafts (6-286/2). Finally, creep is expected to close the void space remaining in the repository backfill within 70 years of closure (6-285/4).

In particular is the self-sealing of voids in salt due to stress requires further support for licensing use. Golder (1977) found large voids in domal salt mines, which had apparently remained stable in geologic times. In addition, other plastic materials appear capable of sustaining joint openings over geologic time, for example in rich oil shale (Brown et al, "Water Management in Oil Shale Mining", USBM, 1977). While the self-sealing hypothesis is attractive, it would appear that some consideration of the impact of the failure of this mechanism to operate would be appropriate in a license-related submission.

2.2.7 Balance of presentation

The EA presentation in general appears to present a balanced picture of the current state of knowledge. There are a number of locations where alternative hypotheses are presented and discussed and negative findings are presented (e.g. 6-153...158, 6-218, 6-231, 6-255, 6-256). There are, however, a number of locations in the assessment where analyses of potentially damaging, albeit unlikely, phenomena do not appear to have been explored (e.g. 6-315, 6-322, 6-326).

It is the opinion of the reviewer that the report generally considers and presents the evaluation of the site in a manner that is consistent with a reasonable interpretation of the available information.

2.2.8 Calculations

The majority of the calculations used to support the conclusions presented in the EA are available in the text, or in supporting Tables. These calculations are simple and checkable. This reviewer finds that this approach to analysis is easier to assess and more convincing than the same evaluations performed on complex, and often proprietary, computer models.

3.0 SELECTED SPECIFIC COMMENTS

3.1 CHAPTER 3 - THE SITE

3-53/1 The reference to the apparent lack of penetration of the Lockhart Fault through the entire Paradox unit is of possible significance (by inference) in the interpretation of other faults identified in the near surface. It is possible that they are not present at the repository elevation.

3-57/5 It would seem that the possibility of "a series of northwest trending faults in the north central part of the Lavender Canyon candidate area" warrants considerably greater discussion than is presented, given their possible hydrologic, tectonic, and engineering significance.

3-66/4 to 3-69/2 The discussion on the rate of uplift of the area seems somewhat weak to the author, and the logic in 3-69/2 appears debatable. This parameter is of considerable importance to licensing, as regional erosion is a possible failure scenario.

3-71/2 The hydrostratigraphic units have not yet been introduced, nor are they in the referenced section.

3-73 to 3-87 These pages were missing in the review copy; this eliminated the opportunity to review the engineering property data.

3-89/2 The lack of brine migration data for Paradox salt is of licensing significance, as this may be a major transport mechanism.

3-92/2 The reference to the possibility of "two separate hydrostratigraphic units" within the upper unit would appear to warrant further discussion.

3-92/3 The acknowledgement of alternate hypotheses about travel time is appreciated.

3-92/4 The lack of hydrochemical data from the entire middle stratigraphic unit is an important licensing data gap at this site.

3-101/3 The "random sample" of drill stem tests suggests that there are a large number. This database would appear to warrant further discussion, given the limited amount of permeability data reported in the EA.

3-107/1 The reference to gas yeild from GD-1 core in the Paradox formation suggests finite permeability. No mention is made of plug tests of permeability of this core.

3-142/3 The use of surface water data only up to 1965 seems inappropriate, given the continuing collection of records.

3-147/3 The opening statement in the paragraph seems to suggest that recharge only occurs in a limited area near the Abajo and La Sal Mountains. If this is intended, it would need to be better supported for licensing purposes.

3-210/2 The last sentence appears to be a relatively weak conclusion given the information available.

3-210/3 No data on the potentiometric levels in the middle hydrostratigraphic unit are referenced, and no relaible data is known to exist. The statement that this data "supports this lack of vertical interconnection ..." therefore appears to be an overstatement.

3-214/4 The hypothesis that "subriver-level seeps to the Colorado River" are responsible for groundwater discharge is an unsupported opinion.

3-214/6 The conclusion about the recharge to the middle and lower hydrostratigraphic units in the vicinity of the site depends on the conceptual model of the site hydrogeology. This model appears to assume a lack of recharge. This therefore appears to be a circular argument.

3-216/4 The discussion of the nature of flow in salt is not particularly clear: this is a major issue for the remainder of the groundwater calculations in the report, and appears to warrant more discussion.

3.2 CHAPTER 4 - EXPECTED EFFECTS OF SITE CHARACTERIZATION ACTIVITIES

4-1/2 The definition of site characterization ("..activities...undertaken to establish the geologic condition and the ranges of parameters of a candidate site relevant to the location of a repository...") differs somewhat from the definition in 10 CFR 60.2 ("...the program...undertaken to establish the geologic conditions and the ranges of those parameters of a particular site relevant to the procedures under this part. Site characterization includes (activities) needed to determine the suitability of the site for a geologic repository..."), in that there appears to be less focus on relevance to site suitability.

4-4 The lack of any testing to evaluate hydrogeologic conditions in the middle hydrostratigraphic unit appears to be a significant omission when considering the resulting database available for licensing evaluations.

4-13 Figure 4-3 indicates that there will be no test wells in the vicinity of the site which will test or monitor the hydrogeology of the middle hydrostratigraphic unit. The two main wells appear to be about 10 miles from the site, which will make the qualification of data from them difficult for licensing purposes. In addition this figure does not appear to agree with the text.

4-16/3 The locations of boreholes SC-1,2,3, and 4 are not shown, which makes evaluation of their usefulness difficult.

4-25/2 It is implied that completions of drill holes will be in "water producing zones". This appears to rule out completion in the Paradox unit, which would seem to be a key area of data need, both for water chemistry and hydraulic head.

4-25/5 It is not clear why the program appears to include testing of stresses only in the Leadville Limestone, considerably below the repository horizon. Data to date suggest that stresses vary considerably between salt and adjacent less creep-prone rock. If the data are to be used to evaluate performance of the repository for licensing purposes, then it would appear prudent to test the repository horizon.

4-50/5 The proposed disposal of brine into a deep formation would seem to have a considerable probability of being disallowed by Utah regulatory agencies.

