NRC COMMENTS

ON

DOE DRAFT ENVIRONMENTAL ASSESSMENT

FOR THE

VACHERIE DOME SITE

March 20, 1985

VACHERIE DOME

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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.

MAJOR COMMENTS

Comment 1

Fractures (Faults, Joints) and Anomalous Zones

Guidelines on Geohydrology 10 CFR 960.4-2-1(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 the relevant available data and does not present a complete appraisal of the data uncertainties regarding structural discontinuities within and near the dome. These discontinuities include internal anomalous zones, subsurface faults, and surface lineaments and their associated subsurface fractures. Structural discontinuities provide a basis for questioning the draft evaluations regarding findings for geohydrology, rock characteristics, and dissolution as discussed below.

Surface lineaments are not described in the draft EA. Lineaments on the eastern and western dome margins, within 3 kilometers of the dome (ONWI-119, Figure 10-8, page 10-27), resemble the dome elliptical outline and may reflect Quaternary dome growth (halokinesis) (see detailed comment 6-35). The possibility that lineaments are surface reflections of subsurface fractures or joints which interact with the regional groundwater flow system has not been considered in the draft EA.

The postulated Payne Fault (Payne, 1968 and ONWI-119) is also not mentioned in the draft EA (see detailed comment 6-37). This suspected fault is recognized in the Sparta aquifer approximately 3 kilometers from the dome. Although the discussion of the fault in ONWI-119 concludes that it may not exist, no corroborating evidence of that conclusion is presented in the draft EA discussion or evaluation. In the absence of evidence to the contrary, it would be reasonable to consider that the postulated Payne Fault exists.

Complex faulting in the overdome sediments is described in the draft EA, but the interpretation that the faults offset caprock (ONWI-467, Figure 31, page 117) is not mentioned (see detailed comment 6-34). With the Wilcox aquifer in fault contact with the caprock, the faults may enhance the vertical component of groundwater flow (see major comment 2) and act as groundwater pathways for dissolution, a situation which appears to have occurred at Winnfield dome (Martinez, et.al., 1975). Furthermore, the faults may be a surface reflection of differential movement between two salt spines and therefore may reflect anomalous zones within the salt stock (Kupfer, 1976) which could adversely affect the amount of host rock available to construct the repository while maintaining an adequate buffer zone (see major comment 4).

The distribution, extent, causes and interrelations of these structural discontinuities 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 here regarding: 1) major comment 2 on the certainty of groundwater 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 4 regarding the lateral extent of available host rock 960.4-2-3 (b)(1) and 960.5-2-9 (b)(1)), and 3) on the potential that a hydraulic interconnection could lead to a loss of waste isolation (960.4-2-6 (c)).

DOE should consider re-evaluating the available data in light of this comment and consider providing a more thorough analysis of the uncertainties of the effects of structural discontinuities around the dome on: the groundwater flow system, the estimates for dissolution, and 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

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 groundwater 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 Austin unit (see detailed comments 3-17, 6-14, 6-17, 6-21, and 6-46). 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 comment 3-12, 3-13, 3-15, and 3-18). Further, the Vacherie groundwater travel times appear to have been obtained using the modeling results of a Mississippi salt dome and may not be applicable to Vacherie, which is located in a different geologic and hydrologic setting (see detail comments 3-16, 6-13, and 6-18). The disturbed zone may be greater than anticipated which could result in shorter groundwater travel time (see detailed comments 6-89 and 6-90). 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 5-16).

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 3

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 2). 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 3-10 and 6-23). 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 6-25). 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 3-10 and 6-23).

The discussion of radiocolloid formation and organo-radionuclide complexation uses data that are not applicable to the expected site conditions (see detailed comment 6-22). 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 6-22 and 6-23). 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 7 and detailed comments 6-24 and 6-25). 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 6-23).

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 4

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 the Rock Characteristics guidelines presented in the Draft EA contain statements that suggest the Vacherie Dome salt stock is essentially homogeneous throughout the site (page 6-101 and 6-158). Generic evidence from Gulf Coast salt mines does not support these statements. Mining experience indicates that heterogeneities such as anolamous zones (which often contain impure salt, clay, brine, and gas pockets and brecciated/shear zones) may exist in dome interiors and near dome peripheries within the dome (see detailed comments 6-25a, 6-29 and 6-31). 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 thermalmechanical properties of the in situ salt mass of the Vacherie 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 Vacherie 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 DOE Smith No. 1 (see detailed comments 6-25b and 6-38a). 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 6-97, paragraph 6), it appears that an implicit assumption of homogeneity of the rock mass was made and the data in Table 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 effect of heterogeneity on several rock mechanics related concerns. These include but are not limited to the adverse effects of heterogenetities 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 6-89).

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 both 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. These uncertainties have not been adequately considered (see detailed comment 6-31). 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 available 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 in the Vacherie Dome Site draft EA based upon the results of the reevaluations.

Comment 5

Retrievability

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

Evaluations presented in the Vacherie Dome Site 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 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 engineering properties to variations in the 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 5-6, 6-43, 6-44 and 6-45). 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, cannister location systems, and cannister 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 comment 6-44).

The evaluation finding 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 comments 6-40, 6-41a and 6-42a). 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 10 CFR 960.5-2-9(c)(4) which addresses 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 6-43, 6-44 and 6-45).

It is recommended that the discussions and evaluations be expanded to consider the uncertainties associated with repository induced thermomechanical loading effects on 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 6

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 Vachierie Dome Site draft EA do not adequately discuss the many uncertainties associated with constructing, sealing, and decommissioning shaft systems to assure long-term containment and isolation of the high level radioactive waste stored at the Vacherie Dome Site. Given the history of salt mine flooding caused by shaft failures in Gulf Coast dome mines (see detailed comment 6-11) and the impact of flooding on personnel safety 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) the 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 the 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)) and does not address adequately 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 has not always been successful in sealing salt mine 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 ground freezing techniques in conjunction with shaft construction are particulary important for salt domes where the upper caprock may be in communication with the 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 5-4). 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 6-36). 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 6-42 and 6-42b). The evaluation is therefore inadequately unsupported.

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 emplacement 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 6-29a). 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 pre-closure period and in post-closure would prevent or delay ground water contact with the waste form or limit of 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 7

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 6-74). In some instances, relevant waste package degradation and failure scenarios, such as pitting corrosion, are apparently either not taken into consideration (see detailed comments 6-54, 6-61 and 6-72) or are not adequately addressed (see detailed comments 6-77 and 6-78). There are also potentially large (but unquantified) uncertainties associated with the calculation of radiation field and thermal conditions (see detailed comments 6-71 and 6-72) and with the solubility of radionuclides in brine (see detailed comments 6-80 and 6-85).

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); (3) lack of consideration of alternative scenarios such as premature failure due to manufacturing defects; (4) the need for a prior 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 6-55).

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 8

Controlled Area

Guidelines On Environmental Qaulity 10 CFR 960.5-2-5 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 the size. This in turn may lead to underestimating site ownership and control and environmental quality 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 preliminary controlled area identified on page 5-4 of the EA is approximately 3.7 sq. mi. or 2400 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 EA states that this preliminary area coincides 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 comments 4 and 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 -117 states that DOE is proceeding further with a two-phase concept. The area needed for the underground facilities for the two phase design is 3734 acres or over double the area of the one-phase design. This amounts to a significant 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 2 and 3): 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.

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 identifications which takes into account the concerns mentioned above. The result of these revisions should be factored into the environmental quality and site ownership and control guidelines as appropriate.

Comment 9

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 10

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 psot-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 anature as opposed to being as 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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DETAILED COMMENTS

EXECUTIVE SUMMARY COMMENTS

Comment ES-1

Executive Summary: Section 5, Regional and Local Effects of Repository Development, Page 14, Paragraph 2

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 5-23, and 5.1.3.4, page 5-31, where it is noted that a specific method of excess salt disposal has not been selected. It is suggested that the inconsistency be resolved.

Comment ES-2

Executive Summary, Section 5, Regional and Local Effects of Repository Development, Page 14, Last Paragraph

This section and paragraph indicate that the water needed for the repository would be supplied by offsite wells, i.e. no surface water would be withdrawn and consumed. In contrast, the text in Section 6.3.3 states that sufficient water appears to be available from ground and surface water sources for repository construction, operation, and closure. It is suggested that these conflicting statements of potential use of surface water be resolved.

Comment ES-3

Executive Summary: Section 5. Regional and Local Effects of Repository Development Page 15, Paragraph 6

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

CHAPTER 3 COMMENTS

Comment 3-1

Section 3.2.2.3, Paleoclimate, Pages 3-13 and 3-15, and Figure 3-7, Page 3-14

The discussion of the impact of increasing atmospheric concentrations of carbon dioxide on future climate is incomplete. From Figure 3-7, the mean global temperature during the "super-interglacial" period induced by increasing concentrations of carbon dioxide in the atmosphere will significantly exceed the mean global temperature during the last interglacial period (about 125,000 years before present). This information appears to be inconsistent with the discussion on page 3-13 that expected climatic conditions over the next 25,000 years will be bounded by the mean global temperature of the last interglacial period. The carbon dioxide induced "super-interglacial" period would last several thousand years before being overwhelmed by orbital-climate relationships expected to cool global temperature and culminate in the next glacial period. It is suggested that the discussion of climate change indicate why the increased warming of the "super-interglacial" period (with a mean global temperature of about 2°F above that estimated for the last interglacial period, from Figure 3-7) can be represented by the existing paleoclimate record.

Comment 3-2

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

The description of the regional faults 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 assess the potential for future faulting, an integrated analysis of the forces which cause fault development must be presented. In the final EA, a description of the regional stress field and its relation to regional faults should be considered.

Comment 3-3

Section 3.2.5.7, Dissolution, Page 3-35, Paragraph 7

The draft EA estimates dissolution rates by measuring the thickness of collapsed overdome sediments. In the draft EA uncertainties inherent in this method may not be satisfactorily addressed. These uncertainties are: 1) an implicit assumption that no resupply of salt occurs at the dissolution front; 2) an implicit assumption that the salt contains a relatively uniform 8-10% impurities; and 3) an implicit assumption that overdome sediment compaction is minimal. This method of estimating dissolution rates should be qualified by an analysis which includes these inherent uncertainties. It is suggested that these uncertainties be considered in the final EA.

