NRC COMMENTS

ON

DOE DRAFT ENVIRONMENTAL ASSESSMENT

FOR THE

RICHTON DOME SITE

March 20, 1985

RICHTON DOME
DRAFT EA REVIEW CONTRIBUTORS

Robert Johnson	Project Manager
Frank Anastasi	Site Manager and Performance Assessment
Charles Billups	Aquatic Ecology
Ed Branagan	Radiological Impact
Al Brauner	Nonradiological Transportation
Lou Bykoski	Arch./Cultural/Historic Resources and Socioeconomics
Larry Chase	Rock Mechanic/Design
Don Cleary	Aesthetic Resources and Natural Resources
John Cook	Radiological Transportation
William Ford	Groundwater Hydrology
Ted Johnson	Surface Water Hydrology
Walt Kelly	Geochemistry
William Lake	Radiological Transportation
Richard Lee	Geology/Geophysics
Bill Lilley	Environment/Socioeconomics
Jerry Pearring	Rock Mechanic/Design
Charles Peterson	Waste Package
Ed Pentecost	Water Quality, Noise and Terrestrial Ecology
Irwin Spickler	Meteorology and Air Quality
Mike Tokar	Waste Package
John Voglewede	Waste Package Modeling

INTRODUCTION

Background

On December 20, 1984, the DOE issued draft environmental assessments (EAs) for nine potentially acceptable sites for the nation's first nuclear high-level waste repository. Issuance of final EAs will be in accordance with the Nuclear Waste Policy Act of 1982 (NWPA) which directs the U.S. Department of Energy (DOE) to issue an EA for each site that the Secretary nominates as being suitable for site characterization. Public review and comment were solicited on draft EAs for a period ending on March 20, 1985. From among the nine potentially acceptable sites, five sites are being proposed for nomination as being suitable for site characterization. Following the issuance of the final environmental assessments, DOE will formally nominate at least five sites as suitable for site characterization and recommend at least three of the nominated sites to the President for site characterization as candidates for the first repository.

Each draft environmental assessment contains: (a) a description of the decision process by which the site was selected; (b) information on the site and its surroundings; (c) an evaluation of the effects of site characterization activities; (d) an assessment of the regional and local impacts of locating a repository at the site; (e) an evaluation as to whether the site is suitable for site characterization and for development as a repository; and (f) a comparative evaluation of the site with other sites that have been considered.

The NWPA and NRC regulations governing licensing of the geologic repository provide for consultation between DOE and NRC staffs prior to formal licensing to assure that licensing information needs and requirements are identified at an early time. In accordance with the NRC/DOE Procedural Agreement on repository prelicensing interactions, NRC and DOE staffs have been conducting such consultations. According to NWPA, the environmental assessments are to provide a summary and analysis of data and information collected to date on sites which the DOE intends to nominate for site characterization. Therefore, they present an important opportunity for NRC and DOE staffs to consult on the issues that exist at each site which must be addressed for site characterization. They also afford an opportunity for the NRC staff to point out at an early stage in DOE's repository program potential licensing problems with a site if they were found to exist on the basis of available information.

NRC Staff Review

The staff conducted its review of the EAs according to the NRC Division of Waste Management's "Standard Review Plan for Draft Environmental Assessments

(Dec 12, 1984)." Because of the limited time available for review and the vast amount of data and information existing for the nine sites, the staff had prepared for the draft EA reviews well before their receipt. Preparation included: 1) broad familiarization with the overall existing data/information base for each site; 2) selected detailed reviews of data; 3) development of a clear understanding of the guidelines; and 4) development of preliminary views and issues through reviews of existing data and scoping reviews of preliminary EA drafts. This early preparation and familiarization with the existing data base has allowed the staff to determine if the conclusions and findings in the EAs are consistent with the available data.

In its review, the staff has sought to identify potential safety issues through a review of DOE's application of the siting guidelines. The staff has focused on the analyses and technical evaluations that are made on individual guidelines which constitute the factual basis upon which the site comparisons are made by DOE. The staff reviewed the available data, interpretations, assumptions and performance assessments in the EA and its references that DOE used to substantiate its evaluation of a site against the guidelines. In commenting on the EAs, the staff has recognized that the level of information which exists on each site is not equivalent to what will be necessary to make findings about the suitability of the one site that is proposed for development as a repository. The staff has reviewed the evaluations and conclusions which are called for at the EA stage by the siting guidelines. These guidelines recognize the inherent uncertainties that will face any site before detailed site characterization.

The staff's review and comment on the evaluations and conclusions on the siting guidelines effectively identified issues which are relevant to potential safety issues. In its concurrence action on the siting guidelines, the Commission found that the guidelines are consistent with the requirements of its own regulations on geologic repositories (10 CFR Part 60). Therefore, while the staff has not identified in each case how its comments relate to the specific requirements of 10 CFR Part 60, we feel that they serve to identify those issues which are relevant to potential licensing of each site based on information currently available and which will need to be resolved during site characterization.

The staff also commented on the analyses of environmental impacts of site characterization activities and repository operation with the intent of assisting DOE's preparation of the final EAs. However, the staff has not performed a detailed review with regard to the site characterization plans in Chapter 4 or the repository descriptions in Chapter 5 of the EAs. The staff only commented on those aspects of site characterization plans, such as the need for characterizing the geohydrological regime beneath Canyonlands Park, which need to be considered to evaluate the site against the siting guidelines, at this time. Site characterization plans will be reviewed upon receipt of such plans in accordance with the NWPA and in other consultations with the DOE under the interagency agreement governing repository prelicensing matters (48 FR 38701); the staff's review and positions will be documented in site characterization analyses at that time.

NRC Staff Comment-Summary

In no case did the staff conclude that a disqualifying condition was clearly present or a qualifying condition clearly absent at the sites being investigated. To a large extent the EAs recognize that uncertainties exist at each site. However, in some instances, the full range of uncertainty that exists about certain factors affecting site suitability is not recognized in the discussion supporting the EA findings. The staff noted that in a number of instances the EAs make conclusions and findings which are not supported by existing data or which existing data indicate are not conservative. In these instances, the staff points out specific data and other information which indicate that EA conclusions are not realistically conservative as required by 10 CFR Part 960 (10 CFR Part 960.3 requires that assumptions made in EA evaluations be... "realistic but conservative enough to underestimate the potential for a site to meet the qualifying condition of a guideline..."). For example, we point out information on hydrologic conditions at several sites which is not fully documented in the EAs and which could realistically support less optimistic conclusions about groundwater travel time than those presented in the EA.

In each comment, the staff has attempted to describe the significance of the comment and to recommend what DOE might do to resolve the comment. Ultimately, it may be found unnecessary to completely eliminate all of the uncertainties about site features that are identified in the comments. It is expected that through further investigation it can be shown that some of these uncertainties are compensated for by other site features which assure overall system guidelines are met. (For example, some questions about geochemical properties may be mooted or lessened in importance by development of information indicating that there are very favorable and compensating groundwater conditions.) Nevertheless, it is essential that all potential problems and uncertainties about sites be explicitly identified at this stage so that site-screening decisions are based on complete assessment of the facts and that future site characterization work is complete.

In pointing out deficiencies in DOE's evaluations of individual sites, the staff has commented on DOE's evaluations and findings with respect to the various individual factors which are important to site suitability (i.e., 10 CFR Part 960 guidelines on geohydrology, geochemistry, rock characteristics, etc.). We expect that the DOE analyses in Chapter 1 through 6 will be revised in light of our comments. The staff therefore recommends that DOE reconsider its ratings and ranking analyses of sites in Chapter 7 so that the overall comparison of sites and resulting decisions are consistent with supporting evaluations and findings on individual factors.

It is the staff's view that by recognizing uncertainties identified in our comments and reexamining its assessments in light of the other technical concerns that we raise, the environmental assessments and related decisions will be strengthened.

Presentation of EA Comments

The staff presents its comments in two parts. First, it presents major comments. The order in which these comments are presented has no special significance; the order is governed by the fact that some comments, which help the reader understand others, come first. Second, detailed comments are presented on each of the chapters of the EA. The major comments are those comments which the staff considers may potentially lead DOE to a change in EA findings with respect to specific guideline or may affect the relative ratings of sites. In some of the detailed comments, the staff identifies areas where the discussions supporting the EA findings are more certain than we believe the data supports. If such supporting discussions were considered in the comparison and ratings of sites, these detailed comments could be as significant as those labeled major comments.

Many of the staff's comments appear identical for different sites because the information presented by DOE in the EAs was often identical and therefore would result in the same comment, particularly when sites are in the same geohydrologic basin. Similar comments do, however, take into consideration differences resulting from site specific information.

Comment 1

Fractures (Faults, Joints) and Anomalous Zones

Guidelines on Geohydrology 10CFR960.4-2-1 (b)(3), (c)(3); Rock Characteristics 960.4-2-3(b)(1) and 960.5-2-9(b)(1); and Dissolution 960.4-2-6(c).

The draft EA does not consider all of the relevant available data or adequately discuss alternative interpretations of the data that could provide an adequate uncertainty analysis of both existing and potential structural discontinuities within and near the dome. These discontinuities include internal anomalous zones, faulted caprock, and subsurface and overdome faults and their associated fractures. Structural discontinuities provide a basis for questioning the draft EA evaluations regarding findings for geohydrology, rock characteristics, and dissolution as discussed below.

The potential for structural features within the salt dome are not satisfactorily discussed in terms of their effect on dome homogeneity and dissolution. Alternative interpretations of existing data (Werner, 1984) suggest the potential for a central anomalous zone near the dome center, separating spines of salt (see detailed comment 3-7). An anomalous zone is a group of compositional, textural or structural features that are not typical of the normal salt which they separate (Karably, 1983, Page 19, ONWI-355); an anomalous zone often contains impure salt, clays, brine and compressed gas. Found both in dome interiors and near dome peripheries, anomalous zones have been reported to have communication with dome exteriors, thereby acting as conduits for groundwater movement to the dome (Kupfer, 1976, 1980). Since they represent the boundary between spines of salt movement, they are important components in evaluating the potential for dissolution. Furthermore, if present, such a central anomalous zone could adversely affect the amount of host rock available to construct the repository while maintaining an adequate buffer zone.

The draft EA has not evaluated the potential for faulted caprock that could act as a pathway for groundwater movement to the dome. This faulted caprock was described in drilling records (Rainey,1981) and in ONWI-120 (see detailed comment 6-33). The criteria by which it was recognized and its spatial distribution are important to evaluating its potential as a groundwater pathway. In addition, it may represent an area of differential dome growth (halokinesis), may provide a clue about the position of an anomalous zone and may also represent a zone of preferred dissolution. None of these concerns have been evaluated in the draft EA.

Subsurface faults, coincident with the salt/sediment contact and mentioned in ONWI-555, have not been described in the draft EA (see detailed comment 6-39). Although recently discovered and not well understood at this time, they could alter the groundwater flow system by providing the mechanism to enhance the vertical component of flow (see detailed comment 6-14). Additional faults and surface lineaments, and their relation to stream drainage patterns, have not been discussed (see detailed comment 6-38). The potential for stream drainage to reflect structural discontinuities suggests that dome growth (halokinesis) related structural features may be expressed by joints and fractures, on the surface. Such joints and fractures can also enhance the vertical component of groundwater flow and complicate geohydrologic modeling.

Two overdome faults with apparent offsets of 20 and 70 feet are considered to be insignificant (draft EA page 3-28, paragraph 2). The absence of Citronelle Formation deposits over the dome (ONWI-120) allows an alternate interpretation of Pliocene-Pleistocene fault movement to be made (see detailed comment 6-36). It is NRC's opinion that the age and displacement of these faults are not the central issue here, but their potential to act as pathways for vertical groundwater movement is a consideration DOE has not addressed.

The distribution, extent, causes, and interrelations of the structural discontinuities mentioned here within and near the dome are important input to understanding the groundwater flow system near the dome. Structural discontinuities are also important for estimating dissolution rates and the homogeneity of the host rock. The NRC therefore suggests that DOE consider the uncertainties presented above regarding: 1) major comment 3 on the certainty of ground water travel time calculations and the extent to which the geohydrologic system can be characterized and modeled (960.4-2-1 (b)(3) and (c)(3)), 2) major comment 5 regarding the lateral extent of available host rock (960.4-2-3 (b)(1) and 960.5-2-9 (b)(1)), and other rock characteristics guidelines, and 3) major comment 2 on both the dissolution phenomenon and the DOE conclusion regarding the amount of Quaternary dissolution (960.4-2-6 (b)).

DOE should consider re-evaluating the available data in light of this comment and consider the potential for that data to support alternative interpretations. They should also consider providing a more thorough analysis of the uncertainties of the effects of structural discontinuities in and around the dome on: the groundwater flow system, the estimates for dissolution and on the conclusions on the availablity of suitable host rock to house a repository. Finally, DOE should consider the concerns presented here in revising the findings for the guidelines as appropriate.

Comment 2

<u>Dissolution</u>

<u>Guideline on Dissolution 10 CFR 960.4-2-6(b)</u>

The draft EA has made conclusive findings regarding dissolution that do not adequately consider alternative data interpretations or weigh data uncertainties. The data, including overdome collapse features and faults, a caprock void and internal anomalous zones, when considered collectively, support the potential for significant Quaternary dissolution. NRC thus considers that there is an insufficient basis for the draft EA conclusion that the favorable condition is found for 960.4-2-6 (b), Dissolution.

The draft EA statement that collapse features resulting from dissolution are absent over the dome (draft EA page 6-93) may not be supported by the existing data. A closed topographic depression on the dome margin has Citronelle Formation deposits on its flanks (ONWI-120) and may be a Quaternary feature (see detailed comment 6-35). The cause of the depression is unknown and not discussed in the draft EA, but its shape, its apparent 100 feet of relief and its position on the dome margin could yield a dissolution-related interpretation.

Additional overdome collapse features are not discussed in the draft EA that could support an alternative interpretation of Quaternary dissolution. Two reported overdome faults recognized in the Hattiesburg Formation with 20 to 70 feet of apparent displacement are not included in the analysis of dissolution (see major comment 1) although overdome collapse features, such as faults, are listed in Section 3.2.5.7 Dissolution as evidence of past dissolution. Since deposits younger than Hattiesburg are absent where the faults are recognized, fault displacement, and thus dissolution, could have occurred as recently as the Quaternary. In addition, the DOE has not considered these faults as potential pathways for ground water movement which might enhance future dissolution (see detailed comment 6-36).

The draft EA states, based on a study by Werner, 1984, that the lithologic gap (void) at the caprock/salt interface does not represent a zone of significant dissolution because the dissolution "was not significant enough to result in structural collapse of the caprock or overlying sediments. This is evidenced by the smooth, arched structure of the top of the caprock (Figure 3-10)." (Draft EA page 3-39, paragraph 3). This cited evidence does not include the topographic depression or overdome faults, discussed above, that may be evidence of structural collapse of the overlying sediments and may be related to the lithologic gap. At Cypress Creek dome, where a similar lithologic void was discovered (ONWI-365) and a significant structural collapse feature occurs over the dome, the collapse feature is concluded by DOE to be attributed to dissolution (Cypress Creek draft EA, page 6-103, paragraph 2) which NRC considers may be related to the lithologic void. Therefore, it is NRC's opinion that the data are sufficiently sparse and the state of understanding of dissolution is sufficiently limited that the conclusive statement made by DOE appears unjustifiably optimistic in light of the uncertainties associated with the caprock/salt gap.

Structural features within the salt and caprock may be areas which can act as preferred pathways for groundwater movement and subsequent dissolution. Anomalous zones within the salt and faulted caprock, discussed in major comment 1, are two such features. The draft EA has not discussed these features in terms of their capability to alter dissolution-rate estimates and act as zones of preferential dissolution.

Independently, these features may not be considered significant in terms of their potential to enhance dissolution, but the draft EA has not considered the potential alternative interpretation that collectively, these features may represent significant Quaternary dissolution.

Lithologic and structural features may indicate Quaternary dissolution or be pathways for groundwater that might result in dissolution. The qualitative appraisal in the draft EA that significant Quaternary dissolution has not occurred (960.4-2-6 (b)) is not not well-supported.

DOE should consider re-evaluating the available data in light of this comment, consider the potential for that data to support alternative interpretations and consider the potential that individual features, when viewed together, increase the possibility that significant Quaternary dissolution has occurred. DOE should also consider factoring in the above concerns regarding lithologic features and structural discontinuities into the revised findings as appropriate.

Comment 3

Groundwater Travel Time

Guideline on Geohydrology 10 CFR 960.4-2-1(b)

The draft EA concludes that the favorable condition of a 10,000 year travel time (960.4-2-1(b)) is present because the pre-waste emplacement ground-water travel time horizontally from the repository to the edge of the salt dome is estimated at 107,000 years and total travel time from the repository to a point 10 kilometers (6 miles) distant is conservatively estimated at 197,000 years. However, many of the assumptions, approaches, and ranges of values are not conservative with respect to available information and may result in inappropriately high calculated groundwater travel times. Specifically, the assumptions and approaches used in the draft EA are not conservative with respect to flow path, gradient, permeability, and porosity, as discussed below.

Potentially shorter flow paths could occur along anomalous zones, faults, and drill holes within the dome and outside the dome through faults, fractures, drill holes and along the dome edge, as opposed to the single pathway horizontally through pure salt and through the upper and Lower Claiborne Unit (see detailed comments 6-10, 6-14 and 6-64). Groundwater travel time calculations used regional model generated hydraulic gradients, permeabilities, and porosities rather than field data. Therefore groundwater travel times may not be conservative (see detailed comments 3-19, 3-20 and 6-11). The disturbed zone may be greater than anticipated which could result in shorter groundwater travel times (see detailed comment 6-100, 6-101, 6-102). Finally, although the draft EA prefers an alternative two-phase repository design (Section 5.5), the groundwater travel time consequences of using this design are not considered. The two-phase design will more than double the repository area resulting in less salt between the repository and the edge of the salt dome and shorter groundwater travel times (see detailed comment 5-17).

The NRC concludes that consideration of the above mentioned concerns may reduce the confidence that the favorable condition is present. Therefore, DOE should consider repeating its groundwater travel time analysis after considering the concerns noted above. The DOE should also consider revising the draft EA to more accurately convey the uncertainty associated with its conclusion regarding this favorable condition and the large uncertainty associated with travel time estimates.

Comment 4

Radionuclide Mobility

Guideline on Geochemistry 10 CFR 960.4-2-2(b)(2),(b)(4),(c)(1) and (c)(3)

Evidence presented in the draft EA regarding processes that affect radionuclide migration, such as precipitation, sorption, radiocolloid formation, and organo-radionuclide complexation, is limited and, in some cases, evaluations are incomplete. Despite the ambiguous nature of the data, optimistic estimates of the above parameters are used which may lead to underestimations of radionuclide mobility.

The draft EA analysis of precipitation and sorption of radionuclides does not consider the potential for migration of radionuclides through flow paths other than the deep saline aquifers (see major comment 3). The effects of radiolysis on precipitation and sorption are also not considered.

The existence of chemically reducing conditions is beneficial to waste isolation in that certain radionuclides are less soluble and more readiliy sorbed in their reduced state. The data and the evaluations used in the draft EA do not adequately support the assertion that reducing conditions are expected (see detailed comments 3-16 and 6-18). The reduced constituents cited in the draft EA to support the contention that reducing conditions are expected (i.e., CH_4, H_2S) can persist metastably in oxidizing groundwater. Certain processes which may influence the redox conditions are ignored, such as radiolysis, waste package corrosion reactions, and the presence of atmospheric O_2 (see detailed comment 6-20). Regardless, the conclusion that effective reduction of nuclides occurs because reducing conditions are expected is not well-founded because slow kinetics inhibit the establishment of equilibrium conditions, allowing redox sensitive elements such as uranium and neptunium to remain in their oxidized state where their solubilities are maximum and they do not readily sorb on the host rock minerals (see detailed comments 3-16 and 6-18).

The discussion of radiocolloid formation and organo-radionuclide complexation uses data that are not applicable to the expected site conditions (see detailed comment 6-17). Without site-specific data, it is premature to conclude that radiocolloids and organo-radionuclide complexes will not form under repository conditions.

By not employing the range of values implied by the uncertainties in the parameters mentioned above used to estimate retardation of radionuclides, the draft EA may be underestimating the potential for radionuclide migration. While information is presented regarding precipitation and sorption of radionuclides, only optimistic estimates of the expected redox conditions, radiocolloid formation, and organo-radionuclide complexation as they affect radionuclide mobility are used in the evaluation of guideline 960.4-2-2(b)(2). Therefore, the finding made in the draft EA that this favorable condition is present is not strongly supported (see detailed comments 6-17 and 6-18). The uncertainties in the redox conditions are not considered in waste package corrosion and solubility performance assessment calculations, thus limiting the applicability of their results (see major comment 8 and detailed comments 6-19 and 6-20). These performance calculations are used to make favorable findings for guidelines 960.4-2-2(b)(4) and 960.4-2-2(c)(1), concerning radionuclide solubility and the effects of groundwater conditions on the stability or chemical reactivity of the engineered barrier system, respectively. The favorable findings are not strongly supported due to the limited applicability of the performance assessment calculations. For guideline 960.4-2-2(c)(3), concerning redox conditions, the data presented are too ambiguous to support a finding that the potentially adverse condition of chemically oxidizing conditions will not be present (see detailed comment 6-18).

The DOE should consider the uncertainties in the available data in re-evaluating processes and conditions that affect radionuclide migration. The DOE should revise as appropriate the findings for the guidelines discussed above and the relevant performance assessments.