3.3 CHAPTER 5 - REGIONAL AND LOCAL EFFECTS OF LOCATING A REPOSITORY AT THE SITE

5-27/6 The project shafts will be sunk conventionally. This would seem to be a reason to sink the exploratory shaft using the same technology. The geotechnical and geohydrological data available from a conventionally sunk shaft is very much greater than that available from a blind bored shaft, which is an additional reason for conventional sinking.

5-28/1 The reference to caprock suggests that this section is written for a shaft into a salt dome.

5-30/4 This and several other statements suggest that relatively rapid closure of the mined openings is expected.

5-41/1 to 5-41/3 The discussion of retrievability appears to be somewhat short, given the importance of this activity, and the acknowledged liklihood of closure of rooms and cannister holes shortly after emplacement. The actual method of cannister retrieval is not stated.

3.4 CHAPTER 6 - SUITABILITY OF THE NOMINATED SITE FOR CHARACTERIZATION AND FOR DEVELOPMENT AS A REPOSITORY

6-3/5 The use of "technical conservatism" has been troublesome in the past in the high level waste program (see for example NUREG 0960). Conservatism in one respect often introduces non-conservatism in others.

6-14/3 The lack of any onsite meterological data is surprising, and could have licensing implications.

6-98/3 ONWI 388 indicated that the hydraulic conductivities of the Paradox member were in general relatively high. While there is significant uncertainty in the analysis of these results (see discussion in ONWI 491, section 4.3), the published results do not support the statement made.

6-100/(b)(3) It is stated in the text that little is known about the hydrogeology and hydrogeochemistry of the Paradox formation. It is therefore difficult to agree with the statement that "Known conditions are relatively simple, consistent, and predictable, and they can be modeled." This is seen as an important licensing issue.

6-102/(c)(3) The statement that there is no stratigraphic or structural features near the site does not agree with the suspected onsite faulting mentioned on page 3-57/5.

6-113/1 The statement that "all borehole hydraulic tests" provide results that "represent only a relatively small volume of rock near the borehole wall" is only true of single hole tests. Multiple hole tests do not generally suffer from this problem

6-118/2 See comment for 6-100/(b)(3)

6-118/4 The concept of effective porosity is difficult. However it seems likely that the value could, and probably does, drop well below the measured value of 0.5% for the total porosity of a sample at in-situ stress and temperature levels. This would speed travel velocities.

6-125/2 There is no data on the chemical nature of the water/brine in the Paradox. Thus the data from GSD-1 will not assist in this evaluation.

6-130/1 The text uses the disturbed zone around a domal salt repository as an indication of the size of the corresponding zone in bedded salt. There appear to be enough differences to warrant a separate analysis for bedded salt.

6-130/6 There appears to be a degree of confusion in the text as to the redox conditions in the repository horizon. The report points out in places that there are no data on redox conditions in the salt (e.g. 6-130/3) and in other places concludes by inference that the conditions must be reducing. While this seems reasonable, a consistent approach will be needed in a license application.

6-133/5 The data points used for the contouring are sufficiently sparse that it is inevitable that the contours will be "smooth" and "parallel".

6-138/4 The statement that the accumulation of 2 to 11 quarts of brine around each cannister "...can be tolerated.." would appear to warrant a re-evaluation prior to licensing, as the cited reference is now over 13 years old.

6-146/1 Laboratory tests have concluded that the permeability of pure salt is effectively zero. The porosity of bedded salt is generally fairly high for an unfractured rock, around 0.5%. The apparent confusion between total and connected porosity (c.f. the statement earlier in the same paragraph) is common throughout the text.

6-156/3 This paragraph indicates the sparseness of the data on which many geological and some hydrogeological inferences are based.

6-164/3 The conclusion that the salt is structurally undisturbed (presumably in the vicinity of the site) is inconsistent with the observation made in 3-57/5, noted above.

6-166/4 There appears to be a change of tone in this paragraph, from "...probably a large gravitational slide..." to "Because gravity is the causative agency...".

6-170/4 The referenced "...low levels of faulting, folding, heat flow, Cenozoic volcanism, and seismicity..." would appear to be important positive factors in licensing. The statement would, however, require support before it could be used in that context.

6-192/3 It is difficult to see how the lack of data on emplacement horizon geochemistry constitutes a "favorable condition".

6-214/4 Water and trapped gas pressures may approach lithostatic in the creep-prone materials. This may pose blowout risks at repository depths. This would appear to be an exception to the favorable finding with respect to hydrology.

6-222/4 The description of the site as "...rolling canyon land..." seems a little mild.

6-223/3 The omission of retrieval from the list of basic engineering functions appears significant from a licensing point of view.

6-225/5 This paragraph contains the first mention of the need for permits from Federal, State, and local agencies. It seems likely that the securing of these permits may be a critical component of the project; accordingly this aspect would appear to warrant greater emphasis.

6-227/4 The suggestion that the salt will be disposed of locally is inconsistent with Chapter 3, where it is stated that the salt will be disposed of in the Gulf of Mexico.

6-255/2 The 5% brine content may be inappropriately high, even with the aim of achieving conservatism.

6-256/2 The assumption of uniform corrosion rates across the package appears to be general in the text (apparently as a result of the belief that a uniformly corroding material can be designed - 6-267/3). This seems both unlikely and unconservative with respect to the time required to breach the cannister.

6-259/4 The generation of hydrogen gas in significant quantities has not been previously mentioned in the text. The implications of this gas for transport of radionuclides, particularly in the event of intrusion, do not appear to have been addressed (see 6-274/1).

6-298/2 The gradient data developed from GD-1 does not always indicate a downward gradient in the cycle 6 salt (ONWI-491, Table 4.2). The wording of this and other such statements should be clarified.

6-315/3 The solution mining disruption scenario would appear to be one of the more significant resource extraction related impacts. The dismissal of this posssibility on the grounds of the effectiveness of the passsive markers is questioned. At the least, it would seem reasonable to evaluate the releases that could occur in such a scenario.

