NRC COMMENTS

ON

DOE DRAFT ENVIRONMENTAL ASSESSMENT

FOR THE

CYPRESS CREEK DOME SITE

March 20, 1985

CYPRESS CREEK 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

Groundwater Travel Time

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

The draft EA concludes that the favorable condition of a 10,000 year travel time (960.4-2-1(b)) is present because the pre-waste emplacement ground-water travel time horizontally from the repository to the edge of the salt dome is estimated at 107,000 years and total travel time from the repository to a point 10 kilometers (6 miles) distant is conservatively estimated to range from 175,000 to 239,000 years. However, many of the assumptions, approaches, and ranges of values are not conservative with respect to available information and may result in inappropriately high calculated groundwater travel times. Specifically, the assumptions and approaches used in the draft EA are not conservative with respect to flow path, gradient, permeability, and porosity, as discussed below.

Potentially shorter flow paths could occur along anomalous zones, faults, and drill holes within the dome and outside the dome through faults, fractures, drill holes and along the dome edge, as opposed to the single pathway horizontally through pure salt and through the upper Claiborne unit (see detailed comments 6-9, 6-10, 6-15, and 6-51). Groundwater travel time calculations used regional model generated hydraulic gradients, permeabilities, and porosities rather than field data. Therefore groundwater travel times may not be conservative (see detailed comments 3-9, 3-10, 3-11, 3-12, and 6-12). The disturbed zone may be greater than anticipated which could result in shorter groundwater travel times (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 5-17).

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

Comment 2

Radionuclide Mobility

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

Evidence presented in the 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 1). 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 readily 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 3-7 and 6-18). The reduced constituents cited in the draft EA to support the contention that reducing conditions are expected (i.e., CH_4, H_2S) can persist metastably in oxidizing groundwater. Certain processes which may influence the redox conditions are ignored, such as radiolysis, waste package corrosion reactions, and the presence of atmospheric O_2 (see detailed comment 6-21). 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 3-7 and 6-18).

The discussion of radiocolloid formation and organo-radionuclide complexation uses data that are not applicable to the expected site conditions (see detiled comment 6-19). 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 unsupported 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 6-18 and 6-19). 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 6 and detailed comments 6-20 and 6-21). These performance calculations are used to make favorable findings for guidelines 960.4-2-2(b)(4) and 960.4-2-2(c)(1), concerning radionuclide solubility and the effects of groundwater conditions on the stability or chemical reactivity of the engineered barrier system, respectively. The favorable findings are not strongly supported due to the limited applicability of the performance assessment calculations. For guideline 960.4-2-2(c)(3), concerning redox conditions, the data presented are too ambiguous to support a finding that the potentially adverse condition of chemically oxidizing conditions will not be present (see detailed comment 6-18).

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

Comment 3

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 Characteristic guidelines presented in the draft EA contain statements that suggest the Cypress Creek Dome salt stock is essentially homogeneous throughout the site (pages 6-95 and 6-151). Generic evidence from Gulf Coast salt mines does not support these statements. Mining experience indicates that heterogeneities such as brine, gas pockets, anomalous zones (which often contain impure salt, clay, and brecciated/shear zones) may exist in dome interiors and near dome perepherie. (See detailed comments 6-23, 6-43, 6-44, 6-49, and 6-50). The effects of such heterogeneities (combined with thermal loads) on construction of the repository, on maintenance, on potential retrieval operations, and on estimates of the extent of the disturbed zone have not been discussed. An assumption of homogeneity tends to underestimate these effects. The presence of heterogeneities would also tend to increase the level of uncertainty regarding the draft EA assumption that rock property data derived from core samples of essentially pure salt may be considered representative of the thermal-mechanical properties of the salt units at the Cypress Creek Dome. 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 draft EA findings presented as noted in the following discussion.

The draft EA presents estimated values of physical, thermal, and engineering properties of the Cypress Creek Dome salt in Tables 3-5 and 3-6 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 MCCG-1 at the Cypress Creek Dome site, and the draft EA has assumed that the properties of salt from Vacherie and Richton

Domes are applicable for salt from this dome (see detailed comments 3-4, 3-6, 6-25, and 6-42). Although the draft EA correctly identified that the domes internal structure is typically steeply dipping and that data from the single borehole cannot be considered representative of the entire salt stock (page 6-82, paragraph 2), it appears that an implicit assumption of homogeneity of the rock mass was made and the data in Tables 3-5 and 3-6 for pure salt were used in rock characteristics evaluations. It also appears that uncertainties related to the adverse effects of heterogeneities were not factored into the evaluations. Since the engineering behavior of the in situ salt rock, especially under waste induced thermomechanical loading conditions, can be dominated by heterogeneities, an assumption of host rock homogeneity would lead to an underestimation of the effects of heterogeneities on several rock mechanics related concerns. These include but are not limited to the adverse effects of hetergeneities 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 comments 3-4, 6-25, 6-26, 6-28, and 6-47).

Specific draft EA findings that are affected include evaluations for post-closure Rock Characteristics guidelines 10 CFR 960.4-2-3(b)(1) and pre-closure Rock Characteristics guidelines 10 CFR 9560.5-2-9(b)(1). The evaluations for these findings do not consider the effects of heterogeneities which would limit the available lateral extent of host rock needed for locating the underground facility and providing an adequate buffer zone beyond the limits of the underground facility. In addition, uncertainties exist concerning the actual shape and extent of the dome at the proposed repository level. These uncertainties have not been adequately considered (see detailed comments 6-23 and 6-43). 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 effected. The evaluations do 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), 10 CFR 960.4-2-3(c)(3), 10 CFR 960.5-2-9(b)(2), and 10 CFR 960.5-2-9(c)(2) does not discuss uncertainties regarding the impact of heterogeneities on artificial support requirements and requirements for engineering measures beyond currently 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 evaluation presented for the guidelines noted above to address the uncertainties related to the effects of heterogeneities and anomalies on repository construction, operations, and waste isolation, and if appropriate, modify the findings based upon the results of the reevaluations.

Comment 4

Retrievability

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

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

Section 6.3.3.2.4 states that "however, the creep closure of the airgap will require overcoring of the canister or removal of the waste form from the overpack, which potentially could pose some difficulty in retrieval and would require special equipment and techniques." However no discussion is presented which addresses the response of a potentially heterogeneous host rock mass to the 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 6.3.3.2.4 do not sufficiently consider the potentially adverse effects associated with heterogeneity of rock mass and elevated temperatures such as reduced rock strength, accelerated creep, pressurized gases surrounding the waste canisters and hot brine flow. 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 system, canister locating system, and canister overcoring systems. In addition, the potentially adverse effects may be unfavorable for the radiological health and safety of the mining personnel retrieving the waste in the event of a breached waste package (see detailed comments 3-6, 5-16, 6-25, 6-26, and 6-44).