Comment 5

Effects of Host Rock Mass Heterogeneity

Guidelines on Rock Characteristics 10 CFR 960.4-2-3(b)(1),(b)(2),(c)(1),(c)(3) and 960.5-2-9(b)(1),(b)(2),(c)(2)

Evaluations of Rock Characteristics guidelines presented in the draft EA contain statements that suggest the Richton Dome salt rock is essentially homogeneous throughout the site (page 6-86 and 6-142). Generic evidence from Gulf Coast salt mines does not support these statements. Mining experience indicates that heterogeneities such as anomalous zones (which often contain impure salt, clay, brine, and gas pockets and brecciated/shear zones) may exist in dome interiors and near dome peripheries (see detailed comments 6-14, 6-21, 6-29, 6-32 and 6-58). Site information also suggests the possibility of an anomalous zône (see major comment 1, and detailed comment 3-7). The effects of such heterogeneities combined with thermal loads on construction of the repository, on maintenance, on potential retrieval operations, and on estimating the extent of the disturbed zone have not been discussed. An assumption of homogeneity tends to underestimate these effects. The presence of heterogeneities would also tend to increase the level of uncertainty regarding the draft EA assumption that rock property data derived from core samples of essentially pure salt may be considered representative of the thermal-mechanical properties of the salt units at the Richton Dome site. This source of uncertainty has not been discussed. Therefore, uncertainties related to the heterogeneous nature of salt dome rock that would be significant for evaluations of several of the Rock Characteristics guidelines may not have been adequately evaluated in arriving at the findings presented as noted in the following discussion.

The draft EA presents estimated values of physical, thermal, and engineering properties of the Richton Dome salt in Tables 3-6 and 3-7 as representative of the in situ host rock mass at the site. The estimates are based on data from limited laboratory testing of a few samples of salt rock cores taken from a single borehole (MRIG-9) (see detailed comments 3-10, 3-12, 3-15 and 6-48). Although the draft EA correctly identified that the domes internal structure is typically steeply dipping and that data from the single borehole cannot be considered representative of the entire salt stock (page 6-82, paragraph 7), it appears that an implicit assumption of homogeneity of the rock mass was made and the data in Tables 3-6 and 3-7 for essentially pure salt rock were used in rock characteristics evaluations. It also appears that uncertainties related to the adverse effects of heterogeneities were not factored into the evaluations. Since the engineering behavior of the in situ salt rock, especially under waste induced thermomechanical loading conditions, can be dominated by heterogeneities, an assumption of host rock homogeneity would lead to an underestimation of the effects of heterogeneities on several rock mechanics related concerns. These include but are not limited to the adverse effects of heterogeneities on the estimated strength, creep, thermal conductivity, and porosity of the host rock which may in turn limit design flexibility, roof and opening stability and requirements for rock support and reinforcement. Uncertainties regarding the impact of these adverse effects on the requirement for unique engineering practices and procedures that are beyond currently available technology to construct and maintain repository openings and to support potential retrieval operations have not been addressed. The potential adverse effects of combined thermal loads on heterogeneities might also lead to a more extensive disturbed zone in the host rock than the 10 meters estimated in Appendix 6A of the draft EA (see detailed comment 6-100).

Specific draft EA findings that are affected include the findings for post-closure Rock Characteristics guidelines 10 CFR 960.4-2-3(b)(1) and pre-closure Rock Characteristics guideline 10 CFR 960.5-2-9(b)(1). The evaluations for these findings do not consider the effects of heterogeneities which would limit the available lateral extent of host rock needed for locating the underground facility and providing an adequate buffer zone beyond the limits of the underground facility. In addition, uncertainties exist concerning the actual shape and extent of the dome at the proposed repository level and the possible presence of a central anomalous zone near the dome center dome which might further limit the availability of suitable host rock. These uncertainties have not been adequately considered (see detailed comments 3-7 and 6-57). Therefore, the evaluation for these guidelines may be inadequate. The finding for post-closure Rock Characteristic guideline 10 CFR 960.4-2-3(c)(1) is also affected. The evaluation does not consider the effects of heterogeneities that would tend to increase the expected engineering difficulties and level of complexity of technology required to construct, operate, and close a repository. The finding, therefore, is not adequately supported. The evaluations for Rock Characteristics guidelines 10 CFR 960.4-2-3(b)(2), and (c)(3) and 10 CFR 960.5-2-9(b)(2) and (c)(2) do not discuss uncertainties regarding the impact of heterogeneities on artificial support requirements and requirements for engineering measures beyond reasonably availabile technology related to repository construction and operation. As a result, the evaluations presented for these guidelines may be inadequate.

The DOE should consider expanding the evaluations presented for the guidelines noted above to address the uncertainties related to the effects of heterogeneities on repository construction, operations, and waste isolation, and if appropriate, modify the findings based upon the results of the reevaluations.

Comment 6

Retrievability

Guidelines on Ease and Cost 10 CFR 960.5-1(a)(3); and Rock Characteristics 960.5-2-9(b)(2),(c)(3),(c)(4)

Evaluations presented in the draft EA tend to underestimate the technical difficulty and do not adequately discuss the uncertainties associated with the rock mechanics aspects of retrieval. Retrieving waste canisters in salt under repository induced thermomechanical loading conditions is unique (i.e., a new concept) to current mining technology. Retrieval operations could be especially difficult in a heterogeneous host rock. The evaluations for several rock characteristic guidelines indicate that the draft EA has not adequately discussed the uniqueness of retrieval technology and the effects of these adverse conditions on retrieving the waste canisters.

Section 6.3.3.2.3 states that "Re-excavation of the storage rooms and locating of waste canisters is assumed to be required for retrieval and while costly should not pose undue hazard or difficulty." However, no discussion is presented which addresses the response of a potentially heterogeneous host rock mass to variations in areal heat loading density and the associated uncertainties related to drift opening maintenance and room stability during retrieval. In addition, the discussions on retrievability in Section 5.1.3.3 and Section 6.3.3.2.3 do not completely consider the potentially adverse effects associated with elevated temperatures such as reduced rock strength, accelerated creep, pressurized gases surrounding the waste canisters and hot brine flow which may be encountered during retrieval (see detailed comments 5-5, 6-57 and 6-60). Blowouts of naturally occurring gas pockets may occur due to reduction of rock strength caused by elevated temperature. These adverse effects would pose technical problems with maintaining room stability as well as locating and removing the waste canisters. As pointed out by Kendorski et al., (1984), retrieval related items where technology has not been proven include ground support systems, canister location systems, and canister overcoring systems. In addition, the potentially adverse effects may be unfavorable for the radiological health and safety of the mining personnel retrieving the waste in the event of a breached waste package (see detailed comments 6-50 and 6-61).

The evaluation for for Rock Characteristics guideline 10 CFR 960.5-2-9(b)(2) (which requires minimal or no artificial support for underground openings to ensure operations including retrieval) does not address potential problems related to remining in a thermally weakened heterogeneous rock mass and changes anticipated to the rock characteristics due to heating over long periods of time. As a result, the draft EA finding may be inadequately supported (see detailed comment 6-51). In addition, the evaluations for the findings presented for guidelines 10 CFR 960.5-1(a)(3), 10 CFR 960.5-2-9(c)(3), and 960.5-2-9(c)(4) which address ease and cost of construction and operation, maintenance of underground openings, and retrieval difficulties respectively, may be incomplete and overestimate the potential suitability of the site for retrieval operations (see detailed comments 6-58 and 6-60).

It is recommended that the discussions and evaluations be expanded to consider, the uncertainties associated with repository induced thermomechanical loading effects on a potentially heterogeneous rock mass, mining problems, radiological safety issues, and adverse rock characteristics conditions expected to be encountered during retrieval. It is also recommended that where appropriate, the results of the re-evaluations be factored into the conclusions and findings presented.

Comment 7

Shaft Sealing

Guidelines on Rock Characteristics 10 CFR 960.4-2-3(c)(3), and 960.5-2-9(c)(2)

Evaluations presented in the Draft EA do not adequately discuss the many uncertainties associated with constructing, sealing, and decommissioning shaft systems to assure containment and isolation of the waste at the Richton Dome site. Given the history of salt mine flooding caused by shaft failures in Gulf Coast dome mines (see detailed comment 6-9 and 6-99) and the impact of flooding on safety, operations and retrievability, shaft sealing is a prime concern for the high level radioactive waste repository. Uncertainties associated with shaft sealing at salt domal sites include risks associated with (1) contemplated use of ground freezing techniques in sediments and caprock overlying the dome; (2) the use of blindhole drilling techniques for shaft construction; (3) the effects of ground thaw after construction; (4) the design of sealing materials for long-term compatibility with engineering and chemical properties of shaft wall rock; (5) the response of shaft seals/shaft wall to potential seismic motion; and (6) the uncertainties associated with potential waste emplacement thermal effects on the integrity of the seals. The draft EA provides only a very general description of shaft seal requirements (Section 5.1.1.3, page 5-12) and does not adequately address the above mentioned uncertainties. As a consequence available evidence that may be significant for evaluation of rock characteristics guidelines may not have been evaluated in arriving at the findings presented as noted in the following discussion.

In the past available technology and standard mining practice have not always been successful in sealing salt mining shafts (Kupfer, 1980). As pointed out in D'Appolonia (ONWI-255, 1981), for a repository in salt, "...even a minor seepage into the evaporite section from overlying aquifers could be disastrous in the long-term." Uncertainties associated with the use of freezing techniques in conjunction with shaft construction are particulary important for domes where the upper caprock may be in communication with freshwater aquifers and the permeability is controlled by fractures. Rock disturbance due to the number of boreholes required for freezing and subsequent thawing in the units overlying the domal salt afford potential opportunities for increased permeability immediately adjacent to the shaft. Uncertainties also arise due to the limited ability to obtain rock characteristics data needed for locating and placing seals when using the blindhole drilling method (see detailed comment 5-3). The discussion presented in Section 5.1.1.3 does not address the potential for differential ground movements caused by initial expansion and subsequent contraction due to the thermal pulse which may extend to the shaft areas and produce deleterious strains in shaft linings and seals. The discussion also does not address the potential for significant damage to shaft seals due to potential dynamic earthquake loads (see detailed comments 6-37 and 6-65).

The evaluation presented in support of the finding for Rock Characteristic guideline 10 CFR 960.5-2-9(c)(2) (which addresses potentially adverse conditions which would necessitate use of engineering measures beyond reasonably available technology) does not address appropriate uncertainties associated with shaft sealing (see detailed comments 6-56 and 6-59).
The evaluation is therefore inadequately supported. The evaluation presented for Rock Characteristic guideline 10 CFR 960-4-2-3(c)(3) (which addresses the potential of waste generated heat decreasing the isolation provided by the host rock as compared with pre-waste implacement conditions) does not present an indepth evaluation of uncertainties associated with long-term seal performance in geohydrologic and thermal environments which could adversely impact on the strength and bonding characteristics of yet undeveloped and untested long-term seals (see detailed comment 6-31). As a result, the evaluation may be inadequate. From a technical standpoint the shaft seal system is a significant

repository component whose objective is to prevent flooding that would preclude the use of the repository for waste emplacement during the preclosure period and in postclosure would prevent or delay ground water contact with the waste form or limit the rate of radionuclide release into the ground water after contact has occurred.

When revising the draft EA it is recommended that the evaluations presented for the guidelines noted above be expanded to address the uncertainties associated with shaft sealing at a domal salt site and, if appropriate, the findings be modified to reflect the results of the reevaluation.

Comment 8

Waste Package Performance Predictions

The waste package performance assessment is based upon a multi-factored, but simplistic approach that leads to a potentially incorrect perception that the reference waste package will last a very long time (at least 10,000 years under expected conditions) (e.g., ch. 6, sections 6.3.2.1 and 6.4.2.4.1). Based on limited evidence and analysis, it is indicated that if the package were to fail (due to some unexpected condition or scenario), the low solubilities of the radionuclides in the expected total volume of brine contacting the waste package would limit the releases, for most elements, to within small fractions of EPA limits (e.g., Ch. 6, sections 6.3.2.1 and 6.4.2.4.1). These conclusions are based on performance assessments which are very preliminary and based on limited data. In some sections of the draft EA, statements on waste package performance properly acknowledge that uncertainties exist at the present time (e.g., ch. 6 sections 6.3.2.2 and 6.4.2.1, paragraph 2, and ch. 7, section 7.7.2, paragraph 4). However, a potentially incorrect overall impression is created that there is considerable margin available for compliance with NRC performance objectives for the waste package and engineered barrier system (e.g., ch. 6, sections 6.3.2.1, 6.4.2.3.4, 6.4.2.4.1, and 6.4.2.5).

The concerns mentioned below cast considerable doubt on the conclusions regarding waste package performance in the draft EA. For example, the waste package lifetime may be as much as two orders of magnitude less than that calculated with the expected conditions. The waste package performance assessment is conducted by first selecting reference (expected and unexpected) conditions for the near-field chemical and physical environment and expected modes of failure of the waste package. The lifetimes, or times-to-failure, of the waste package are then calculated through a series of computational steps involving principally the calculation of thermal conditions, rates of brine migration, and rates and amounts of corrosion of the waste package overpack. The reference conditions are, in many cases, selected either in lieu of data (e.g., regarding brine composition) or after rather optimistic interpretation and application of sparse existing data (e.g., the rate of uniform corrosion as a function of brine composition and rate of migration) (see detailed comment 6-78). In some instances, relevant waste package degradation and failure scenarios, such as pitting corrosion, are apparently either not taken into consideration (see detailed comments 6-72, 6-76 and 6-81) or are not adequately addressed (see detailed comments 6-89 and 6-90). There are also potentially large (but unquantified) uncertainties associated with the calculation of radiation field and thermal conditions (see detailed comments 6-74, 6-82 and 6-83) and with the solubility of radionuclides in brine (see detailed comments 6-97 and 6-98).

In lieu of applicable long-term data, the waste package performance assessment has relied heavily upon analytical models to make predictions over the expected lifetime of the repository. However, the analytical approach, as well as the models themselves, appear to have a number of limitations, which are summarized below. Because the information presented in support of the analytical models is limited, it is not possible to ascertain the precise nature of the modeling limitations in the performance assessment. From what evidence is available, it appears that significant problems may exist that could have a major effect on the results of the performance assessment.

The limitations in the modeling approach include the following: (1) conceptual limitations, such as the use of a wastage allowance (thickness of the container allocated) for overpack corrosion, which is valid only for uniform corrosion; (2) analytical oversimplifications, such as the use of one-dimensional analysis where multi-dimensional effects are expected (see detailed comment 6-82); (3) lack of consideration of alternative scenarios such as premature failure due to manufacturing defects; (4) the need for a priori knowledge of the results in order to run the analysis; (5) lack of consideration of synergistic effects (e.g., more than one corrosion process active at one time); and (6) lack of consideration of the effects of uncertainties in the models and input parameters (see detailed comment 6-73).

The significance of these remarks pertain to (1) the statements made in the draft EA (sections 6.4.2.4.1 and 6.4.2.5) that the 10 CFR 60 and 40 CFR 191 requirements are met by the proposed waste package design under reference expected conditions, and (2) the fact that the sense of large available margin may obscure the need for creation of appropriate models for waste package failure and radionuclide release. Regarding the former point, the draft EA has provided insufficient information to adequately support these conclusions. Regarding the latter point, the use of inappropriate or inaccurate modeling assumptions could lead to incorrect decisions regarding waste package data requirements.

Therefore, the effects of the input parameter and model uncertainties on the waste package performance assessment should be considered in revising the draft EA conclusions. The DOE should also consider appropriate qualifying statements where overly optimistic conclusions are given (e.g., ch. 6, sections 6.3.2.1, 6.4.2.3.4, 6.4.2.5, and 6.4.2.5).

Comment 9

Controlled Area

Guidelines on Environmental Quality 10 CFR 960.5-2-5, Socioeconomic Impacts 960.5-2-6, and Site Ownership and Control 960.4-2-8(2)(c) and 960.5-2-2(c)

No basis or supporting calculations or assumptions for the preliminary controlled area are given in the draft EA. It appears that the size of the preliminary controlled area did not consider factors discussed below which might enlarge the size. This in turn may lead to underestimating site ownership and control, environmental quality, and socioeconomic problems and may not provide adequate protection of the site from activities such as non-DOE drilling that could adversely affect the containment and isolation capability of the site.

The size of the prliminary controlled area identified on page 5-4 of the EA is approximately 7.6 sq. mi. or 4910 acres. This amounts to the edge of the controlled area (accessible environment) being less than 1 km from the edge of the underground facility. Page 6-6 of the draft EA states that this preliminary area coincide with the margin of the salt dome at - 2000 feet MSL. Because no additional basis is given or referenced it appears that the following factors were not accounted for: 1) possible adjustments to size and orientation of the underground facility design, 2) size of the underground facility assuming the two-phase design and 3) uncertainties associated with assumptions and estimates regarding groundwater travel time and radionuclide transport.

The draft EA states in Chapter 5 that the design information presented is based on a feasibility study and no site specific data. Given the uncertainties related to heterogeneities and thermal effects which might affect the design (see major comment 5) it is possible that the underground facility might be enlarged or reoriented to account for thermal effects and site heterogeneities identified during site characterization or construction. The preliminary controlled area presented does not seem to account for such flexibility of design.

The preliminary controlled area is based on the single-phase design described in Chapter 5. However, p. 5-116 states that DOE is proceeding further with the two-phase concept. The area needed for the underground facilities for the two phase design is 4095 acres or over double the area of the one-phase design. This amounts to a significent reduction of the buffer zone between the edge of the underground facility and the margin of the salt dome.

NRC assumes that the preliminary controlled area size was based on preliminary calculations of groundwater travel times and radionuclide transport which are based upon various geologic, hydrogrologic and geochemical assumptions presented in the draft EA. Many of these draft EA assumptions have uncertainties related to them (see major comments 1, 3 and 4); it does not appear that the size of the controlled area has accounted for these uncertainties in such a way that it would provide enough area to adequately account for the range of conditions that might be expected at this time to be encountered during site characterization.

Because the town of Richton lies adjacent to the boundary of the preliminary controlled area, a larger controlled area would necessitate additional acquisition of private lands in the town and the possibility of related socioeconomic impacts. Therefore, the size of the preliminary controlled area is important to the evaluations of environmental quality (land use) (960.5-2-5), socioeconomic impacts (960.5-2-6) and site ownership and control conditions (960.4-2-8(2)(c), 960.5-2-2(c)).

Furthermore, the preliminary controlled area size is important to adequate protection during site characterization against activities such as non-DOE drilling, which could adversely affect the containment and isolation capability of the site.

The DOE should consider re-evaluating the size of the preliminary controlled area and provide a basis for its identification which takes into account the concerns mentioned above. The result of these revisions should be factored into the environmental quality, socioeconomic impact and site ownership and control guidelines as appropriate.

Comment 10

Comparative Evaluation of Sites Against Guidelines on Surface Flooding

Guidelines on Surface Characteristics 10 CFR 960.5-2-8(c) and Hydrology 10 CFR 960.5-2-10(b)(2)

In assessing the guidelines relating to surface water flooding (960.5-2-8(c) and 960.5-2-10(b)(2)) DOE appears to be inconsistent among the nine sites. DOE correctly concludes that at two sites (Deaf Smith and Swisher) the repository facilities are not subject to surface water flooding while at the other seven sites they are. The sites that are subject to flooding would have to be flood-protected in varying degrees through the use of engineering measures. At four of those sites (Davis Canyon, Lavender, Cypress Creek, and Vacherie) DOE concludes that because flood protection would have to be provided the adverse condition (960.5-2-8(c)) is present and the favorable condition (960.5-2-10(b)(2)) is not. At the remaining three sites (Hanford, Yucca Mountain, and Richton) DOE concludes that since flood protection could be provided, through engineering measures, the adverse condition is not present and the favorable condition is. The seven sites susceptible to surface flooding have not been treated equitably.

We suggest that DOE decide whether credit for flood protection through engineering measures be considered in applying guidelines 960.5-2-8(c) and 960.5-2-10(b)(2) and then implement the decision consistently. We note that engineering measures, if properly designed and implemented, can be used to protect almost any site from almost any flood. Thus, a decision to allow credit for such flood protection may amount to eliminating the differentiation between sites with respect to these guidelines.

Comment 11

Comparative Evaluation of Sites

The draft EA's describe in Chapter 7 and Appendix B the relative weights given to post-closure and pre-closure guidelines. As required by the guidelines, DOE gave greater weight to post-closure guidelines (i.e., from 51% to 85% in applying the so-called utility estimation method). However, the staff notes that the spread of site ratings on individual guidelines (see, for example, Tables B-2 and B-3) is distinctly different between the post-closure and pre-closure analyses. The spread of ratings on pre-closure guidelines is much greater than it is for post-closure guidelines. The result of this wider spread is to have pre-closure guidelines dominate the overall ranking, notwithstanding the greater weight given to post-closure guidelines. It appears as if the ratings might be relative in nature as opposed to being an assessment of sites on an absolute scale. If ratings are indeed relative in nature, then inconsistent treatment of post-closure and pre-closure ratings may be interpreted as effectively going counter to the requirement that post-closure guidelines be assigned greater weight in site comparison.

The staff recommends that the description of the rating methods in the final EA be expanded to explain the reason for the wider spread on pre-closure ratings and, in general, to describe more specifically the method of assigning ratings on individual factors.

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Rainey, D.L., 1981. Letter from Transgulf Chemicals Company to Mark Smith, Mississippi Bureau of Geology, about information describing a summary of 34 sulfur wells drilled in Mississippi in 1944 and 1945.

Werner, M.L., 1984. "Stratigraphy and Structure over Richton Dome - Data and Findings Relevant to the Issue of Dissolution," Ertec Technical memo (EW-OWNI-82-7562), September 12, 1984, 18 pp.

DETAILED COMMENTS

EXECUTIVE SUMMARY COMMENTS

ES-1

Executive Summary, Section 3, The Site, page 11, paragraph 2

In this section of the draft EA it is stated that the potential for discovering additional oil and gas fields seems to be very low. However, Section 3.2.8.1 of the EA presents information on a substantial hydrocarbon show (30 meters (100 feet) of sand containing heavy asphaltic oil) that has been identified. The assessment of low potential for future hydrocarbon reserves also appears to be inconsistent with information presented in Karges (1975), a reference cited in 3.2.8.1. Two quotes from this reference, "Future drilling should establish significant reserves on shallow salt domes" (last sentence of abstract), and "Excellent heavy oil shows were seen in lower Cretaceous sands on the flanks of D'Lo, Richton, and Midway Domes" (p. 181, first paragraph) would appear to support an assessment of greater potential. Therefore, it is recommended that the potential for discovering additional oil and gas fields be reassessed.