Swisher EA - Comments 8/2/84

Section 3.2.3.2 Site - Specific Stratigraphy

Fig. 3-15 Sonic, gamma ray, and lith logs are presented. Resistivity would be helpful for interpretation of lithology. Neutron log would be helpful for determination of porosity.

Fig. 3-16 Salt horizons not cored

Only dolomite sections were cored in above 2 holes. Gamma Ray log does give good responses for shales and does allow relatively good distinction of salt beds, but responds to any heterogeneity in the salt regardless of its impact on the permeability or structure. The sonic log is very sensitive to any structural discontinuities. Neither of these logs gives a good handle on lithology or porosity. Resistivity and self potential or even natural gamma would be helpful.

Cores of the salt sections are available in other holes, however it should be noted that permeabilities derived from cores may not be accurate due to expansion of the cores after extraction. It may be desireable to correlate permeabilities of cores determined in the lab with electric logs to get an estimate of permeabilities in uncored holes, and an estimate of actual permeabilities compared to lab permeabilities by comparison with down hole geophysical logs. Generally density and neutron-neutron logs would be helpful in this regard.

The intervals shown in the two figures cited above are below the San Andreas Formation, or repository horizon. The same is true for Fig. 3-19.

p. 3-35: Eventually the lateral extent of the mudstone and anhydrite interbeds will have to be determined. Such discontinuities could provide significant preferrential flow paths.

p. 3-39 Fig. 3-25 has been deleted.

p. 3-40 The statement that "The parallelism of salt margins suggest that variations of dissolution rates average out over geologic time" is not well supported. There are too many variables such as original thickness, groundwater composition, and general conditions in the local hydrologic regime for such a concludsion to be drawn on such thin evidence.

p. 3-41 The average rate of dissolution is double that of the eastern Caprock Escarpment if double can be considered

"similar". The statement that the maximum calculated rate of horizontal dissolution is an order of magnitude higher than the average is not supported. Reference to Figure 3-4 does not support the statement regarding Permian strata.

p. 3-50	SWEC reference is incomplete. Fig. 3-28 is missing.
p. 3-64	Fig. 3-34 is ille gible.
p. 3-72	Fig. 3-8 is incomplete
p. 3-73	Portions of a line (1st) or paragraph are missing.
p. 3-74	"
3.2.6.2	No data on Creep V.S. T?

Further detail/comments on Chapter 3 are needed. These will be provided as allowed by the budget and time restrictions.

RAC 9/3/84 1148-003

Swisher EA
Major Comments
Chapt. 4-- Expected effects of site characterizatoi

1. Our comments on the scope/methods/thoroughness of the site characterization strategies discussed throughout 4.1 are phrased as "detailed comments". In the aggregate, the impression we get is that the site characterization plan needs considerable refinement. The EA admits that specific boreholes' locations, sampling horizons, logging methods, etc., will be stated later (SCP). In general the EA does not discuss how the data are to be blended to produce a clear picture of the site as an engineering medium, into which a repository may be introduced.
2. The EA does not address the details of site characterization activities: logging, sampling, geophysical interpretation, and others.
3. There seem in general to be minimal site characterization activities that support hydrogeological characterization of HSUB (middle hydrostratigraphic unit -- containing the salt) and there are not sufficient details to determine how the plan would support engineering design. Characterization of HSUB for hydrogeology appears to be essentially limited to the ES.

Recent correspondence between DOE and NRC has identified information needs and design considerations necessary to ensure the proper function of the ES while maintaining the isolation capability of the site; these concerns revolve around the shaft drilling construction method.

5. Geologic sections showing the salt horizons appear as parts of overall sections and are generally simplified. This leaves the impression that there are clear-cut boundaries between formations and uniformity within formations, which is not realistic for Permian Basin salt stratigraphy. Care needs to be taken in not oversimplifying the geologic setting. This has strong implications for seal placement and for design.

RAC 9/3/84 1148-003

Swisher EA
Detailed Comments
Chapter 4-- Expected effects of site characterization.

Section 4.1.1. Field Studies
Table 4-1, p. 4-3.
No geohydrology testing is indicated for the middle hydrostratigraphic unit, which is assumed to be an aquitard. An understanding of the hydraulic properties of this unit, which includes the salt horizons is necessary to understand the gross site hydrogeologic behavior. A methodology for testing this unit needs to be provided.

). Section 4.1.1. Field Studies
P. 4-9, first sentence
Closure of exploration boreholes is not addressed. Are the boreholes to be backfilled or sealed? How? These boreholes may be effective hydraulic links between strata.

) Section 4.1.1. Field Studies
P. 4-9, 4th paragraph
The locations, numbers, and types of short-term hydrologic tests are not detailed. While it is clear that this is not the SCP and extensive detail may not have been thought essential

the discussion seems to imply a lack of certainty in what the testing program will include, as well as that the middle hydrostratigraphic unit will not be tested. How will hydrologic parameters be selected to confirm models and performance assessments of the geologic media if tests are not to be carried out? A clear plan needs to be formulated.

) Section 4.1.1. Field Studies
Table 4-2 Summary of Field Activity Requirements, Swisher County, Texas

Several comments are in order regarding this table. The entry for the scope of the HSUA test wells (row 2, column 2) seems to imply that no logging, geophysical or otherwise, and no coring will be done from these holes. How then will the field test data be correlated to the laboratory permeability/porosity data; how will the generality of the test data be established; how will the loss of geologic data be compensated? It seems desirable to obtain as much geotechnical, stratigraphic, and hydrogeologic data from the subsurface as possible. Also, effective sealing of boreholes is in doubt unless the borehole conditions are known.

The methods and approach for the borehole search

and Characterization (Column 2, Row 14) are vague and uncertain. How is this search to be conducted so that the findings are reasonably assured of being complete? In other words, how will the survey be conducted so that an absence of boreholes located may reasonably be construed as an absence of boreholes at the site?. The question of old wildcat wells is germane to the isolation capability of the site. Perhaps the combined results of field surveys, study of well-drilling records in the area, assessment of geologic trends that could have been construed as favorable by earlier interests, and knowledge of well abandonment techniques from various periods, may yield the required level of assurance.