The draft EA 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. In addition, the evaluations for the findings presented for guidelines 10 CFR 960.5-1(a)(3) (which addresses ease and cost of construction and operation), 10 CFR 960.5-2-9(c)(3) (which addresses maintenance of underground openings), and 10 CFR 960.5-2-9(c)(4) (which addresses difficulties of retrieval), may be incomplete and overestimate the potential suitability of the site for retrieval operations (see detailed comments 6-44, 6-46, 6-47, and 6-48).

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

Comment 5

Shaft Sealing

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

Evaluations presented in the draft EA do not adequately discuss the many uncertainties associated with constructing, sealing, and decommissioning shaft systems to assure containment and isolation of the high level radioactive waste stored at the Cypress Creek Dome site. Given the history of salt mine flooding caused by shaft failures in Gulf Coast dome mines (see detailed comment 6-44) and the impact of mine flooding on personnel safety and operations, 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; 2) with 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; 6) the uncertainties associated with potential waste emplacement thermal effects on the integrity of the seals. The draft EA provides only a very general description of shaft seal requirements (Section 5.1.1.3, page 5-11) and does not adequately address the above mentioned uncertainties. As a consequence, available evidence that may be significant for evaluation of rock characteristics guidelines as it effects shaft seal may not have been evaluated in arriving at the findings presented as noted in the following discussions.

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 particularly 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 caused by the number of boreholes required for freezing and subsequent thawing in the rock units overlying the salt dome, afford potential opportunities for increased permeability immediately adjacent to the shaft that will be difficult to seal. The use of the blind hole drilling method leads to uncertainties due to the limited ability to obtain rock characteristics data needed for locating and placing seals (see detailed comments 4-9, 5-5, and 6-51). The discussion presented in Section 5.1.1.3 also 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 (see detailed comments 6-28 and 6-44). The discussion also does not address the potential for significant damage to shaft seals due to potential dynamic earthquake loads (see detailed comments 6-35 and 6-53).

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 6-46 and 6-51). As a result, the evaluation is inadequate. The evaluation presented in support of the finding for Rock Characteristic guideline 10 CFR 960-4-2-3(c)(3) (which addresses the isolation aspect of the repository as controlled by the combined response of host rock and hydrologic conditions to the heat generated by the emplaced waste), 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. As a result, the evaluation for this guideline may be inadequate. From a technical standpoint, the shaft seal system is a significant repository component whose objective is to prevent flooding that would preclude the use of the repository for waste emplacement during the preclosure period, and in post-closure would prevent or delay ground water contact with the waste form or limit the rate of radionuclide release into the ground water after contact has occurred.

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

Comment 6

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 6-61, 6-63 and 6-78) or are not adequately addressed (see detailed comments 6-75 and 6-76). There are also potentially large (but unquantified) uncertainties associated with the calculation of radiation field and thermal conditions (see detailed comments 6-64, 6-73 and 6-77) and with the solubility of radionuclides in brine (see detailed comments).

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

The limitations in the modeling approach include the following: (1) conceptual limitations, such as the use of a wastage allowance (thickness of the container allocated) for overpack corrosion, which is valid only for uniform corrosion; (2) analytical oversimplifications, such as the use of one-dimensional analysis where multi-dimensional effects are expected (see detailed comment 6-77); (3) lack of consideration of alternative scenarios such as premature failure due to manufacturing defects; (4) the need for a priori knowledge of the results in order to run the analysis; (5) lack of consideration of synergistic effects (e.g., more than one corrosion process active at one time); and (6) lack of consideration of the effects of uncertainties in the models and input parameters (see detailed comment 6-62).

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 parameters 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 7

Controlled Area

Guidelines on Environmental Quality 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 enlarge 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 draft EA is approximately 4.5 sq. mi. or 2905 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 6-7 of the draft EA states that this preliminary area coincides with the margin of the salt dome at -2000 feet MSL. Because it appears that no additional basis is given or referenced, it appears 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 assoicated with assumptions and estimates regarding groundwater travel time and radionuclide transport.

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

The preliminary controlled area is based on the single-phase design described in Chapter 5. However, p. 5-116 states that DOE is proceeding further with a two-phase concept. The area needed for the underground facilities for the two-phase design is has not been presented in the draft EA. However, based on areas presented for the other salt dome site two-phase designs, a significant reduction of the buffer zone between the edge of the underground facility and the margin of the salt dome would result.

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, hydrologic and geochemical assumptions presented in the EA. Many of these draft EA assumptions have uncertainties related to them (see major comment 1 and 2); it does not appear that the size of the controlled area has accounted for those uncertainties in such a way that it would provide enough area to adequately account for a 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 8

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 9

Comparative Evaluation of Sites

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

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

References

D'Appolonia, 1981, "Sealing Considerations for Repository Shaft in Bedded and Dome Salt," ONWI-255.

Kendorski, F.S., D.F. Hambley, P.L. Wilkey, 1984, "ASsessment of Retrieval Alternatives for the Geologic Disposal of Nuclear Waste", NUREG/CR-3489.

Kupfer, 1980, "Problems Associated with Anomalous Zones in Louisiana Salt Stocks, U.S.A." Fifth symposium on Salt, Volume 1, The Northern Ohio Geological Society, Inc., Cleveland, OH, pp 119-134.

Levy, P.W., and J.A. Kierstead, Brookhaven National Laboratory, "Very Rough Preliminary Estimate of the Sodium Metal Colloid Induced in Natural Rock Salt by the Radiations from Radioactive Waste Containers," Batelle Memorial Institute, Office of Nuclear Waste Isolation, Columbus, OH, ONWI/SUB/78/E511-01000-42, September 1982.

DETAILED COMMENTS

EXECUTIVE SUMMARY COMMENTS

ES-1

Executive Summary: Section 5 Regional and Local Effects of Repository Development, Page 14, Paragraph 3

The last sentence of this paragraph states that about 10 million tons of excess salt would be removed from the site for disposal in an offsite mine. This statement is inconsistent with the detailed discussion in Sections 5.1.3, page 5-23, and 5.1.3.4, Salt Disposal, pp. 5-31, where it is noted that a specific method of excess salt disposal has not yet been selected. It is suggested that the inconsistency be reconciled.

ES-2

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

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

CHAPTER 3 COMMENTS

3-1

<u>Section 3.2.5.1, Faulting, pages 3-21 to 3-24</u>

The DOE's description of 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. The DOE should consider adding a description of the regional stress field and its relation to regional faults in the final EA.