Comment 3-4

<u>Section 3.2.5.7, Dissolution, Page 3-35, Paragraph 6</u>

Estimates of dissolution rates using combined maximum thickness of Quaternary deposits and "anomalous" sand that are presented in the draft EA contains uncertainties that may result in a misrepresentation of actual dissolution rates. Relatively extensive studies of "anomalous" sand (ONWI-467, pages 114-115) concludes that these deposits are probably Pliocene in age. This suggests the potential for one period of dissolution-related collapse in the Pliocene evidenced by the "anomalous" sand and another in the Quaternary evidenced by thickened Quaternary deposits. Estimating dissolution rates by combining the thicknesses of these two deposits misses the potential for discovering two independent rates occurring at different times. The distinction is important in determining an accurate picture of possibly disparate dissolution rates over time. The final EA might also consider including the high "lip" of Tertiary deposits (ONWI-467, page 87) in its analysis of Quaternary dissolution and consider the uncertainties of their dissolution rate estimates.

Comment 3-5

<u>Section 3.2.6.1.1, Geomechanical Properties of Overburden, Page 3-36, Table 3-4</u>

The reference given as Reference (1) on page 3-36 has been superseded. 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 the Navy Design Manuals: DM 7.1, DM 7.2, and DM 7.3 in May 1982.

Comment 3-6

<u>Section 3.2.6.1.2, Geomechanical Properties of Caprock and Salt, Pages 3-38 to 42, Paragraph 4</u>

The draft EA presents a limited description of the strength model and the creep parameters for the Vacherie Dome salt. No data are given for the uniaxial compressive strength of this salt. Instead, the Mises-Schleicher criterion has been chosen to represent "failure". The form and parameters of the Mises-Schleicher criterion resemble a yield criterion rather than the ultimate strength. The parameters for the Mises-Schleicher criterion have been derived only at 24°C, although shear stress versus normal stress data at higher termperatures are also available. Moreover, the Mises-Schleicher concept of the word "failure" is not defined. Based on three triaxial creep tests, the parameters for an exponential-time creep law (with six independent parameters) have been derived. A comparison of the derived parameter values for different salt sites (Pfeifle, 1983, Table 4.3) indicates vast differences. Given such large variations in five of the six parameters, the assumption of a constant (i.e., same for all sites) baseline steady state creep rate, with time is questionable. It is suggested that this section be expanded to discuss uncertainties related to the creep parameters and the Mises-Schleicher strength criterion used.

Comment 3-7

Section 3.2.6.1.2, Geomechanical Properties of Caprock and Salt, Page 3-38, Paragraph 5

No information or data are provided on the state of stress either outside the salt stock at repository levels or in the overburden including caprock at the Vacherie Dome site. The draft EA states that site-specific data on in-situ stress conditions are not available, and assumes a lithostatic state of stress at the repository level. For meaningful thermomechanical response prediction calculations, it is important to know the state of stress for the modeled region. It is suggested that the discussion presented in this section 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.

Comment 3-8

Section 3.2.6.1.2, Geomechanical Properties of Caprock and Salt, Page 3-38, Paragraph 5

The draft EA presents an estimate of a stress magnitude of approximately 17 megapascals at 793 meters depth. Contrary to the statement in the draft EA, Tammamagi et al. (1984 ONWI-364) 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 gradient derived 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 gradient substantially above 0.023 MPa/m. It is suggested 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 that proposed by Hoek and Brown (1980), 0.027 MPa/m, or by Lindner and Halpern (1977).

Comment 3-9

<u>Section 3.2.6.2, Thermal Properties, Page 3-38, Paragraph 6</u>
This section states that the thermal conductivity of caprock and salt varies non-linearly with temperature. The data presented in Table 3-7 (p. 3-44) gives conductivity values for caprock and halite at 100°C. Moreover, Footnote (b) in the table incorrectly claims that "thermal conductivity data as a function of temperature is presented in Section 6.4.2.3." This statement also appears in Paragraph 1 on Page 38. Recommend that the temperature-dependent data be provided or the footnote in Table 3-7 and the statement in Paragraph 1 that makes the incorrect reference be deleted.

Comment 3-10

<u>Section 3.2.7.3, Geochemistry of Ground Water in Sediments Adjacent to the Dome, Page 3-49, Paragraph 7</u>

The DOE uses indirect evidence that 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 Eh measurements are indirect indicators of reducing conditions. However, data such as these are not conclusive. These minerals can exist metastably under oxidizing conditions, indicating reducing conditions at some time in the past (e.g., during formation), but not necessarily in the present. Measured Eh values may yield misleading results due to internal disequilibrium of normal groundwaters (see Whitfield, 1974, and Lindberg and Runnells, 1984). Without additional data (e.g., 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 presumed to occur.

Comment 3-11

<u>Section 3.3.1.1, Hydrology, Page 3-55, Paragraph 1</u>

This section describes the surface waters in the vicinity of Vacherie Dome. In other sections of the draft EA, the "Mud Branch of Black Lake Bayou" is indicated as a stream which may be impacted by site characterization and repository development activities (e.g. see Sections 4.2.1.2.2 and 4.2.1.4.3). Neither the text nor the supporting maps and figures identifies the location of the Mud Branch of Black Lake Bayou.

Since this surface water body is expected to be impacted and is also a tributary to Black Lake Bayou, a state-designated "natural and scenic river," it is suggested that the descriptive section identify its location and provide more detail on its physical and biotic characteristics.

Comment 3-12

Section 3.3.2.1.1, Geohydrologic Units, Table 3-18, Page 3-67

The assessment does not indicate which hydraulic conductivity data are derived from field data. Hydraulic conductivity data presented in Table 3-18 appear to be a combination of field-measured parameters and digital model-generated numbers. The assessment should adequately reference hydraulic parameter data in order to confirm the reliability of groundwater travel-time calculations.

Comment 3-13

Section 3.3.2.1.2, Ground-Water Flow, Page 3-70, Paragraph 8

The draft Environmental Assessment states that regional flow is southeast, towards the Gulf Coast, however, no data are presented to substantiate this claim. For example, an alternative explanation would be regional flow to the Mississippi or Red River or other major river valley. The flow systems depicted (Figures 3-25 and 3-26) indicate flow in the opposite direction to the northeast and to many directions for the Sparta and Wilcox-Carrigo units, respectively. Further Hosman, 1978, page 10, shows a northeast flow direction for the Sparta. If regional south eastern flow exists then it should be documented or this statement should be significantly revised.

Comment 3-14

Section 3.3.1.3, Flooding, Page 3-61, Paragraph 6

The information presented in the draft EA and in ONWI-119 is not adequate to document flood effects at this site or to support the conclusions reached with regard to flooding. A review of the flood evaluations in ONWI-119 indicates that certain basic information is needed to better determine site compliance with Guidelines 960.5-2-8 and 960.5-2-10. This information includes the following:

- Peak 100-yr and PMF flood flows
- Peak 100-yr and PMF flood velocities
- Water surface profiles and stream cross-sections
- Location of possible downstream controls, constrictions, or backwater effects
- Estimates of times of concentration
- Rainfall distributions
- Unit hydrographs
- Manning 'n' values

This information should be readily available, since the final results of the data and analyses were summarized in the draft EA. This information should be included in a single document and referenced in the final EA.

In addition, more information is needed regarding the engineering measures that will be provided to mitigate potential flood problems. Without such information, it is difficult to evaluate their feasibility, impact on the environment, and cost. Such information on the anticipated mitigative measures to overcome the flood problems should be provided.

Comment 3-15

Section 3.3.2.2, Modeling, Page 3-73

The draft Environmental Assessment 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.

Comment 3-16

Section 3.3.2.2, Modeling, Page 3-73

To support its statements about modeling results, the draft Environmental Assessment references Intera (1984). However, Intera (1984) is not contained in Chapter 3 references. Therefore, the groundwater modeling and time of travel calculations could not be checked against the source and confirmed. The final Environment Assessment should explain how the modeled hydrology for Vacherie Dome was determined.

Comment 3-17

Section 3.3.2.2, Modeling, Page 3-73

The draft Environmental Assessment does not model alternative groundwater flow paths. It is stated in Section 6.4.2.3.4, page 6-224 that "Currently available data can support several different conceptualizations of the regional ground-water flow regime. As such, the direction of vertical flow near the dome must be treated with some uncertainty". However, the Environmental Assessment presents only one conceputal model. Further, the groundwater flow model for Vacherie Dome does not model any aquifers deeper than the Austin Formation. This may be particularly important at Vacherie Dome, since it has active oil fields in the deeper units within 10 kilometers of the dome, that could act as pathways to the accessible environment. The draft Environmental Assessment should include a discussion of other possible conceptual models and consider flow gradients in units deeper than the Austin. Any changes should then be incorporated into the time of travel to the accessible environment calculations in Section 6.3.1.1.2.

Comment 3-18

Section 3.3.2.2 Modeling Page 3-73

The draft Environmental Assessment does not adequately describe how the vertical hydraulic conductivities of aquifers and confining units were obtained.The report states that "the model provides estimates of the hydraulic interconnection between geohydrologic units." However, Intera (1983) and Ryals (1982), state that no data currently exists on the vertical hydraulic conductivity of the confining units. As concluded in Intera (1983, p. 71), "Uncertainties in the vertical hydraulic conductivities of aquitards...are relatively large; Confidence in travel time is considerably less than confidence in flow directions." The Environmental Assessment should describe how the vertical hydraulic conductivities of aquifers and confining units were obtained, since they are used to calculate groundwater travel times.

Comment 3-19

Section 3.3.3, Water Supply, Page 3-76

The draft Environmental Assessment does not identify the location of surface and groundwater 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 groundwater withdrawal sites that can be correlated with a table that shows the type of use (domestic, agricultural, etc.), the source (groundwater with geologic unit or surface water with stream name), and withdrawal rate.

Comment 3-20

<u>Section 3.4.2.1 Terrestrial Biota, Page 3-86, Paragraphs 1 and 2</u>

To gain an understanding of the importance of the site as habitat for recreationally important species (i.e. game species) density data for the area are needed on game species such as whitetail deer, eastern cottontail, fox squirrel, and bobwhite. It is suggested that hunter harvest statistics for Webster and Bienville Parishes would provide an index of importance of the area for game species.

Comment 3-21

<u>Section 3.4.3, Air Quality and Meteorology, Page 3-88, and Table 3-22, Page 3-89</u>

The discussion of existing air quality is not clear because the information appears to be derived from averages rather than from an examination of the year-to-year variability. (See, for example, the discussion of existing air quality in Section 3.4.3 of the draft Environmental Assessments for the Deaf Smith County and Swisher County sites.) Examination of annual information would provide a better characterization of existing air quality and comparisons with the National Ambient Air Quality Standards.

Comment 3-22

<u>Section 3.4.3, Air Quality and Meteorology, Pages 3-88 through 3-90</u>

The discussion of dispersion and mixing heights is incomplete because no discussion of atmospheric stability is presented. The discussion presently emphasizes occurrences of relatively large-scale air pollution episodes which are not as important for local air quality and radiological impact assessments as occurrences of stable conditions accompanied by low wind speeds. It is suggested that the discussion include the monthly, seasonal and annual distributions of atmospheric conditions (Pasquill types "A" through "F" or "G") representative of the Vacherie site. Such information is routinely available form the National Climatic Data Center.