In general, the Table does not mention downhole geophysical logging, which is apparently (according to the text) to be done in some holes and not in others. This suggests that a standardized approach has not been developed, or that site characterization or design studies data needs have not fully been listed.

). Section 4.1.1.1.2. Upper Hydrostratigraphic Unit Test Wells
Figure 4-4, Schematic of drilling program in vicinity of the surface facilities and the underground layout.

This figure shows a single well out in the repository area. The purpose of this well is not explained; presumably

it is a monitoring well to be used in conjunction with the pump tests. The text does not elaborate.

The inset to this figure (and the inset to figure 4-3) show a hatchured zone between hydrostratigraphic units. What is this zone?

I believe the figure numbers and figure references in the text do not correspond.

6. Section 4.1.1.1.2. Upper Hydrostratigraphic Unit Test Wells Paragraph 2, p. 4-13

The discussion mentions the single-well installation, but does not describe it purpose or construction.

It is stated that each well will be "sampled within the stratigraphic interval to be tested". The type and purpose of this sampling is not stated. Presumably these intervals are not to be cored (See Comment 4) although some (it is not stated what or how many) geophysical logs are to be run.

The need to obtain core for more detailed stratigraphic characterization will become more clear after the stratigraphic correlation boreholes have been completed and interpreted. Some of the hydrostratigraphic test wells described in Section 4.1.1.1.1. (HSUC) will be cored, but only in the horizons to be tested, implying that the only coring of the salt that is planned, for site characterization and design support for the ADT facility, will be from the widely-spaced stratigraphic confirmation boreholes and the EDBH. Given the demands on

the core for laboratory testing and the fact that site-specific data have not been collected yet, it would seem that it makes sense to acquire as much core as practicable to adequately characterize the geologic variability at the site.

(7) Section 4.1.1.1.3. Long-Term Hydrologic Testing, Sampling, and Monitoring

P. 4-18, first paragraph.

The location of the 5th "regional" test well is not clear. Are these the lower unit test wells? If so, there are only 4 shown on Figure 4-3.

(8) Section 4.1.1.1.5. Determination of Pre-Waste Emplacement Geochemical Conditions.

p. 4-19, first paragraph.

Are the rock samples to be obtained from core? If so, how are the effects of brine drilling fluids to be accounted for? How are fluids to be sampled?

(9). Section 4.1.1.1.8. Resistivity

p. 4-19, last paragraph.

What is this test intended to show? Will the depth and locations of anomalies, as well as their nature, be determined without interfacing tests in other, nearby boreholes?

(10) Section 4.1.1.1.12 Gravity Surveys

p. 4-21 first paragraph

The statement about gravity surveys is conditional -- they may or may not be run. What criteria will be used to determine where gravity data will be collected. These data will give very general impressions of the distribution of strata densities.

D. 4.1.1.1. 14 Borehole Search and Characterization p. 4-21, third paragraph.

Are only those boreholes that could impact repository stability to be evaluated? Given the expected low permeabilities of the middle hydrostratigraphic unit, the presence of one or more old wells could impact the pumptest results. Such wells may be detected by metal detectors if cased with metal pipe or if the wellsite contained buried metallic objects. In general, detection of such wells "in the blind" will be difficult and subject to many uncertainties, especially if uncased. The discussion referred to here seems to indicate that the procedure to carry out this search has not been decided upon. Perhaps the most valuable approach would be to examine old maps and airphotos for traces of roads with no apparent purpose, to identify potential drilling targets that might have been known to past interests and to combine this "detective" work with an assessment of the impact of such

boreholes on repository construction and performance.

2) Section 4.1.1.2.2. Engineering Design Borehole (EDBH)
p. 4-21, 6th paragraph

The EDBH is a critical information source for site characterization as well as for ES design support, inasmuch as this will be the only borehole within the repository boundary that is fully cored. It should be regarded as a source of site characterization data as well.

3) Section 4.1.2. Exploratory Shaft (ES)
Whole section

This section should be carefully reviewed for the realism of the quantities and schedules discussed. The ADT facility layout differs somewhat from earlier conceptual design (ONWI-498) and it seems that the selection of excavation and support methods is also in a state of flux. These define the overall environment of the at-depth testing and need to be evaluated. Any assumptions that could result in limitations or changes to the testing program should be identified.

It is reiterated that the choice of large-diameter drilling is the basis for this section's discussion. Without going into detail, there is a continuing dialog between NRC and DOE regarding how concerns regarding sealing and construction control are

to be met. To date, these issues await resolution. Thus, the selection of a blind-hole drilling method may still be subject to change.

(14). Section 4.1.2. Exploratory Shaft
p. 4-38 Figure 4-10 Exploratory Shaft Profile
Most of the geologic descriptions and footage dimensions are illegible on our copy of this figure.

(15). Section 4.1.2. Exploratory Shaft
p. 4-41, 3d Paragraph
It is stated that gas detectors will automatically shut off equipment when triggered. Which equipment? Could a sensor malfunction shut off critical monitoring equipment for ongoing tests? No discussion is given as to what gas levels are expected in the ES facility.

(16) Section 4.1.2.3. Testing
p. 4-48 first line
There is almost no mention of shaft performance monitoring. The EA should at least describe how the shaft performance is to be established. Also, the ADT facility will be rather small to evaluate the horizontal continuity of the host horizon without drilling; no such drilling is indicated. The discussion and Table 4-12 give very little insight as to the testing program

(17) Section 4.1.2.3. Testing
p. 4-49 At-depth testing (top of page, items 1-3.
The locations and organization of these tests cannot be determined from Figure 4-11. Clearly, there is no intent to commit to an in-situ testing plan in this document, as practically no real information on this topic is provided.

4-2 <u>Section 4.3.1 Alternate Exploratory Shaft Locations</u>

<u>Page 4-134, paragraph 2</u>

<u>Inadequate support</u>

Statements are made regarding the criteria for site selection, but the criteria are vague and no supporting evidence is offered. Alternative sites are not suggested and there are no references or data to review. A complete discussion of alternate shaft sites is needed along with reasons for the selection of the proposed site and supporting data. Certainly maps would be helpful.