3-2

<u>Section 3.2.5.4, Uplift and Subsidence, page 3-29, paragraphs 1 and 2</u>

Regional uplift rates of 2-4 mm/year are substantiated by Jurkowski et al. (1984) in which they arrive at uplift rates of 2.9 - 3.9 mm/yr after re-evaluation of the leveling survey data. At this time these uplift rates should not be discounted by DOE without explanation while waiting for data to "...be re-evaluated for possible errors in measurement or complications introduced by methods of analysis..." (Draft EA, p. 3-29, paragraph 2).

3-3

This comment was incorporated elsewhere in the comment package.

3-4

<u>Section 3.2.6.1.2, Geomechanical Properties of Caprock and Salt, Page 3-35, Paragraph 4</u>

This section summarizes deformation, strength and creep parameters for the Cypress Creek Dome caprock and salt stock. The data used for establishing the geomechanical parameters pose the following concerns - minjmal testing; tests performed on samples obtained from Vacharie and Richton domes; in situ stress and temperature conditions not simulated in the tests; no discussion on the correlation or validity of these parameters to represent the in situ response of the salt in the Cypress Creek Dome. There is no data on caprock, but only on salt stock. Furthermore, elastic, strength and creep values for salt in Table 3-5 are based on one study (ONWI-450) reporting a total of 12 triaxial quasi-static tests (6 from Richton Dome and 6 from Vacherie Dome) and 6 triaxial creep tests (3 from Richton Dome and 3 from Vacherie Dome). Also, the elastic Poisson's Ratio reported as 0.55 is an unrealistically high value. There is no basis given for selecting the Miser-Schleicher strength criteria, particularly using the extremely limited data base. The stress-strain behavior of the salt is very much dependent on temperature, time, and in situ stresses. The laboratory tests (performed to determine parameters presented in Table 3-5) did not simulate the in situ stresses and temperature conditions. This data cannot be considered sufficient to characterize the Cypress Creek Dome Salt. No analysis was performed to relate test results to the in situ conditions. There is no basis given for relating the Richton Dome salt to the Vacherie Dome salt. It is recommended that the evaluation be expanded to address the above concerns and demonstrate a correlation between in situ conditions and reported geomechanical properties (perhaps in terms of index properties, or large-scale testing results).

3-5

Section 3.2.6.1.2, Geomechanical Properties of Caprock and Salt, Page 3-35, Paragraph 5

The draft EA presents an estimate of the stress magnitude of approximately 16 megapascals at 730 meters depth. The evaluation needs clarification. Contrary to the statement in the draft EA, Tammamagi et al., 1984 (RE/SPEC 1983), 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 rate is approximately 0.023 Mpa/m. Lindner and Halpern, 1977, include one number from a Louisiana salt dome in their data basis, but give no details. Of the three empirical prediction equations given by Lindner and Halpern, 1977, two, including the one proposed by the authors, suggest a stress rate increase substantially above 0.023 MPa/m. It is recommended that the discussion be expanded to present the rationale for proposing a stress rate increase of 0.023 MPa/m which is significantly lower than the rates proposed by Hoek and Brown (1980), of 0.027 MPa/m, or by Lindner and Halpern.

3-6

Section 3.2.6.2, Thermal Properties, Page 3-38, 3-41, Paragraph 1

The evaluation of thermal properties of salt does not address the effect of limited data base and test temperature and stress being non-representative of field conditions. The data base for the thermal properties presented in Table 3-6 is limited to tests on 4 samples obtained from a boring. These tests were conducted in an unstressed mode and for very short time. The test temperature ranged up to 450°C, and thermal decrepitation of the samples was not noticed. Considering the substantial strength loss exhibited when cores were tested at 200°C temperature (Pfeifle, 1983, Page 33), the possibility that rock adjacent to canisters may have impurities not present in the test specimens, and that the expected maximum temperature next to the waste canisters is 266°C (Page 6-186 of the draft EA for Cypress Creek Dome), it appears that the potential for thermal decrepitation has not been adequately investigated. Recommend that the evaluation address the effects of stresses and impurities on the thermal properties of salt.

3-7

Section 3.2.7.3, Geochemistry of Ground Water in Sediments Adjacent to the Dome, Page 3-46, Paragraph 1

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 dissolved gases (methane and hydrogen sulfide) are indirect indicators of reducing conditions. However, data such as these are not conclusive, because these minerals and dissolved gases can exist metastably under oxidizing conditions (e.g., see Thorstenson et al., 1979). Their presence indicates reducing conditions at some time in the past (e.g., during formation), but not necessarily in the present. Without additional data (e.g., Eh measurements, several dissolved redox couples, dissolved oxygen content, etc.), the existence of reducing or oxidizing conditions in groundwater cannot be demonstrated unequivocally. Although there is uncertainty associated with all types of data related to redox conditions, consistency among various types of data and measurements generally provides a reasonable indication of reducing or oxidizing conditions.

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

3-8

Section 3.3.1.3, Flooding, Page 3-58, Paragraph 2

The information presented in the draft EA and in ONWI-120 is not adequate to evaluate flood effects at this site or to support the conclusions reached with regard to flooding. A review of the supporting documentation in ONWI-120 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 these 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 implemented to mitigate the potential flood problems. Without more information or analyses on these measures, it is difficult to evaluate their feasibility, impact on the environment, and cost. Additional information on the anticipated mitigative measures to overcome the flood problems should be provided.

3-9

Section 3.3.2.1, Geohydrologic Units, page 3-65, Table 3-14

The draft EA appears to have ignored field data in the presentation of hydraulic conductivities for the Cypress Creek Dome geohydrologic units. Hydraulic conductivity data presented in table 3-14 are not field-measured parameters, but rather model-generated numbers or numbers selected for model input. However, the reference cited for this table (Ertec, 1983,) contains field hydraulic conductivities which are considerably higher than the model-generated values. The reasons for not using the field data should be discussed.

3-10

Section 3.3.2.2, Modeling, Page 3-73 through 3-74

The groundwater flow model for Cypress Creek Dome does not model any units deeper than the Wilcox formation. Since the Wilcox has a downward vertical gradient (3.6 E-4) larger than its horizontal gradient (1.8 E-4) (Table 3-15), it could act as a pathway to deeper units. This may be particularly important at Cypress Creek Dome, since it has an active oil field in the deeper units, which could act as pathways to the accessible environment. The final EA should include a discussion of flow gradients in units deeper than the Wilcox and incorporate this information into the time of travel to the accessible environment calculations in Section 6.3.1.1.2.