Comment 3-23

<u>Section 3.4.3.2, Dispersion and Mixing Heights, Pages 3-88 through 3-90</u>

The section does not provide a description of the meteorological data base used for air quality and radiological impact assessments presented in Sections 4.2.1.3, 5.2.5, and 6.4.1. It is suggested that the source of the meteorological data and the period of record used for such assessments be fully described in Section 3.4.3.5. It is also suggested that the discussion in Section 3.4.3.5 include a comparison of the wind speed distribution, wind direction distribution, and distribution of atmospheric stability classes for the selected data base with the climatological of "expected" distributions presented as representative of the site.

Comment 3-24

Section 3.4.5, Aesthetic Resources, Page 3-94, Paragraph 2

This section indicates that Black Lake Bayou is one of two surface water bodies located near the Vacherie Dome site which are state-designated natural and scenic rivers. Black Lake Bayou is indicated to be approximately 1 mile to the east of the site. In Section 4 of the Executive Summary, a judgment is made that visual impacts on the two rivers are expected to be negligible. In Section 5 of the Executive Summary, it is indicated that EPA noise guidelines may be exceeded at a distance of up to 1 mile from the center of the surface facilities. There is no evaluation of potential noise impact on the aesthetic value of the state-designated "natural and scenic river." It is suggested that resolution should involve the consideration of users of Black Lake Bayou as sensitive receptors for noise associated with site characterization and repository development activities.

Chapter 3 References

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CHAPTER 4 COMMENTS

4-1

Section 4.1.1.1.12, Anomalous Sand Boring, Page 4-24, Paragraph 2

This paragraph mentions a boring to investigate the anomalous sand. According to the text, Figure 4-7 shows the location of this boring, however, the location is not shown on that figure. Recommend the planned location of the boring be identified on Figure 4-7.

4-2

Section 4.1.2, Exploratory Shaft Facility, Page 4-28, Paragraph 4

In this section, it is stated that 4250 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 exploratroy excavation is planned in the actual repository 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 comments.

4-3

Section 4.1.2.2, Construction, Page 4-37, Paragraph 8

The EA presents inconsistent data on the required length of an access road. On p. 4-37 (and a number of other places in the EA) this length is given as 0.5 mile. In Table 4-4 (page 4-38), however, this dimension is given as 1 mile. It is recommended that the inconsistency be resolved.

4-4

This comment was incorporated elsewhere in the comment package.

4-5

Section 4.1.2.4, Final Disposition, Page 4-6, 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 will to be done with the exploratory shaft facility if it does not become a part of the repository. This information is of importance to 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. Recommend the discussion be expanded to address and provide clarification of the above points.

4-6

Section 4.1.3.1.2, Terrestrial and Aquatic Ecosystems, Page 4-80

This section describes the detailed environmental baseline studies to characterize existing conditions at the Vacherie Dome site prior to construction activities. The planned baseline study is not based on hypothesis testing; hence, information is likely to be obtained which cannot be used in the identification of mitigative needs. It is suggested that greater emphasis be given to the identification of habitats and biota at risk based on site activities. Mitigation needs should be obvious without detailed ecological studies. The study of impacts via field methods which are too insensitive to detect changes should yield to the implementation of qualitative, intuitive (by a qualified professional) mitigative methods. It is suggested that the final EA identify good engineering practices and mitigative action plans to protect the most sensitive habitats and species.

4-7

Section 4.2.1.3, Air Quality Effects, Page 4-97

The meteorological data base used for the air quality impact assessment is not sufficiently described. Meteorological data from Shreveport, LA are reasonable as input for a preliminary assessment of air quality impacts at the Vacherie Dome site. However, it is suggested that the period of record of the data base be specified, and the data base be determined to be representative of "expected" conditions at the site in terms of wind speed, wind direction, and atmospheric stability. Cross-reference to Section 3.4.3.5 would be appropriate.

4-8

Section 4.2.1.3, Air Quality Effects, Page 4-96, and Table 4-21

The estimated emissions from exploratory shaft construction activities (Table 4-21) appears to be incomplete because no source estimates are provided for fugitive emissions and operation of the concrete batch plant. Analyses of air quality effects from these activities were included in the environmental assessments for both the Deaf Smith County and Swisher County sites (see Table 4-19, page 4-86, and Table 4-20, page 4-84, respectively). It is suggested that these sources be considered in the final EA.

4-9

Section 4.2.1.4.1 Hydrological Effects - Surface Water, Page 4-103, paragraph 6

It is suggested that the potential stream diversion methods be discussed in detail to provide information on the time needed to establish the new channel and the impacts to water quality of Bashaway Creek during construction of the diversion. Information is also lacking regarding duration of the diversion and mitigative measures to be used to protect Bashaway Creek during removal of the diversion.

4-10

Section 4.2.1.6.2 Noise, Offsite Activities, Page 4-112

This section indicates that seismic surveys will be conducted during daylight hours with the number of explosive charges estimated to average 70 per day. In order to further mitigate noise impacts from explosives, blasting could not only be limited to daylight hours but also to weekdays. It is suggested that this be considered as an additional mitigation measure.

4-11

Section 4.3.2, Exploratory Shaft Alternative Facility, Page 4-28, Paragraph 2

The rationale for choosing two different shaft sinking approaches is not provided. In the draft EA for the Yucca Mountain site a detailed discussion for preferring the drill and blast method is presented. It is recommended that the discussion in this section be expanded to include rationale for choosing two different construction methods for the two exploratory shafts at the Vacherie Dome site.

CHAPTER 5 COMMENTS

5-1

Section 5.1.1.1, Repository Site Layout, Page 5-4

The rationale for the selection of the Surface Area Land Control Rights area of 2,400 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 accessible environment. As the area selected by DOE provides for a controlled zone extending beyond the subsurface repository area by less than one kilometer, it also significanlty impacts postclosure technical guideline 960.4.2-1(b)(1) related to ground water travel time. Recommend this section of the draft EA be expanded to present 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 (This comment was incorporated elsewhere in the comment package.)

5-3

Section 5.1.1.4, Repository Subsurface Facilities, Table 5-3, Page 5-15

Table 5-3, Approximate Waste Storage Room Quantities, p. 5-15, shows that the Vacherie Dome site is projected to receive 55,456 TRU packages, 7899 spent fuel packages and 3673 CHLW packages out of a total of 74,048 packages. All of the analyses are in terms of spent fuel and CHLW. However, nearly 75% of waste packages will be TRU packages. No TRU package design information is presented in the EA.

Recommend an analysis of waste package performance be presented based on emplacement of TRU packages, or an analysis be presented to show that the conclusions from the analyses presented are not invalidated by emplacement of TRU packages.

5-4

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 drill and blast method. 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 repository performance assessment. These uncertainties include:

a) It is possible that the damage to the repository 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 using the exploratory-shaft-developed data to assess stability and sealing of the repository shafts.

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

5-5

Section 5.1.2.4, Shafts and Facilities Development, Page 5-25, Paragraph 8

The draft EA states that concrete linings will extend from ground surface to 30m into the salt domes 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." It is recommended that this inconsistency be resolved.

5-6

Section 5.1.3.3, Retrievability, Page 5-34, Paragraphs 5 & 6

This section presents a discussion on retrievability; it is very brief and does not state how retrievability will be maintained. No analysis on retrievability is reported nor on how this decision to backfill will be made. Thermal load limits, access drift support design, maintenance, personnel radiological safety, etc., are important factors that effect retrievability. The greater creep tendency for Vacherie Dome salt at elevated temperature may influence retrieval operations by limiting the allowable thermal loading. It is recommended that the discussions include all pertinent retrievability consideration.

5-7

Section 5.2.1.1, Structure and Tectonics, Page 5-39, Paragraph 3

The NRC staff is in the process of preparing a generic technical position on seismotectonic evaluation methods. This paper will cover the types of seismotectonic investigation 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 can be determined. At the present time, it is premature to state that the design requirements for a waste repository are the same as those required for nuclear power plants. It can only be stated that the design requirements of structures important to safety will comply with 10CFR60 and appropriate EPA regulations.

5-8

Section 5.2.5, Air Quality, Pages 5-52 and 5-53

The discussion of air quality impacts throughout Section 5.2.5 confuses the increases due to site activities with the overall impacts by not considering existing air quality levels. Existing air quality levels were specifically considered in Section 4.2.1.3, where "background values of 40 micrograms per cubic meter (TSP), and 10 micrograms per cubic meter (NO_x) were assumed" (see page 4-97). "The increase in maximum 24-hour TSP concentrations immediately offsite is estimated at approximately 230 micrograms per cubic meter during land disturbance activities" (page 5-52), which, when added to a background level of 40 micrograms per cubic meter, exceeds the primary National Ambient Air Quality Standard (260 micrograms per cubic meter). The emission rates for TSP already include application of some control measures. It is suggested that this section be clarified to reflect consideration of existing air quality levels in estimating emissions.

5-9

Section 5.2.5.5, Air Quality Impacts, Pages 5-54 and 5-64

The discussion of air quality impacts should include a comparison of the primary and secondary National Ambient Air Quality Standards with projected air quality conditions. The secondary 24-hour TSP National Ambient Air Quality Standard will be exceeded, and the primary TSP standard could be exceeded if background air quality levels have not been considered in the analyses. It is suggested that the section be revised to reflect air quality impacts compared to existing standards.

5-10

Section 5.3, Expected Effects of Transportation and Utilities, Page 5-74

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 EA include either an explanation for the use of existing analyses and studies to substantiate the statement that transportation accident impacts are small, or an analysis of the consequences, probabilities, clean-up cost and risks for a severe transportation accident enroute to the site.

5-11

5.3.1.1.2, Waste Transportation Costs, Page 5-76

Certain transportation corridors along the routes to the sites (e.g., those with high accident frequency or 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 final EA.

5-12

Section 5.4, Expected Effects on Socioeconomic Conditions, Page 5-93, Paragraph 3

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.

5-13

Section 5.4.1.4, Displacement of Residents, Page 5-100

The discussion in this section omits reference to the number of residents expected to be displaced. It is suggested 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.

5-14

Section 5.4.5, Fiscal Conditions and Government Structure, Pages 5-114 and 5-115

The discussion in this section of technical and financial assistance for local 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 replanning 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 timing of pre-impact planning assistance available for mitigative planning.

5-15

Section 5.5, Implications of an Alternate Repository Design Concept, Pages 5-117 through 5-122, Paragraphs all

The draft EA states 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 5-117, Paragraph 3) that impacts somewhat different than those described in Sections 5.1 through 5.4 of Chapter 5 could result. Some 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 need for increased repository area may be difficult to fulfill in the Vacherie Dome which has limited lateral extent.