4-3 <u>Section 4.3.2 Alternate Exploratory Shaft Construction</u>

Page 4-134, paragraph 3

Inadequate support

Section 4.1.2.2 is referenced but is missing.

4-4 Section 4.3.2 Alternate Exploratory Shaft Construction

Page 4-135, paragraphs 2, 3, & 4

Inadequate presentation of data

The presentation of construction procedures is too vague for review. At the very least maps and general arrangement (GA) drawings should be presented so that dimensions can be checked ~~and etcetera~~.

4-5 Ibid.

Page 4-136, Fig. 4-18

Inadequate detail

The figure is not labeled as schematic and yet no scale is given. No background is offered for orientation/perspective purposes. The dimensions of the freeze wall should be given along with the stratigraphy and rationale for location of the grouted zone. A portion of the freeze wall is shown to be open to the shaft indicating a complete open section in the preliminary lining. This seems unreasonable. The preliminary lining is represented as not being water tight, yet no indication is given of a pumping

system or provision for disposal of the waste water.

4-6 Ibid.

Page 4-137

Inadequate development of subject

This entire section is a light brush-over of a critical area. It does not appear that sufficient thought has been given to shaft construction and certainly the data presented is not in sufficient detail to afford any opportunity for meaningful review. In the entire discussion no mention is made of bonding, which is by definition of the engineered barrier, a critical issue as is the disturbed zone. The effects of freeze-thaw on bonding and stability of materials are well known. Certainly the impacts of the alternate methods of construction on the disturbed zone should be discussed. The materials of construction should be discussed along with their bonding characteristics. The stratigraphy should be discussed with respect to the placement of grout and the ability of various types of grout to form an effective seal with formation material. The method of sealing the shaft and bonding over the freeze wall zone should be discussed. This section must be expanded to show sufficient detail for analysis because it involves potential preferential pathways for groundwater to flow into the repository area and out to the accessible environment.

Swisher EA. Comments (Detailed)
Section 6.

6-1 Section 6.2.1 Technical Guidelines

not reviewed

6-2 Section 6.2.1.4 Meterology

not reviewed

6-3 Section 6.2.1.8 Transportation, Guideline 10 CFR 960.5-2-7.

not reviewed

6-4 Section 6.3.1 Postclosure Technical Guideline
Page 6-103, paragraph 2
Page 6-104, Table 6-13, paragraph 1
Inadequate support

Travel times of 100,000 yrs. have not been adequately demonstrated.

6-6 Ibid.

Paragraph 3

Inadequate discussion

Climatic changes are said to have an insignificant effect on the repository performance, but the effect is not identified. The possible effects should at least be discussed or identified.

6-7 Ibid.

Page 6-106, paragraph 2 (C-1)

Inadequate support

The statement is made that expected changes in the geohydrologic conditions will not significantly increase transport, but the statement is not supported. Supporting data should be presented or cited.

6-8 Ibid.

Page 6-107, paragraph 1

Inadequate support

Pre-waste emplacement ground-water travel times are projected to be greater than 1,000 years, but no supporting data is offered. Data should be presented or cited.

6-9 Ibid.

Paragraph 2

Oxidizing conditions are considered to be indeterminant, even though the high chloride content is known and it is obvious that emplacement of waste will result in elevated oxygen levels. Such conditions must be chemically oxidizing. Measurements must be made.

6-18 Ibid.

Paragraph 4

Inadequate support

The qualifying condition is stated but no supporting data is offered. Data should be presented or cited.

6-19 Ibid.

Page 6-110, paragraph 1

Inadequate support

Insufficient data is presented to establish the continuity of the Lower San Andreas in this area. Data should be presented or cited.

6-20 Ibid.

Paragraph 2

Inadequate support

Insufficient data is presented to establish that thermal expansion will be small. Data should be presented or cited.

6-21 Ibid.

Paragraph 3

Inadequate support

The parameters on rock strength and insitu stress should be presented or cited.

6-22 Ibid.

Paragraph 4

Inadequate support

Supporting data on temperatures and thermo-chemical effects should be presented or cited.

6-23 Ibid.

Paragraph 5

Inadequate discussion

There is no mention of thermal effects on the engineered barriers. This should be the most critical impact as it involves preferential pathways. The subject should be considered in detail.

6-24 Ibid.

Page 6-111, paragraph 1

Inadequate support

Data on climatic changes and erosion--dissolution rates should be presented or cited.

6-25 Ibid.

Paragraph 2

Inadequate support

Data regarding effects of increased precipitation on waste isolation should be presented or cited.

6-26 Ibid.

Paragraph 3

Inadequate support

Data regarding the effects of changes on shallow aquifers and surface drainage should be presented or cited.

6-27 Ibid.

Paragraph 5

Inadequate support

Data regarding the effect of increased hydraulic head or groundwater flow should be presented or cited.

6-28 Ibid.

Page 6-113, paragraph 3

Inadequate support and typographical error

The statement of Qualifying Condition should read: "... subsurface rock dissolution will not be likely

to lead to radionuclide releases greater..."

Data on projections of estimated rates of dissolution should be presented or cited.

6-29 Ibid.

Paragraph 4

Inadequate support

At the very least dissolution data should be presented and maps should be offered showing the location of the data sources.

6-30 Ibid.

Page 6-114, paragraph 1

Inadequate support

Data and maps should be presented or cited confirming evidence of no structural collapse features.

6-31 Ibid.

Paragraph 2

Inadequate support

Data confirming long term isolation from migrating dissolution fronts should be presented or cited.

6-32 Ibid.

Paragraph 3

Inadequate support

Data confirming a non-disruptive tectonic environment for the next 10,000 years should be presented or cited.

6-33 Ibid.

Page 6-115, paragraph 1

Inadequate support

Data and maps confirming a lack of volcanism should be presented or cited.

6-34 Ibid.

Paragraph 5

Inadequate support

Data confirming a lack of seismic activity should be presented or cited.