ES-2

Executive Summary, Section 5 Regional and Local Impacts of Repository Development, page 14, paragraph 3

The last sentence of this paragraph states that about 10 million tons of excess salt would be removed from the site for disposal in an offsite mine. This statement is inconsistent with the detailed discussion in Sections 5.1.3, (page 5-27) and 5.1.3.4, (5-31). These discussions note that a specific method of excess salt disposal has not yet been selected. It is recommended that the inconsistency be reconciled in the final EA.

ES-3

Executive Summary, Section 5. Regional and Local Effects of Repository Development Page 15, Last Paragraph

This section discusses radiological risks from routine shipments but does not discuss radiological risks from transportation accidents. It is suggested that radiological risks from transportation accidents be considered in this section.

Executive Summary References

Karges, H.E., 1975, Petroleum Potential of Mississippi Shallow Salt Domes," Transactions of the Gulf Coast Association of Geological Societies, Vol. 25, pp. 168-181.

CHAPTER 3 COMMENTS

3-1

This comment was incorporated elsewhere in the comment package.

3-2

Section 3.2.5, Structure and Tectonics, Pages 3-24 to 3-34

The possible relationship among several structural features has not been considered in the draft EA. Not recognizing such relationships may lead to underestimates of the potential seismic hazard associated with the features. Figures 3-13, 3-14, and 3-16 indicate a possible interaction between several structural features. The Phillips Fault appears to be a possible splay of the more northern Pickens-Gilbertown Fault; the Phillips Fault then appears to extend into the Waussau anticline which contains the F-9 Faults. The geographic relations of these structural features suggests that they may have developed under a similar tectonic regime or more probably that the oldest structural features contributed to the development of younger ones. Possible relations among these structural features considering their associated seismic hazard potential, should be considered in preparing the final EA.

3-3

Section 3.2.5.1, Faulting, Pages 3-24 to 3-28

The description of the regional faults presented in the draft EA does not consider their significance in relation to the regional stress field. In order to adequately assess the faults in terms of their affect upon the geologic repository operations area and the potential for future faulting, an integrated analysis of the forces which cause fault development should be presented. Therefore, consideration should be given to including a description of the regional stress field and its relation to regional faults in the final EA.

3-4

Section 3.2.5.2, Seismicity, Page 3-28; Paragraphs 3/6

In the draft EA, the seismic risk is considered low. Although the potential influence of hydrocarbon production is mentioned, and even more explicitly so in LETCO (1982, ONWI-120, pp. 12-135/140), it appears that the seismic assessment only considers past seismicity. Induced seismicity being caused by future hydrocarbon production, particularly when secondary and tertiary recovery methods are used is a possibility. It is recommended that an assessment of the risk of induced seismicity in the future be considered.

3-5

Section 3.2.5.4, Uplift and Subsidence, page 3-33, paragraphs 5 and 6

Regional uplift rates of 2-4 mm/year are substantiated by Jurkowski, et al (1984) in which they arrive at uplift rates of 2.9 - 3.9 mm/yr after re-evaluation of the leveling survey data. At this time these uplift rates should not be discounted by DOE without explanation while waiting for data to "be re-evaluated for possible errors in measurement or complications introduced by methods of analysis ..." (Draft EA, page 3-33, paragraph 6).

3-6

Section 3.2.5.5, Folding, page 3-34, paragraph 2

This paragraph states that the salt withdrawal basin abuts the F-7 Fault but does not go on to point out why that may be important. NRC considers that the F-7 is in some way related to dome growth (halokinesis) or regional uplift, and its stratigraphic offset may provide important information about the timing of dome development. Consideration should be given to providing a more thorough description of the relation between the F-7 Fault and the salt withdrawal basin which integrates this relationship into the discussion of dome development.

3-7

Section 3.2.5.6 Salt Dome Development and Geometry, Page 3-34, Paragraphs 5 & 6 and Page 3-35 Paragraph Continued From Previous Page and Paragraphs 1 & 2

The presence of two centers of arching, COA II and COA III (Werner, 1984, Figure 2), suggests the potential for an anomalous zone within the geologic repository operations area. NRC considers that these two areas may represent areas of salt spine movement similar to those described in Karably (1983) and Kupfer (1976) and may contain a relatively extensive central anomalous zone. The occurrence of a central anomalous zone at this location could limit the lateral extent of salt suitable for housing the repository. Therefore, the conclusion in the draft EA that the host rock is sufficiently laterally extensive to allow significant flexibility for siting the repository may not be substantiated.

3-8

Section 3.2.5.7, page 3-39, paragraph 3

The argument presented by Werner (1984), and cited in the draft EA, claims that the occurrence of gypsum-veined anhydrite caprock at Richton indicates that water moving through pre-existing caprock fractures dissolved the material recognized now as a gap at the salt/caprock interface. The argument appears to be solely supported by the observation that gypsum-veined anhydrite occurs throughout the entire caprock thickness. Further, the dissolution at the caprock/salt interface is concluded to have been "not significant enough to result in a structural collapse of the caprock or overlying sediments."

Werner's explanation for the occurrence of the gap appears to be feasible, however, alternative explanations are not considered in the draft EA. Werner's explanation does not appear to apply to Cypress Creek dome where similar caprock features are found. Gypsum-veined caprock occurs in the upper portion of the caprock but dies out about 20 feet above the void at the caprock/salt interface. NRC considers that the void may not have been caused by downward moving water through pre-existing caprock fractures but by some variation of the mechanism such as lateral water movement. Because at some domes gaps may originate by a mechanism different from that proposed by Werner, it remains to be shown whether or not a mechanism other than Werner's can be applied to Richton dome. Alternative explanations for the origin of the gap and a discussion of the uncertainties associated with all of the potentially feasible explanations should be considered in the final EA.

3-9

Section 3.2.6.1.1, Geomechanical Properties of Overburden, Page 3-41, Table 3-4

The reference given as Reference (3) in Table 3-4 on Page 3-41 is outdated. The Department of the Navy document, "Soil Mechanics, Foundations, and Earth Structures," NAVFAC DM-7, of March, 1971 was superseded in its entirety by three Department of Navy Design Manuals: DM 7.1, DM 7.2, and DM 7.3 in May, 1982.

3-10

Section 3.2.6.1.2, Geomechanical Properties of Caprock and Salt, Page 3-40

The representativeness of the values of geomechanical properties of Richton Dome salt presented in Table 3-6 on page 3-44 relative to the in situ rock mass properties has not been evaluated. The representativeness of the rock core samples used in estimating the value of the listed parameters relative to the in situ rock mass has also not been addressed. Lacking these correlations, it is difficult to make judgments regarding the engineering properties of the in situ rock. It is recommended that this section be expanded to include a discussion of the representativeness of the samples tested relative to the in situ rock quality; to provide an estimate of sampling bias and core quality;

and to provide a discussion of problems associated with test sample selection and preparation. It is further recommended that a table of measured compressive strengths of Richton Dome salt be provided to aid in formulating judgments regarding the strength of the Richton Dome salt.

3-11

Section 3.2.6.1.2, Geomechanical Properties of Caprock and Salt, Page 3-40

Table 3-6 presents strength criteria parameters developed from 24°C test data. According to Section 3.2.6.2, Thermal Properties, the estimated ambient in situ temperature at the proposed repository depth is 50°C. At 100°C, according to Figure 3-19, the rock salt strength is significantly lower than at 24°C. Estimated strength criterion parameter values of the salt at ambient in situ and at repository induced temperatures up to approximately 250-300°C are not provided. It is recommended that this section be expanded to include a discussion of anticipated geomechemical properties of the Richton Dome salt at temperatures at and above ambient repository-level tempertures. (NOTE: The symbols for the last two Strength Criterior Parameter values presented in Table 3-6 are missing. The appropriate symbols should be identified.)

3-12

Section 3.2.6.1.2, Geomechanical Properties of Caprock and Salt, Page 3-40, Paragraph 2

The uncertainties in the numerical values of the creep parameters are not addressed in this section of the draft EA. Table 3-6 (page 3-44) presents point values of six creep parameters that have been obtained from a total of three tests. Creep closure during operation is a potential problem because it can interfere with construction and emplacement activities. It also has implications on artificial support, frequency of scaling, and retrievability. The site-to-site variations in measured creep rates are large as evidenced by Figure 4.6 in Pfeifle et al. (1983, ONWI-450) where it is reported that steady-state creep rates differ by orders of magnitude. The representativeness of the values presented for Richton Dome is not addressed. Recommend the discussion be expanded to address the uncertainties associated with the creep parameters and the representativeness of values presented for Richton Dome.

3-13

Section 3.2.6.1.2, Geomechanical Properties of Caprock and Salt, Page 3-40, Paragraph 3

The draft EA presents an estimate of the stress magnitude at a depth of 648 meters of between 13 and 15 megapascals. Contrary to the statement in the draft EA, Tammemagi et al (1984 ONWI-364), incorrectly referenced as Tammemagi (1981), does not give actual stress measurements in salt mines in the Gulf Coast Region (although on p. 16 a number is given for the Paradox Basin). Hoek and Brown (1980) include one data point from a Louisiana salt dome for which the rate is approximately 0.023 MPa/m. Lindner and Halpern, (1977) include one number from a Louisiana salt dome in their data base, but give no details. Of the three empirical prediction equations given by Lindner and Halpern, 1977, two, including the one proposed by the authors, suggest a stress rate increase substantially above 0.023 MPa/m. It is recommended that the discussion be expanded to present the rationale for proposing a stress rate increase of 0.023 MPa/m which is significantly lower than the rates proposed by either Hoek and Brown (1980), of 0.027 MPa/m, or by Lindner and Halpern (1977).

3-14

Section 3.2.6.1.2, Geomechanical Properties of Caprock and Salt, Page 3-40, Paragraph 3

No information or data are provided on either the state of stress outside the salt stock at repository levels or in the overburden (including caprock). Estimates of stress conditions for these regions are required when modeling thermomechanical response prediction calculations. It is recommended that the discussion be expanded to address proposed methods of estimating the state of stress in the non-salt strata adjacent to and above the salt stock and to explain the rationale used to support the assumptions presented.

3-15

Section 3.2.6.2, Thermal Properties, Page 3-40, Paragraphs 4/5

BMI/ONWI-522, (Lagedrost and Capps, 1983) p. 15, identifies the difficulties encountered in preparing samples from Richton Dome core. These difficulties suggest that Richton Dome might have weak caprock and salt rock and that samples used, and hence thermal properties listed, might be biased towards the strongest salt formations. It is recommended that the discussion in this section be expanded to clearly identify the representativeness of the data listed, i.e., include an estimate of the sampling bias and address the above sample preparation difficulties.

3-16

Section 3.2.7.3, Geochemistry of Ground Water in Sediments Adjacent to the Dome, page 3-53, paragraph 6

The indirect evidence presented here does not strongly support the contention that reducing conditions exist in the sediments around the dome. There are many problems associated with the concept of redox conditions in groundwater (see Stumm, 1966, and Lindberg and Runnells, 1984). The presence of "reducing" mineral assemblages (lignite and pyrite) and dissolved gases (methane and hydrogen sulfide) are indirect indicators of reducing conditions. However, data such as these are not conclusive, because these minerals and dissolved gases can exist metastably under oxidizing conditions (e.g., see Thorstenson et al., 1979). Their presence indicates reducing conditions at some time in the past (e.g., during formation), but not necessarily in the present. Without additional data (e.g., Eh measurements, several dissolved redox couples, dissolved oxygen content, etc.), the existence of reducing or oxidizing conditions in groundwater cannot be demonstrated unequivocally. Although there is uncertainty associated with all types of data related to redox conditions, consistency among various types of data and measurements generally provides a reasonable indication of reducing or oxidizing conditions.

It is stated that the groundwaters become more reducing with increasing depth because "dissolved oxygen combines with minerals along the flow path." This is an important statement and a reference to available data should be included. If supporting evidence is not available, then the statement should be deleted, because these types of reactions are kinetically sluggish and cannot be arbitrarily presumed to occur.

3-17

Table 3-15, Surface Water Quality Data, Pages 3-67 and 3-68

The water quality information cited for Bogue Homo, Beaver Dam Creek and Thompson Creek is old for describing the waters of the site vicinity. In addition, the number, frequency and continuity of the data collection represented by the summaries in the table is not described. It is suggested this information be provided to allow an independent assessment of the value of the data.

3-18

Section 3.3.1.3, Flooding, Page 3-69

The analyses presented in LETCO (1982) may not be adequate to define the flood potential for the Richton Dome site or to support conclusions reached with regard to flooding. Based on an examination of the drainage areas of adjacent streams, particularly Thompson Creek and Beaver Dam Creek, it appears that a potential for backwater effects due to flooding in these streams exists. These backwater effects could influence peak water levels on smaller streams, making site protective features more elaborate or expensive. Since Fox Branch and Linda Creek produce estimated flood levels that could affect repository operations, it is important that the maximum water levels and velocities on those streams be determined with a reasonable degree of accuracy. Based on the limited data that was provided in the draft EA, it is not clear if backwater effects were considered in determining the peak flood levels for the smaller streams which drain the dome.

Since it is possible that the peak flood levels in either Beaver Dam Creek or Thompson Creek exceed the peak flood levels produced in the smaller tributaries and that peak levels on the larger streams could influence the water surface profile calculations on the smaller tributaries, the potential backwater effects and their effects on flood analyses should be discussed in the final EA.

3-19

Section 3.3.2.1, Geohydrologic Units, Page 3-71, Table 3-16

Field data appears to have been ignored in presenting hydraulic conductivities for the Richton Dome geohydrologic units. Hydraulic conductivity data presented in Table 3-16 are not field measured parameters, but rather model generated numbers selected for model input. However, the reference cited for this Table (Ertec, 1983) contains field hydraulic conductivities which are considerably higher than model input conductivities. The reasons for not using the field data in Table 3-71 should be presented and discussed since hydraulic conductivities affect groundwater travel time calculations.

3-20

Section 3.3.2.2, Modeling, Page 3-77, Paragraph 5

The final EA should include a discussion of the data and assumptions used to model the groundwater flow system. Model inputs and assumptions determine model outputs. Since model outputs are used to calculate groundwater travel times, the data and modeling assumptions should be described in order to evaluate the validity of the groundwater travel time calculations.

3-21

Section 3.3.3 Water Supply, Page 3-84

The draft EA does not identify the location of surface and ground water users with respect to the repository site. This information is needed to assess the environmental impacts from site characterization and construction. It is suggested that the final EA provide a map showing the location of surface and ground water withdrawal sites that can be correlated with a table that shows the type of use (domestic, agricultural, etc.), the source (ground water with geologic unit or surface water with stream name), and withdrawal rate.

3-22

Section 3.4.2.1, Terrestrial and Aquatic Habitats, Page 3-92

It is suggested that a more detailed description of the Leaf River, which is under study for the Federal Wild and Scenic Rivers System, be provided. It is also suggested that consideration be given in the subsequent impact assessment sections to the causal relationships of the planned site activities on the Leaf River as a potential unique habitat.

3-23

Section 3.4.2.1 Terrestrial Biota Page 3-92, Paragraph 3

This paragraph states that most of the proposed restricted area has been recently clear-cut of all vegetation. It is also important to know what condition the land was left in, i.e., was it replanted or abandoned, etc. It is suggested that DOE provide a map of clear-cut areas on site and provide a description of the current condition of the site

3-24

Section 3.4.2.3 Threatened and Endangered Species, Page 3-96, Paragraph 2

The draft EA states that bald eagles and gray bats are not expected even though there is available habitat. It is suggested that the final EA state the basis for not expecting these species in the site area.

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Thorstenson, D.C., D.W. Fisher, and M. G. Croft, "The Geochemistry of the Fox Hills -Basal Hell Creek Aquifer in Southwestern North Dakota and Northwestern South Dakota," Water Resources Research 15, 1479-1498, (1979).

Werner, M.L., 1984. "Stratigraphy and Structure over Richton Dome - Data and Findings Relevant to the Issue of Dissolution," Ertec Technical memo (EW-ONWI-82-7562), September 12, 1984, 18 pp.

CHAPTER 4 COMMENTS

4-1

Section 4.1.2, Exploratory Shaft Facility, Page 4-27, Paragraph 5

In this section, it is stated that 5000 linear feet of underground excavation will be accomplished to connect the two shafts and to support suitability and at-depth testing. However, it appears that no exploratory excavation is planned in the actual repository storage area where the HLW is to be emplaced. It is important to gain reasonable assurance that the "host rock is sufficiently thick and laterally extensive" as stated in 10 CFR Part 960.4-2-3 Rock Characteristics. Also, a knowledge of the type, number, and location, of anomalies that can be expected in the actual repository area is important for brine migration, stability of openings, and retrievability assessments. It is suggested that this section be expanded to address the above comment.

4-2

Section 4.1.2.4, Final Disposition, Page 4-64, Paragraphs All

If the site is found suitable and is selected for the first repository, the exploratory shaft facility may be incorporated into the repository design (page 4-64, paragraph 1). It is unclear how such a decision will be reached and what would be done with the exploratory shaft facility if it does not become a part of the repository. This information impacts on an assessment of the performance of the shaft pillar area or the shaft seal system, or to identify/evaluate further environmental impacts and warrants appropriate consideration. It is recommended the discussion be expanded to address and provide clarification of the above points.

4-3

Section 4.1.2.4.4 Storage Area and Mud Pit Reclamation, Page 4-68, Paragraph 2

This paragraph describes how the sediment detention basin will be reclaimed if the site is not selected as a repository. It is possible that it would be an environmentally desirable option to retain the basin depending on the future use of the site. For example, it might be valuable as a farm pond or as wildlife habitat. Therefore, the final determination should be left open until nearer the time it will be performed, in order to allow site restoration in a manner compatible with its use after being released from site characterization studies. It is suggested that a discussion be included in the final EA that encompasses these points.

4-4

Section 4.1.2.4.4 Storage Area and Mud Pit Reclamation, Page 4-68, paragraphs 1 and 2

In these paragraphs it is stated that contaminated soil, liner and drilling fluid will be transported to an acceptable disposal area offsite. There is no evaluation of the environmental impact of transporting the material to an offsite disposal site nor of the amount of space needed or the need for special requirements, if any, for the actual disposal of this type of material. In other sections it is also stated that other types of waste will be transported to offsite disposal areas without an evaluation of the environmental impacts. It is suggested that an evaluation of these activities be made.

4-5

Section 4.1.3.1.2, Terrestrial and Aquatic Ecosystems, Twelve-Month Ecological Studies, Page 4-78, Paragraph 1

This section indicates that the NRC's Reg. Guide 4.2 and the ESRPs (NUREG-0555) will be used to prepare the field baseline programs. These documents were not designed for the stated purpose and, also, may not represent the state-of-the-art in impact assessment methodology even for the construction of a nuclear-powered generating plant.

4-6

Section 4.1.3.1.2, Terrestrial and Aquatic Ecosystems, Aquatic Ecology, Page 4-79

This section describes the baseline aquatic ecology program to be conducted prior to land-disturbing activities of site characterization. The program appears too broad to identify potential impacts and pre-project mitigative action plans. The mitigative plans should be emphasized rather than broad ecological studies. Those habitats and species most likely impacted should be identifiable from the reconnaissance level information and from consultation with Federal and local experts on aquatic resources. It is suggested that good engineering practices and mitigative action plans be identified in the final EA to protect the most sensitive habitats and species.

4-7

Section 4.2.1.4.1, Surface Water, Page 4-100

During site characterization, waste, fresh, or saline waters may be produced (see Section 4.1.1). No estimate of the expected range of how much water may be produced over the project time period is given. Also there is no estimate of the rate at which it may be produced. It is suggested that the impact of disposal of these waste streams be discussed.

4-8

Section 4.2 Expected Effects of Site Characterization, Page 4-85

Offsite deposition of salt from salt handling or salt transfer activities is acknowledged. However, the impacts to surface water quality are stated to be not quantifiable without additional data on salt deposition, surface streamflows and surface stream water quality. The potential for impacts to surface water quality could be assessed based on the known frequency of stream flow, and on a proposed salt transfer schedule. It is suggested that this type of qualitative assessment be considered.

4-9

Section 4.2 Expected Effects of Site Characterization, Page 4-85

The 3-D Seismic Reflection Survey is expected to require the clearing of some 380 acres. Runoff and erosion from these disturbed areas could significantly impact surface water quality for a "short period of time". Because the streams draining the site are intermittent, water quality may be considered crucial for the successful propagation of their indigenous aquatic biota. Degraded water quality even for a short period of time, if it were to occur at the wrong time, could be a severe impact on these biota. Furthermore, these streams represent tributaries that make up the Leaf River, further underscoring their ecological significance. It is suggested that the mitigative measures to be taken during this activity to prevent degradation of stream water quality be identified.

4-10

Section 4.2.1.4.2, Ground Water, Page 4-102, Paragraph 3

It is stated that measures proposed to avoid or minimize degradation of ground water quality include using shaft construction techniques to minimize any hydraulic connection between water-bearing strata, hydrocarbon reserves, and salt deposits. No discussion of how large-hole shaft boring construction techniques would tend to minimize hydraulic connections is presented.
It is recommended that the discussion be expanded to reconcile its stated intent of using shaft construction techniques that minimize hydraulic connections with the use of large-hole shaft boring techniques.

4-11

Section 4.2.1.6 Noise Effects, Page 4-105

It is suggested that the nearest residences, cemeteries, schools, churches, hospitals and other noise-sensitive land uses within a 2 mile distance of the site work area be located on a scaled map for clarity. Additionally, other such land uses that are predicted to experience increases in noise levels due to the project should be similarly identified.

4-12

Section 4.2.1.6.3 Mitigating Noise Impacts, Page 4-107

No mention is made of limiting use of explosives and other activities that may also produce impulse noise to daytime and non-weekend hours, as a form of mitigation. It is suggested that this form of impact mitigation be considered in preparing the final EA.

4-13

Section 4.3.2, Exploratory Shaft Alternative, Page 4-118/119, Paragraph 7

This section discusses alternatives in exploratory shaft facility design. No discussion, however, is given of the shaft construction method. Two shafts are planned at the site, one constructed by large-hole drilling and the other by the drill and blast method. The rationale for choosing two different construction approaches is not presented. The draft EA for the Yucca Mountain site gives a strong argument for preferring the drill and blast method. It is recommended that the discussion be expanded to include an analysis of construction methods.