3-11

Section 3.3.2.2 , Modeling, Page 3-73, Paragraph 6

The draft EA does not contain a discussion of assumptions used in the groundwater model. Model inputs and assumptions determine model outputs. Since model outputs are used to calculate groundwater travel times, the data and modeling assumptions should be described in order to evaluate the validity of the groundwater travel time calculations.

3-12

Section 3.3.2.2, Modeling, Page 3-73

It is difficult to determine how vertical hydraulic gradients were determined for the Wilcox, since the regional and local groundwater model for Cypress Creek Dome does not model any units deeper than the Wilcox. In the models the Wilcox is treated as an aquifer with a vertical gradient of 0.00036. However, the vertical gradient in an aquifer also is influenced by gradients of adjacent hydrogeologic units (above and below). It is difficult to evaluate how a vertical gradient for the Wilcox could be determined when only units above the Wilcox were modeled. The final EA should discuss how the vertical gradients in the Wilcox were determined, because this might affect the alternative ground water travel times calculations.

3-13

Section 3.3.3, Water Supply, Page 3-76

The draft EA 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.

3-14

Section 3.4.2.3 Threatened and Endangered Species, Page 3-88, Paragraph 1

This section does not define what is meant by "vicinity" or "immediate vicinity of the Cypress Creek Dome area." This paragraph refers to critical habitat of threatened/endangered species and areas considered particularly sensitive to human disturbance. These habitats are stated to be in the "vicinity" or "immediate vicinity of the Cypress Creek Dome area." For impact purposes, more precise locations of these sensitive areas in relation to site activities would be useful. It is suggested that more precise descriptions be provided (or located on a map) in the final EA.

Chapter 3 References

Ertec, 1983, "Regional Groundwater Flow Near Richton Dome, Mississippi: Annual Status Report for fiscal Year 1982," ONWI-426, 147 p.

Hoek, E., and E.T. Brown, 1980. Underground Excavations in Rock, The Institution of Mining and Metallurgy, London, England

Jurkowski, G., et al., 1984. Modern Uparching of the Gulf Coast Plain, JGR, v. 89, No. B7, p. 6247-6255.

Law Engineering Testing Company, "Gulf Coast Salt Domes, Geologic Area Characterization Report, Mississippi Study Area, Vol. VI and VII, ONWI-120, July 1982.

Lindberg, R.D. and D.D. Runnells, "Ground Water Redox Reactions: An Analysis of Equilibrium State Applied to Eh Measurements and Geochemical Modeling," Science 225, 925, (1984).

Lindner, E.N., and J.A. Halpern, 1977, "In Situ Stress: An Analysis" Proceedings, 118th U.S. Symposium on Rock Mechanics, Energy Resources and Excavation Technology, Keystone, Co., June, Vol. 2, pp. 4C1-1 to 4C1-7

Pfeifle, T. W., K. D. Mellegard, and P. E. Senseny, 1983. "Preliminary Constitutive Properties for Salt and Non-salt Rocks from Four Potential Repository Sites," ONWI-450.

Stumm, W., "Redox Potential as an Environmental Parameter; Conceptual Significance and Operational Limitation" in Advances in Water Pollution Research, Proceedings of the Third International Conference held in Munich, Germany, September 1966. Vol 1, O Jaag and H. Liebermann, co-chairmen, Water Pollution Control Federation, Washington, D.C., 1966.

Tammamagi, H.Y., C.P. Humphreys, IV, and D.E. Shattler, 1984, "A Compilation of Data for Thermomechanical Analyses of Four Potential Salt Repositories," ONWI-364 Topical Report RSI-0181, RE/SPEC, Inc., March 1983

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

CHAPTER 4 COMMENTS

4-1

Section 4.1.2, Exploratory Shaft Facility, Page 4-26, Paragraph 1

In this section, it is stated that 4,250 linear feet of drift to connect the two shafts and to support suitability and at-depth testing will be needed. However, no drift is planned to characterize 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 the section be expanded to address the above comments.

4-2

Section 4.1.2.4, Final Disposition, Page 4-60, Paragraph: All

If the site is found suitable for the first repository, the exploratory shaft facility may be incorporated into the repository design (page 4-60, paragraph 1). It is unclear how such a decision will be reached and what would be done with the exploratory shaft facility if it does not become a part of the repository. This information is of importance to an assessment of the performance of the shaft pillar area or the shaft seal system, or to identify/evaluate further environmental impacts and warrants appropriate consideration. Recommend the discussion be expanded to address and provide clarification of the above points.

4-3

Section 4.1.3.1.2, Terrestrial and Aquatic Ecosystems, Aquatic Ecology, Page 4-75

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

4-4

Section 4.2.1.2.2, Aquatic Biota, Page 4-87

This section describes the expected effects of site characterization on aquatic biota. The major impact on aquatic biota will be due to stream channel diversion described in Section 4.2.1.4.1. This activity will precede clearing and filling activities, so all aquatic biota in the existing channel will be destroyed. It is suggested that this activity be identified, in Section 4.2.1.2.2, as the primary cause of impact on aquatic resources rather than "land clearing activities."

4-5

Section 4.2.1.3.1, Activities and Emissions, page 4-92, second paragraph

Meteorological data from Amarillo, TX, used in the diffusion modeling may not be representative for this site. The Amarillo area is noted as being one of the windiest areas in the country, while the wind speed average in the Jackson, Mississippi area is stated as 7.3 mph, which is below the national average of 10 mph. The use of Amarillo data may underestimate the potential air concentrations offsite. It is suggested that meteorological data from Jackson, MS be utilized to assess the air quality impacts of site characterization, site construction, operation, and post-closure.

4-6

Section 4.2.1.3.2, Air Quality Consequences, page 4-96, first and second paragraph

The potential peak offsite 24-hour TSP and PM_{10} concentrations presented by DOE were 247 ug/m^3 and 114 ug/m^3, respectively. These values are slightly below the health limits for TSP and PM_{10} which are 260 ug/m^3 and between 150 and 250 ug/m^3, respectively. As calculated, the peak 24-hour TSP concentration is above the secondary NAAQS limit of 150 ug/m^3. As was pointed out in Section 4.2.1.3.1, these air concentrations may be underestimated due to the use of Amarillo meteorological data. If Amarillo, TX, data were utilized in this air quality assessment, it is suggested that it be redone utilizing meteorological data from Jackson, MS.

4-7

Section 4.2.1.4.2, Ground Water, Page 4-99, Paragraph 3

It is stated that the measures proposed to avoid or minimize degradation of ground water quality include use of shaft construction techniques that would minimize any hydraulic connection between water-bearing strata, hydrocarbon reserves, and salt deposits. The draft EA does not discuss how this can be accomplished in the 3m bored shaft. It is recommended to expand the discussion on the use of shaft construction techniques that would minimize hydraulic connections between several strata during large-hole shaft boring.