6-35 Ibid.

Page 6-117, paragraph 1

Question

Is there no potential for salt mining?

6-36 Ibid.

Page 6-118, paragraphs 2, 3, & 4

No response

6-37 Section 6.3.1.1

Page 6-103, paragraph 3

Page 6-119, Table 6-14, paragraph 1

Inadequate support

Geohydrologic data should be presented which confirm that the site is compatible with isolation of nuclear waste.

6-38 Ibid.

Paragraph 2

Inadequate support & typo.

Data must be presented or cited which confirm that groundwater travel times along likely pathways will exceed 10,000 years.

6-39 Ibid.

Paragraph 3

Inadequate support

Data regarding the hydrologic processes which would affect the geologic repository should be presented or cited.

6-40 Ibid.

Page 6-120, paragraph 1

Inadequate discussion

The nature and recharge area of the Deep Basin aquifer should be presented. Is this a favorable

condition considering the very slow ground water migration rate?

6-41 Ibid.

Page 6-121, paragraph 3

Inadequate support

Data confirming that changes in the geohydrologic regime are not likely should be presented.

6-42 Ibid.

Paragraph 5

Inadequate consideration of available data

No mention is made of mud dikes. The frequent occurence of mud dikes in South Texas aquifers is well documented and should be given careful consideration.

6-43 Ibid.

Page 6-122, paragraph 1

Inadequate support

Data confirming travel times greater than 1,000 years should be presented or cited.

6-44 Section 6.3.1.1.2 Evaluation Process

Page 6-122, paragraph 3

Inadequate discussion

The assumption that salt is a porous medium, characterized by Darcian flow, is a poor assumption. Flow through salt, as in most formations, is probably through channels. An analysis of channel development is needed before any assumptions can be made regarding flow.

6-45 Ibid.

Page 6-123, paragraph 1

Poor assumptions

There is an apparent conflict with the statement in this paragraph regarding the empirical determination of permeabilities and the statement earlier that the salt is so impermeable that it allows insufficient flow for measurement of permeability. Ignoring fracture flow is not acceptable, since the majority of flow is most likely to occur through fractures. The assumption, as stated, is not conservative. An analysis of fracture/dissolution channel development and the nature of groundwater flow in the area is basic to an Environmental Assessment.

6-46 Ibid.

Paragraph 3

Inadequate support

Data and calculations supporting the assumption that site conditions are not significantly different from

regional conditions should be presented or cited, as should data supporting the claim that the site geohydrologic conditions satisfy the guidelines.

6-47 Ibid.

Paragraph 4

Poor assumption

The calculated total travel time is based on the assumption of uniform tabular bodies and Darcian flow, which are admittedly inadequate. Only field tests can give credibility to such calculations.

6-48 Section 6.3.1.1.3 Analysis of Favorable Conditions

Page 6-124, paragraph 3

Inadequate support

The conclusion that pre-waste-emplacement groundwater travel times along likely radionuclide paths is greater than 10,000 years has not been established. An adequate model of the local geohydrologic regime must first be developed and tested.

6-49 Ibid.

Page 6-125, paragraph 7

Question regarding guideline

In an area where the hydraulic gradient is low and hence groundwater migration is extremely slow, is

it wise to look for a conductive aquifer between the repository and the accessible environment? Rather than the desired dispersion and dilution, the contamination may follow a pressure gradient to the nearest fracture through which flow is occuring and thus find a pathway to the accessible environment. At least in the repository development area, the fractures which have been encountered are known, documented, and can be controlled.

6-50 Ibid.

Page 6-127, paragraph 1

Inadequate discussion

The basis of the calculation of the hydraulic gradient is not presented. In light of the anomalously high hydraulic gradient, leakage may be suspected. The discussion should certainly address this possibility and the calculation and data should be presented.

6-51 Section 6.3.1.1.4 Analysis of Potentially Adverse Conditions

Page 6-128, paragraph 4

Inadequate support

Data supporting a downward flow path and high TDS in the groundwater should be presented or cited.

6-52 Ibid.

Paragraph 5

Inadequate discussion

Salt and mud dikes occur frequently in the area, but no mention is made of them.

6-53 Ibid.

Paragraph 6

Inadequate detail

The location of any suspected faults should be presented on a map.

6-54 Section 6.3.1.2 Geochemistry, Guideline

10 CFR Part 960.4-2-2

Page 6-129, paragraph 4

Page 6-130, Table 6-15, paragraph 1

Inadequate support

Data confirming geochemical characteristics compatible with containment and isolation of waste should be presented or cited.

6-55 Ibid.

Paragraph 2

Inadequate support

Data demonstrating the nature and rates of geochemical processes should be presented or cited.

6-56 Ibid.

Paragraph 3

Inadequate support

Geochemical condition listed should be supported by data.

6-57 Ibid.

Page 6-131, paragraph 1

Inadequate support

Documentation of mineral assemblages should be presented.

6-58 Ibid.

Paragraph 2

Inadequate support

Solubility and flow data should be presented or cited.

6-59 Ibid.

Paragraph 3

Inadequate support

Favorable physical and geochemical processes should be documented. Typo on "accessible".

6-60 Ibid.

Paragraph 4

Inadequate discussion

The reactivity of chloride with iron is totally ignored. Consideration of interaction of brines with materials of construction must be documented.

6-61 Ibid.

Paragraph 5

Inadequate discussion

The possibility of water intrusion is ignored as well as its potential effect on rock strength. Such a possibility should at least be considered.

6-62 Ibid.

Paragraph 6

Inadequate discussion

Does pre-waste-emplacement include past development? Again the presence of chloride ion, a powerful oxidizing agent, is ignored.

6-63 Section 6.3.1.2.2 Evaluation Process

Page 6-133, paragraph 3

Inadequate support

Supporting data documenting the most likely pathways should be presented as well as the various retardation mechanisms.

6-64 Ibid.

Page 6-134, paragraph 4

Inadequate documentation

The worst case analysis should be documented.

6-65 Ibid.