3. 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.

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

5. An additional shaft would be required.

6. 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 still evolving. Nevertheless uncertainties regarding technical aspects of the design concept which impact environmental consideration, 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 related to these impacts 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 rehandling at the surface has been adequately considered in all aspects of its environmental impact.

4. There is no apparent difference between the proposed two-phase concept design and the reference repository design evaluated in the draft EA 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 requirements 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 requirement will be impacted by the effect of increased extraction percentage, waste emplacement schedules as it 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 on personnel 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 HLW emplacement which could adversely affect performance of the repository should be considered.

Recommend the discussion presented in this section be expanded to address the above items.

5-16

Section 5.5, Impact of an Alternate Repository Design Concept, Page 5-117

The draft Environmental Assessment does not adequately evaluate the effects of using the two-phase design on ground water travel times through the salt stock perimeter pillar. The total dome area (p. 3-3, Figure 3-2) is 2400 acres at the -2500 foot (MSL) elevation. One result of using the Two Phase Repository Design concept in preference to the draftEnvironmental Assessments reference design is to increase the approximate underground facilities area from 1600 to 3734 acres. This would significantly diminish the distance between the repository and the edge of the salt dome and therefore reduce ground water travel time through the host rock. The effects of using the Two-Phase Repository Concept on ground water travel times through the salt stock perimeter pillar should be discussed.

5-17

Section 5.6, Table 5-26, Summary of Repository Impacts, Page 3 of 14, Page 5-125, Item 7, First Bullet

This bullet indicates that resident aquatic biota will be "temporarily" lost by relocation of Bashaway Creek. 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.

5-18

Section 5.6, Table 5-26, Page 5-127

The summary of noise impacts includes the statement, "Blasting associated with shaft sinking may occasionally be perceptible in Heflin, and will be noticed by several residents closer to the site." No discussion of blasting impacts on nearby residents is included in Section 5.2.7.1. It is suggested that blasting impacts to nearby residents be considered in the final EA.

CHAPTER 6 COMMENTS

Comment 6-1

Section 6.2.1.1, Site Ownership and Control Guidelines 10 CFR 960.4-2-8-2, Pages 6-6 to 6-7

The draft EA states that DOE can obtain necessary ownership rights of privately owned land by condemnation. It would be desirable to document this statement by reference to applicable law. With repect to the Forest Service lands, the EA should document, if applicable, whether there are any special uses, such as wilderness areas or scenic rivers or trails, that could stand in the way of DOE's acquiring jurisdiction and control.

Comment 6-2

Section 6.2.1.4, Meteorology Guideline 10 CFR 960.5-2-3, Pages 6-12 and 6-13

The radiological impact assessment described in Section 6.4.1 utilizes information other than the meteorological data base identified in this section as "relevant data." As discussed on page 6-13, meteorological data from Shreveport, LA are identified as the basis for the analysis, and are assumed to "provide a reasonable base of technical information for estimating likely on-site meteorologic conditions." Meteorological data from Shreveport, LA are summarized in Section 3.4.3 and apparently used in the air quality impact assessments described in Sections 4.2.1.3 and 5.2.5. However, the meteorological information used for the 40 CFR 191 calculation described in Section 6.4.1.3 includes data from Mobile, AL. The use of meteorological information from Mobile, AL to represent conditions at the Vacherie Dome site is inconsistent with discussions of meteorology throughout the Environmental Assessment. It is suggested that Section 6.2.1.4.1 be revised to clarify this inconsistency in the evaluation of the qualifying condition.

Comment 6-3

Section 6.2.1.5, Offsite Installations and Operations, Page 6-15 and Table 6-7

Table 6-7 refers to a petroleum pipeline that crosses the dome as a potentially adverse condition that could interfere with repository operations. There is no indication of the exact location and depth of the pipeline in relation to the repository facilities. There are many facts about this pipeline that are unknown. It is suggested that information about what substance is currently transported through the line and whether other substances possibly more volatile could be transported through it in the future, the age and condition of the line, etc., be considered in order to determine if this pipeline poses a threat to the repository.

Comment 6-4

Section 6.2.1.6, Environmental Quality Guideline, Page 6-48 and Table 6-4, Page 6-43

The discussion of air quality impacts in this section may not be supported because it appears to be somewhat inconsistent with the assessments presented in Sections 4.1.2.3 and 5.2.5. The discussion in Section 6.2.1.6 and Table 6-4 implies that air quality impacts could be further reduced by implementing control measures. However, the analyses of air quality impacts presented in Sections 4.1.2.3 and 5.2.5 already assume control measures. Even with control measures, the secondary National Ambient Air Quality Standard for TSP "is more likely to be exceeded on more than one occasion" (page 4-98) during site characterization. Although the air quality analyses presented in Section 5.2.5 is ambiguous, the secondary TSP standard could also be exceeded during site clearing and construction, assuming control measures. Depending on consideration of background air quality levels, the primary TSP standard could be exceeded, also assuming control measures. It is suggested that the discussion of air quality impacts be clarified in Section 6.2.1.6 and Table 6-4.

Comment 6-5

Section 6.2.1.6.4, Analysis of Disqualifying Condition, Page 6-50, Disqualifying Condition (3)

The evaluation for this disqualifying condition does not consider the state-designated "Natural and Scenic River" which flows about 1 mile to the east of the site. It has not been demonstrated in the draft EA that impacts of noise and impacts of reduced water flow and quality will be insignificant. It is suggested that further analysis of these impacts be considered.

Comment 6-6

Section 6.2.1.8, Transportation Guideline, Page 6-62 Favorable Condition (a), Paragraph 4

Examination of "regional" meteorological conditions for determination of "significant" transportation disruptions is ambiguous. The "region" of the Vacherie Dome site is not well-defined, nor are the criteria for determining "significant" transportation disruptions. Use of "regional" meteorological information would appear to be of limited value in assessing transportation disruptions. A more meaningful indicator could be whether the site is unique with respect to meteorological conditions which disrupt transportation, or whether the site could be sufficiently isolated during portions of an annual cycle to significantly limit transportation to the repository during a particular period. Another concern is that hazards such as tornadoes or snow and ice could increase the likelihood of transportation accidents, thereby increasing the risk to public health and safety. It is suggested that the discussion of the potential for increased risk at the Vacherie Dome site due to meteorological conditions be expanded.

Comment 6-7

Section 6.2.1.8.2, Analysis of Favorable Conditions, Pages 6-59 & 6-62

No conclusion (i.e., finding) is presented for Favorable Condition #5. Recommend that DOE present a conclusion for this guideline and include in Chapter 6 the result from Chapter 7 with respect to this favorable condition.

Comment 6-8

Section 6.2.1.8.3, Analysis of Potentially Adverse Conditions, Page 6-63, Paragraph 2

In this section of the draft EA no data or references have been presented in the evaluation to support the statement 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. Specifically no discussion of the potential for rock slides or landslides has been addressed. Without supporting data, the finding that a potential adverse condition is not present may be too certain. Recommend the analysis be expanded to support the finding and if appropriate this finding be modified to reflect the results of the reevaluation.

Comment 6-9

Section 6.2.2.1, Preclosure Radiological Safety Guideline, Pages 6-71 and 6-76

References are made to use of meteorological data described in Section 3.4.3 for radiological impact assessments. Section 3.4.3 implies use of meteorological data from Shreveport, LA, which is in direct contradiction of the discussion in Section 6.4.1.3, which also references meteorological data from Mobile, AL. The use of meteorological data from Mobile, AL to represent conditions at the Vacherie Dome site is inconsistent with discussions of meteorology throughout the draft Environmental Assessment. It is suggested that the discussion of meteorological data used for radiological impact assessments be clarified and made consistent among Sections 6.2.1.4.1, 6.2.2.1 and 6.4.1.3.

Comment 6-10

<u>Section 6.2.2.1.2, Page 6-61, Paragraph 2 Analysis.</u>

Modeling results (Section 6.4.1) 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 an 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 EA. For Deaf Smith, maximum individual dose is given as 4.5×10^{-3} millirem annually during construction and 2.8×10^{-3} millirem annually during operational period. For Richton Dome, the doses are 9.0×10^{-3} millirem and 5.6×10^{-3} millirem, respectively.

Since Waite did site-specific calculations, that fact should be stated in 6.2.2.1.2.

Comment 6-11

<u>Section 6.2.2.2.1, System Guideline Requirements (Environ., Socio. Trans.), Page 6-78, Paragraph 4</u>

The assumptions in this section include the following: "Existing shaft sealing technology is sufficient to provide protection of the overlying aquifers." In the context of environment, a malfunction of the seals in the shaft could provide connections between aquifers or cause shaft flooding. Kupfer (1980) cites a shaft leak at Belle Isle mine that appears to be due to seal failure. Recommend a discussion be provided to substantiate this assumption or the assumption be modified as appropriate.

Comment 6-12

<u>Section 6.2.2.1, Preclosure Radiological Safety, Pages 6-81 through 6-84</u>

Table 6-8 has a number of inconsistencies with some of the findings in the text that precedes it.

1. The finding on Page 6-81 (Table 6-8) should be changed <u>from</u> "... the site meets the qualifying condition" <u>to</u> "... the site is <u>not</u> likely to meet the qualifying condition" in order to be consistent with the finding in 6.2.2.1.3 on Page 6-77.

2. The findings on Page 6-82 and 6-84 (Table 6-8) are "level 4" determinations. To be consistent with the finding in 6.2.2.2.3 on Page 6-80, they should be changed to a "level 3" finding.

3. The Section numbers under guideline titles in Table 6-8 on Page 6-83 and Page 6-84 are incorrect. Specifically, Environmental Quality should be 6.2.1.5; Socioeconomic Impacts should be 6.2.1.6; Transportation should be 6.2.1.7.

It is suggested that the inconsistencies be resolved.

Comment 6-13

Section 6.3.1.1.1, Statement of Qualifying Condition, Page 6-86, Paragraph 5

A regional model was used to simulate groundwater flow through Vacherie dome. The model cited (Intera, 1984) is for Richton Dome and not for Vacherie dome. The final EA should state how regional gradients and geohydrologic data from the Mississippi dome sites are suitable for Vacharie Dome which is in a different geologic and hydrologic setting.

Comment 6-14

Section 6.3.1.1.1, Statement of Qualifying Condition, Page 6-86, Continuing ¶

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 Vacherie dome. Large scale features such as faults, fractures, bulk permeability, rock inclusions, unsealed drill holes, partly sealed wells, or vugs could provide increased travel times through the dome are not measured by core. This observation is important because core data cannot supply information on the major forms of water movement through salt. The final Environmental Assessment should indicate the uncertainties associated with exclusively using salt core data to calculate groundwater travel times.