4-8

Section 4.2.1.6.3 Mitigating Noise Impacts, Page 4-103

Noise impacts could be further mitigated by limiting blasting to weekday daylight hours only. It is suggested that this be considered as an additional mitigative measure.

4-9

Section 4.3.2, Exploratory Shaft Alternative, Page 4-115, Paragraph 6

The draft EA does not present the rationale for selecting the two different shaft construction methods. Two shafts are planned at the site, one constructed by large-hole drilling and the other by the drill and blast method (page 4-26, paragraph 1). 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 discussions in this section be expanded to include the rationale for choosing two different construction methods for the two exploratory shafts at the Cypress Creek Dome site.

4-10

Section 4.4, Table 4-30, Page 4-121

According to Table 4-30, number 7, traffic noise is expected to be perceptible to 10-25 residences during the exploratory shaft construction phase and geologic studies. However, no discussion of the transportation noise impacts is included in Section 4.2.1.6. It is suggested that impacts to these residences be considered in the noise effects section (4.2.1.6).

CHAPTER 5 COMMENTS

5-1

Section 5.1.1.1, Repository Site Layout, Page 5-2, Paragraph 3

The rationale for selecting a surface area of 2905 acres for land control rights for evaluating environmental impacts and comparing sites is not addressed in the draft EA. The size of the controlled area significantly affects the environmental impact associated with land ownership and the technical guideline relating to available flow-path distance between the edge of repository and the accessible environment. The controlled zone (2905 acres) extends beyond the subsurface repository area (1500 acres) by less than 1 kilometer, and this significantly impacts postclosure technical guidelines 960.4-2-1(b)(1) related to ground water travel time. At the repository level, the area of the dome is approximately 3100 acres (page 6-92) which is slightly larger than the controlled zone (2905 acre). It is recommended that this section of the draft EA be expanded to provide a detailed discussion of the parameters affecting the selection of the groundwater travel distance used, and an analysis containing the rationale used in arriving at the distance selected and its relation to the selection of land control rights area.

5-2

This comment was incorporated elsewhere in the comment package.

5-3

Section 5.1.1.4, Repository Subsurface Facilities, Page 5-14

Table 5-3, Approximate Waste Storage Room Quantities, p. 5-14, shows that the Cypress Creek 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 draft EA. It is recommended that this section of the draft EA be expanded to present an analysis of waste package performance based on emplacement of TRU packages, or an analyses be presented to show that the conclusions presented in this section are not invalidated by emplacement of TRU packages.

5-4

Section 5.1.2.4, Shafts and Facilities Development, Page 5-22, Paragraph 6

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". There is no discussion on the plans for handling rock stability problems in anomalous zones which might be encountered in sinking the shafts. It is recommended that this inconsistency in the document be resolved and appropriate modifications be made to all evaluations that might be affected.

5-5

Section 5.1.2.4, Shafts and Facilities Development, Page 5-22, Paragraph 5

It is stated that all of the Repository Shafts will be excavated using conventional drill-and-blast method. The decision to blind-drill the Exploratory Shaft and drill-and-blast the Repository Shaft introduces the following shaft sealing uncertainties:

a) It is possible that the damage to the repository shaft walls induced by blasting will be different from the damage to the exploratory shaft walls as a result of blind drilling. This would introduce uncertainty in using the exploratory-shaft-developed data to assess stability and sealing aspects of the repository shaft.

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

It is recommended that this section be expanded to include an evaluation of the impact of using different shaft construction techniques on shaft sealing.

5-6

Section 5.1.3.3, Retrievability, Page 5-30, Paragraph 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 the decision to backfill will be made. Thermal load limits, access drift support design, maintenance, personnel radiological safety etc., are important factors that affect retrievability. The greater creep tendency for the Cypress Creek 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 5.1.4, Decommissioning and Decontamination, Page 5-33, Paragraph continuing

The draft EA discussion on shaft backfilling, plugging and sealing consists of a single sentence. Specifically, it states that "Shaft backfilling will be composed of salt and selected materials with seal plugs at predesigned depths." Recommend that the discussion be expanded to describe the placement of seals, their performance requirements, composition of backfill materials, degree of compaction for salt backfill, and the compatibility constraints at different depths.

5-8

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

The NRC is in the process of preparing a generic technical position on seismotectonic evaluation methods. This paper will cover the types of seismotectonic investigations and evaluation methods which will need to be conducted for a repository. In addition, the NRC will need to separately review the types of structures to be constructed, their functions and the consequences of potential accidents before the actual design requirements 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 10 CFR 60 and appropriate EPA regulations.

5-9

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

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

5-10

5.3.1.1.2, Waste Transportation Costs, Page 5-74

Certain transportation corridors along the routes to the sites, for example, 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 this type of consideration be included in the final EA assessment of transportation impacts.

5-11

Section 5.3.1.2 Radiological and Nonradiological Effects Associated with Nuclear Waste Transport, Page 5-77 First Paragraph

The paragraph implies that under incident free operating circumstances, no radioactive material would be released from the shipping containers during transport. While this may be true for the contents of the package, there have been cases of contamination being released from the package surface during transport. It is suggested that the potential radiation doses to radiation workers involved in close proximity decontamination efforts be addressed in the final EA.

5-12

Section 5.3.2.1 Radiological effects on nuclear waste transportation Page 5-81, Table 5-15, Page 5-84, Table 5-16

These tables provide estimated latent cancer fatalities associated with the 30-year operating lifetime of a repository. It is suggested that the tables list the exposures for the occupational and non-occupational population subgroups.

5-13

Section 5.3.1.3.3 Additional Regional Concerns, Page 5-83, Last Paragraph

This paragraph provides average annual radiation doses to a maximally exposed individual (member of the general public) resulting from routine transportation to the repository.. It is suggested that the text also include maximum exposure that would occur in a transportation accident.

5-14

Section 5.4, Expected Effects on Socioeconomic Growth, Page 5-91

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 therefore be assessed.

5-15

Section 5.4.5, Fiscal Conditions and Government Structure, Pages 5-113 and 5-114

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

5-16

Section 5.5, Implications of an Alternate Repository Design Concept, Pages 5-116 through 5-120, Paragraphs-All

The draft EA states that the DOE has decided to proceed with further consideration of the two-phase concept, to meet the NWPA Draft Mission Plan objective of having the first repository in operation by year 1998. The draft EA states (page 5-116, paragraph 3) that somewhat different impacts than those described in Sections 5.1 through 5.4 of Chapter 5, could result. Possible significant differences between the Reference design presented in the draft EA and the proposed two-phase concept design are:

1. Volume of excavated salt will increase and salt handling operations will increase. 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 the Cypress Creek 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)]. In addition, more stringent ventilation requirements must be met for gassy-mine conditions.