CHAPTER 5 COMMENTS

5-1

Section 5.1.1.1, Repository Site Layout, Page 5-4

The rationale for the selection of a Surface Area Land Control Rights area of 4,910 acres, as presented in Table 5.1, for use in evaluating environmental impacts and comparing sites, is not addressed in the draft EA. The size of the controlled area significantly affects the environmental impacts associated with land ownership and the technical guideline related to available flow path distance between the edge of a repository and the accessable environment. As the area selected provides for a controlled zone extending beyond the subsurface repository area of less than one kilometer, it also significantly impacts post closure technical guideline 960.4-2-1(b)(1) related to ground water travel time. It is recommended this section of the draft EA be expanded to provide a detailed discussion of the parameters affecting the selection of the distance used and an analysis containing the rationale used in arriving at the distance selected.

5-2

Section 5.1.1.4, Repository Subsurface Facilities pages 5-12 to 5-13, paragraph all

No TRU package design information is presented in the draft EA. Table 5-3, Approximate Waste Storage Room Quantities, p. 5-13, indicates that a repository at the Richton Dome site would receive 55,456 TRU, 7899 spent fuel and 3673 CHLW packages (total of 74,048 packages). Many of the analyses in the draft EA are in terms of spent fuel and CHLW in spite of the fact that 75% of waste packages will be TRU packages. It is recommended that an analysis of waste package performance based on emplacement of TRU packages, be presented, or an analysis presented to show that the conclusions presented in this section are not invalidated by emplacement of TRU packages.

5-3

Section 5.1.2.4, Shafts and Facilities Development, Page 5-23, Paragraph 7

In this paragraph it is stated that all of the repository shafts will be excavated using conventional blasting methods. Considering the decision to blind drill the exploratory shaft, the decision to drill and blast the repository shafts introduces shaft sealing uncertainties that may impact on repository performance assessment. These uncertainties include:

a) The possibility that the damage to the main shaft walls induced by blasting will be of a different type than the damage to exploratory shaft walls due to boring. This would introduce uncertainty in extrapolation of exploratory shaft developed sealing data on stability and sealing of the main shafts.

b) More certain overburden and rock data can be obtained in the main shafts than in the exploratory shaft. This will make it more probable that better control of seal locations and seal installation can be obtained in the main shafts as compared to the exploratory shaft.

It is recommended that this section be expanded to include an analysis of the impact of using different shaft construction techniques on shaft sealing and thus on repository operations and closure.

5-4

Section 5.1.2.4, Shafts and Facilities Development, Page 5-23 Paragraph 8

In this section of the draft EA it is stated that concrete linings will extend from ground surface to 30m into the salt dome and shafts will be unlined below the bottom of the concrete liners. This is not consistent with the information in Table 5-1 on p. 5-4 which lists the liner depth as "concrete lined from shaft collar to the shaft bottom. Recommend this inconsistency be resolved.

5-5

Section 5.1.3.3, Retrievability, Page 5-31, Paragraph 1 & 2

In this section a commitment is made to maintain the ability to retrieve previously emplaced waste packages. According to the discussion, the only decision that appears to be influenced by the retrievability requirement is whether or not to backfill the waste package storage rooms. Other decisions related to thermal load limits, access drift support designs, maintenance, personnel radiological safety, etc., which will also be impacted by retrievability considerations, have not been addressed. The greater creep tendency for Richton Dome salt at elevated temperature may influence retrieval operations by limiting the allowable thermal loading. It is recommended that the discussion include all pertinent retrievability considerations.

5-6

Section 5.2.1.1, Regional Subsidence and Uplift, Page 5-36, Paragraph 1

The NRC is in the process of preparing a generic technical position on seismotectonic evaluation methods. This paper will cover the types of seismotectonic investigations and evaluation methods which will need to be conducted for a repository. In addition, the NRC will need to separately review the types of structures to be constructed, their functions and the consequences of potential accidents before the actual design requirements, which will be necessary, can be determined. At the present time, it is premature to state that the design requirements for nuclear power plants are the same as those required for a waste repository. It can only be stated that the design requirements of structures important to safety wil comply with 10CFR60 and appropriate EPA regulations.

5-7

Section 5.2.1.1, Regional Subsidence and Uplift, Page 5-35/6, Paragraph 2

The section quotes results from a study performed for WIPP to justify the conclusion that subsidence will not exceed 0.3 meter. WIPP is a bedded salt site with very different geology, and possibly with different waste (thermal effects), emplacement configuration, and other differences. It is unclear how these particular results from WIPP apply to the Richton Dome.

5-8

Section 5.2.1.1, Regional Subsidence and Uplift, Page 5-36, Paragragh 1

The concept that backfilling voids will in itself minimize subsidence is misleading. Progressive creep closure of repository openings prior to waste emplacement, repeated scaling of openings during the repository lifetime, and creep closure following waste emplacement but prior to backfilling might cause a major, if not the greatest portion of the subsidence. These alternative causes of subsidence that might realistically be expected during the repository operation should be discussed in this section.

5-9

Section 5.3 Expected Effects of Transportation and Utilities, Page 5-72 Paragraphs All

The impacts from transportation accidents, including the estimated dose to the maximally exposed individual and the estimated number of latent cancer fatalities, are not discussed. It is suggested that the final EA include either an explanation of the use of existing analyses and studies to substantiate the assertion that transportation accident impacts are small, or an analysis of the consequences, probabilities, cost of cleanup and risks for a severe transportation accident enroute to the site.

5-10

5.3.1.1 Waste Transportation Costs, Page 5-76

Certain transportation corridors along the routes, for example, those with high accident frequency, high waste traffic volume, or adverse weather conditions, are a potentially important issue. Although the radiological risks along these special corridors are estimated to be small, such corridors may be subject to increased state and local emergency response actions. This response may be costly and could be disruptive to communities. It is suggested that this type of consideration be included in the assessment of transportation impacts.

5-11

Section 5.3.1.2.2 Radiological Health Effects Page 5-78, Table 5-13

This table provides estimated collective radiological and nonradiological health effects associated with the 26 to 28-year operating lifetime of a repository. It is suggested that the table list the effects for the occupational and non-occupational population subgroups separately.

5-12

Section 5.3.1.3.1 Highway Transport Page 5-82 Table 5-15

This table does not provide total and average radiation doses to a maximally exposed individual (member of the general public) resulting from routine transportation to the repository. It is suggested that the table should also include maximum exposure that is likely to occur in a transportation accident.

5-13

Section 5.4.1.1, Construction, page 5-96, paragraph 1

No indication is given of the uncertainties of the labor force estimates used in the socioeconomic analyses. The size of the labor force during construction, operation, and closure is a major determinant of socioeconomic impacts. It is suggested that the uncertainty in labor force estimates be assessed.

5-14

Section 5.4.1.4, Displacement of Residents page 5-101

The discussion in this section omits reference to the number of residents expected to be displaced. It is recommended that DOE provide an estimate of the number of residents to be displaced. A discussion of the type of displacements (residential and business, if applicable) and the number of persons involved would present a more complete picture of the magnitude of this anticipated impact.

5-15

Section 5.4.5, Fiscal Conditions and Government Structure, Pages 5-113 through 5-115

The discussion in the section on technical and financial assistance for planning and mitigation needs to consider how assistance will be provided to assure timely planning. Early planning is necessary to prevent impacts that can be mitigated. Many of the tax benefits cited in this section are during construction when it will be too late to mitigate the impacts of construction. More emphasis needs to be placed on preplanning potential of financial and technical assistance. Specifically, the DOE grants may be available during site characterization to assist in planning for economic, social, and public health and safety impacts of a repository. This planning would identify potential impacts and requirements well in advance of the beginning of construction and allow timely mitigation. A detailed approach to impact mitigation is suggested and plans for the timely implementation of studies should be considered. Mitigation planning is a lengthy process which should take place as early in the repository siting as possible. It is suggested that there be a full discussion of the timing of pre-impact planning assistance available for mitigation planning.

5-16

This comment was incorporated elsewhere in the comment package.

5-17

Section 5.5, Implications of an Alternate Repository Design Concept, Page 5-116

The draft EA does not discuss the effects of using the two-phase concept on groundwater travel time through the salt stock perimeter pillar. The total dome area (page 3-3, Figure 3-2) is 4910 acres at the -2000 foot (MSL) elevation. One result of using the Two Phase Repository Concept in preference to the EA reference design is to increase the approximate underground facilities area from 2000 to 4095 acres. This would significantly diminish the distance between the repository and the edge of the salt dome and therefore groundwater travel time through the host rock. The effects of using the

Two-Phase Repository Concept groundwater travel times through the salt stock perimeter pillar should therefore be discussed.

5-18

Section 5.5, Implications of an Alternate Repository Design Concept, Page 5-116 thru 5-134, Paragraphs All

In this section of the draft EA it is stated that it has been decided to proceed further with considerations for a two-phase concept, to meet the NWPA Mission Plan objective of having the first repository in operation by 1998. The draft EA states (Page 5-116, Paragraph 2) that impacts, somewhat different than described in Sections 5.1 to 5.4 of the draft EA, would result. Some possible significant differences which could result are identified:

1. Total volume of excavated salt will increase and salt handling procedures will change. Increased salt volume and handling may require a larger surface area and result in larger on-site salt pile(s) with larger salt runoff and infiltration.

2. The two-phase concept specifies that gassy mine conditions shall be assumed (30 CFR Part 57, and 30 CFR Part 58 (Draft)). Additional, more stringent, ventilation requirements must be met for gassy-mine conditions.

3. More extensive surface facilities would be required for waste handling, salt storage and rehandling, and other activities.

4. An additional shaft would be required.

5. The construction schedule will be compressed.

These and other differences are important in the context of all environmental impacts, safety, long-term and short-term performance of shafts and other major repository components, quality assurance probabilities, and site characterization requirements.

The environmental impact of the alternative repository design concept addressed in this section is not discussed in detail because the design concept is evolving. Nevertheless, uncertainty regarding technical aspects of the design concept which impact environmental considerations, construction, shaft sealing, and retrieval operations appear important enough to warrant early consideration. These uncertainties are related to the following:

1. The two-phase concept presents the potential for additional impacts on geologic host rock conditions. The increased extraction could result in additional subsidence, larger pillar dilation and potentially more rapid creep under repository induced thermal conditions. No discussion has been presented.

2. Information has not been presented to demonstrate that the HEPA filter system can handle the increased ventilation requirement of a two-phase concept.

3. It does not appear that the subject of salt re-handling at the surface has been adequately considered in all aspects of its environmental impact.

4. There is no apparent difference between the phased and reference repository concepts that should result in one being regarded as gassy and not the other. It appears they both should be regarded as potentially gassy.

5. The incorporation of the exploratory shafts into the repository design should be addressed in sufficient detail to permit an adequate evaluation of shaft seal systems and repository performance.

6. Changes in the requirement for site characterization activities, including the relocation of boreholes to accommodate the larger restricted zone and larger subsurface areas should be considered with due consideration to the uncertainty imposed by the resultant decrease in density of exploration data.

7. The retrieval requirements will be impacted by the effect of increased extraction percentage, waste emplacement schedules as affects thermal build up, changes in amount of waste retrieval that may be required, canister transport distances, and other applicable factors. These impacts should be considered.

8. The simultaneous activities of both underground construction and waste emplacement operations may impact personal radiological safety and long term repository performance. Risks associated with the simultaneous performance of operations related to shaft construction and sealing, ventilation system modifications and waste emplacement which could adversely affect performance of the repository should be considered.

It is recommended the discussion be expanded to address the above items in this section.

5-19

<u>Section 5.6 Summary of Repository Impacts, Table 5-27, Page 3 of 13, Page 5-124, Item 7, First Bullet</u>

This bullet indicates that resident aquatic biota will be "temporarily" lost by relocation of intermittent drainages. It is suggested that the word "temporarily" be changed to "permanently" since all of the aquatic biota in the present natural channels will be destroyed.

CHAPTER 6 COMMENTS

6-1

Section 6.2.1.1, Site Ownership and Control, Page 6-6

The draft EA discusses the actions necessary for DOE to obtain ownership, and to control access to the surface and subsurface land, mineral rights, and even the water rights within the controlled area of the repository. U.S. Highway 42 runs across the dome area, as shown on Figure 3-37, and is accessible to the general public. There is no specific reference about controlling access to this highway. It is suggested that there be some discussion about how access will be controlled, and who will be responsible for controlling it in the event of an accident at the repository.

6-2

Section 6.2.1.2, Site Ownership and Control, Page 6-6 to 6-7

The draft EA states that DOE has authority under Federal law to condemn State and privately owned land. It would be desirable to document this statement by reference to applicable law.

6-3

Section 6.2.1.4.2, Analysis of Favorable Conditions, Page 6-13

No information is provided on ground-based inversion frequency and the frequency of low wind speed conditions which effect the potential ground level releases expected at the site. Only mixing height and stagnation episode information, which effect long distance transport and multiple elevated sources of air pollution, is discussed. Insufficient information is provided to support the finding that a favorable condition exists at this site. It is suggested that DOE provide the joint frequency of wind speed, wind direction, and atmospheric stability.

6-4

Section 6.2.1.5.4, Analysis of Potentially Adverse Conditions, Page 6-17 and 6-18, Paragraphs All

In the finding presented in Table 6-7, Page 6-59d, for Guideline 960.5-2-4(c)(1), Offsite Installation and Operations, it is stated that the evidence indicates that a potentially adverse condition is not present. That finding is in conflict with the analysis, evaluation, and findings presented on Pages 6-17 and 18 in this section that a potentially adverse condition is present. The evidence and evaluation presented in this section and in Section 3.5.1, Page 3-108, supports a finding that a potentially hazardous condition may exist due to the transport of dangerous chemicals or explosives along roads passing through the dome area. Table 6-7 should be revised to reflect a finding that a potentially adverse condition is present.

6-5

Section 6.2.1.6.2, Analysis of Favorable Condition, Page 6-39, Table 3-6

The statement that "air quality impacts are acceptable because they are less than permitted levels even for fugitive dust" is not supported by the analyses in Sections 4.2.1.3 and 5.2.5 of the draft EA, which indicate exceedance of Primary TSP NAAQS due to site characterization and construction activities. It is suggested that DOE expand the discussion of the air quality impacts to justify how the air quality levels will be brought down below the primary and secondary TSP NAAQS levels to satisfy this condition.

6-6

Section 6.2.1.8.2, Analysis of Favorable Conditions, Page 6-54, Paragraph 2

In this section, it is stated that access routes to the site will require minimal upgrading of bridge and grade crossings and that such routes are free of sharp curves or steep grades and are not likely to be affected by landslides or rock slides. No supporting documentation for the statements are presented or referenced. In Section 5.1.2.2., Offsite Development, Page 5-2, it is stated that existing highways and bridges require upgrading to meet design requirement and a new highway bridge will be required at Beaver Dam Creek. It is also stated that numerous bridges, grade crossings and new railroad construction will be required for the entire railroad route selection. No discussion related to landslides or rockslides is present. It appears that the finding that a favorable condition is present is based upon these statements. It is recommended that the analysis and evaluation be expanded to provide rationale to support the finding that a favorable condition is present and, if appropriate, the finding be modified.

6-7

Section 6.2.1.8.3, Analysis of Potential Adverse Conditions, Page 6-57, Paragraph 4

In this section, it is stated that conventional rail line engineering and construction will assure use of operationally acceptable grades and curvature and that terrain presents no unusual difficulties in avoiding such hazards. Neither relevant data or references have been presented in the evaluation to support this statement. Specifically, no discussion of the potential for rock slides or landslides has been addressed. It is recommended that the evaluation be expanded to discuss the potential for rock slides or landslides.

6-8

Section 6.2.2.1.2, Analysis, Page 6-61, Paragraph 2

Modeling results presented in Section 6.4.1 (pages 6-158 to 6-165) indicate that no member of the public is likely to receive an annual whole-body dose greater than 9.0×10^{-3} millirem during the construction period, or greater than 5.6×10^{-3} millirem in a year from normal operations during the operational period.

This section is apparently based on Waite (1984). The same assumptions and references are given here and in the Deaf Smith site draft EA. For the Deaf Smith site, the maximum individual dose is given as 4.5×10^{-3} millirem annually during construction and 2.8×10^{-3} millirem annually during operational period. As it appears the Waite did site-specific calculations, that fact should be stated in Section 6.2.2.1.2.

6-9

Section 6.2.2.2.2, Evaluation Process (Environ., Socio Trans.), Page 6-62, Paragraph 8

The assumptions in this section include the following: "Existing shaft sealing technology is sufficient to provide protection of the overlying aquifers." As documented in the literature, there are uncertainties in the performance of seals. For example, Kupfer (1980) cites a shaft leak at Belle Isle mine that appears to be due to seal failure. Assumptions such as these should be qualified with respect to uncertainties and subsequent evaluations should address the uncertainties.

6-10

Section 6.3.1.1.1, Statement of Qualifying Condition, Page 6-70, Paragraph 4

The uncertainties associated with using salt core data to calculate groundwater travel times are not adequately discussed. Core samples represent only a small volume of Richton Dome. Large scale features such as faults, fractures, bulk permeability, rock inclusions, unsealed drill holes, partly sealed wells, or vugs, that could provide decreased travel times through the dome, are not measured by core. Therefore, core data cannot supply information on the major forms of water movement through salt. The final EA should, therefore, indicate the uncertainties associated with exclusively using salt core data to calculate groundwater travel times.

6-11

Section 6.3.1.1.2, Analysis of Favorable Conditions, Page 6-72

Model uncertainties and their effect on groundwater velocities is not adequately discussed. The modeling used to infer travel times outside the host rock should be based upon field data, as well as assumptions. However, data are not presented in the draft EA to substantiate the model (Ertec, 1983) inputs. Consequently, the flow directions and velocities presented are the product of a model based on a variety of assumptions, and not the product of analysis of field data via a mathematical model. Model uncertainties and their effect on groundwater velocities need to be discussed.

As a further example, travel time calculations for the Upper Claiborne Unit do not use field data. Hydraulic conductivities and gradients are the result of Ertec (1983, ONWI-484) models. The effective porosities presented also are not field data. The final EA must justify the reasons for ignoring field-determined hydraulic parameters and for assuming the accuracy of model-generated numbers. For instance, using effective porosities and hydraulic gradients given in the text and field-determined hydraulic conductivity (the 30 m/day maximum reported in Ertec (1983, ONWI-456)), the 10-km travel time from the Dome through the Upper Claiborne is 195 years not 39,000 years. Therefore, the assessment must justify using regional model generated numbers over field data in travel time calculations.

6-12

Section 6.3.1.1.2, Analysis of Favorable Condition, Page 6-72, Paragraph 5

The groundwater travel time of 77,000 years from the edge of the salt dome vertically through the Lower Claiborne as stated in the draft EA does not appear to be correct. The draft EA uses a vertical hydraulic gradient of 0.027, a vertical hydraulic conductivity of 3E-5 to 3E-9 meters per day, an effective porosity of 0.025, and a thickness of 110 meters to calculate a travel time from the edge of the salt dome vertically through the Lower Claiborne of 77,000 years. A time of travel of 9,301.54 and 93,015,389.8 years has been calculated by the NRC using these same numbers. This discrepancy should be addressed.

6-13

Section 6.3.1.1.2, Analysis of Favorable Condition, Page 6-72

A unique accessible environment has not been defined for the Richton Dome site. The text states that "The accessible environment has not been defined specifically for this site at this time." However, the text does not state the reasons why an accessible environment cannot be determined. Since groundwater travel times are very dependent on the definition of accessible environment an explanation of why an accessible environment cannot be determined at this time should be provided.

6-14

Section 6.3.1.1.2, Analysis of Favorable Condition, Page 6-72

Alternative pathways to the accessible environment should be addressed in the groundwater travel time calculations. The present state of knowledge about Richton Dome allows for a number of possible ground water flow paths and therefore a greater range of travel times than presented in the draft EA. The following prargraphs provide specific examples of other possible flow paths.

The draft EA contains a groundwater travel time calculation from the edge of the dome to the accessible environment through the Lower and Upper Claiborne Units. However, on page 6-73, paragraph 6, it is stated that "The structural complexity around the dome flanks is somewhat uncertain, hence the potential for significant upward or downward flow along the flanks is uncertain." This suggests that if the edges of the domes possess high permeabilities, shorter travel times to the accessible environment could result if water moves upward along the dome edge and longer travel times, should the water move downward. In addition, if the dome edges possess a very low permeability (Letco, 1983, page 120) longer travel times than those presented in the draft EA would result.

The draft EA in its analysis of host-rock travel time does not consider the effect of anomalies or splines in the salt stock. For example, Section 6.4.2.3.2, page 6-187, Paragraph 1 states, "Some of the splines may have significant transmissivity and provide a potential conduit for ground-water." The travel times calculations must also take into account cavities developed as a consequence of anomalies (e.g., gas pockets that can extend up to 100 meters in height and anomalous zones "from 3 to 100 meters wide and of very long horizontal extent" (Kupfer, 1980, p. 121). Since anomalies could shorten groundwater travel times, the assessment's analysis of host-rock travel time should consider the effects of these anomalies.

Section 6.3.1.8.4, page 6-103 states that six petroleum exploration wells enter the salt stock below repository level. However, the groundwater travel time calculations do not address wells and abandoned drill holes in and around the salt dome as possible pathways to the accessible environment. If any of these pathways exist, the time of travel to the accessible environment could be shortened.

The text indicates that any groundwater migration from the repository which enters the Upper Claiborne will remain in this unit "until it reaches the maximum extent of the accessible environment." This may not be the case as evidenced by the saline anomaly in the Upper Aquifer, which is within 10 kilometers and down groundwater gradient of the dome, and may be the result of upward leakage of saline waters from deeper units (Section 3.2.5.7, page 3-39, paragraph 1). Furthermore, open faults within 10 kilometers of the dome may act as pathways to the Upper Claiborne. For example, faulting similar to the F-7 Fault is suspected to be present south and west of the dome near the salt sediment contact (Letco, 1982, Page 15) and more extensive faulting than presented in Section 3.2.5.1, Page 3-24 may be present to the west and near the dome flank (seismic reflection line WW', Ertec, 1984, Figure 13-46). Because upward gradients and faults exist within 10 kilometers of the dome, alternative ground water flow paths with shorter travel times to the accessible environment are possible.