Comment 6-15

Section 6.3.1.1 Analysis of Favorable Conditions,Table 6-11 Page 6-123

The draft Environmental Assessment is not consistent in the finding of a favorable condition with respect to guideline 960.4-2-1(4). Table 6-11 (page 6-123) of the report states that the favorable condition is present. However, Section 6.3.1.1.1 and the findings for the four items in the Table state that none of the favorable conditions exist. This discrepancy should be resolved.

Comment 6-16

Section 6.3.1.1.2, Analysis of Favorable Condition, Page 6-87

A unique accessible environment has not been defined for the Vacherie Dome site. The text provides more than one groundwater travel time to the accessible environment. 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.

Comment 6-17

Section 6.3.1.1.2, Analysis of Favorable Condition Page 6-87

Alternate pathways to the accessible environment should be addressed in the groundwater travel time calculations. This is because the present state of knowledge about Vacherie Dome allows for a number or possible groundwater flow paths and therefore a greater range of travel times than presented in the draft EA. The following paragraphs provide specific examples of other possible flow paths.

The draft Environmental Statement contains a groundwater travel time calculation from the edge of the dome to the accessible environment through the Austin Unit. However, page 6-89, paragraph 13, 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 the edges of the domes have high permeabilities, shorter flow paths and 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 have a very low permeability (Letco, 1983) longer travel times than those presented in the draft Environmental Assessment would result. If vertical migration does occur, the flow paths could result in movement through units of good water quality.

Section 3.2.8.1, Page 3-51, ¶4, state that "More than 423 petroleum exploration wells have been drilled within 10 kilometers of the dome: 19 wells have been drilled within 1.6 kilometers (1 mile) of the 762 meter (2,500 foot) MSL contour of the salt dome. However, the groundwater travel time calculations do not consider 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 travel time to the accessible environment could be shortened.

The draft EA's analysis of host-rock travel time does not consider the effect of anomalies or splines on groundwater travel time in the salt stock. For Example Section 6.4.2.3.2, page 6-194,¶5, of the draft Environmental Assessment states "Some of the splines may have significant transmissivity and provide a potential conduit for ground-water." The travel time 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, page 121)).

Since anomalies could shorten groundwater travel times the assessment, in its analysis of host-rock travel time, should it consider the effect of these anomalies.

Given the examples above, the draft EA should incorporate a discussion of the alternative flow paths on the travel time calculations.

Comment 6-18

Section 6.1.1.1.2, Analysis of Favorable Condition, Page 6-87

To support groundwater travel time to calculations and the groundwater modeling a recent Vacherie Dome the draft Environmental Assessment cites the reference, (INTERA, 1984). However, the only Intera (1984) referenced in this section models groundwater flow around Richton Dome and does not contain any modeling data on Vacherie. The problem is that it is unlikely that dome modeling at Richton applies directly to Vacherie. The draft Environmental Assessment should explain how the hydrology around and in Vacherie Dome was modeled to determine groundwater travel times.

Comment 6-19

Section 6.3.1.1.3, Analysis of Potentially Adverse Conditions, Page 6-90, Paragraph 7

The draft Environmental Assessment 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 radionuclides a vapor phase. Inclusions possibly containing radionuclides and a vapor phase have the potential to migrate away from the waste package. The Environmental Assessment should discuss the implications of this process.

Comment 6-20

Section 6.3.1.1.3, Analysis of Potentially Adverse Condition, Page 6-91

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

Comment 6-21

Section 6.3.1.1.5, Conclusion Page 6-92, Paragraph 1

The draft Environmental Assessment finds a favorable condition for guideline 960.4-2-8-1(b)(2) which deals with groundwater with 10,000 parts per million or more of total dissolved solids along any path of likely radionuclide travel to the accessible environment. However, the draft Environmental Assessment only describes one flow path and does not discuss the likelihood of other alternative flow paths. Since upward flow paths could encounter fresh water supplies, the Environmental Assessment should discuss the likelihood of alternative flow paths and their effect on guideline 960.4-2-8-1(b)(2).

Comment 6-22

Section 6.3.1.2.2, Analysis of Favorable Conditions(2)-Geochemistry; page 6-93/6-94, paragraph 5-6/1-7

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, the DOE must present evidence that the geochemical conditions promote or inhibit, as appropriate, one or more of the processes that influence radionuclide migration listed in this guideline. The DOE discusses several of the listed processes in its 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 hypothesis (see detailed comment 3-10). In addition, it is uncertain whether or not reducing conditions will actually cause redox sensitive radionuclides to precipitate (see detailed comment 6-23). Groundwater pathways other than those in deep saline aquifers should also be considered for this guideline.

Apparently conflicting evidence is presented concerning the effect of brines on the agglomeration of colloids that could influence radionuclide migration. Paragraph 4 (p. 6-94) states that "Brine salinity will inhibit the formation of some types of colloids..." This appears to contradict paragraph 6 (p. 6-96), that "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 conditions is present. Regardless, the data do not support the statement 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 demonstrably 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 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 re-evaluate the evidence relevant to this guideline, considering the uncertainties, and perform a demonstratably conservative analysis.

Comment 6-23

Section 6.3.1.2.2, Analysis of Favorable Conditions(2)-Geochemistry; Page 6-94, Paragraph 1 and Section 6.3.1.2.3 Analysis of Potentially Adverse Conditions(3); Page 6-96, paragraph 4

The assertion 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 support the hypothesis. The DOE has asserted that chemically reducing conditions exist, despite the fact that "limited site-specific geochemical information is available for Vacherie Dome" (page 6-93, paragraph 1). The arguments used to support the assumption of chemically reducing conditions (the potential presence of methane and mineral assemblages likely to create a reducing environment) are not well documented or supported (see detailed comment 3-10). The assertion 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 3-10).

The statement made in the 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.

Comment 6-24

<u>Section 6.3.1.2.2, Analysis of Favorable Conditions(4)-Geochemistry, Page 6-95, Paragraphs 3 and 4</u>

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. Since 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. 6-215, continuing paragraph). 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 6-216) 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. 6-215, continuing paragraph). 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 ignored, including gas evolution, radiolysis, the introduction of atmospheric oxygen, and sulfide formation (see detailed comment 6-25).

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 comments 6-25, 6-69 and 6-83). The DOE should consider the uncertainties discussed above when evaluating the evidence relevant to this guideline and perform a demonstrably conservative analysis.

Comment 6-25

Section 6.3.1.2.3, Analysis of Potentially Adverse Conditons(1)-Geochemistry, page 6-95, paragraphs 8 and 9

There are concerns that the performance assessment calculations used to assess this guideline concerning the effects of groundwater conditions on the solubility or chemical reactivity 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 migrate to intercrystalline areas. Intercrystalline fluids may migrate toward the waste canisters at considerably different rates than predicted by intercrystalline brine 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 6-202, paragraph 1, #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 6-202, paragraph 1, #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 6-206, paragraph 1, to page 6-210, paragraph 5). The DOE should consider the intrusive brine scenario in its evaluation of radionuclides releases.

Comment 6-25a

Section 6.3.1.3.2, Analysis of Favorable Conditions, Page 6-97, Paragraph 4

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 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 heterogeneities upon the in situ behavior of the salt rock mass and, if appropriate, modifying the finding.

Comment 6-25b

Section 6.3.1.3.1, Statement of Qualifying Condition, Page 6-97, Paragraph 7

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 DOE-Smith No. 1 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 Vacherie Dome site. As no generic data for other Gulf Coast Domes are given it is diffucult to make a comparison. Due to difficulties in obtaining core samples suitable for testing (Lagedrost, 1983, page 14) 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 6-98, may overestimate the quality of the Vacherie Dome in situ rock mass. The relatively low strength of Vacherie Dome salt rock, as reported in Pfeifle (1983) raises additional uncertainties ad 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.

Comment 6-26

Section 6.3.1.3.1, Statement of Qualifying Condition, Page 6-98, Paragraphs All

The uncertainties in the numerical values of the creep parameters are not addressed. Table 3-6 in Chapter 3 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); the steady-state creep rates are different by orders of magnitude. The assumption of similar domal salt properties for different sites becomes questionable with respect to creep. Recommend the discussion be expanded to address the uncertainties associated with the creep law and its various parameters. Possible dependence on temperature of the creep constants should also be considered.

Comment 6-27

Section 6.3.1.3.1, Statement of Qualifying Condition, Page 6-97, Paragraph 5

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 is 2.60-3.42 Watts/MC. However Lagedrost and Capps (1983, pp. 18-20) present data that indicate a (k) variation from 2.09-3.92 Watts/MC° over the entire temperature range tested. Recommend that DOE consider presenting the range of (k) variation for the entire temperature range tested. (NOTE: Footnotes (d) and (e) in Table 6-9 appear to have been transposed.)

Comment 6-28

Section 6.3.1.3.2, Analysis of Favorable Conditions, Page 6-99, Paragraph

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 indicate that in relation to other possible repository host rock the coefficient is high. For example, basalt has a coefficient range of $6.2\text{-}10.8 \times 10^{-6}$, and tuff a range of $4\text{-}9 \times 10^{-6}$ per °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. By comparison, the Vacherie Dome draft EA gives a range for dome salt of $36.5\text{-}46.5 \times 10^{-6}$/°C. Recommend that this data be considered in the evaluation.

Comment 6-28a

Section 6.3.1.3.2, Analysis of Favorable Conditions, Page 6-99

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 may be optimistic. 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.

Comment 6-29

<u>Section 6.3.1.3.3, Analysis of Potentially Adverse Conditions (1), Page 6-100 Paragraph 1</u>

It is stated that the Vacherie Dome salt rock conditions do not require engineering measures beyond reasonable technology to ensure waste containment or isolation. Although many Gulf Coast salt mines have been and are being mined successfully, shear zones have been encountered (gas pockets and other inpurities) 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 do not have the thermal conditions expected in the repository. As a consequnce, the likelihood and nature of expected adverse condtions which may require engineering measurements beyond reasonably available technology is uncertain. Without site specific data regarding Rock Characteristics within the Vacherie Dome the presence of potentially adverse conditions should be considered. It is recommended that the evaluation be expanded to address the uncertainties related to the expected rock conditions and if appropriate the finding be modified to reflect the results of the reevaluation.

Comment 6-29a

<u>Section 6.3.1.3.3, Analysis of Potentially Adverse Conditions Page 6-101 Paragraph 1</u>

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. Recommend 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.

Comment 6-30

Section 6.3.1.3.3, Analysis of Potentially Adverse Conditions, Page 6-101, Paragraph 1

In this section it is stated that analysis of the effects 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 analyses presented in section 6.4.2.3 to support this statement appears to be based upon 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). This section 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 elevated temperature on stress is not addressed. It is recommended that the analysis be expanded to address thermomechanical coupling effects on a potentially heterogeneous system to support the finding presented and that the finding be modified as appropriate.