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

5. An additional shaft will be required.

6. The construction schedule will be compressed.

These and other differences are important in the context of 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 impacts of the alternative repository design concept mentioned in this section is not discussed in detail because the two-phase 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 the host rock conditions. The underground facilities area for the Two-Phase-Repository will be substantially larger than the 1500 acre area of the Reference Design evaluated in the draft EA. Also, the increased extraction of salt from the repository horizon could result in additional subsidence, larger pillar dilation and potentially more rapid creep under thermal conditions. No discussions related to these impacts have been presented.

2. The 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 particular difference between the phased and reference repository concept which should result in one being regarded as gassy and not the other. They both should be regarded as potentially gassy.

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

6. Changes in the requirement for site characterization activities should be addressed, including the relocation of boreholes to accommodate the larger restricted zone and larger subsurface areas, with due consideration to the

uncertainty imposed by the resultant decrease in density of exploration data.

7. The retrieval requirements will be impacted by the effect of possible increase in 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 operation 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.

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

5-17

Section 5.5, Implications of an Alternate Repository Design Concept, Page 5-116 to 5-120

The draft EA fails to discuss the effects of using the two-phase design on groundwater travel time calculations through the salt stock perimeter pillar. The total dome area (p. 3-3, Figure 3-2) is 2905 acres at the -2500 foot (MSL) elevation. One result of using the Two-Phase Repository Design Concept in preference to the draft EA reference design is to increase the approximate underground facilities area from 1500 acres to an unspecified larger area. This should significantly diminish the distance between the repository and the edge of the salt dome and therefore reduce groundwater travel time though the host rock. The effects of using the two-phase design on groundwater travel times through the salt stock perimeter pillar should be discussed.

5-18

Section 5.6, Summary of Repository Impacts, Table 5-26, Page 3 of 11, Page 5-123, Item 7, First Bullet

This bullet indicates that resident aquatic biota will be "temporarily" lost by relocation of Cypress Creek. The word "temporarily" should be changed to "permanently" since all of the aquatic biota in the present natural channels will be destroyed.

CHAPTER 6 COMMENTS

6-1

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

The draft EA discusses the actions necessary for DOE to obtain ownership, and to control access to surface and subsurface land, mineral rights, and even the water rights within the controlled area of the repository. State Highway (SH) 29 runs through a portion of the control area as shown on Figure 3-35, and is accessible to the general public. There is no specific reference about controlling access to this highway. It is suggested that there be some discussion about how access will be controlled, and who will be responsible for controlling it in the event of an accident at the repository.

6-2

Section 6.2.1.1, Site Ownership and Control, Guideline 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 respect to the Forest Service lands, the final EA should document whether there are any special uses that could stand in the way of DOE's acquiring jurisdiction and control.

6-3

Section 6.2.1.4.2, Analysis of Favorable Conditions, Page 6-13, Last Paragraph and Last Sentence

No information is provided on ground-based inversion frequency and the frequency of low wind speed conditions which effect the potential ground level releases expected at the site. Only mixing height and stagnation episode information, which effect long distance transport and multiple elevated sources of air pollution, is discussed. It is suggested that the joint frequency of wind speed, wind direction, and atmospheric stability for Jackson, MS be provided by DOE.

6-4

Section 6.2.1.5.3, Potentially Adverse Conditions, Page 6-17, Paragraph 6

The evaluation in the draft EA states that potentially hazardous installations or operations in the vicinity of the Cypress Creek Dome are: three currently producing hydrocarbon wells in the dome, ongoing military operations and exercises over the dome, railroad and highway which may be transporting hazardous materials and toxic material within a distance of less than 5 miles from the repository site. These are sources of potential hazardous conditions and could cause a potentially adverse condition for the repository. However, the evaluations in the draft EA (Page 6-18) conclude that a favorable condition is present. But the findings presented in Table 6-7, page 6-61, states that a potentially adverse condition is present. Recommend that the above discrepancy be corrected in the final EA.

6-5

Section 6.2.1.6.1, Statement of Qualifying Condition, Page 6-37, Table 6-4

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

6-6

Section 6.2.1.8.2, Analysis of Favorable Conditions, Pages 6-50 to 56

The following discrepancies in the draft EA should be rectified.

(1) Evaluation for guideline 960.5-2-7(b)4, Page 6-54, does not state the conclusion. Conclusion on this guideline should be included in the final EA. However, a favorable conclusion is presented in the Summary Table 6-7, Page 6-67. For consistency within the draft EA, a conclusion should be presented on Page 6-54.

(2) Evaluation for guideline 960.5-2-7(b)7, Page 6-56, states that a favorable condition is not present whereas Summary Table 6-7, Page 6-67 states that a favorable condition is present for the same guideline. The discrepancy in Table 6-7 should be corrected in the final EA.

(3) Evaluation for guideline 960.5-2-7(b)8, Page 6-56, states that a potentially adverse condition is present. This conclusion is inconsistent with the findings presented in Summary Table 6-7 which states that a favorable condition is present. (Evaluation for the same guideline for the Richton Dome site, which is in the state of Mississippi concludes that a favorable condition is present.) The conclusion on Page 6-56 for this guideline should be revised to state that a favorable condition is present.

6-7

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

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 x 10^{-3} millirem during the construction period, or greater than 5.6 x 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 draft EA. For Deaf Smith, maximum individual dose is given as 4.5 x 10^{-3} millirem annually during construction and 2.8 x 10^{-3} millirem annually during operational period. For Richton Dome, the doses are 9.0 x 10^{-3} millirem and 5.6 x 10^{-3} millirem, respectively. Since Waite did site-specific calculations, that fact should be stated in 6.2.2.1.2.

6-8

Section 6.2.2.2.2, Evaluation Process (Environ., Socio Trans.), Page 6-72, Paragraph 3

It is assumed that: "Existing shaft sealing technology is sufficient to provide protection of the overlying aquifers." This needs further evaluation. In the context of environment, a malfunction of the seals in the shaft could provide connections between aquifers or cause flooding. As mentioned in other comments and documented in literature, there are many uncertainties in the performance of seals. Kupfer (1980) cites a shaft leak at Belle Isle mine that appears to be due to seal failure. It is recommended that the discussion be expanded to include assessment of performance of sealing under construction conditions and repository induced thermal load conditions.