Fluid movement through the salt is assumed to be horizontal and any migration of contaminants out of the salt would then be into the Lower Claiborne confining unit, which possesses a low hydraulic conductivity. However, Intera (1984) suggests that the downward component of flow within salt stock would lead to migration into the Wilcox formation, which has a higher hydraulic conductivity and therefore may have a faster travel time.

Given the examples above, the final EA should consider alternative flow paths and the effect of the alternative flow paths on the travel time calculation.

6-15

Section 6.3.1.1.3, Analysis of Potentially Adverse Conditions - Hydrology, Page 6-75, Paragraph 6

The draft EA does not consider the creation of vapor phase inclusions that could move away from the waste package. It is asserted that brine migration will be toward the waste canisters. However, brine inclusions with a vapor phase migrate down a thermal gradient, i.e., away from the waste canisters (Anthony and Cline, 1972). Migration down a thermal gradient may be a significant process in transporting radionuclides away from the repository. High temperatures at the waste package may cause boiling of inclusions, allowing fluids to develop a vapor phase. Inclusions possibly containing radionuclides and a vapor phase have the potential to migrate away from the waste package. Implications of this process should be considered in preparing the final EA.

6-16

Section 6.3.1.1.3, Analysis of Potentially Adverse Conditions, Page 6-76

The draft EA does not find a potentially adverse condition for guideline 960.4-2-1(c)(2), which deals with the presence of ground-water sources suitable for crop irrigation or human consumption without treatment along ground-water flow paths from the host rock to the accessible environment. However, only one flow path is described and the likelihood of other alternative flow paths is not discussed. Since upward flow paths could encounter fresh water supplies, the final EA should discuss the likelihood of alternative flow paths and their effect on guideline 960.4-2-1(c)(2).

6-17

Section 6.3.1.2.2, Analysis of Favorable Conditions(2)-Geochemistry; Pages 6-78/6-79, Paragraphs 6/1-7

Portions of the discussion of this guideline (960.4-2-2 (b)(2)) do not present existing data that clearly support the conclusion that this favorable condition is present. To make a favorable finding for this guideline, evidence that the geochemical conditions promote or inhibit, as appropriate, one or more of the processes that influence radionuclide migration listed in this guideline must be presented. Several of the listed processes are discussed in this evaluation.

In the discussion of promotion of precipitation in the dome, precipitation of iron-silica phases are expected to limit radionuclide mobility. However, because the repository is emplaced in a salt deposit, NaCl should be considered a dominant component of the system. The large concentration of Cl^- in the brine might contribute to relatively high solubilities of radionuclides due to formation of chloride complexes. In the discussion of promotion of precipitation outside the dome, the DOE states that chemically reducing conditions are expected. The data do not strongly support this contention (see detailed comment 3-16). In addition, it is uncertain whether or not reducing conditions will actually cause redox sensitive radionuclides to precipitate (see detailed comment 6-18). Groundwater pathways other than in deep saline aquifers should also be considered for this guideline.

Conflicting evidence is presented concerning the effect of brines on the agglomeration of colloids that could influence radionuclide migration. Paragraph 4 (p. 6-79) states that "Brine salinity will inhibit the formation of some types of colloids...". This contradicts paragraph 6 (p. 6-79), that states "Brines tend to promote the agglomeration of some types of colloids and particles." The draft EA suggests that the resulting colloidal-sized radionuclides will not be transported due to sorption. The DOE should not take credit for two conflicting processes in support of the finding that this favorable condition is present. Regardless, the data do not support the state-ment that "Brine salinity will inhibit the formation of some types of colloids (Stumm and Morgan, 1981) and also may act to inhibit agglomeration of colloidal material into particulate size ranges." The colloids referred to in this statement may not be those which are likely to form in the system of interest. Other types of colloids may form, not inhibited by the presence of brines, and colloids may form in the fresh water aquifers surrounding the dome. In the absence of data that clearly support this favorable condition with respect to colloid formation, a conservative position should be taken.

The draft EA states that no information exists for organo radionuclide complexes. However, it states that brines should inhibit the formation of organic complexes because of competing ion effects in brines. This could be true, but it requires the formation of inorganic complexes which is not addressed. Thus, the presence of brine can be both favorable and unfavorable. In addition, groundwater containing methane reacts to form polymers when irradiated (Gray, 1984). The effect of these polymers on radionuclide retention is presently unknown, but the possibility exists that deleterious effects could result. Consideration of the formation of organic complexes from seemingly inert compounds such as methane as a result of radiation cannot be discounted. There is insufficient evidence to state that the favorable condition is met with respect to organic complexation.

There are a number of uncertainties regarding the migration and retardation of radionuclides. Because data are lacking and uncertain, the DOE should consider re-evaluating the evidence relevant to this guideline, considering the uncertainties, and performing a conservative analysis.

6-18

Section 6.3.1.2.2, Analysis of Favorable Conditions(2)-Geochemistry; page 6-79, paragraph 1 and Section 6.3.1.2.3 Analysis of Potentially Adverse Conditions(3); Page 6-81, Paragraph 5

The statement made by the DOE that chemically reducing conditions exist is used as evidence in support of favorable findings for these two guidelines concerning radionuclide mobility (960.4-2-2 (b)(2) and 960.4-2-2(c)(3)). However, the data do not conclusively support the contention. The DOE has stated that chemically reducing conditions exist, despite the fact that "limited site-specific geochemical information is available for Richton Dome" (page 6-78, paragraph 1). The arguments used to support the assumption of chemically reducing conditions (the presence of methane and mineral assemblages likely to create a reducing environment) are not well documented or supported (see detailed comment 3-16). The statement that oxidizing conditions are not possible cannot be stated unequivocally based on the available data. There are many problems associated with the concept of redox conditions in groundwaters (see Stumm, 1966, and Lindberg and Runnells, 1984). For example, methane can persist metastably in oxidizing groundwater (see Thorstenson et al., 1979). Further, the presence of mineral assemblages indicative of reducing conditions does not necessarily imply that reducing conditions are present in the groundwater in contact with the rocks. Kinetic and disequilibrium constraints may prevent mineral assemblages, theoretically capable of poising a groundwater system to reducing conditions, from effectively reacting with the groundwater.

Therefore, although the data do not exclude the presence of reducing conditions, neither do the data necessarily demonstrate that reducing conditions are actually present (see also detailed comment 3-16).

The statement made in the draft EA under guideline 960.4-2-2(b)(2) that migration of redox sensitive radionuclides are greatly decreased under reducing conditions because they form compounds having much lower solubilities than those formed under oxidizing conditions is not always true. Garrels and Christ (1965, figure 7.32b) show that even under extremely reducing conditions uranium can exist in solution in significant concentrations. The uranium bearing species $UO_2(CO_3)_3^{4-}$, which contains uranium in the oxidized state (U^{6+}), can be thermodynamically stable even under reducing conditions . In addition, slow kinetics inhibit the establishment of equilibrium conditions, allowing redox sensitive radionuclides such as uranium and neptunium to remain in their oxidized state where their solubilities are maximum and they do not readily sorb on the host rock minerals. Further, the presence of oxidizing conditions in aquifers surrounding the dome was not discussed in the analysis of radionuclide precipitation.

Considerably more information is needed before chemically reducing conditions and their favorable effects on radionuclide concentrations can be assumed for this site. In the absence of data that clearly support conclusions regarding redox conditions for these guidelines, a conservative analysis should be made.

6-19

Section 6.3.1.2.2, Analysis of Favorable Conditions(4)-Geochemistry, Page 6-80, Paragraphs 3 and 4

There are concerns that the performance assessment calculations used to assess this guideline concerning radionuclide solubility (960.4-2-2(b)(4) may not be conservative. Because the existing data are inadequate to claim that this favorable condition is present, the DOE bases its evaluation of this condition solely on performance assessments. A significant portion of the DOE's evaluation of this condition is based on solubility calculations. However, a "good deal of subjective judgment" was used in selecting the solubilities presented in the WISP Report (Pigford et al., 1983, p. 195) that are used in the draft EA (p. 6-199, paragraph 3). Single numbers presented for elements with more than one oxidation state (e.g., Tc, U, Np, Pu, Sn) "must be used with caution" because solubilities are "very sensitive to slight changes in Eh" (Pigford et al., 1983, p. 194). In addition, multiple valances may exist simultaneously for actinides. For some elements, solubilities are simply unknown (e.g., Sn, Se, Cm, Am) and numbers presented are "guesses based on chemical similarities" (Pigford et al., 1983, p. 195). For strontium (Sr), the solubility value presented in table 6-33 (page 6-201) does not correspond with the value presented in the WISP Report. The WISP Report states that solubility for Sr is "high", while table 6-33 presents a value of 0.8 g/m^3. It is unclear where this value came from.

It is probable that the radiation field and corrosion reactions will strongly affect the Eh and pH, contrary to what is stated in the draft EA (p. 6-199, paragraph 3). Pederson et al. (1984), state that "actinide solubilities may be altered by alpha and gamma radiolysis through changes in the Eh/pH of solution." In addition, several factors concerning the geochemical conditions around the waste packages are not addressed including gas evolution, radiolysis, the introduction of atmospheric oxygen, and sulfide formation (see detailed comment 6-20).

There are additional concerns regarding matrix dissolution of the waste form, brine migration, and waste package geochemical environment that affect the evaluation of this condition (see detailed comments 6-20, 6-91, and 6-96). The DOE should consider the uncertainties discussed above when evaluating the evidence relevant to this guideline and perform a demonstrably conservative analysis.

6-20

Section 6.3.1.2.3, Analysis of Potentially Adverse Conditons(1)-Geochemistry, Page 6-80, Paragraphs 7 and 8

There are concerns that the performance assessment calculations used to assess this guideline concerning the effects of groundwater conditions on the solubility or chemical reativity of the engineered barrier system (960.4-2-2(c)(1)) may not be conservative. Because the existing data are inadequate to claim that this potentially adverse condition is not present, the DOE bases its evaluation of this condition solely on performance assessments. The performance assessment calculations used in support of the evaluation of this condition include calculations concerning brine migration and waste package corrosion. The BRINEMIG code used in the draft EA to calculate brine accumulations due to thermally induced brine migration is based on a number of assumptions that limit the applicability of its results. First, the equation of Jenks and Claiborne (1981) used in BRINEMIG is an empirical equation that was derived from single-crystal, intracrystalline migration experiments at the Carey mine in Kansas. Intercrystalline migration is not accounted for. Intercrystalline inclusions may account for 50% of the initial water (Roedder, 1984, p. 431), and eventually most of the intracrystalline brine in the salt affected by thermal gradients may mitigate to intercrystalline areas. Intercrystalline fluids may migrate toward the waste canisters at considerably different rates than predicted by intracrystalline migration theory. Roedder and Chou (1982, p. 1) found that Jenks and Claiborne used values for major input parameters that were "either nonconservative, selected numbers, or ... based on inadequate data," resulting in invalid calculations. Truly conservative estimates should be larger, perhaps by "two orders of magnitude" (Roedder and Chou, 1982, p. 1). Second, the use of Salt Block II data to validate the code may be inappropriate. The salt cylinder used in that study (Hohlfelder, 1979) was only 1 meter in diameter--spatial scale effects should cause agreement between the experimental data and the model results to decrease with time because only water within 0.5 meters of the heat source was available for migration. Thus, BRINEMIG may not "overestimate" brine flow at higher temperatures. Third, the discussion does not explicitly state whether the accumulation of brine is calculated from fluid inclusions migrating only in a radial direction perpendicular to a waste package, or if migrating fluids reaching the waste package from the volume of salt above and below the waste package are also included in the accumulation. McCauley and Raines (1984) state that BRINEMIG is a one-dimensional code; thus, it would appear that only radial migration, and not three-dimensional migration, was included in the calculations. The difference is that the volume of migrating fluid inclusions should theoretically be an oblong spheroid rather than a cylinder. This difference in volume could be significant and the method of calculation should be explained in more detail. Neglecting the accumulation of fluids from above and below the waste package results in underestimations of brine accumulations, perhaps offsetting the conservative assumption of a constant, maximum temperature gradient.

Several factors concerning the geochemical conditions around the waste packages are not addressed by the DOE in calculating optimistic corrosion rates to show that waste packages in salt should be intact beyond 10,000 years. First, the authors state that 271 cubic meters of hydrogen gas (H_2) will be produced from the water in each 0.32 cubic meters of brine that reacts with the overpack (page 6-187, paragraph 5, #2). There is no discussion about how this H_2 gas will affect the physicochemical environment around a waste package or the waste package itself. It is suggested that consideration be given to the potentially large volumes of gas liberated by the anticipated reactions and how this would affect repository performance. Second, the effects of radiolysis are not considered. Studies indicate that gases may be formed due to irradiation, such as H_2, chlorine (Cl_2), or oxygen (O_2) (see Panno and Soo, 1984). The radiation field is only considered regarding dose rate at the package surface (page 6-189, continuing paragraph, #4). The effects of radiation-induced gases should also be considered. Third, it does not appear that the DOE has considered the effect of the repository being open to the atmosphere before closure; i.e., that O_2 will be present initially. Thus, O_2 will be reacting with the iron overpack before the repository is closed and for an indefinite period afterwards. The effects of this scenario on the waste package corrosion calculations should be considered. Fourth, if reducing conditions are actually present, the reduction of sulfates to sulfides would be expected before the reduction of H_2O to H_2. Sulfide formation may negatively affect waste package performance. In addition, a protective calcium sulfate or iron oxide layer would not be expected to form.

The gross brine accumulations used by the DOE for "conservative" estimates of radionuclide releases do not account for the possibility of an intrusive brine reaching the waste package, only for thermally migrating brines. This scenario is, however, considered in evaluation of waste package performance (page 6-195, paragraph 3 to page 6-199, paragraph 1). The DOE should consider the intrusive brine scenario in its evaluation of radionuclide releases.

The DOE should consider the uncertainties discussed above when evaluating the evidence relevant to this guideline and perform a demonstrably conservative analysis.

6-21

Section 6.3.1.3.1, Statement of Qualifying Condition, Page 6-82, Paragraph 6

The discussion presented in this section does not address uncertainties regarding the assumption that properties of salt obtained from testing salt rock cores from borehole MRIG-9 are similar to salt properties in other Gulf Coast domes and therefore generic data and experience obtained from salt mines in other domes can be used to supplement existing data for the Richton Dome site. As no generic data for other Gulf Coast Domes are given it is difficult to make a comparison. Due to difficulties in obtaining core samples suitable for testing (Lagedrost, 1983, page 15) and the effect of rock mass heterogeneities that may exist within the dome (Kupfer, 1980) there are uncertainties that the results of thermal, strength, stiffness, and creep parameters testing given in Table 6-9 page 6-83 may overestimate the quality of the Richton Dome in situ rock mass. The relatively low strength of Richton Dome salt rock, as reported in Pfeifle, 1983 raises additional uncertainties as to the general suitability of the assumption. It is recommended that the discussion be expanded to present the uncertainties associated with the assumption made in this section.

6-22

Section 6.3.1.3 Rock Characteristics, Guideline 10 CFR 960.4-2-3, Page 6-83,

The range of unconfined compression strength for caprock as presented in Table 6-9 on Page 6-83 is not consistent with the data presented in the reference (Pfeifle, et al., 1983, Page 53). The lower value of the range as given in the reference is 71.2 mPa. The apparent inconsistency should be resolved.

6-23

Section 6.3.1.3.2, Analysis of Favorable Conditions, Page 6-84, Paragraph 6

A discussion of the adverse influence of potential heterogeneities such as inclusions, brine/gas pockets, etc., on the reported rock properties presented in Table 6-9 (incorrectly referenced as Table 6-6) was not presented in the evaluation in this section. An assessment of the behavior of the in situ rock mass should consider uncertainties relating to the adverse effects of heterogeneities on rock characteristics. Consideration should be given to expanding the evaluation to include an assessment of the uncertainties related to the influence of heterogenities upon the in situ behavior of the salt rock mass and, if appropriate, modifying the finding.

6-24

Section 6.3.1.3.1, Statement of Qualifying Condition, Page 6-82, Paragraph 6

The temperature dependence of the thermal conductivity (k) of salt is not reflected by the data presented in Table 6-9. The range of k values given in Table 6-9 at a fixed temperature of 100°C and is in error. Data from Lagedrost and Capps (1983), as presented in Table 3-7, page 3-46 of the draft EA, indicates the correct range of thermal conductivity at 100°C is 2.66 - 4.17 watts/MC°. However, Lagedrost and Capps (page 47-52) present data that indicate a kvariation from 1.93 - 4.34 watts/M°C over the entire temperature range tested. Therefore, consideration should be given to presenting the range of k variation for the entire temperature range tested.

6-25

Section 6.3.1.3.2, Analysis of Favorable Conditions, Page 6-84, Paragraph 3

In this section of the draft EA, it is stated that "Tables 5-1 and 5-2 give the required physical dimensions of the waste disposal areas and the expected volumes of different types of nuclear waste." Table 5-1 does give the required physical dimensions of the waste disposal area, but neither Table 5-1 nor Table 5-2 provide information about the expected volumes of different types of nuclear waste. The latter information is given in Table 5-3. It is recommended that the reference to "Tables 5-1 and 5-2" be replaced by "Tables 5-1 and 5-3."

6-26

Section 6.3.1.3.2, Analysis of Favorable Conditions, Page 6-84, Paragraph 7

In this section of the draft EA, it is stated that the coefficient of thermal expansion of the host rock is low. However, data presented in the literature indicates that in relation to other possible repository host rock the coefficient is high. For example, basalt has a coefficient range of $6.2\text{-}10.8\times10^{-6}$, and tuff a range of $4\text{-}9\times10^{-6}$ °C (Curtis and Wart, 1983). Jumikis (1979) cites average values for igneous, sedimentary, and metamorphic rocks that range from 2.0×10^{-6} to 6.8×10^{-6}/°C. The Richton Dome EA gives a range for dome salt of $37.5\text{-}46.5\times10^{-6}$/°C (page 3-46). It is recommended that this data be considered in the evaluation and analyses presented.

6-27

Section 6.3.1.3.2, Analysis of Favorable Conditions, Page 6-84, Paragraphs 5 to 7

The draft EA states that thermal stress effects are manageable and that fractures induced in the disturbed zone will tend to close as a result of salt ductility effect. It is stated that ductility of salt will hasten consolidation of the crushed salt that is backfilled into waste emplacement rooms. Rock salt exhibits sufficient ductility provided it is adequately confined and under sufficient pressure. It is uncertain that the crushed salt backfill will be under sufficient confinement or under sufficient pressure to exhibit ductility to the extent that lithostatic conditions will result in the salt backfilled rooms and surrounding rock formation within a reasonably short period of time after backfilling. Without relevant experience or data, this evaluation of the ductility phenomenon may be optimistic. The possibility of time delay in this phenomenon should be considered. It is recommended that the evaluation be expanded to consider the above comments and, if appropriate, the finding be modified based upon the result of the reevaluation.

6-28

Section 6.3.1.3.2, Analysis of Favorable Conditions, Page 6-84, Paragraph 3

It is stated that the favorable condition, a host rock that is sufficiently thick and laterally extensive to allow significant flexibility in selecting the depth, configuration, and location of the underground facility to ensure isolation, is present. This finding appears to be based upon an evaluation of limited geophysical (seismic reflection, gravimetric) evidence and on data from one borehole. The evaluation does not address uncertainties regarding the potential existence of major inclusions, anomalous zones, etc. within the dome. In addition, the analysis and evaluation presented does not address the degree to which the presence of anomalies and inclusions within the dome and at its flanks would limit the expected lateral flexibility at the repository level at which depth no data is presently available. As the presence of anomalous zones, brine portals and inclusions would serve to both restrict lateral and vertical flexibility, the finding, that adequate flexibility is present, may be uncertain. It is suggested that the evaluation be expanded to include a more detailed discussion of uncertainty related to flexibility in selection of the location of the underground facility and, if appropriate, the finding be modified based upon the results of the reevaluation.

6-29

Section 6.3.1.3.3, Analysis of Potentially Adverse Conditions, Page 6-85 Paragraphs 1-4

It is stated that the Richton Dome salt rock conditions do not require engineering measures beyond reasonably available technology to ensure waste containment or isolation. Although it is true that many Gulf Coast salt mines have been and are being mined successfully, shear zones have been encountered (gas pockets and other impurities) that must be avoided and the workings are commonly stopped when they are encountered (ACRES American, Inc 1977). The salt dome mines quoted as examples of successful mining have not been exposed to the thermal conditions expected in the repository. As a consequence, the likelihood and nature of expected adverse conditions which may require engineering measures beyond reasonably available technology is uncertain. Without site specific rock characteristics data from within the Richton Dome, the presence of potentially adverse conditions must be considered. It is recommended that the evaluation be expanded to address uncertainties related to the expected rock conditions and, if appropriate, the finding be modified to reflect the result of the reevaluation.

6-30

Section 6.3.1.3.3, Analysis of Potentially Adverse Conditions, Page 6-86, Paragraph 1

In this section, it is stated that analysis of the affects of heat on the natural conditions of the host rock demonstrate that the heat generated by the waste would not significantly decrease the isolation provided by the host rock compared with pre-waste emplacement conditions. The analysis presented in section 6.4.3 to support this conclusion appears to be based on the assumption of uniform homogeneous salt containing only microscopic brine inclusions (Section 6.4.2.3.1, p. 6-179, second paragraph; Section 6.4.2.3.2, p. 6-182, third paragraph). The analysis recognizes that other sources of water might be present (p. 6-187) and that these sources will be identified only during site characterization. However, the analysis does not address the uncertainties related to how anomalies (if present) will respond to repository thermal loading. In addition, the analysis does not appear to adequately treat thermomechanical coupling effects of the system. For example, the effect of temperature on stress is not addressed. It is recommended that the analysis be expanded to address thermomechanical coupling effects on a potentially heterogeneous host rock system to support the finding presented, and, if appropriate, the finding be modified to reflect the results of the reevaluation.