Comment 6-31

Section 6.3.1.3.5, Conclusion, Page 6-101, Paragraph 1

The Draft EA states that the Vacherie Dome is a massive body of halite. This characterization does not consider the possibility that the salt dome may have anomalies. The absence of site specific data raise uncertanties regarding the characterization made. Recommend that the evaluation be expanded to include a consideration of uncertainries regarding the presence of anomalies.

Comment 6-32 (This comment was incorporated elsewhere in the comment package.)

Comment 6-33

Section 6.3.1.6, Dissolution, Page 6-108, Paragraph 5 and Page 6-109, Paragraph Continued From Previous Page

The discussion of possible Quaternary collapse of overdome deposits does not include the high "lip" of Tertiary deposits which may be evidence for more extensive Quaternary collapse. This lip of Tertiary deposits at the constricted mouth of Bashaway Creek has been interpreted to represent Quaternary collapse caused by dissolution (ONWI-467, page 87). This interpretation allows that Quaternary dissolution may have been more extensive, in different locations of the dome, than has been reported in the draft EA. It also suggests that dissolution can occur independently in different portions of the dome. Uncertainties regarding the extent and distribution of Quaternary dissolution are not included in the evaluation and addiditonal evidence exists for finding the favorable condition to be not present for 960.4-2-6, b, Dissolution. DOE should consider including a discussion of the uncertainties associated with Quaternary dissolution in revised findings.

Comment 6-34

Section 6.3.1.6, Dissolution, page 6-109, paragraph 1

The draft EA has not presented a discussion of caprock fault offset, here or in section 3.2.5.1, and its effect on groundwater travel times and dissolution. The complex overdome faults shown in ONWI-467, Figure 31, page 117, penetrate and offset caprock to an undetermined depth. Numerous faults into the caprock may be important as preferred pathways for vertical groundwater travel to the dome. Martinez et al.,(1975) report a similar situation at Winnfield dome. As a result of groundwater movement, dissolution may be greatly enchanced and additional evidence exists to consider the potentially adverse condition to be present for 960.4-2-6, c, Dissolution. Furthermore, if the faults reflect spines of movement and are underlain by central anomalous zones, the central anomalous zones could adversely affect the lateral extent of available host rock and the favorable condition may not be present for 960.4-2-3(b)(1) and 960.5-2-9(b)(1), Rock Characteristics. These faults should be considered by DOE as a major component of their discussions of groundwater travel, dissolution, and rock characteristics. DOE should consider amending the EA to reflect these considerations.

Comment 6-35

Section 6.3.1.7, Tectonics, page 6-112, paragraphs 1 and 2

The omission of a discussion of lineaments and their relation to the dome, both here and on pages 3-26 to 3-35, does not enable the NRC staff to make an independent evaluation of their influence on dome growth (halokinesis) or groundwater travel times. Arcuate lineaments discussed in ONWI-119, page 10-27, Figure 10-8 and ONWI-467, pages 6, 7, and 9 on both the eastern and western dome margins may be important in evaluating dome growth and groundwater travel times. Their positions within two miles of the dome and their resemblance to the shape of the dome margin suggests the possibility of recent dome growth (halokinesis) that disturbed adjacent surface deposits. Fractures or joints in these deposits may enhance the vertical component of groundwater travel. Thus, additional factors exist to support the draft EA findings that the favorable condition is not present and the potentially adverse condition is present for 960.4-2-1(b)(3) and 960.4-2-1(c)(3), Geohydrology. DOE should consider including a discussion of these lineaments and as appropriate integrate them into Section 3.2.5.4, Uplift and Subsidence, 3.2.5.6, Salt Dome Development and Geometry, and 3.3.2, Groundwater.

Comment 6-36

Section 6.3.1.7, Tectonics, page 6-112, paragraph 3

The NRC staff'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 Herrmann, 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. 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.

Comment 6-37

Section 6.3.1.7, Tectonics, page 6-113, paragraph 3

The draft EA has not included a discussion of the "Payne Fault" (Payne, 1968) that NRC considers may have an effect on regional groundwater travel times. The fault, recognized in the Sparta sand, is discussed at some length in ONWI-119 but is omitted, without basis, from consideration both here and in Section 3.2.5.1. Fault offset of the Sparta aquifer near the dome is important to the evaluation of regional groundwater travel times. Without such consideration, additional evidence is considered by NRC to exist to support the DOE 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 the Payne Fault and its effect on groundwater travel times in the final EA.

Comment 6-38

Section 6.3.1.7, Tectonics, page 6-112, paragraph 4

The draft EA has not presented a discussion here or in Section 3.2.5.2, Seismicity, on the spatial correlation between two felt events, maximum intensity VII, and the Mt. Enterprise Fault Zone which the NRC staff considers may have an effect on evaluations of the future seismic potential of this fault zone. The zone is located southwest of the dome and trends toward the site. The zone is important as a potential growth feature in the evaluation of seismic hazard potential near the site. Until this correlation and its associated uncertainties are addressed, the potentially adverse condition is present for 960.4-2-7 (c)(2), Tectonics. DOE should consider including a discussion of the future seismic potential of this fault zone in the final EA.

Comment 6-38a

Section 6.3.3.2.1, Qualifying Condition-Assumptions and Data Uncertainty, Page 6-154 Paragraph 10

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; Page 86-92), 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 14). 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 DOE-Smith No.1 for the Vacherie Dome may not 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.

Comment 6-39

Section 6.3.3.2.1, Qualifying Condition - Assumption & Data Uncertainties, Page 6-155, Paragraph 1

The statement is made in the Vacherie Dome Site Draft EA that design parameters derived from three tests will lead to a conservative design. The reference used for this evaluation (Pfeifle et al., 1983), however, considers only laboratory-derived creep parameters and does not indicate a basis for what "conservative" design parameters are for room closure. It is recommended that further supporting evidence be given for this statement.

Comment 6-40

Section 6.3.3.2.2, Analysis of Favorable Conditions (2), Page 6-155, Paragraph 1

This section of the Vacherie Dome Site draft EA states that use of artificial support for roof control of underground openings is expected to be minimal. This section does not include a discussion describing the thermomechanical effects of elevated temperature on salt strength vs. lithostatic pressure at the host rock horizon, ground control methods, and the resulting support measures. Also, ventilation circuits may have to remain open through areas adjacent to waste emplacement panels to provide a safe working environment for underground personnel. Recommend that the evaluation be expanded to consider retrievability of a waste package in an elevated temperature environment.

Comment 6-40a

Section 6.3.3.2.1, Statement of Qualifying Conditions, Page 6-155, Paragraph 1

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 uncertainties.

Comment 6-41

Section 6.3.3.2.2, Analysis of Favorable Conditions, Page 6-155, Paragraph 6

In this section of the Vacherie Dome Site Draft EA the effect of the virgin salt rock temperature has not been adequately discussed. Earlier studies (Stearns-Roger, 1981, ONWI-283) have identified virgin salt temperature as an important geotechnical factor for engineering feasibility evaluations with regard to room closure. Temperatures reported by Law Engr. 1983 (ONWI-289) vary considerably for the Cypress Creek (110°F - 118°F), Vacherie (127°F - 136°F) and Richton (122°F) dome sites and all are much higher than the value of 100°F used for ventilation studies in the Stearns-Roger 1984 report.

It is recommended that the evaluation be expanded to include consideration of in situ temperature effect on room closure and stability analysis.

Comment 6-41a

Section 6.3.3.2.2, Analysis of Favorable Conditions, Page 6-155, Paragraph 8

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 appropirate, the finding presented be modified based upon the results of the reevaluation.

Comment 6-42

Section 6.3.3.2.3, Analysis of Potentially Adverse Conditions Page 6-156, Paragraph 1

The evaluation presented may underestimate the potential problems associated with shaft freezing. 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 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. It is recommended that the discussion be expanded to include consideration of uncertainties should expand this evaluation to include mining experience in mines temperature environment expected after emplacement of waste of appropriate the finding be modified to reflect the results of the reevaluation.

Comment 6-42a

Section 6.3.3.2.2, Analysis of Favorable Conditions, Page 6-155, Paragraph 8

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.

Comment 6-42b

Section 6.3.3.2.3, Analysis of Potentially Adverse Conditions, Page 6-156 Paragraph 2

The EA states that "shaft construction will require dewatering and groundwater freezing techniques in penetrating aquifers, but these techniques are proven technology." In Section 4.1.2.2.1, p. 4-51, it is stated that the water-bearing strata will be stabilized by freezing. Uncertainties are not reflected in these statements. As reported in D'Appolonia (ONWI-255, 1981) there are several disadvantages of freezing with regard to its impacts on long-term sealing particularly where a thich fractured caprock is present. This report (page 90) stated 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 Vacherie Dome cannot be ruled out. Thus, a conclusion that freezing techniques may be considered to be proven technology for the Vacherie 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.

Comment 6-43

Section 6.3.3.2.3, Analysis of Potentially Adverse Conditions, Page 6-156, Paragraph 5

In this section of the EA, the finding is made that a potentially adverse condition is present with regard to the requirement for extensive maintenance of underground openings. This finding is inconsistant with the evaluation which state that only routine remedial maintenance of subsurface conditions of the site will be required. Experience in Gulf Coast salt mines, as documented in Kupfer (1980), suggests that anomalous zones which would require extensive maintenance may be encountered. Extensive maintenance may be required especially under adverse induced thermal loading and in support of retrieval operations. Although the finding presented is not in question, the evaluation should be expanded to include a discussion of expected maintenance requirements.

Comment 6-44

Section 6.3.3.2.3, Analysis of Potentially Adverse Conditions , Page 6-156, Paragraph all

The EA identifies principal geomechanical factors that could influence retrieval in the immediate vicinity of the waste canister. The uncertainties related to the influence of geomechanical factors is not adequately addressed. While the very-near-field conditions are important, particularly for locating canisters, describing their orientation, and extracting them, conditions remote from the canister will also influence remining and retrieving operations. Retrieval operations may have to be carried out in thermally-elevated conditions that will pose ventilation, mining, and 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. Operators proficient in using such equipment under repository retrieval conditions do not exist and will need to be trained. The discussion presented does not address the effect of the potential presence of anomalies on retrieval. It is recommended that this discussion be expanded to address the above concerns.