6-9

Section 6.3.1.1.1, Statement of Qualifying Condition, Page 6-80, No. 1

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 Cypress Creek dome. Large scale features such as faults, fractures, bulk permeability, rock inclusions, unsealed drill holes, partly sealed wells, or vugs that may provide decreased travel times are not measured by core. Core data cannot supply information on the major forms of water movement through salt. The final EA should indicate the uncertainties associated with exclusively using salt core data to calculate groundwater travel times.

6-10

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

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

The draft EA contains a groundwater travel time calculation from the edge of the dome to the accessible environment through the Lower and Upper Claiborne Units. However, paragraph 13, page 6-83 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 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 EA will result.

Section 6.3.1.8.4, page 6-111, paragraph 2, states that seven petroleum exploration wells penetrate the salt of Cypress Creek Dome and five enter the salt stock below repository level. However, the groundwater travel time calculations do not address wells and abandoned drill holes in and around the salt dome as possible pathways to the accessible environment. The travel time to the accessible environment could be shortened should any of these pathways exist.

The draft EA does not adequately discuss the possibility of alternative groundwater flow paths. It is stated that any water or nuclides originating in the repository and entering the Upper Clairborne will remain in the unit for at least 18,000 years "because of the extremely small component of vertical flow." This may not be the case because upward groundwater movement along faults is possible as discussed in Section 3.2.5.7, paragraph 3.

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

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

6-11

Section 6.3.1.1.2, Analysis of Favorable Condition, Page 6-81, Paragraph 4

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

6-12

Section 6.3.1.1.2, Analysis of Favorable Conditions, Page 6-81

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

As a further example, travel time calculations for the Upper Claiborne Unit do not use field data. Hydraulic conductivities and gradients are the result of Ertec (1983, ONWI-484) models. The effective porosities presented also are not from field data. The final EA must justify the reasons for ignoring field-determined hydraulic parameters and for assuming the accuracy of model-generated numbers. For instance, using effective porosities and hydraulic gradients given in the text and field-determined hydraulic conductivity (the 30 m/day maximum reported in Ertec, 1983, ONWI-456), the 10-km travel time from the dome through the Upper Claiborne is 274 years, not 54,000 years. The assessment must explain why field data are not applicable in travel time calculations. Therefore, the assessment must justify using regional model generated numbers over field data in travel time calculations.

6-13

Section 6.3.1.1.2, Analysis of Favorable Condition, Page 6-81

The draft EA is not internally consistent in stating that groundwater flow in the domes has a significant downward flow component. In Intera (1984, p 98 & 99), the downward flow velocities are greater than the horizontal for all simulations. This contradicts the predicted travel distances of 13 meters downward and 23 meters horizontally. The final EA should indicate how the vertical and horizontal travel times were determined.

6-14

Section 6.3.1.1.2, Analysis of Favorable Condition, Page 6-81

The draft EA gives a range of groundwater travel times, but does not explain which is the conservative travel time and why. In pages 6-81 to 6-82 the text provides the following range of groundwater travel times from the disturbed zone to the accessible environment; 1) From inside the salt to the edge of the salt dome (107,000 years); 2) From the edge of the salt dome to a point 10 Km downstream through the Upper Claiborne Unit (18,000 to 54,000 years); 3) From the edge of the salt dome to a point 10 Km downstream through the Lower and Upper Claiborne Units (32,000 to 68,000 years); and 4) From inside the salt dome, through the Lower and Upper Claiborne to a point 10 Km downstream (139,000 to 175,000 years). In addition the text does not list another possible path from inside the salt dome to a point 10 Km downstream through the Upper Claiborne Unit (125,000 to 161,000 years). An additional groundwater travel time within the salt stock is provided in Table 6-11, Page 6-118 (1,630,000 years). Given the large number of possible travel times and the range from 18,000 to 1,630,000 years, the text should explain which is the conservative travel time and why.

6-15

Section 6.3.1.1.2, Analysis of Favorable Condition, Page 6-81 Paragraph 5

The draft EA's analysis of host rock travel time does not consider the effect of anomalies or splines in the salt stock. For example, Section 6.4.2.3.2, page 6-187,¶1, of the draft EA states "some of the splines may have a significant transmissivity and provide a potential conduit for ground-water." The travel times must also take into account cavities developed during repository construction that are 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" (Kuper, 1980, p. 121). Since anomalies could shorten groundwater travel times the final EA should indicate how anomalies affect groundwater travel times.

6-16

Section 6.3.1.1.3, Analysis of Potentially Adverse Conditions (1)-Hydrology: Page 6-85, Paragraph 1

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

6-17

Section 6.3.1.1.4, Analysis of Potentially Adverse Condition, Page 6-83

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

6-18

Section 6.3.1.2.2, Analysis of Favorable Conditions(2)-Geochemistry; Page 6-88, Paragraph 3 and Section 6.3.1.2.3, Analysis of Potentially Adverse Conditions(3); Page 6-90, Paragraph 9

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 conclusively support the contention. The DOE has asserted that chemically reducing conditions exist, despite the fact that "limited site-specific geochemical information ... is available for Cypress Creek Dome" (page 6-87, paragraph 3). The arguments used to support the assumption of chemically reducing conditions (the presence of methane and mineral assemblages likely to create a reducing environment) are not well documented or supported (see detailed comment 3-7). The assertion that oxidizing conditions are not possible cannot be stated inequivocally 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 3-7).

The statement made in the draft EA under guideline 960.4-2-2 (b)(2) that migration of redox sensitive radionuclides are greatly decreased under reducing conditions because they form compounds having much lower solubilities than those formed under oxidizing conditions is not always true. Garrels and Christ (1965, figure 7.32b) show that even under extremely reducing conditions uranium can exist in solution in significant concentrations. The uranium bearing species $UO_2(CO_3)_3^{4-}$ which contains uranium in the oxidized state (U^{6+}), can be thermodynamically stable even under reducing conditions. In addition, slow kinetics inhibit 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 demonstrably conservative analysis should be made.

6-19

Section 6.3.1.2.2, Analysis of Favorable Conditions(2)-Geochemistry; Page 6-88/6-89, Paragraph 1-6/1-3

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 limited radionuclide mobility. However, because the repository is emplaced in a salt deposit, NaCl should be considered a dominant component of the system. The large concentration of Cl^- in the brine might contribute to relatively high solubilities of radionuclides due to formation of chloride complexes. In the discussion of promotion of precipitation outside the dome, the DOE states that chemically reducing conditions are expected. The data do not strongly support this contention (see detailed comment 3-7). In addition, it is uncertain whether or not reducing conditions will actually cause redox sensitive radionuclides to precipitate (see detailed comment 6-18). Groundwater pathways other than in deep saline aquifers should also be considered for this guideline.