6-31

Section 6.3.1.3.3, Analysis of Potentially Adverse Conditions Page 86, Paragraph 1

The evaluation presented in this section does not address the potential for repository induced thermomechanical caprock distress. The repository induced heat can be expected to accelerate salt rock creep (Pfeifle et al. 1983) and produce salt rock deformations which may result in significant deformation of the caprock. The resultant stresses and the differential displacements near the salt/caprock interface may then cause fractures in the caprock or open any pre-existing fractures (e.g., joints) that could later become preferential pathways for groundwater intrusion. This raises uncertainties regarding long term shaft seal performance in a geohydrologic and thermal environment. It is recommended that the evaluation be expanded to include an analysis that addresses the potential for the phenomena mentioned above, and, if appropriate, the finding be modified.

6-32

Section 6.3.1.3.5, Conclusion, Page 6-85, Paragraph 4

This section contains several statements which do not appear to be supported by evaluations presented in the draft EA. One statement is that "The Richton dome is a massive body of halite." Based upon information presented in Kupfer, 1980, and Acres American Inc, 1977, significant anomalies may be present. Another statement is that domal salt has a "low" coefficient of thermal expansion of the host rock. As discussed in the comment related to Section 6.3.1.3.2, reported data indicates that salt may have a relatively high thermal expansion coefficient in comparison to tuff or basalt and other rock types. A third statement is that mining methods are proven techniques in salt domes and require no engineering measures beyond reasonably available technology. No discussion or evaluation of potential engineering difficulties that might be encountered due to the potential presence of anomalies is presented. The effects of repository induced thermomechanical loadings on anomalies is also not discussed. A fourth statement is that "It (Richton Dome) is considered to be capable of accommodating the stresses expected from a repository." There is no reference given and no discussion presented to demonstrate the range of values over which the stress could vary and the statement remain true. It is recommended that the discussion be expanded to reflect consideration of the above topics.

6-33

Section 6.3.1.6, Dissolution, Page 6-93, Paragraph 3

The DOE has not discussed faulted caprock and its relation to other dome processes here or on pages 3-18 to 3-24. Faulted caprock, mentioned in ONWI-120, Table 12-2 and Rainey, 1981, may be important in evaluating dome growth (halokinesis), dissolution and vertical groundwater travel times. Because the fault could provide a conduit for groundwater travel to the dome, it may be an important consideration in the analysis of dissolution, and if the fault is caused by spines of movement, it is important to an evaluation of dome growth (halokinesis) rates. Its presence, regardless of the cause, could provide a pathway for groundwater movement to the dome that could enhance dissolution. Therefore, additional evidence exists that the potentially adverse condition is present for 960.4-2-6 (c), Dissolution. The criteria by which the fault was recognized and a description of its spatial extent should be considered along with its cause and relation to groundwater travel, dissolution, and dome growth (halokinesis) in the final EA.

6-34

Section 6.3.1.6., Dissolution, Page 6-93, Paragraph 3

NRC does not necessarily disagree with the finding that the potentially adverse condition is present; however, the statement of the postclosure technical guideline for the Dissolution potentially adverse condition is incorrect. The analysis used to arrive at the finding is applied to the incorrectly stated guideline. DOE should consider amending its finding and analysis using the correct statement of the guideline.

6-35

Section 6.3.1.6, Dissolution, Page 6-93, Paragraph 2

The statement that no structural or stratigraphic features indicate the presence of significant dissolution is not supported by the data. The USGS 7½ minute topographic map of Richton shows a closed topographic depression at the edge of the -2,000' dome contour that NRC considers may be related to dissolution. The presence of Citronelle Formation deposits on the depression flanks indicates the depression developed after deposition of the Citronelle or during the Quaternary. Therefore, the favorable condition for 960.4-2-6 (b), Dissolution is not satisfactorily supported. The DOE should consider this topographic depression a potential dissolution collapse feature and consider including the uncertainties related to that potential in the final EA.

6-36

Section 6.3.1.6, Dissolution, Page 6-93, Paragraph 2

The statement in this paragraph that no faults over the dome exhibit Quaternary activity is not substantiated by the data. Two faults with limited offset, 20 and 70 feet, are recognized in the Hattiesburg Formation (ONWI-120), and since deposits younger than Hattiesburg are absent from the fault postions, draft EA Figures 3-9 and 3-15, Pliocene-Pleistocene movement cannot be discounted. Because these faults may be dissolution related collapse features and are not included in the evaluation, the favorable condition for 960.4-2-6(b), Dissolution, is not adequately supported. In addition, the faults have not been considered as potential pathways for groundwater movement to enhance future dissolution. DOE should consider these faults in its data uncertainty analysis and include that uncertainty in the final EA.

6-37

Section 6.3.1.7, Tectonics, Page6-96, Paragraph 8, and Page 6-97, paragraph continued from previous page.

NRC's review of DOE's calculations of expected ground accelerations near the epicenter of the maximum earthquake (magnitude 5.3) are in disagreement with those cited. For distances less than 15 kilometers, calculations using equation 7 of the cited reference (Nuttli and Hermann, 1978, page 86) appear to result in a maximum horizontal ground acceleration of about 0.25g and not 0.14g as reported by DOE both here and in Section 3.2.5.2, page 3-26, paragraph 3. This horizontal ground acceleration difference may be significant to surface and subsurface facility design. In addition, the potential for soil amplification and associated potential damage to the shaft seals near the surface has not been addressed. Therefore, the potentially adverse condition is present for 960.4-2-7, (c)(2) and 960.5-2-11 (c)(2), Tectonics. DOE should document its calculations, provide an explanation for any discrepancy, and if a higher acceleration than that considered in the draft EA is justified, recognize or amend the need for facility design changes to account for the expected higher ground motion.

6-38

Section 6.3.1.7, Tectonics, Page 6-98, Paragraph 2

The explanation for the cause of stream drainage patterns, both here and in page 3-8, does not accurately represent the cited reference and thus does not consider alternative causes such as structural control. The statement in the draft EA that "variations in the drainage network have been shown to be controlled by lithology" (Letco, 1982b, ONWI-120, p. 13-125) misrepresents the citation. The reference actually states that "Field geologic mapping supports the observation that the drainage courses in the near-dome area are dominantly controlled by variations in lithology." This citation inaccuracy is important in that it does not mention possible structural influence in the control of stream drainage courses. ONWI-120, page D-1-43 states that "channel segments of intermediate order... appear to be preferentially oriented in an NW/SE direction, parallel to one of the major lineament modes in the area." This correlation between a lineament and Beaver Dam Creek can be seen in ONWI-120, Figure 13-55, page 13-137. Page 13-148 adds that the surface projection of Fault F-7 is nearly parallel or coincident with Boque Homo Creek. These observations support the possibility that structural features (joints and fractures), as well as surface lithology, affect the patterns of stream drainage at the Richton Dome site. NRC considers that these structural features appear to be closely associated with dome development, thus joints and fractures in the subsurface may contribute to difficulties in groundwater modeling. Therefore, additional evidence contributes to DOE's finding that the favorable condition is not present for 960.4-2-1 (b)(3) and the potentially adverse condition is present for 960.4-2-1 (c)(3), Geohydrology. The DOE should consider more accurately representing the cited reference, and consider the influence of structural control on stream drainage patterns at the site in the final EA.

6-39

Section 6.3.1.7, Tectonics, Page 6-98, Paragraph 2

The draft EA does not contain descriptions of all of the suspected faults near the dome. This omission makes an independent evaluation of their potential effects on regional groundwater flow difficult. Faults similar to the F-7 Fault, suspected to be present south and west of the dome near the salt/sediment contact (Ertec, 1984 p. 15), are not mentioned in this section. NRC considers that these faults may contribute to difficulties in characterizing and modeling the regional groundwater flow system. Therefore, additional evidence exists to support DOE's findings that the favorable condition is not present for 960.4-2-1 (b)(3), and the potentially adverse condition is present for 960.4-2-1 (c)(3), Geohydrology. DOE should consider including a description of these suspected faults which addresses their potential for influencing regional groundwater flow.

6-40

Section 6.3.1.8.2 Analysis of Favorable Conditions, Page 6-100

The draft EA does not appear to have made the correct determination that water quality of less than 10,000 ppm TDS does not occur along the travel path to the accessible environment. The text states the "TDS concentrations for the Upper Claiborne Unit downgradient of the dome, along the likely travel path, range from 24,500 to 30,000 milligrams per liter (Section 3.3.2.2), well in excess of the 10,000 part per million needed to satisfy the condition." However, the text is not consistent in the presentation of TDS concentrations for the Upper Claiborne. In Table 3-18, Section 3.3.2.3, page 3-83, the Cook Mountain Formation, which is part of the Upper Claiborne Unit is reported to have TDS values that range from 3,120 to 197,000 milligrams per liter. Also in Section 6.4.2.2.3, page 6-175, the Upper Claiborne is reported to contain water that ranges from 3,000 to 40,000 parts per million. These values are significant because they indicate that the Upper Claiborne contains waters of less than 10,000 parts per million. In addition, Section 6.3.1.1.2, page 6-73 states that "the structural complexity around the dome flanks is somewhat uncertain, hence, the potential for significant upward or downward flow along the flanks is uncertain." This suggests that if water moves up along the sides of the dome it could encounter water of less than 10,000 milligrams per liter TDS. If either of these situations are possible a favorable condition of groundwater with 10,000 parts per million or more of total dissolved solids along any path of likely radionuclide travel to the accessible environment cannot be reached. Therefore a favorable condition may not be found for guideline 960.4-2-8-1(b)(1). The final EA should address the water quality discrepancies and discuss the water quality of other likely flow paths.

6-41

Section 6.3.1.8.3, Analysis of Potentially Adverse conditions, Page 6-101, Paragraph 1

The third paragraph of the evaluation states that hydrocarbon resources are not known to exist at Richton Dome, and that petroleum is rarely associated with shallow salt domes of the interior salt basins and then only in small quantities. This statement appears inconsistent with the discription of a 30m thick oil bearing sand formation which was been identified, and deemed sufficiently promising to warrant intensive testing, as described in Section 3.2.8.1. The statement also appears to be inconsistent with statements from Karges, 1975 (reference cited in 3.2.8.1): "Future drilling should establish significant reserves on shallow salt domes" (last sentence of abstract), and "Excellent heavy oil shows were seen in Lower Cretaceous sands on the flanks of D'Lo, Richton, and Midway Domes" (Page 181, first paragraph). It is recommended that the evaluation be expanded to consider the above and, if appropriate, the statement be modified.

6-42

This comment was incorporated elsewhere in the comment package.

6-43

Section 6.3.1.8.4, Analysis of Disqualifying Conditions, Page 6-103

The evaluation summarizes the information available regarding drilling into the Richton Dome salt. There are inconsistances between sulfur exploratory well locations shown on Figure 4-9 (Page 4-26) as compared to Figure 3-11 (Page 3-22). In addition, the six petroleum exploration wells reported to have entered salt (third paragraph of the Evaluation in Section 6.3.1.8.3(3) are not included in Summary Table 6-10, Page 6-104. Although the evaluation concludes that this large number of penetrations of the dome have not created significant pathways, no detailed analysis in support of this conclusion is presented. In particular, evidence is not given that waste induced heat will not generate water flow patterns that might promote flow and dissolution along these penetrations. It is recommended that the evaluation be expanded to include an analysis of the risk that flow and/or dissolution might be promoted along drillholes intersecting the dome.

6-44

Section 6.3.2.3, Geologic Setting, Page 6-125, Paragraph 4

The last sentence of the rock characteristics paragraph states that no potentially adverse conditions are found regarding rock characteristics. In Section 6.3.3.2.3, Analysis of Potentially Adverse Conditions, pages 6-139 to 6-141, findings are made that potentially adverse conditions are present for rock characteristics guidelines 10 CFR 960.5-2-9 (c)(3),(4) and (5). It is recommended that the last sentence of the paragraph be appropriately modified.

6-45

This comment was incorporated elsewhere in the comment package.

6-46

This comment was incorporated elsewhere in the comment package.

6-47

Section 6.3.3.1.3, Analysis of Potentially Adverse Conditions, Page 6-137, Paragraph All; Section 6.3.3.3, Hydrology Guideline 10 CFR 960.5-2-10, Page 6-142, Paragraph All

The DOE concludes that surface facilities will be located in areas subject to only minor and infrequent flooding and that this flooding can be mitigated during repository construction and operation. Based on this conclusion, the draft EA finds that (1) surface characteristics that could lead to the flooding of surface facilities are not present at the site (Potentially Adverse Condition 960.5-2-8) and (2) there is the absence of surface water systems that could potentially cause flooding of the repository (Favorable Condition 960.5-2-10).

Review of the draft EA and supporting flood analyses presented in the draft EA indicates that the information presented is not adequate to support the conclusions; the DOE acknowledges that a potential for site flooding exists and that engineering measures will be required for flood protection. The DOE bases its favorable conclusions with respect to the guidelines on the ability to implement flood protection measures which mitigate flood effects. The guidelines, however, address the question of site flooding, rather than the feasibility of engineering measures to control flooding. Hence, it appears that consideration of potential flooding of surface facilities at this site may alter the conclusion that the favorable condition is present and that the unfavorable condition is not present. The DOE should reconsider the findings associated with these guidelines, or to support the conclusions with further documentation and analyses that clearly show that site flooding will not occur.

6-48

Section 6.3.3.2.1, Qualifying Condition-Assumptions and Data Uncertainty, Page 6-138, Paragraph 4

The first sentence states that it has been assumed that the limited core tested is representative of the in situ rock at the site. No discussion is presented regarding the core sample selection procedures that were used to assure that the cores selected for testing were representative of the in situ rock at the site. The core tested is extremely weak (Pfeifle, et al., 1983; ONWI-450; Pages A.2-A.7), and the samples tested may have been stronger than the representative true strength of the salt cored, as is indicated by the difficulties in sample preparation (Lagedrost and Capps, 1983; ONWI-522; Page 15). Moreover, most strength results given are from tests performed at 24°C, while the ambient repository temperature is expected to be about 50°C, Test data at 100°C and 200°C shows a distinct strength reduction as a function of temperature. Generic evidence from salt mining experience in the Gulf Coast Domes where anomalies were encountered suggests that the test samples obtained from MRIG-9 for the Richton Dome may not to be representative of salt rock mass that will be encountered throughout the repository level. It is recommended that a discussion to support the assumption that the core tested is representative of the in situ rock be presented and, if appropriate, the assumption be modified.

6-49

Section 6.3.3.2.1, Qualifying Condition, Page 6-138, Paragraph 5

In this section of the draft EA, it is stated that design parameters are considered conservative for room closure computation. The reference used for this evaluation (Pfeifle, et al., 1983, ONWI-450), however, presents only laboratory-derived creep parameters and does not indicate a basis for choosing "conservative" design parameters for in-situ rock mass room closure computation. Evidence has not been presented to indicate how the laboratory derived creep parameter values would be conservative if extended to an in situ rock mass that is potentially heterogeneous. It is recommended that the discussion be expanded to present further supporting evidence for this statement or that the statement be modified to reflect the results of the reevaluation.

6-50

Section 6.3.3.2.1, Statement of Qualifying Conditions, Page 6-138, Paragraph 6

The evaluation presented does not address the uncertainties regarding re-excavation of storage rooms and relocation of waste canisters. There are no data or analyses cited to support the expectation that retrieval can be accomplished without undue hazard and with reasonably available technology. Current availability of technology has not been demonstrated and compliance with the retrieval requirement cannot be guaranteed (NUREG/CR-3489). Uncertainty related to the possibility of breaching a waste package has not been addressed. It is recommended that the discussion be expanded to address these uncertainties.

6-51

Section 6.3.3.2.2, Analysis of Favorable Conditions, Page 6-139, Paragraph 5

It is stated in the evaluation that mining experience in the Gulf Coast salt domes suggests that use of artificial supports is expected to be minimal. However, the experience quoted is of relevance only until the repository rock behavior becomes significantly affected by waste emplacement heat effects. The evaluation presented does not address the effects of waste induced thermal repository loading on support requirements. The strength of the rock in the zone in which a temperature rise occurs will be substantially reduced, strongly suggesting the possible need for heavy support if re-excavation for retrieval were required. It is recommended that the evaluation be expanded to address post emplacement thermal loading effects and, if appropriate, the finding presented be modified based upon the results of the reevaluation.

6-52

Section 6.3.3.2.2, Analysis of Favorable Conditions, Page 6-139, Paragraph 2

The evaluation for this guideline states that Table 5-2 presents the expected volumes of nuclear waste to be placed in the repository. Table 5-2 presents the personnel requirement of the repository, and Table 5-3 presents the expected volumes of nuclear waste. It is recommended that the reference to Table 5-2 be deleted and a reference to Table 5-3 be included.

6-53

Section 6.3.3.2.2, Analysis of Favorable Conditions, Page 6-139, Paragraph 2

In the evaluation presented in this section, it is stated that at the repository level an area of 4910 acres is available to construct and house a repository with suitable buffer zones, and that the Richton Dome has several thousand feet of vertical extent. It is also stated that "the Richton Dome is sufficiently thick and laterally extensive to allow significant flexibility in selecting the depth, configuration, and location of the underground facility." In the evaluation presented, no mention is made of the potential presence of heterogeneities within the dome area which would serve to restrict flexibility in locating a repository (see detailed comment for Section 6.3.1.3.2, Analysis of Favorable Conditions, Page 6-84, Paragraph 3). In addition, the evaluation does not address the degree to which the presence of anomalies and inclusions within the dome and at its flanks would limit the expected flexibility at the repository level. It is recommended that the evaluation presented in this section be expanded to address uncertainties associated with heterogeneities within the Richton Dome site and, if appropriate, the finding presented be modified to reflect the results of the reevaluation.

6-54

Section 6.3.3.2.2, Analysis of Favorable Conditions, Page 6-139, Paragraph 5

The evaluation presented in this section does not address uncertainties regarding the effects of temperature on roof and rib failures (slaking, spalling, etc.) and the resulting support requirements to prevent such failures. In addition, an analysis of salt rock/rock bolt thermomechanical relationships has not been provided to evaluate anticipated rock bolt performance. It is recommended that the evaluation be expanded to address potential alternative scenarios related to support requirements and, if appropriate, the finding be modified based upon the results of the reevaluation.

6-55

Section 6.3.3.2.2, Analysis of Favorable Conditions, Page 6-139, Paragraph 5

This section evaluates characteristics of the host rock which impact on support requirements for underground openings and concludes that a favorable condition is found. The evaluation does not state whether the effect of the virgin rock temperature has been considered. Earlier studies (Stearns-Roger, 1981, ONWI-283) have identified virgin salt temperature as an important geotechnical factor for engineering feasibility evaluation with regard to room closure. Temperatures reported by Law Engineering Testing Company (1983, ONWI-289) vary considerably for the Cypress Creek (110°F - 118°F), Vacherie (127°F -136°F) and Richton (122°F) dome sites. All are higher than the value of 100°F used for ventilation studies in Stearns-Roger, (1984). It is recommended that the evaluation be expanded to address the above considerations and, if appropriate, the finding be modified.

6-56

Section 6.3.3.2.3, Analysis of Potentially Adverse Conditions, Page 6-139, Paragraph 11

The draft EA states that "shaft construction will require dewatering and ground-freezing techniques in penetrating aquifers, but these techniques are proven technology." In Section 4.1.2.2.1, p. 4-49, it is stated that the water-bearing strata will be stabilized by freezing. Uncertainties associated with potential problems associated with ground freezing - thawing are not reflected in these statements. As reported in D'Appolonia (ONWI-255, 1981) there are several disadvantages of freezing with regard to its impact on long-term sealing particularly where a thick fractured caprock is present. This report (page 90) states that "it is doubtful that freezing will be successful in a thick, fractured caprock." Since the thickness and condition of the caprock is not well known, it would appear that uncertainties related to the use of ground freezing techniques in support of shaft construction at Richton Dome cannot be ruled out. Thus, a conclusion that freezing techniques may be considered to be proven technology for the Richton Dome site may not be supportable. It is recommended that the evaluation presented be expanded to address the concerns raised in ONWI-255 and, if appropriate, this finding be modified based upon the result of the reevaluation.

6-57

Section 6.3.3.2.3, Analysis of Potentially Adverse Conditions, Page 6-139, Paragraph 8

In this section of the draft EA, it is stated that the salt at Richton Dome provides more than adequate thickness and lateral extent for locating the underground facility. Neither the evaluation presented here; nor the evaluation presented under Section 6.3.3.2.2(1), and referenced here, address some salt dome characteristics that could potentially reduce the available flexibility for selecting the depth, configuration, or location of the underground facility. Based upon information presented in the draft EA it appears that the design concept (Section 5.1.1.4; Fig. 5.-5, p. 5-14; also Stearns Catalytic (1984), 4.2, Underground Layout) is based on the assumption that, at the repository level, the entire cross-sectioned area of the dome, except for an 800-foot thick buffer zone between the repository and the edges of the dome, is of sufficiently good quality salt to allow waste emplacement. This assumption may be too optimistic. It does not appear that the estimation of the available extent of lateral flexibility considered the potential for changes in mechanical, hydrological, or geochemical characteristics of the saltrock at the dome edge, where anomalies such as large brine inclusions, brecciated zones, clay or shale inclusions are likely. It seems possible that heating of these zones could change their characterists significantly, e.g., by gas or fluid (brine) expansion. Analysis of such possibilities appears appropriate prior to consideration of waste implacement within 800 feet from the dome edge.

In addition, uncertainty exists about the actual shape of the dome at the proposed repository level, and about the possible presence of a central anomalous zone near the dome center (major comment 1 and detailed comment 3-7). Uncertainties related to the available lateral flexibility also raise doubts about the feasibility of the proposed use of an offset or flank shaft pillar (EA Section 5.1.1.3; Figure 5-5; Stearns Catalytic, 1984, p. 4-2). This might have major implications for shaft maintenance and sealing until permanent closure, i.e., during the retrievability period. This is especially true when the alternate (two-phase) design concept described in Section 5.5 is considered, because this concept may require more than twice the subsurface repository area required for the reference design concept. It is recommended that the evaluation presented be expanded to include consideration of the above and, if appropriate, the finding presented be modified based upon the results of the reevaluation.