Paragraph 5

Inadequate discussion

No consideration is given to diffusion or changes in hydraulic or chemical gradients.

6-66 Section 6.3.1.2.3 Analysis of Favorable Conditions

Page 6-134, Paragraph 9

Inadequate discussion

The conclusion assumes control of groundwater at the shafts and engineered barriers. These points require careful consideration.

6-67 Ibid.

Page 6-135, paragraph 3

Inadequate detail

Sulfate concentration should be documented.

6-68 Ibid.

Page 6-137, paragraph 4

Inadequate support

Field measurements are not documented and the possibility of groundwater intrusion resulting from mining activities is ignored. Such possibilities should at least be considered.

6-69 Ibid.

Paragraph 5

Question

Results of calculations range over 10 orders of magnitude. Can such a wide range be considered any better than guessing? Perhaps the calculations should be reviewed and checked with empirical data.

6-70 Section 6.3.1.2.4 Analysis of Potentially Adverse Conditions

Page 6-138, paragraph 6

Inadequate definition

It is not clear whether the calculations included only entrained brine or also water which may have intruded as a result of mining activity.

6-71 Ibid.

Paragraph 7

Inadequate support

Corrosion rates in the presence of unlimited brine are not documented.

6-72 Ibid.

Page 6-139, paragraph 3

Non-conservative assumption and typo

Second sentence should read "It is not clear..."

The conclusion that sorption and rock strength will remain unaltered is not conservative. ~~by Murphy's Law.~~

6-73 Ibid.

Paragraph 4

Inadequate discussion

Intruded groundwater will be oxidizing. This should at least be considered.

6-74 Section 6.3.1.2.5 Analysis of Disqualifying Condition

Page 6-139, paragraph 6

Inadequate discussion

No documentation is presented for review

6-75 Section 6.3.1.2.5 Conclusion

Page 6-139, paragraph 8

Inadequate discussion

No documentation is offered regarding the integrity of the waste package for potential retrieval. This should at least be considered as an integral part of the retrievability requirement.

6-76 Section 6.3.1.3 Rock Characteristic, Guideline 10 CFR Part 960.4-2-3

Page 6-139, paragraph 11

Incomplete documentation

Table 6-16 is referenced, but missing.

6-77 Section 6.3.3.1.2 Evaluation and Relevant Data

Page 6-202, paragraph 7

Discussion unclear

There are apparently conflicting statements regarding surface impoundments--small farm ponds should at least be located on a map. The reference to upstream is unclear--does it refer to surface drainage?

6-78 Ibid.

Paragraph 8

Inadequate development

More detailed analyses are mentioned, but no plan or schedule is offered for implementation. There appears to be some doubt about flooding potential. This whole subject deserves more complete consideration.

6-79 Section 6.3.3.2 Rock Characteristics, Guideline 10 CFR Part 960.5-2-9

Page 6-204, paragraph 4

Page 6-205, Table 6-24, paragraph 5

Inadequate documentation

The conclusion has not been well documented that present technology can satisfy all of the requirements for a repository in salt--especially with respect to retrievability.

6-80 Ibid.

Paragraph 6

Inadequate documentation

The conclusion is not well founded in light of the effects of salt creep. This should at least be considered, documented, and laid to rest.

6-81 Section 6.3.3.2.2 Evaluation Process

Page 6-206, paragraph 4

Missing text

Continuity of text here is not apparent. Perhaps something has been left out.

6-82 Ibid.

Page 6-207, paragraph 2

Inadequate development

Uncertainty regarding room closure rates must be removed before definitive projections can be made.

6-83 Ibid.

Page 6-208, paragraph 3

Inadequate detail

A description of the watertight shaft-lining systems is needed for review.

6-84 Section 6.3.3.2.4 Analysis of Potentially Adverse Conditions

Page 6-211, paragraph 2

Questionable conclusion

The conclusion is questionable considering the creep properties of salt.

6-85 Ibid.

Page 6-212, paragraph 1

Typographical omission

It appears that something is missing in the second sentence: "There is potential for difficulty..."

6-86 Ibid.

Paragraph 4

Reference

Documentation of procedures should be checked.

6-87 Section 6.3.3.2.5 Analysis of Disqualifying Condition

Page 6-213, paragraph 1

Inadequate detail

Second to last sentance is incomplete: "..., such potential_____ hazards at...". Mitigating procedures should be identified and examined to determine whether or not they offer a permanent solution.

6-88 Ibid.

Paragraph 2

Inadequate discussion

Insufficient support is offered for the conclusion. Additional data must be gathered and the results documented--especially in view of the unusual rock characteristics of salt.

6-89 Section 6.3.3.3.5 Conclusion

Page 6-216, paragraph 1

Questionable conclusion

The potential for suface flooding has not been fully explored, nor mitigation sufficiently analyzed.

6-90 Section 6.3.3.4.2 Evaluation Process

Page 6-216, paragraph 7

Inadequate detail

The source of geologic and seismologic data is not given.

6-91 Section 6.3.3.4 Tectonics, Guideline 10 CFR Part 970.5-2-11
Page 6-216, paragraph 3
Page 6-217, Table 6-25, paragraph 3

Data on faulting should be presented or cited.

6-92 Section 6.3.3.4.2 Evaluation Process
Page 6-218, paragraph 3
Inadequate development

A concerted effort should be made to identify all faults and other tectonic structures within the site region.

6-93 Section 6.3.3.4.4 Analysis of Potentially Adverse Conditions
Page 6-219, paragraph 6
Questions

Surface faulting is commonly associated with salt domes--are there none in the Palo Duro Basin?

6-94 Section 6.3.4.2.1 Site Characteristics
Page 6-223, paragraph 2
Inadequate discussion

All stability problems should be identified and mitigating measures analyzed to determine whether they offer a permanent solution.

6-95 Section 6.3.4.2.2 Engineering Considerations

Page 6-223, paragraph 5

Inadequate discussion

There is no discussion of the stability of the seal system excavations upon which the claims of radionuclide migration limitations are based. Analysis of the stability of the seal system is basic to this entire discussion.

6-96 Ibid.