Comment 6-45

Section 6.3.3.2.3, Analysis of Potentially Adverse Conditions, Page 6-156, Paragraph All

The Vacherie Dome Site draft EA states that thermally induced fracturing, hydration and dehydration of mineral components, or other physcial, chemical, or radiation related phenomena could pose potentially adverse conditions during the retrieval phase of repository operation. The evaluation appears to understate the difficulties and hazards that may 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, for example the thermal distribution calculations (Figure 6-6, p. 6-198, Figure 6-7, p. 6-199) it is clear that an extensive area (radius) close to the emplacement holes will be subjected to temperatures of over 100°C within 5-10 years after emplacement. Extrapolating the (admittedly very limited) data from Figure 3-16 (p. 3-43) at 100°C suggests that the shear strength of salt at 100°C will be approximately 16-18 MPa. The in situ vertical stress at the repository level should be over 15MPa. It would appear therefore, that either the salt rock in the vicinity of the emplacement holes will have to be cooled down significantly or that extensive heavy support measures may be required to enable the re-excavation of the emplacement rooms to recovery the waste canisters. The second paragraph of this section of the draft EA states that the potential for thermal decrepitation of rock adjacent to the canister is minimal. Uncertainties regarding this statement have not been addressed. Based upon information presented in Lagedrost and Capps, 1983, ONWI-522 regarding the difficulty of obtaining acceptable test samples from the Vacherie Dome core it is probable that the Vacherie Dome samples on which decrepitation tests have been performed were stronger than the average rock salt in the cored sections. Uncertainties regarding decrepitation due to hetrogenities within the salt rock mass were not addressed. Furthermore, the thermal decrepitiation tests have been performed on unloaded samples. Given the very substantial reduction in strength with increasing temperature (as documented in Figures 3-16, p. 3-44) and the potential heterogenteities of the host rock mass it is possible that thermal decrepitation would be more severe for in situ rock salt loaded to a stress similar to that expected around the canister holes. The potential for migration of brine towards the waste package is another factor to be considered 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. Recommend that the evaluation for this guideline be expanded to address the above comments.

Comment 6-45a

Section 6.3.3.2.5, Conclusion for Qualifying Condition, Page 6-158, Paragraph 4

In this section of the draft EA, it is stated that "The salt at Vacherie Dome is clean and uniform", and in the same section, it is stated that "The clean uniform composition and massive characteristics of the Vacherie Dome salt will require minimal artificial support." In the Assumptions and Data Uncertainty section, p. 6-97, 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 Vacherie 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 Vacherie Dome salt stock.

Comment 6-46

Section 6.3.3.3.3, Analysis of Potentially Adverse Condition, Page 6-160

This section states that the potentially adverse condition is not present for groundwater 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 groundwater problems. There are two concerns with the evaluation and finding. First, groundwater 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 ground freezing. In salt domes where water in the water bearing zone is controlled by fractures and possibly by open cavities there are uncertainties that freezing will be successful (D'Appalonia, 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 groundwater inflows and indicate methods that could be used to seal the shafts should ground freezing provie impracticable.

Comment 6-46a

Section 6.3.3.3.3, Analysis of Potentially Adverse Conditions, Page 6-160, Paragraph 11

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 possible 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.

Comment 6-47

Section 6.3.4.2.2, Assumption and Data Uncertainty, Page 6-170, paragraphs 2 and 3

This section states that the engineering work performed thus far assumes non-gassy subsurface conditions. A statement on Page 6-156 notes that gas or brine pockets may be encountered in the dome. Moreover, brine and/or gas pockets could significantly affect the overall subsurface costs. Recommend that gassy or brine conditions be considered in appropriate evaluations.

Comment 6-48

Section 6.3.4.3, Analysis, Page 6-170

The analysis in this section assumes a two-level repository system at Vacherie Dome. The considerations in this section, however, do not discuss any different treatment for a two-level system. The limited lateral extent of the Vacherie Dome imposes the two-level configuration. The special design and construction problems of a multi-level repository are not explicitly identified nor is an analysis cited. It is recommended that the unique features of the proposed design for Vacherie dome be clearly stated for comparison with a single-level design.

Comment 6-49

Section 6.4.1, Preclosure Radiological Assessment for Vacherie, Page 6-171 to 6-184

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 6-72).

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 defected waste package could conceivably begin immediately after emplacement. This damage process and its potential consequences should therefore be considered in the performance analysis.

Comment 6-50

Section 6.4.1.2, 10 CFR Part 20 Calculation Page 6-161, Paragraph 4.5

In the draft EA the term "accessible environment" is incorrectly applied 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 draft EPA standard the term "accessible environment" is used only for postclosure releases. For preclosure releases, EPA refers to the "general environment" which includes areas "outside sites with which any operation . . . is conducted."

Comment 6-50a

Section 6.4.1, Preclosure Radiological Assessment, Page 6-171 to 179

In calculating the source term for the preclosure radiological assessment are selected scenarios are not shown to be bounding scenarios, are not complete and it was nonconservatively assumed that a most 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 the release fractions are eifficult to obtain largely because of the acciden-specified nature of the release and the lack of addquate 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 EA.

Comment 6-51

Section 6.4.1.2, 10 CFR 20 Calculations, Pages 6-175 to 6-177

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 6.4.1.2.2.7 DOE/RW-0012).

Comment 6-51a

Section 6.4.1.3, 40 CFR 191 Calculation, Page 6-177

The meteorological data base identified in this section includes information not identified in Section 6.2.1.4 (see also detailed comment 6-1). The use of meterological data from Mobile, AL (Reference NOAA, 1971) as the bases for the selection of the atmospheric dispersion conditions for the 40 CFR 191 calculation is without substantiation and inconsistent with the atmospheric dispersion analysis presented in Section 3.4.3 and the air quality impact assessments presented in Sections 4.2.1.3 and 5.2.5. Also, the 40 CFR 191 calculation apparently relies on the use of the straight-line, Gaussian atmospheric dispersion model for calculating centerline concentrations to approximate annual average conditions (see the reference to Waite, 1984). The resultant relative concentration (X/Q) values are consistent with expected annual average values, although this consistency is somewhat fortuitous. Both the meteorological data from Mobile, AL and Shreveport, LA (used elsewhere in the draft EA) are available in the proper format for use in an appropriate annual average atmospheric dispersion model. It is suggested that Section 6.4.1.3 be revised to be consistent with respect to Sections 6.2.1.4, 3.4.3. 4.2.1.3, and 5.2.5. True annual average conditions could also be calculated and compared to the approximations to ensure consistency.

Comment 6-52

Section 6.4.1, Preclosure Radiological Assessment for Vacherie Page 6-171.

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) and with the management of the solid low-level radioactive 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 be disposed of also. 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 should present an assessment that considers 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/CR-0695).

Comment 6-53

Section 6.4.1.4, Accident Calculations, Table 6-26,Vacherie Accident Dose Comparison, Page 6-184.

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 an expected value of 7E-03 for this location (Turner 1967). The expected value has been determined from the meteorological conditions stated (Waite, 1984) and compares favorably with the values at 240 meters (Waite, 1984, Table 2-5, 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, Table 6-26 should be reviewed and revised as appropriate.

Comment 6-54

Section 6.4.2, Preliminary Postclosure Performance Assessment, Pages 6-184 to 6-234

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, the probability of discrete event failure modes should be considered. The consequences of the potential failure modes should be presented regardless of the occurrence probability of these disruptive events.

Comment 6-55

Section 6.4.2.3, Preliminary Subsystem Performance Assessments, Pages 6-191 to 6-224

Uncertainties in the input data and modeling procedures, which concern radiation conditions, thermal conditions, fluid conditions, and engineered barrier subsystem performance, lead to uncertainties in the performance predictions 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 should be provided to support the conclusion that the site meets the Postclosure Guidelines specified in 10 CFR 960.4-1, 960-4-2-1, and 960.4-2-2.

Comment 6-56

Section 6.4.2.3, Preliminary Subsystem Performance Assessments, page 6-193 paragraph 2

The statement in the draft EA that "Chambre and others (1983) have found that the low solubility..." of elements and materials around a waste package limit the radionuclide release rate implies that there is more information than there actually is in this reference. The wording "have found" implies that direct evidence from experiments or field data confirm the existence of the favorable geochemical processes discussed in this paragraph. However, the work of Chambre and others (1983) is strictly one of theoretical model calculations. No confirmatory results have been obtained to validate the predicted processes. It is suggested that wording more representative of the available information be used, and that additional conservatism not be claimed, because of the uncertainty in whether or not expected processes will actually occur.

Comment 6-57

Section 6.4.2.3.1, Thermal Conditions Pages 6-193 to 6-196; Uncertainties in Waste Package Thermal Analysis

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 of waste package lifetime should be considered in the final EA.

Comment 6-58

Section 6.4.2.3.1, Thermal Conditions Page 6-193, Paragraph 6

The thermal analyses by McNulty and others (1984, Part 1) presented in this section have apparently used thermal conductivity values for Vacherie salt that have been increased by 40 percent. The reason cited is that the laboratory measurements are suspect for a number of reasons (such as sample disturbance). Wherein the lab-measured data may have uncertainties, arbitrarily increasing the conductivity by 40 percent introduces a lack of conservatism in the analyses. Higher values of thermal conductivity would reduce the predicted peak temperatures in the very-near-field as well as reduce temperature gradients, thus resulting in a more moderate thermal and thermomechanical environment. It is recommended that lower values of conductivity be used until in situ measurements or reliable laboratory data are available.

Comment 6-60

Section 6.4.2.3.2, Fluid Conditions in Salt, Page 6-196, Paragraph 3

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 $2.7 \times 10^6 m^3$ 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.

Comment 6-61

Section 6.4.2.3.2, Fluid Conditions In Salt; Pages 6-196 to 6-197

The waste package performance assessment does not address heterogeneities 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 (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 waste package performance assessment (including the calculations of brine migration, corrosion of the overpack, and related factors) should be carried out taking into account local (near-field) conditions, including inhomogeneities in in-situ brine quantity and composition.

Comment 6-62

Section 6.4.2.3.2, Fluid Conditions in Salt; Analytical Approach, Page 6-196/6-197, Continuing Paragraph and 1 to 3

The BRINEMIG code used in the 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 detailed comment 6-25). 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). The DOE should consider these uncertainties regarding BRINEMIG and the application of its results when evaluating the evidence relevant to these conditions and perform a conservative analysis.

Comment 6-63

Section 6.4.2.3.3, Waste Package Performance; 2. Brine Flow Rate, Page 6-202, Paragraph 1, Item 2

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 is a 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.

Comment 6-64

Section 6.4.2.3.3, Waste Package Performance 3: Brine Composition, Page 6-202 Paragraph 1, Item 3

Hubbard, et al. (1983) (note: should be 1984), is incorrectly cited to support the statement that the composition of thermally migrating brine at Vacherie "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 the Vacherie Dome site may be non-conservative. The inconsistency with respect to the Mg content of brines should be resolved.