6-58

Section 6.3.3.2.3, Analysis of Potentially Adverse Conditions, Page 6-139 Paragraph 14

The evaluation states that some maintenance of passageways is anticipated due to salt creep, and that subsurface conditions of the site will necessitate only routine remedial maintenance operations. This evaluation appears to be inconsistant with the finding that the potentially adverse condition related to geomechanical properties that could necessitate extensive maintenance of the underground openings during repository operation and closure is present. Extensive maintenance is most likely to be required in shear zones or in major anomalies or inclusions within the dome, especially under induced thermal loading and in support of retrieval operations. Experience in Gulf Coast salt mines as documented in Kupfer (1980) suggests that anomalous zones which would require extensive maintenance may be encountered. Therefore, generic experience suggests that extensive maintenance may be required in some areas of the repository. Although the finding presented for this guideline is not in question, it is recommended that the evaluation presented in the draft EA be expanded to include the above concerns.

6-59

Section 6.3.3.2.3, Analysis of Potentially Adverse Conditions, Page 6-139, Paragraph 11

The evaluation presented appears to underestimate the potential problems associated with shaft freezing (see detailed comment on Section 6.3.3.2.3, Page 6-139, Paragraph 11). The evaluation also does not present a discussion of the effect of thermal loading on in situ characteristics and conditions. If canister emplacement occurs before construction is completed, thermal effects may influence the underground facility construction procedure by requiring extensive remedial work to maintain the openings in the passageway. The effects of repository thermal loading may also require unique construction techniques. In addition, the steel shaft liner and seals must remain effective in preventing flooding to satisfy possible retrieval requirements until permanent closure. Given the lengthy total time from shaft liner installation until permanent closure, uncertainties may exist regarding the ability of the steel shaft liner to provide adequate protection, if exposed to repository induced thermal loading, without requiring unique maintenance efforts. It is recommended that the evaluation be expanded to include consideration of uncertainties regarding requirement for engineering measures in the temperature environment expected after emplacement of waste and, if appropriate, the finding be modified to reflect the results of the reevaluations.

6-60

Section 6.3.3.2.3, Analysis of Potentially Adverse Conditions p. 6-140, Paragraph 3-8

The draft EA states that thermally induced fracturing, hydration and dehydration of mineral components, and other physical, chemical, and radiation related phenomena could pose potentially adverse conditions during the retrieval phase of repository operation. While the finding that the potentially adverse condition is present is supported by the evaluation, the evaluation appears to understate the difficulties and safety hazards likely to be encountered during retrieval.

The first paragraph states that re-excavation of the storage rooms is assumed to be required and while costly, should not pose undue hazard or difficulties. From the thermal distribution calculations (Figure 6-6, p. 6-183, Figure 6-7, p. 6-184) it appears that extensive sections of the rooms close to the emplacement holes will be subjected to temperatures of over 100°C within 5-10 years after emplacement. Extrapolating the (admittedly limited) data from Figure 3-19, p. 3-45, at 100°C suggests that the minimal unconfined compressive strength of salt at 100°C will be significantly less than 10 MPa. Section 3.2.5.1.2 suggests an in situ vertical stress of 13-15 MPa based on the stated assumptions. It would appear, therefore, that the salt near the emplacement holes may have to be cooled down significantly and/or that support measures may be required to re-excavate the emplacement rooms.

The second paragraph of this section states that the potential for thermal decrepitation of rock adjacent to the canister is minimal. The uncertainties regarding this statement have not been addressed. Based upon the information presented in Lagedrost and Capps (1983) regarding the difficulty of preparing acceptable test samples from the very weak Richton Dome core provided, it is probable that the Richton Dome samples on which decrepitation tests have been performed were stronger than the average rock salt in the cored section. Uncertainties regarding decrepitation due to heterogeneities within the salt rock mass were not addressed. Furthermore, the thermal decrepitation tests were performed on unloaded samples. Given the substantial reduction in strength with increasing temperature (as documented in Figures 3-19, p. 3-45), and the potential heterogeneities of the in situ rock mass it is possible that thermal decrepitation would be more severe for in situ rock salt around the canister holes.

The potential migration of brine towards the waste package is a factor not only in corrosion of the waste overpack but also in changing the position/orientation of the canister. If a brine-filled cavity develops around a waste package, the waste package may change position. This would cause overcoring complications. It is recommended that the evaluation be expanded to address uncertainties, as mentioned, in the above comments.

6-61

Section 6.3.3.2.3, Analysis of Potentially Adverse Conditions, Page 6-140, Paragraph 3-8

The draft EA identifies principal geomechanical factors that could influence retrieval in the immediate vicinity of the waste canisters. Uncertainties related to the influence of geochemical factors in areas away from the waste canisters are not adequately addressed. While the very-near-field conditions are important, particularly for locating canisters, describing their orientation, and extracting them, conditions more remote from the canister will also influence remining and retrieval operations. Retrieval operations may have to be carried out in high temperatures that will pose ventilation, mining, and potential radiological safety problems and/or will require sophisticated remote mining, rock handling and possibly roof support installation equipment with cooled and shielded enclosures for the operator and all support personnel. This type of equipment remains to be developed. In addition, operators proficient in using such equipment under repository retrieval conditions will need to be trained. The discussion presented also does not address the effect of the potential presence of anomalies on retrieval. It is recommended that the evaluation be expanded to address the above concerns.

6-62

Section 6.3.3.2.5, Conclusion for Qualifying Condition, Page 6-142, Paragraph 1

In this section of the draft EA, it is stated that "The salt at Richton Dome is clean and uniform," and in the same paragraph, it is stated that "The clean and uniform composition and massive characteristics of the Richton Dome salt will require minimal artificial support." In the Assumptions and Data Uncertainty section, p. 6-82, it is stated that petrologic data was obtained from one borehole, and that "Because the salt's internal structure is typically steeply dipping data from this borehole cannot be assumed to be representative of the entire salt stock." The statement that the Richton Dome is a clean, uniform and massive salt dome does not reflect the uncertainties regarding the nature of the domal salt that is conveyed by the later statement. It is recommended the discussion presented be expanded to address the uncertainty regarding the uniformity of the Richton Dome Salt stock.

6-63

Section 6.3.3.2.5, Conclusion for Qualifying Condition, Page 6-142, Paragraph 2

In this section of the draft EA, it is stated that the only maintenance expected is routine recutting in the access drifts to remedy room convergence. Previously a finding has been made (Section 6.3.3.2.3, pp. 6-139/140) that a potentially adverse condition necessitating extensive maintenance of the underground openings is present. It is recommended that the inconsistency between these statements be resolved.

6-64

Section 6.3.3.3.3, Analysis of Potentially Adverse Conditions, Page 6-144, Paragraph 5

This section states that the potentially adverse condition is not present for ground water conditions requiring complex engineering measures beyond reasonably available technology for repository construction, operation and closure. The evaluation only references ground freezing as technology available for handling ground water problems. There are two concerns with the evaluation and finding. First, ground water inflow must be appreciated as an important concern, not just as a pumping problem but, also, because of the effect on dissolution of the salt. Second, the evaluation underestimates the potential problems associated with shaft freezing. In salt domes where water flow in the water bearing zones is controlled by fractures and possibly by open cavities, there are uncertainties that freezing will be successful (D'Appolonia, 1981). Furthermore, the large number of holes required for freezing and the ground disturbance resulting from the freezing/thawing cycle may significantly increase the hydraulic conductivity of the ground around the shaft (e.g., NUREG/CR-2854, Page 46). Evaluation of the above uncertainties has not been presented. The assessment should discuss the risks of using ground freezing to prevent ground water inflows and indicate other methods that could be used to seal the shafts should groundfreezing prove impracticable.

6-65

Section 6.3.3.4.3, Analysis of Potentially Adverse Condition, Page 6-146, Paragraph 10

The evaluation presented in this section does not address the possibility of the occurrence of potential damage modes that would increase permeability with the salt rock mass or disturb borehole or shaft seals during seismic events. A seismically induced compression-dilation wave will be propagated along the shaft axis developing unit strains in the rock wall along which the wave progresses. The shaft sealing material between the liner and the rockwall must be capable of responding to the strain without loss of integrity and bonding to preclude failure of the seals. Failure of the seal may compromise the geologic isolation of the nuclear waste by providing a path of increased permeability to allow acceleration of the transport of radioactive material to the accessable environment. It is recommended that the evaluation presented be expanded to consider all potential damage modes and, if appropriate, the finding be modified based upon the results of the reevaluation.

6-66

Section 6.3.3.4.3, Analysis of Potentially Adverse Conditions, Page 6-146, Paragraph 10

The evaluation presented for this potentially adverse condition does not address the potential for soil amplification due to local site soil conditions in the estimate of expected surface ground motions. As the intensity of ground motion during earthquakes and resultant damage to buildings are greatly influenced by local geologic and soil conditions, the estimate of earthquake motion to be incorporated into an analysis to evaluate the potential for damage to structure important to safety should reflect due consideration for these influences. As the analysis and evaluation presented have not ruled out the possibility of significant local site amplification of ground motions, the finding that a potentially adverse condition does not exist may be too certain. It is recommended that the evaluation be expanded to address the potential influence of local site geologic and soil condition on the estimate of surface motions and, if appropriate, the finding should be modified based on the results of the reevaluation.

6-67

Section 6.4.1, Preclosure Radiological Assessment for Richton Dome, Page 6-158.

The Preclosure Radiological Assessment does not consider the full variety of potentially significant source terms. The source term presented for routine operational releases is only one of the source terms expected from the various operations indicated in the facility description, Section 5.1.1.2. There will be other source terms associated with cleaning and decontamination of shipping casks, with fuel disassembly and pin consolidation, with the handling of DHLW containers and TRU packages, and with the processing of 17,000 gallons per day of radioactive liquid wastes (Table 5-1, p. 5-6) and the management of the low-level wastes generated on site. Spent fuel when removed from the reactor has a layer of radioactive crud on its outer surfaces that provides a source term for fuel handling operations even if no leaky fuel pins are present. Leaky fuel pins are present in most spent fuel pools and must also be disposed of. In the contamination found in spent fuel pool water the predominant radionuclides are usually Cesium-134, Cesium-137, Cobalt-58, Cobalt-60, and Ruthenium-106, depending upon the history of the spent fuel and the pool water. It is suggested that the final EA present an assessment that addresses the source terms originating in the various cleaning, handling, packaging, and processing operations that might be conducted in the Waste Handling and Packaging Facility, the expected emissions after cleanup in the HVAC and any other gaseous waste handling systems, and the resulting radiological impacts in the environment (NUREG-0695).

6-67a

Section 6.4.1, Preclosure Radiological Assessment, Pages 6-158 to 6-165

In calculating the source term for the preclosure radiological assessment the selected scenarios are not shown to be bounding scenarios, are not complete, and it was nonconservatively assumed that almost all the released particulates will always be filtered out for all accident scenarios.

In the quantitative evaluation of radiological consequences, the major source of uncertainty arises from the estimate of source term, i.e., the release fractions of radionuclides. Reliable estimates of release fractions are difficult to obtain largely because of the accident-specific nature of the release and the lack of adequate experimental data. This uncertainty in the release fraction should be recognized. In addition, in the spent fuel accidents, it is assumed that only 30 percent of the void gases in the pins would be released. In the preclosure radiological assessment sections of the EA's, nonconservative source term was assumed without supporting data, calculation or specific indication of how releases would be limited by facility design. For the accident scenarios, the releases of radionuclides were determined using the assumption that material released passes through a roughing filter and two HEPA filters (with Decontamination Factor for particulates of 10^7) prior to release to the environment. It is conceivable that some scenarios may cause the failure of the ventilation system, e.g., a scenario that involves fire in the facility may at the same time damage the filter system. Thus it is important to consider common-cause failure in developing the preliminary design. The uncertainty that arises from the possible lack of completeness and conservatism in the selected accident scenarios should be considered in the preclosure radiological assessment for the final EA.

6-68

Section 6.4.1, Preclosure Radiological Assessment, Pages 6-158 to 6-165

Neither the preclosure nor the postclosure radiological assessment considers damage to the waste package during the preclosure period. Such damage may result in immediate failure of the waste package. The only scenario analyzed in the postclosure performance assessment is very slow degradation, failure and subsequent radionuclide release. This assumes an intact container at the time of repository closure and does not include any preclosure damage, such as initial container flaws or loading damage to the container (corrosion of the waste package during the preclosure period is covered in detailed comment 6-81).

Because flawed or damaged containers could lead to immediate radionuclide release (preclosure), or could lead to unexpected degradation of waste package performance (postclosure), absence of preclosure damage assessment leaves a major source of early failures unevaluated. Transport of some radionuclides from a defective waste package could conceivably begin immediately after emplacement. This damage process should be considered in the performance analysis.

6-69

Section 6.4.1.2, 10 CFR 20 Calculations, Pages 6-159 to 6-161

The source term may be underestimated because the assumed pin failure rate may be too low. The assumed pin failure rate of two per million is considerably lower than the 0.25 percent conservatively assumed for normal transport by WASH-1238. In fact, the original 0.01 percent failure rate described in the draft EA appears to be more representative of discharged fuel (e.g., NUREG/CR-3602) than shipped fuel. The 0.01 percent discharge failure rate supported by NUREG/CR-3602 does not consider the effects of shipping, consolidation and other anticipated operations on the spent fuel. In light of this higher value, it is not clear that the low pin failure rate (and associated confidence level) and assumed Poisson distribution are justified in the 10 CFR 20 calculation. For the final EA, a more representative set of fuel pin failure assumptions should be considered (e.g. Section 6.4.1.2.2 of DOE/RW-0012).

6-70

Section 6.4.1.2, 10 CFR Part 20 Calculation, Page 6-161, Paragraph 4.

In the draft EA, the term "accessible environment" is incorrectly applied in discussing preclosure releases. The draft EA states "that atmospheric dispersion can be expected to further reduce concentrations before released radionuclides are transported to the accessible environment." However, in the EPA standard the term "accessible environment" is used only for post-closure releases. For pre-closure releases, EPA refers to the "general environment" which includes areas "outside sites with which any operation . . . is conducted."

6-71

Section 6.4.1.4, Accident Calculations, Page 6-170

The value of X/Q of 1.74E-05 at 240 meters (Based on an "F" stability class with a wind speed of 1m/sec) where the maximum-exposed individual will be located is not consistent with the value for normal conditions (5.58 E-04; BMI/ONWI-541, p.10) and with an NRC expected value of 7E-03 for this location (Turner 1967). The expected value has been determined by NRC staff from the meteorological conditions stated (Waite, 1984) and compares favorably with the values at 240 meters found (Waite, 1984), Table 2-5 (p.10), Calculated X/Q Values for Normal Conditions. Because of this difference, the dose for the maximum-exposed individual (Waite, 1984), Table 3-7 will be low by about a factor of 400. Consequently, it is suggested that Table 6-26 be reviewed and revised, as appropriate.

6-72

Section 6.4.2, Preliminary Postclosure Performance Assessment
Pages 6-165 to 6-220

The expected case predictions for waste package failure do not include the possibility of disruptive events. The preliminary postclosure performance assessment in the draft EA utilizes a waste package behavior scenario wherein the waste package is expected to slowly degrade, eventually leading to package failure and radionuclide release. Disruptive scenarios, such as human intrusion or earthquakes, are only qualitatively treated.

While it is assumed that such events will play a minor role in the overall failure probabilities for the waste package, this assumption has not been quantitatively established. Disruptive events may result in early failures with more significant consequences than relatively slow failure processes, such as corrosion. For the final EA, discrete event failure modes should be considered.

6-73

Section 6.4.2.3, Preliminary Subsystem Performance Assessments
Pages 6-177 to 6-220

Uncertainties in the input data and modeling procedures, which concern radiation conditions, thermal conditions, fluid conditions, and engineered barrier performance, lead to uncertainties in the performance predictions. An estimate of the uncertainty in these factors has not been included in the draft EA.

Given the complexities involved in the models and their input data, an estimate of the confidence that can be placed in the model predictions might appropriately be provided to support the conclusion that the site meets the Postclosure Technical Guidelines.

6-74

Section 6.4.2.3.1, Thermal Conditions Page 6-179

Confidence in the waste package thermal analysis may be overstated. Neither the magnitudes nor the effects of uncertainties in thermal analyses are provided in the draft EA, although the existence of the uncertainties is acknowledged. Corrosion rates are generally assumed to have an exponential dependence on temperature. NRC analyses indicate that the effects of temperature uncertainties are important when this dependence is used. For example, using data from Fig. 6-13 in the draft EA, it can be estimated that a difference of 30°C or less in peak overpack temperature can change the calculated corrosion by up to a factor of 2. The effects of uncertainties in the thermal analysis on waste package lifetime should be considered in the final EA.

6-75

Section 6.4.2.3.2, Fluid Conditions in Salt, Page 6-182, Paragraph 1

Several statements in the draft EA concerning brine inclusions and brine migration appear to be incorrect. First, brine inclusions are not necessarily small, and there may actually be large brine pockets. A brine pocket containing 2.7×10^6 m^3 of brine was encountered at the WIPP site (National Research Council, 1984). Second, if an intracrystalline inclusion contains a significant vapor phase, it will migrate down a thermal gradient (see Anthony and Cline, 1972). This may be significant because high temperatures at the waste package may cause boiling if inclusions that have migrated to a waste package allowing fluid to develop a vapor phase and dissolve radionuclides. Inclusions possibly containing radionuclides then have the potential to migrate away from the waste package. Third, intracrystalline migration does not necessarily stop at a crystal boundary, but may move across the boundary into an adjacent crystal (see Cline and Anthony, 1971). Intercrystalline movement may be controlled by pressure gradients more than by thermal gradients, and is generally a poorly understood process.

6-76

Section 6.4.2.3.2, Fluid Conditions In Salt; Page 182

The waste package performance assessment does not address inhomogenities in the waste package environment, but instead treats the surroundings (i.e., the near field) as if they were homogeneous and isotropic.

Although the average clay content (which is a source of moisture) at a site may be small (claimed in the draft EA to be typically 3%), if locally large sections of clay occur, the brine accumulation in that area can be much higher than calculated from the mean value for in-situ brine inclusions (because the clay could contain about 20 wt.% water). Inasmuch as the performance of a given waste package is a function of its local surroundings, not the average, or homogenized, conditions of the site, the current EA predictions of waste package lifetimes, which are based on calculations of the amount of brine that would be available to corrode the overpack, and related factors may be inaccurate. Local (near-field) conditions, including inhomogeneities in in-situ brine quantity and composition, ahould be considered in the waste package performance assessment.

6-77

Section 6.4.2.3.2, Fluid Conditions in Salt; Analytical Approach, Page 6-182, Paragraphs 2-5

The BRINEMIG code used in the draft EA to calculate brine accumulations due to thermally induced brine migration is based on a number of assumptions that limit the applicability of its results (see comment 6-20). Results from BRINEMIG are used in support of the geochemistry favorable condition (3) favorable condition (4) and potentially adverse condition (1) and rock characteristics potentially adverse condition (2). These uncertainties regarding BRINEMIG and the application of its results should be considered when evaluating the evidence relevant to these conditions.

6-78

Section 6.4.2.3.3, Waste Package Performance, Pages 6-187 to 6-199

Corrosion rate data and analyses provided in the draft EA address only low magnesium brine. Because low magnesium brine is less corrosive than high magnesium brine, the amount of corrosion of the waste package overpack may be significantly underestimated.

There are two sources of potential error with regard to the brine composition. They both stem from the assumption that the reason that the thermally migrating, inclusion brine will be of low (less than 200 ppm) Mg content as it contacts the waste package is that the in-situ, initial Mg content, of the inclusions is low. For reasons outlined in detailed comment 6-87, this assumption of low initial magnesium content appears to lack adequate foundation.

The second problem with the low-Mg brine assumption is that, regardless of the initial brine composition, the composition may change significantly as the brine migrates toward the package. As stated in the 1984 McElroy and Powell report, which is the primary reference cited in the draft EA for corrosion test data, "a possibility exists that the [brine] inclusions may become enriched in magnesium.... The exact composition of the brine that will eventually contact the waste package at any given site is not known, as the composition of the brine in the inclusions migrating up the temperature gradient toward the hot waste package has not been analyzed."

The uncertainty in the brine composition that will contact the waste packages should be acknowledged in the draft EA, and the potential effects of corrosion by high-Mg brine should be addressed. These results should be reconciled with the finding for the 960.4-1(a) Postclosure System Guideline with regard to demonstrating for the given reference waste package design, that the site is amenable to the use of engineered barriers.

6-79

Section 6.4.2.3.3, Waste Package Performance Pages 6-187 to 6-199

The draft EA indicates that WAPPA, BRINEMIG, TEMPV5 and other computer codes, which were used in the EA, may be used to obtain relevant licensing information. Should these codes contain inappropriate or inaccurate modeling assumptions, these assumptions may lead to incorrect decisions regarding data requirements. Data needed for licensing may, therefore, not be available when required. Peer review is a recognized means confirming these modeling assumptions. Supporting documentation (which identifies the code input data, the source(s) of these data, and the model limitations) makes peer review possible. This documentation should be made available prior to committing these codes to the decision process.

It should be noted that the version of WAPPA used in the waste package performance assessment appears to be different from the version that is currently available from ONWI, and the other codes have not been released. The versions of these codes that were used should be identified and released as part of the supporting documentation identified above.

6-80

Section 6.4.2.3.3, Waste Package Performance; 2. Brine Flow Rate, Page 6-187, Paragraph 5

Brine migration with a threshold thermal gradient below which flow does not occur has not been demonstrated to be the expected condition, contrary to the position taken in the draft EA. Although a number of investigators support the concept of a threshold thermal gradient (e.g., Jenks and Claiborne, 1981), others do not (e.g., Roedder and Chou, 1982). Because this condition about which there is not a consensus and it is the less conservative alternative, the draft EA should not consider analyses using a threshold thermal gradient as representing "expected" conditions.