Page 6-224, paragraph 1

Inadequate detail

Additional insitu and laboratory tests must be identified and a schedule offered.

6-97 Section 6.3.4.2.3 Written Agreements

Page 6-224, paragraph 6

No response

Agreements must be reviewed when available.

6-98 Section 6.3.4.2.4 Repository Personnel

Page 6-224, paragraph 8

Inadequate discussion

A plan must be developed for decommissioning.

6-99 Ibid.

Paragraph 9

Missing figure

Fig. 6-7 is referenced but shown as still under preparation.

6-100 Section 6.4.2.1 Performance of Engineered Barriers

Page 6-242, paragraph 1

Inadequate detail

The conditions under which oxide layers are supposed to accumulate are not described. Data must be presented which documents the rates of radionuclide release through oxide layers remaining in the metal of the waste package.

6-101 Section 6.4.2.1.2 Brine Migration In Salt

Page 6-246, paragraph 3

Page 6-244

Missing figure

Figure 6.4.2.1-3 is referenced but missing.

6-102 Section 6.4.2.1.2 Brine Migration In Salt

Page 6-246, paragraph 2

Inadequate discussion

The subjects of expansion, convection, and heat transfer are ignored.

6-103 Ibid.

Page 6-247, paragraph 3

Questionable conclusion

Overprediction of brine migration by the code BRINEMIG is not adequately established until the magnitude of brine movement along grain boundaries is established.

6-104 Section 6.4.2.1.3 Corrosion

Page 6-252, paragraph 3

Inaccurate assumption

Corrosion seldom occurs uniformly. Generally it begins at a point as a result of a galvanic effect and then spreads in a front. Suprisingly there is no discussion of cathodic protection.

6-105 Ibid.

Page 6-262, paragraph 1

Typo

The last sentance should read "... 10^4 r per hour is only about a factor of two."

6-106 Ibid.

Paragraph 2

Inadequate development

The decay histories of stresses are admittedly poorly defined, but no schedule or plan is offered for determining these values. The effects of stress on permeability are only now beginning to be investigated. An effort should be made to determine these effects for the assessment to be complete.

6-107 Ibid.

Page 6-265, paragraph 1

Inadequate discussion

Is oxidation the only corrosive mechanism? Has the reaction mechanism been analyzed to look for steps that can be retarded? What about sacrificial layers or protective oxides. Can the currently accepted materials of construction be defended?

6-108 Ibid.

Paragraph 3

Inadequate support

Supporting data must be presented to confirm uniform corrosion. The assumption of limited brine ignores the possibility of groundwater intrusion, a poor assumption based on the record of most underground operations.

6-111 Ibid.

Paragraph 2

Questionable conclusion

The fact is that local penetrations are generally much higher than uniform corrosion. The galvanic effect in corrosion seems to have been ignored in this analysis--a glaring omission. This subject of corrosion requires considerable more development before credibility can be established.

6-114 Ibid.

Paragraph 2

Inadequate support

Travel times to control zone boundaries have not been established.

6-115 Section 6.4.2.1.5 Summary of Performance of Engineered Barriers

Page 6-275, paragraph 3

Inadequate support

Corrosion conditions have not been adequately described, groundwater intrusion has been neglected, and kinetics and solubilities must be verified.

6-116 Section 6.4.2.2 Performance of Shaft-Seals

Page 6-276, paragraph 2

Inadequate treatment

Locations of keyed bulkheads are not specified. The use of keyed bulkheads is questionable because of the resulting expansion of the disturbed zone resulting from excavation.

6-117 Ibid.

Paragraph 2

Page 6-277, Figure 6.4.2.2-1

Questionable conclusion

Analyses of groundwater flow around and through the shaft-seal system should be checked.

6-117 Ibid.

Paragraph 2

Page 6-277, Figure 6.4.2.2-1

Missing figure

Figure 6.4.2.2--1 is referenced but shown as under preparation.

6-118 Ibid.

Page 6-278, paragraph 1

Inadequate development

The design must be demonstrated to function as predicted.

6-119 Ibid.

Paragraph 2

Questionable data

Penetration times for groundwater to reach the repository level should be checked and compared with other similar data. The ultimate integrity of creep closure must be established.

6-120 Ibid.

Paragraph 3

Erroneous conclusion

Water migration depends more on porosity and permeability than on stress--in fact stress and relaxation may increase permeability.

6-121 Section 6.4.2.3.2 What Constitutes a Significant Effect on Performance?

Page 6-279, paragraph 3

Typo

Last sentence should read "... limit on release to the accessible environment is jeapardized."

6-122 Section 6.4.2.3.4 Physical Extent of Potential Changes.

Page 6-281, paragraph 4

Inadequate support

Data confirming limits of mechanical effects from excavation should be presented.

6-123 Ibid.

Paragraph 5

Questionable data

Data cited on limits of mechanical effects due to excavation should be checked.

6-124 Ibid.

Page 6-283, paragraph 1

Typo

The second sentence should read "... the ventilation system is also of interest."

6-125 Ibid.

Page 6-285, paragraph 5

Poor assumption

Groundwater flow through salt beds layers is most likely through fractures and interbeds, and most certainly is not well represented as Darcian flow.

6-126 Ibid.

Page 6-286, paragraph 4

Inadequate support and typo

The first sentence should read "... while flux is influenced by the waste-induced heat." Data confirming steady state conditions within 10,000 years should be presented.

6-127 Ibid.

Page 6-287, paragraph 1

Inadequate support

Supporting data is needed demonstrating the limits

of effect of waste-generated heat on groundwater flow to 10 meters.

6-128 Section 6.4.2.4.1 Groundwater Movement In Host Rock.

Page 6-289, paragraph 4

Questionable conclusion

Models are based on unrealistic assumptions of Darcian flow through uniform tabular bodies. Most flow is through fractures, channels, and at contacts between salt beds and interbeds.

6-129 Ibid.

Page 6-297, paragraph 2

Inadequate discussion

The projection for maximum penetration after 1,000,000 years is based on the assumption of Darcian flow, which is admittedly not realistic.