Comment 6-65

Section 6.4.2.3.3, Waste Package Performance, Page 6-202

The draft EA states that the corrosion reaction stoichiometry produces 271 cubic meters of hydrogen gas per centimeter of steel overpack thickness dissolved. The document does not address the consequences of this gas generation. Given the low permeability of the salt, it is unlikely that this gas will dissipate quickly into the rock matrix. The possibility of creating cracks or fractures in the salt due to the pressure build-up cannot be ruled out. On Page 6-210, it is stated that the effect of gas evolution from the corrosion process on the package integrity has not been considered. Recommend that DOE present appropriate analyses that investigate potential adverse effects that might be caused by this large volume of gas that apparently cannot escape.

Comment 6-66

This comment has been incorporated elsewhere in the comment package.

Comment 6-67

Section 6.4.2.3.3, Waste Package Performance, Page 6-206, #6

Boundary stress calculations assume lithostatic pressure only. The additional pressure on the canister created by the generation of hydrogen gas (see p.

6-202, #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.

Comment 6-68 (This comment was incorporated elsewhere in the comment package.)

Comment 6-69

Section 6.4.2.3.3, Waste Package Performance, Page 6-206, 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 mechansims discussed are relevant only for certain radionuclides, this additional conservatism may not be claimed for all radionuclides in the calculation.

Comment 6-70

Section 6.4.2.3.3, Waste Package Performance, Boundary Conditions at the Package Surface, Subpart 6, Boundary Stresses, Page 6-206; on the Waste Package

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 20 years after burial, starting at time zero.

In Figure 6-15, where time starts at two years, the failure thickness (i.e., the thickness of the overpack required to withstand lithostatic pressure) of the overpack is provided as a function of time for the first 20 years following repository closure. No explanation of this time-dependent variation 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 the peak 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.

Comment 6-71

Section 6.4.2.3.3, Waste Package Performance, Pages 6-197 to 6-209 Radiation Field, Figures 6-11 and 6-12

The radiation levels associated with the waste package influence corrosion, decrepitation of the salt, and formation of colloidal sodium. While the draft EA presents the results of a recent calculation (Jansen G., 1984a) of the expected radiation dose rate with distance and time, 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 order of magnitude. 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 (Jansen, G., 1984a and b; Shornhorst, J. R., 1982) 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.

Because the radiation field influences the characteristics of the immediate environment and, therefore, the predicted containment time and concentration of nuclides in solution, an explanation should be provided for the values used.

Comment 6-72

Section 6.4.2.3.3, Waste Package Performance, Pages 6-197 to 6-210, Thermal Conditions

The draft EA does not adequately discuss the uncertainties in the predicted temperatures used in waste package performance analysis. There are two components of the 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, this becomes a dominating factor in the accuracy of the predictions. The thermal conductivity of salt is affected by the content of non-salt materials, such as water, clay and other minerals. 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, may not account for the effects of non-salt materials.

The maximum temperature at the salt/canister interface depends 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, the brine migration rates, the chemical composition of the brine, package degradation mechanisms and, therefore, package lifetime. The temperature gradients in the vertical direction is expected to contribute to brine flow toward the waste package. An assessment of the impact of the uncertainties in temperature on package performance should therefore, be provided 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 associated Technical Guidelines 960.4-2-1, 960.4-2-2, and 960.4-2-3). Any uncertainties that do exist in the analysis should be considered.

Comment 6-72a

Section 6.4.2.3.3, Waste Package Performance, Pages 6-197 to 6-210

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 three months at 150°C to salt containing 30% brine had a penetration rate of 0.3 mm/yr. (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 allowances specified for SFPWR packages 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 become 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 corrosion 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.

Comment 6-73

Section 6.4.2.3.3, Waste Package Performance, Pages 6-197 to 6-210

The draft EA indicates that WAPPA, BRINEMIG, TEMPV5 and other computer codes, which were used in the draft 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.

Comment 6-74

Section 6.4.2.3.3, Waste Package Performance, Pages 6-197 to 6-210

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 in-situ, initial Mg content of the inclusions is low, hence the thermally migrating, inclusion brine will be of low (less than 200 ppm) Mg content as it contacts the waste package. For reasons outlined in detailed comment 6-64, this assumption appears to lack adequate foundation.

The second problem with the low-Mg brine assumption is related to the fact that regardless of the initial content of the brine, the composition of the brine may change significantly as it 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 Guidelines with regard to demonstrating for the given reference waste package design, that the site is amenable to the use of engineered barriers.

Comment 6-75

Section 6.4.2.3.3, Waste Package Performance; Corrosion and Failure of the Overpack, Page 6-210, Paragraph 2 to 5

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 detailed comment 6-25). 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.

Comment 6-76

Section 6.4.2.3.3, Waste Package Performance, Page 6-210, Corrosion and Failure of the Overpack (by non-uniform corrosion)

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 can not 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 corrosion process should also be considered.

Comment 6-77

Section 6.4.2.3.3, Waste Package Performance, Page 6-210, Corrosion and Failure of the Overpack (Brine Distribution)

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 the 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 EA; and the results of the calculation should be reconciled with the 960.4-1(a) Postclosure Guideline finding.

Comment 6-78

Section 6.4.2.3.3, Waste Package Performance, Page 6-202 and 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 warrant 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 EA should consider the possibility of radiation-induced changes to the waste form and canister.

Comment 6-79

Section 6.4.2.3.3, Waste Package Performance, Page 6-210, Paragraph 3

The draft EA mentions numerous corrosion mechanisms but claims that the over-pack material "is not especially susceptible to pitting and non-uniform corrosion..." Later in the same paragraph, it is stated that, " A similar result would be obtained if pitting or stress corrosion cracking increased the local penetration." These statements seem to suggest that pitting corrosion is possible. It is not clear what is meant by "similar results." Data presented in a Westinghouse (1983, ONWI-438) report show sea water pitting corrosion rates for carbon steels to be a factor of 2 to 13 (Table B-6, Page 398) higher than the uniform corrosion rates. Such rates could alter the predicted waste package life time significantly. DOE should consider the potential for significantly higher corrosion rates than have been suggested in the draft EA and modify the predicted package life accordingly.

Comment 6-80

Section 6.4.2.3.4, Release Rates from the Engineered Barrier Subsystem

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 lowered 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, T. H., 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, T. H., 1982). Recent data indicates that radiolyses of brines could result in oxidizing conditions thus increasing the solubilities of many nuclides (Gray, W. J. and Simonson, S. A., 1984). While Sr forms relatively insoluble complexes with sulfate and carbonate anions, it does form soluble chlorides. M. A. 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 objectives (10 CFR 60.113). These uncertainties should be specifically considered in the EA performance assessment.

Comment 6-81

Section 6.4.2.3.4, Release Rate from the Engineered Barrier Subsystem, Page 6-210/215, Paragraph 7 and Continuing Paragraph

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. Only thermally migrating brines are considered for estimating radioactive releases. However, the intrusive brine scenario is considered in evaluation of waste package performance. The EA should also consider the intrusive brine scenario in its evaluation of radionuclide releases.

Comment 6-82

Section 6.4.2.3.4, Release Rate from the Engineered Barrier Subsystem, Page 6-210/215, Paragraph 7 and Continuing Paragraph

The DOE notes that there are measured solubilities that would be more conservative than the WISP values, but they are not used.

Comment 6-83

Section 6.4.2.3.4, Release Rate From the Engineered Barrier Subsystem, Page 6-215, Paragraph 2

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.

Comment 6-84

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

Inconsistencies in the amounts of radionuclides tabulated in the draft EA suggest calculational errors in estimates of 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 for C-14, I-219 and Cm-244 (among others) in Table 6-26, when expressed in terms of grams per package, do not appear to agree with those in Table 6-32. These inconsistencies 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 reach the 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 6-80), or related changes in flow rates and total accumulated brine, will introduce further uncertainties into these predicted releases. These preliminary estimates should be reexamined to resolve the inconsistencies.

Comment 6-85 (This comment was incorporated elsewhere in the comment package.)

Comment 6-86

Section 6.4.2.3.5, Geologic Subsystem Performance, Page 6-223, Paragraph 2

The draft EA cites calculations by Gureghian, et al., (1983) that predict very long ground water penetration times in evaluating performance of shaft seals. These calculations made assumptions that may have precluded adverse findings. Specifically, the analysis uses unsaturated flow which would have given longer travel times and reduced fluxes. Further, it ignores salt dissolution due to intruding water, and finally, it assumes that the disturbed zone around the shaft perimeter is negligible. All of these above assumptions (which are not conservative) tend to reduce the ground water flux and increase the penetration times. In addition, the performance of shaft seals and their ability to prevent ground water from entering the repository is discussed in this section. The section concludes that " ... a successful seal system will not affect the expected performance of a repository ..." While a successful seal will clearly not affect the site adversely. The final EA should address the consequences of unsuccessful seals. It is recommended that DOE consider a more conservative set of conditions in calculating the penetration time for ground water to reach repository level.

Comment 6-87

Section 6.4.2.4.2, Performance Limits Case, Page 6-228

The draft EA has presented results of diffusion analyses that assume a 300-year package life and 10^{-5} per year release rate. These analyses are not conservative in that the case of unlimited brine flow is not analysed in conjunction with a 300-year package life. Availability of larger quantities of brine (than the assumed $0.19m^3$) will result in higher concentrations of radionuclides at a given location. It is recommended that DOE include in its analysis the case of a failed package at 300 years in conjunction with unlimited brine flow.

Comment 6-88

Appendix 6-A, Estimation of the Extent of the Disturbed Zone, Pages A-3 Paragraph 7

This section presents rationale for estimating the potential for fracturing aquitards 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 a bedded formation. No discussion of the relevancy of the analysis to dome was presented. Recommend that the discussion be expanded to address uncertainties related to the relevancy of the information presented to the Vacherie Dome site.

Comment 6-89

Appendix 6-A, Estimation of the Extent of the Disturbed Zone, Page 6A-2, Paragraph 4

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. Page 21 of the reference states that "gas bursts" or "blowouts" which occur during excavation result in rounded or conical opening into the walls or ceilings that are commonly 1 to 10 meters 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 A-18), 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 permeability...". In volume II, Appendix II, p-20 of the Golder Associates, 1977 reference it is stated: "The process 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, page 32b, also stated that "one might assume that fractures (caused by mining process) are abundant within three feet (1 m) of the surface, commonplace to 10 feet (3 m), and potentially present for 20 to 50 feet (6-15m)." On this same page is 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 (2 m) in diameter and extends up into the roof at least 30 feet (10 m)." 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 the extent of the disturbed zone be modified as appropriate to reflect the results of the evaluation.

Comment 6-90

Appendix 6A, Estimation of The Extent of The Disturbed Zone, Page 6A-6

The Table included in the conclusion paragraph shows a disturbance range of 10 meters for the thermal-hydrologic effects. It is not clear whether 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. Recommend the discussion be expanded to provide clarification of the above.

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