6-81

Section 6.4.2.3.3, Waste Package Performance, Pages 6-187 to 6-199

There is no consideration in the draft EA of corrosion during the period prior to repository closure. Depending on the rate of waste package emplacement (and retrieval, if necessary) some containers could be exposed to high-temperature oxic conditions for times up to above 50 years. to obtain an estimate of the container lifetime, the preclosure corrosion loss must be added to that for the postclosure period.

To estimate the preclosure rate, data by Braithwaite and Molecke (1980) may be used. They found that 1018 steel placed in contact with crushed salt at 100°C, in the presence of 100 percent relative humidity, gave a uniform corrosion rate of 0.15 mm/yr. Over a 50-year period this would translate to a metal loss of 0.75 cm, assuming a conservative linear rate of corrosion. Braithwaite and Molecke also cite data from Project Salt Vault (Bradshaw et al., 1971) in which a low-carbon steel was exposed to synthetic salts containing 0.5 percent water at 200-300°C. The uniform corrosion rate was 0.1 mm/yr. In 50 years this would give a metal loss of 0.5 cm, which is in reasonable agreement with their own study. More recent work (PNL-4250-5, 1984) shows that a range of ferrous materials exposed for 3 months at 150°C to salt containing 30% brine had a penetration rate of 0.3 mm/year. (Using data reported in ONWI/9, the corrosion rate would be even higher.) In 50 years, the metal loss would be approximately 1.5 cm. This is a significant fraction of the corrosion allowance specified for SFPWF package using this low carbon steel container. In effect, 30 to 60% of the overpack thickness that is set aside to account for corrosion after emplacement would be used up during the first 50 years. On the other hand, it is conceivable that, near the waste packages, the temperatures during the preclosure period could be high enough (and the ambient pressure low enough) to vaporize the brine water. This could alter the flow of brine toward the waste package in ways that do not appear to have received consideration in the draft EA analyses. With regard to the effect on corrosion of the waste package overpack, the rate of corrosion of the 1025 steel in a steam environment could thus be significantly different from that in a liquid brine environment. Preclosure container corrosion should be considered in the final EA.

6-82

Section 6.4.2.3.3, Waste Package Performance, Pages 6-187 to 6-199

The draft EA does not adequately discuss the uncertainties in the predicted temperatures used in waste package performance analysis. There are two components of uncertainty in the prediction of temperatures. The first derives from uncertainty in the data, and the second results from the probability that the model used for the prediction may be inadequate.

Since the temperature is expected to vary linearly with the thermal conductivity of the salt , this becomes a dominating factor in the accuracy of the predictions. The thermal conductivity of the salt is affected by the content of non-salt materials. Data reviewed by McNulty (1984) show a wide variability in the data, close to a factor of two. The thermal conductivities used in this analysis are increased by 40% over laboratory measured values as suggested by Lagedrost and Capps, 1983.

Considering the models, it appears that the TEMPV5 code, which is used to calculate temperature profiles (McNulty, 1984), treats the host media as a homogeneous isotropic material and, therefore, does not account for the effects of non-salt materials.

The maximum temperature at the salt/canister interface depends also on the heat generation rate, the previous thermal history of the rock, the presence of other heat sources such as other waste packages, and the geometry of the source. An independent estimate of the temperatures at the canister/salt interface using a simple model (Sastre, C., 1984) indicates that as much as 100°C or more uncertainty may exist in the predicted profile.

Temperature is one of the most important characteristics associated with the waste package and one which establishes a feedback between materials performance and the immediate host medium. The temperature affects the rock mechanics properties, brine migration rates, the chemical composition of the brine, package degradation mechanisms and, therefore, package lifetime. The temperature gradient in the vertical direction is expected to contribute to brine flow towards the waste package. An assessment of the impact of the uncertainties in temperature on package performance should, therefore, be given to demonstrate that the uncertainties in thermal performance do not lead to potentially adverse conditions at this site (Postclosure System Guideline 960.4-1(a) and Technical Guidelines 960.4-2-1, 960.4-2-2, and 1960.4-2-3). Any uncertainties that do exist in the analysis should be considered.

6-83

Section 6.4.2.3.3, Waste Package Performance, Page 6-189, Radiation Field

The predicted radiation levels associated with the waste package, as presented in the draft EA, do not correspond to previous predictions. There is nearly a two-order of magnitude discrepancy between the dose rate at the outer surface of the overpack presented in the draft EA and the waste package conceptual design (Shornhorst, J. R., 1982). A simple calculation (Sastre, C., 1984), which would underpredict the dose rate gives a dose rate that is also higher by approximately two orders of magnitude.

While the draft EA presents the results of a recent calculation (Jansen G., 1984a) of the expected radiation dose rate with distance and time, more recent calculations (Jansen, G., 1984b) indicate the radiation field should be an order of magnitude greater than that presented in the draft EA. The exact cause of this difference can not be determined at this time due to lack of information.

Both the Jansen and Shornhorst calculations generate the radiation source term through use of the computer code ORIGEN2. The results from ORIGEN2 are then used in the one-dimensional transport code ANISN to calculate the radiation levels throughout the waste package.

Since both the draft EA and the conceptual design calculations use the same computer codes the major cause for the discrepancy in the results may arise from differences in input or the data bases required by the codes. In particular, using different cross section libraries in ANISN will alter the results. Another source of error could arise in converting the information from ORIGEN2 to a form useful for ANISN. This procedure is not automated and is not straightforward.

Since the radiation field influences the characteristics of the immediate environment and, therefore, the predicted containment time and concentration of nuclides in solution, some explanation of why draft EA values are preferred should be provided.

6-84

Section 6.4.2.3.3, Waste Package Performance, Page 6-189, Paragraph 2, Figures 6-11 and 6-12

The possibility of radiation-induced changes in the waste form that could influence the leach rate on canister failure is not addressed in the discussion of the radiation field in and near the waste packages. Rough estimates of the total doses to waste package components indicate that the accumulated dosages are large enough to warrent discussion. Radiation-induced changes could make the HLW in the glass form and in the spent fuel more susceptible to leaching. This would tend to increase radionuclide release rates after package failure, making compliance with 10 CFR 60.113 less likely. The final EA should consider the possibility of radiation-induced changes to the waste package form and canister materials.

6-85

Section 6.4.2.3.3, Waste Package Performance, Boundary Conditions at the Package Surface, Subpart 6, Boundary Stresses, Pages 6-189 to 6-195

The information provided in Figures 6-14 and 6-15 does not make it clear that there will be sufficient thickness of overpack to withstand lithostatic stresses throughout the required service life of the waste package container. In the discussion of waste package boundary conditions, transient excess radial and axial pressures are assumed to be 25% and 35%, respectively, of the static lithostatic pressure. However, this does not appear to be consistent with the curves in Figure 6-14 which shows the variation in axial and radial stresses for the first 18 years after burial, starting at time zero.

In Figure 6-15, where time starts at two years after burial , the failure thickness (i.e., the thickness of the overpack required to withstand the applied stress) overpack is provided as a function of time for the first 20 years following repository closure. No explanation of the different starting times is given.

In Figure 6-15, the failure thickness of the overpack also appears to be nearly equal to the wall thickness 2 years after closure. Since transient pressure peaks at 1 year after closure, the failure thickness may exceed the wall thickness at that time, (i.e., it appears that the overpack could fail one year after closure). These points should be considered and the inconsistencies resolved in the final EA.

6-86

This comment was incorporated elsewhere in the comment package.

6-87

Section 6.4.2.3.3, Waste Package Performance Subpart 3: Brine Composition, Page 6-189, Paragraph 1

The DOE incorrectly cites Hubbard et al. (1983) (note: should be 1984) to support the statement that the composition of thermally migrating brine at Richton "is expected to be of low magnesium content." Hubbard et al. (1984) do not discuss the brine composition of Richton Dome or any other salt domes. It is unclear why low-Mg brines are expected under these conditions.
The presence of low-Mg brine inclusions would indicate that meteoric water has infiltrated the dome at some time during its diagenetic history. If this is so, it is not discussed with respect to dissolution. If the brine inclusions are, in fact, high-Mg, then waste package corrosion calculations for Richton Dome may be non-conservative. The inconsistency with respect to the Mg content of brines should be resolved.

6-88

Section 6.4.2.3.3, Waste Package Performance, Subpart 6, Page 6-189

Boundary stress calculations assume lithostatic pressure only. The additional pressure on the canister created by the generation of hydrogen gas (see p. 6-187, #2) is not accounted for. The inclusion of this additional pressure may indicate an earlier waste package failure, and should be considered in the final EA.

6-89

Section 6.4.2.3.3, Waste Package Performance, Page 6-195, Corrosion and Failure of the Overpack

It is stated in the draft EA that a reduction in the surface covered by brine would cause a decrease in the package lifetime, but a quantitative indication of the amount of decrease is not provided, except in the case of low magnesium brine (the distribution of low magnesium brine reportedly does not affect the conclusion that the waste package will be intact at 10,000 years, because the rate of corrosion in low-Mg brines is low). As noted in other comments the brine contacting the waste package may not be low in magnesium concentration. Moreover, the brine may not be uniformly distributed over the surface of the overpack. Consideration should be given to an assessment of the corrosion effects of a non-uniform distribution of brine (of varying Mg content) over the surface of the overpack in the draft EA; and the results of the calculation should be reconciled with the 960.4-1(a) Postclosure Guideline finding.

6-90

Section 6.4.2.3.3, Waste Package Performance, Page 6-195, Paragraph 4, Corrosion and Failure of the Overpack

Some plausible modes of waste package failure have not been considered in the draft EA. In the calculation of waste package lifetime under expected conditions, uniform corrosion, rather than pitting or stress corrosion/cracking, hydrogen embrittlement, etc., is the expected, or assumed failure mode. A wastage allowance of 2.5 to 5.0 cm (for SFPWR and CHLW packages, respectively) is provided; it is assumed that the package will fail under lithostatic stress when the overpack is corroded by an amount equal to the wastage allowance.

Although the corrosion wastage allowance approach works reasonably well in materials engineering applications where uniform corrosion is the dominant failure mechanism, it is less suitable where other mechanisms such as pitting, stress/corrosion cracking (SCC), or hydrogen embrittlement apply. The current state of knowledge suggests that such potential failure mechanisms can not be ruled out, as evidenced by the fact that (a) pitting has been observed in Project Salt Vault tests with carbon steel (Bradshaw, et al., 1971) (b) a number of potential SCC agents are present in salt repository environments (Beavers, et al., 1984), and (c) H-embrittlement can occur in low carbon steels (Seabrook, et al., 1950). Because non-uniform corrosion processes cannot be ruled out at this time, they should be given more attention in the final EA waste package performance assessment. In the absence of definitive experimental results, the uncertainties in the chosen corrosion process should also be considered.

6-91

Section 6.4.2.3.3, Waste Package Performance, Page 6-195, Paragraph 1

The discussion implies that radionuclides will not be released into solution at a rate faster than the rate of dissolution of the spent fuel or glass matrix. However, experimental studies have shown that some radionuclides (e.g., Cesium and Iodine in spent fuel) are released into solution at a faster rate than the rate of dissolution of the matrix (Johnson, 1982). The first stage in glass dissolution is a leaching of alkali elements, which could release some radionuclides into solution at a faster rate than the rate the subsequent mechanism of matrix dissolution (Adams, 1984). It is stated that none of these factors are considered in the performance assessment calculation, implying an additional degree of conservatism. However, because the mechanisms discussed are relevant only for certain radionuclides, additional conservatism cannot be claimed for all radionuclides in the calculation.

6-92

Section 6.4.2.3.3, Waste Package Performance; Corrosion and Failure of the Overpack, Pages 6-195 to 6-199, Paragraph 3

Several factors concerning the geochemical conditions around the waste packages are not considered in calculating corrosion rates intended to show that waste packages in salt should be intact beyond 10,000 years. These factors include gas evolution, radiolysis, the introduction of atmospheric oxygen, and sulfide formation (see comment 6-20). The waste package performance assessments are used in support of findings for the geochemistry qualifying condition, favorable condition (4) and potentially adverse condition (1). To support the conservatism claimed in the draft EA, these factors should be considered.

6-93

Section 6.4.2.3.4, Release Rate from the Engineered Barrier Subsystem, Page 6-199, Paragraph 2 to Page 6-203, Paragraph 3

The gross brine accumulations used for estimates of radionuclide releases do not account for the possibility of an intrusive brine reaching the waste package at some time in the history of waste package failure. Only thermally migrating brines are considered for estimating radioactive releases. However, the intrusive brine scenario is considered in evaluation of waste package performance. The draft EA should also consider the intrusive brine scenario, in its evaluation of radionuclide releases.

6-94

Section 6.4.2.3.4, Release Rate from the Engineered Barrier Subsystem, Page 6-199, Paragraph 2

The draft EA notes that there are measured solubilities that would be more conservative than the WISP values, but they are not used. There are a number of uncertainties regarding the solubility data used in the draft EA. These include the uncertain nature of the data itself and the effects of Eh and pH (see detailed comment 6-19). Since there is no site-specific data, as confirmed in the draft EA, and all available solubility data are uncertain, the DOE should use more conservative values.

6-95

This comment was incorporated elsewhere in the comment package.

6-96

Section 6.4.2.3.4, Release Rate From the Engineered Barrier Subsystem, Page 6-199, Paragraph 5

The statement that "dissolution of cesium-137 would be limited by dissolution of the matrix" is not consistent with currently available data. Experimental studies have shown that some radionuclides (e.g., Cesium and Iodine in spent fuel) are released into solution at a faster rate than the rate of dissolution of the matrix (Johnson, 1982). The DOE should consider the possibility that some radionuclides could be released faster than the rate of dissolution of the matrix.

6-97

Section 6.4.2.3.4, Release Rate From The Engineered Barrier Subsystem, Pages 6-20 and 6-205, Tables 6-33 to 6-36

Inconsistencies in the amounts of radionuclides tabulated in the draft EA suggest calculational errors in estimates of the maximum concentration of nuclides at the waste packages and release rates for a single package that has failed at 300 years. For example, the inventories of C-14, I-129, and Cm-244 (among others) in Table 6-27, when expressed in terms of g/package, do not appear to agree with the values in Table 6-32. These inconsistencies which may influence the conclusions drawn in section 6.4.2.3.4 on the ability of the EBS in salt to comply with 10 CFR·60.113. These inconsistencies could also affect the calculation of the volume of saturated brine needed to meet EPA limits. The effect could be significant in that comparison of the tabulated values to the NRC controlled release criterion (10 CFR 60.113) shows that the package would not meet those criteria for some radionuclides at the package/salt interface. Variations of two to three orders of magnitude in the solubilities (see detailed comment 6-98), or related changes in flow rate, and total accumulated brine, will introduce further uncertainties into these predicted releases.

These preliminary estimates should be reexamined to resolve the inconsistencies.

6-98

Section 6.4.2.3.4, Release Rates from the Engineered Barrier Subsystem: Pages 6-199 to 6-206

The draft EA does not adequately discuss the uncertainties in solubility limits of radionuclides in brine. As noted in the tables 6-33 through 6-36 "other solubility data exist, some with higher and some with lower values... These data may be no more or no less applicable for this preliminary analysis."

Uncertainties exist in the assumption of solubility limited release. These uncertainties are due primarily to the uncertainties in the solubilities of nuclides and uncertainty in the assumption that only dissolved nuclides can be transported. The solubility of an individual element will be affected by the character of the solid phase, the presence of common ions, the pH, the Eh, the temperature, and the presence of concentrated electrolytes. Elemental solubilities are listed but the chemical and ionic species are not identified.

Strickert and Rai (1982) measured the solubilities of two solid forms of Pu over a pH range from 4 to 8 and under oxidizing conditions. $Pu(OH)_4$ was found to have a higher solubility than crystalline PuO_2 and both forms exhibit a change in solubility of greater than 3 orders of magnitude in the pH range investigated. Solubilities for Americium are ambiguous (Pigford, 1982). Ogard (1981) estimates that at pH 4 the solubility of uranium in deionized water may very 10 orders of magnitude depending on whether conditions are oxidizing or reducing. Neptunium, like uranium, exhibits a wide range in solubilities depending on Eh and the crystallinity of solid NpO_2 (Pigford, 1982). Recent data indicates that radiolyses of brines could result in oxidizing conditions thus increasing the solubilities of many nuclides (Gray, and Simonson, 1984). While Sr forms relatively insoluble complexes with sulfate and carbonate anions, it does form soluble chlorides. Clynne (1981) measured the solubilities of $SrCl_2$ in brines and bitterns, and in the quartenary system $SrCl_2$-NaCl-KCl-H_2O at 100°C, the $SrCl_2$ content is 45% by weight.

The uncertainties in the nuclide solubilities, combined with uncertainties in brine flow rate and total accumulated brine, appear not to have been specifically included in the assessment of whether the engineered barrier system will meet the controlled release rate performance objective (10 CFR 60. 113). These uncertainties should be specifically considered in the final EA performance assessment.

6-99

Section 6.4.2.3.5, Geologic Subsystem Performance, Page 6-208, Paragraphs 1 to 4

In this section, it is stated that "Preliminary Analyses show that ground-water flow around and through the shaft seal system will likely be very small." However, recorded experience indicate that at least two salt mine shafts have been lost in the Gulf Coast area due to water dissolution around the shaft (Kupfer, 1980). The analyses do not explain or predict such failures. It is recommended that the discussion presented be expanded to address how shaft failures such as those that have occurred in the past can be predicted and/or avoided at the Richton Dome site.

6-100

Appendix 6-A, Estimation of the Extent of the Disturbed Zone, Page A-2, Paragraph 7

The evidence presented to support the statement that "Present data indicates that mechanical effects (due to excavation) may be limited to no more than 1 to 2 meters from the excavation (rooms and tunnels)" is incomplete. In the Acres American, Inc. (1977) reference cited, other evidence is presented that would support an estimate of the disturbed zone (due to excavation) as much as tenfold greater than the estimate presented. The reference (p. 21,) indicates that "gas bursts" or "blowouts" which occur during excavation result in rounded or conical openings into the walls or ceilings that are commonly 1-10 meter deep and can conceivably extend to 200 to 300 feet above the mining horizon in multi-level workings. Furthermore, in Supplement A to this report (page A18) Kupfer states "... salt is highly disturbed for distances of 20 to 50 feet (6-15m) into the walls of all mine workings. In this disturbed zone the salt may have a significant porosity and premeability ...".

In Volume II, Appendix II, p. 20 of the Golder Associates, 1977 reference it is stated: "The processes of mining (salt) develops a jointing that is easily identifiable and extends back into the salt for several tens of feet (meters); how far has not been determined." Appendix II, p. 32b also stated that "One might assume that fractures (caused by the mining process) are abundant within three feet (1m) of the surface, commonplace to 10 feet (3m), and potentially present for 20 to 50 feet (6-15m)." On this same page it is stated "... this friability might imply openings, porosity, and even permeability that might extend for 10 to 50 feet or more into the salt." On page 33 of this Appendix it is stated that "The largest one (pressure pocket) within the salt that blew explosively at the time of excavation in Cote Blanche is about 6 feet (2m) in diameter and extends up into the roof at least 30 feet (10m)."

It is recommended that the discussion be expanded to provide a comprehensive analysis of available generic information related to the extent of damage to salt rock walls and ceilings caused by the mining process and the estimate of extent be modified as appropriate to reflect the result of the evaluation.

6-101

Section Appendix 6-A, Estimation of the Extent of the Disturbed Zone, Page A-4

This section presents rationale for estimating the potential for fracturing acquitards by thermal expansion of the host formation. However, it appears that the thermal mechanical analysis summarized in support of the estimate presented was performed for bedded formations. No discussion of the relevancy of the analysis to domes was presented. NRC recommends that the discussion be expanded to address uncertainties related to the relevancy of the information presented to the Richton Dome site.

6-102

Appendix 6A, Estimation of the Extent of the Disturbed Zone, Page A-7

The Table printed in this paragraph shows a distubance range of 10 meters for the thermal-hydrologic effects. It is not clear whether the 10m distance represents the extra distance travelled in 10,000 years due to the effect of heat on flow, or it represents the size of the thermal-hydrologic disturbed zone. NRC recommends that the discussion be expanded to provide clarification of the above.

References for Chapter 6 Comments

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CHAPTER 7 COMMENTS

7-1

Section 7.2.1.2 Geochemistry -Favorable Conditions; Page 7-16, Paragraph 5

The DOE states that highly saline groundwater at Richton would inhibit the formati^n of colloids. However, in the evaluation of favorable condition (2) in the Richton draft EA, the DOE states that "brines tend to promote the agglomeration of some types of colloids" (p. 6-79, paragraph 6), as well as inhibit some types from forming. Based on the evaluation in the draft EA, the DOE cannot unequivocally claim that the evidence supports a favorable finding for this condition.

7-2

Section 7.2.1.2 Geochemistry - Favorable Conditions; Page 7-16, Paragraph 5

In chapter 7, the DOE states that carbonate in the groundwater at salt sites may react with radionuclides "to form complexes that would be more mobile than the uncomplexed radionuclides." However, this potentially adverse effect is not discussed in the Chapter 6 evaluation of geochemistry favorable condition (2). The reason why this effect is minimized in the discussion in chapter 6 but is presented as a potential problem in chapter 7 is unclear.

7-3

Section 7.2.1.2 Geochemistry -Qualifying Condition and Ranking of Sites; Page 7-22, Continuing Paragraph

The statement that the groundwater at Richton Dome is "less reducing than that of the bedded-salt sites" is one reason presented by the DOE that Richton Dome is ranked below the bedded-salt sites in geochemistry. There is no basis for this statement based on the information presented in chapters 3 and 6 of the draft EA. The data on redox conditions at all sites are limited and indirect, and the DOE makes no attempt to define the conditions other than state that reducing conditions are expected at all 7 salt sites. The other reason presented by the DOE for ranking Richton Dome lower that the bedded-salt sites in geochemistry is because Richton Dome "does not contain appreciable amounts of highly sorbing minerals." This fact may be irrelevant because brines are noted by the DOE to inhibit sorption (see p. 6-79, paragraph 2).