Conflicting evidence is presented concerning the effect of brines on the agglomeration of colloids that could influence radionuclide migration. Paragraph 6 (p. 6-88) states that "Brine will inhibit the formation of some types of colloids . . ." This contradicts the statement that "Brines tend to promote the agglomeration of some types of colloids and particles" (p. 6-89, paragraph 2). The draft EA suggests that the resulting colloidal-sized radionuclides will not be transported due to sorption. The DOE should not take credit for two conflicting processes in support of the finding that this favorable condition is present. Regardless, the data do not support the 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.

6-20

<u>Section 6.3.1.2.2, Analysis of Favorable Conditions(4)-Geochemistry, Page 6-89, Paragraphs 6, 7 and 8</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. Because the existing data are inadequate to claim that this favorable condition is present, the DOE bases the 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. 6-206, paragraph 2). 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 6-208) 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 <u>will</u> strongly affect the Eh and pH, contrary to what is stated in the draft EA (p. 6-206, paragraph 2). 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 6-21).

There are additional concerns regarding matrix dissolution of the waste form, brine migration, and waste package geochemical environment that affect the evaluation of this condition (see detailed comments 6-21, 6-14, and 6-18). The DOE should consider the uncertainties discussed above when evaluating the evidence relevant to this guideline and perform a demonstrably conservative analysis.

6-21

<u>Section 6.3.1.2.3, Analysis of Potentially Adverse Conditons(1)-Geochemistry, Page 6-90, Paragraphs 3 and 4</u>

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 intracrystalline migration theory. Roedder and Chou (1982, p.1) found that Jenks and Claiborne used values for major input parameters that were "either nonconservative, selected numbers, or...based on inadequate data," resulting in invalid calculations. Truly conservative estimates should be larger, perhaps by "two orders of magnitude" (Roedder and Chou, 1982, p.1). Second, the use of Salt Block II data to validate the code may be inappropriate. The salt cylinder used in that study (Hohlfelder, 1979) was only 1 meter in diameter--spatial scale effects should cause agreement between the experimental data and the model results to decrease with time because only water within 0.5 meters of the heat source was available for migration. Thus, BRINEMIG may not "overestimate" brine flow at higher temperatures. Third, the discussion does not explicitly state whether the accumulation of brine is calculated from fluid inclusions migrating only in a radial direction perpendicular to a waste package, or if migrating fluids reaching the waste package from the volume of salt above and below the waste package are also included in the accumulation. McCauley and Raines (1984) state that BRINEMIG is a one-dimensional code; thus, it would appear that only radial migration, and not three-dimensional migration, was included in the calculations. The difference is that the volume of migrating fluid inclusions should theoretically be an oblong spheroid rather than a cylinder. This difference in volume could be significant and the method of calculation should be explained in more detail. Neglecting the accumulation of fluids from above and below the waste package results in underestimations of brine accumulations, perhaps offsetting the conservative assumption of a constant, maximum temperature gradient.

Several factors concerning the geochemical conditions around the waste packages are not addressed by 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 6-192, paragraph 5, #2). There is no discussion about how this H_2 gas will affect the physicochemical environment around a waste package or the waste package itself. It is suggested that consideration be given to the potentially large volumes of gas liberated by the anticipated reactions and how this would affect repository performance. Second, the effects of radiolysis are not considered. Studies indicate that gases may be formed due to irradiation, such as H_2, chlorine (Cl_2),or oxygen (O_2)(see Panno and Soo, 1984). The radiation field is only considered regarding dose rate at the package surface (page 6-196, continuing paragraph, #4). The effects of radiation-induced gases should also be considered. Third, it does not appear that the DOE has considered the effect of the repository being open to the atmosphere before closure; i.e., that O_2 will be present initially. Thus, O_2 will be reacting with the iron overpack before the repository is closed and for an indefinite period afterwards. The effects of this scenario on the waste package corrosion calculations should be considered. Fourth, if reducing conditions are actually present, the reduction of sulfates to sulfides would be expected before the reduction of H_2O to H_2. Sulfide formation may negatively affect waste package performance. In addition, a protective calcium sulfate or iron oxide layer would not be expected to form.

The gross brine accumulations used by the DOE for "conservative" estimates of radionuclide releases do not account for the possibility of an intrusive brine reaching the waste package, only for thermally migrating brines. This scenario, however, is considered in evaluation of waste package performance (page 6-202, paragraph 3, to page 6-206, continuing paragraph). The DOE should consider the intrusive brine scenario in its conservative evaluation of radionuclide releases.

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

6-22

Section 6.3.1.3.1, Statement of Qualifying Condition, Page 6-92, Paragraph 2

The discussion presented in this section does not address the uncertainties that exist regarding the draft EA assumption that properties of salt obtained from testing salt rock cores from borehole MCCG-1 at Cypress Creek site and MRIG-9 at Richton site 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 Cypress Creek Dome site. As no generic data for other Gulf Coast domes are given it is difficult to make a comparison. Due to the difficulties in obtaining core samples suitable for testing (Lagedrost, 1983 page 15) and a lack of consideration of rock mass heterogeneities that are likely to exist within the dome (Kupfer, 1980), it is possible that the results of thermal, strength, stiffness, and creep parameters testing given in Table 6-9, page 6-93, overestimate the quality of the Cypress Creek Dome in situ rock mass. The relatively low strengths of Richton Dome salt rock as reported in Pfeifle (1983, page 67) raises additional uncertainties as to the general suitability of the assumption. It is recommended that the discussion presented be expanded to address the uncertainties associated with the assumption made in this section.

6-23

Section 6.3.1.3.2, Analysis of Favorable Conditions (1), Page 6-92, Paragraph 6

The evaluation for the draft EA finding that a favorable condition is not present for a host rock of sufficient thickness and lateral extent to allow significant flexibility in selecting the depth, configuration, and location of the underground facility to ensure isolation needs clarification. There are two concerns with this evaluation. First there is only a very limited data base to support this finding. The dome shape and size is apparently estimated using data from petroleum exploration wells, seismic reflection surveys and gravity studies and one bore hole (MCCG-1). The evidence is very limited, and the evaluation does not consider the possibility of the presence of heterogeneities such as anomalous zones, brine and gas inclusions etc. within the dome which would further restrict the flexibility in locating a multiple-level repository. Second, the evaluation states that the Cypress Creek Dome is sufficiently thick and laterally extensive to allow significant flexibility for locating a multiple-level repository. However, the evaluation concludes that a favorable condition is not present, but does not specifically state which favorable condition is not present nor does it state the severity of restriction on the lateral extent flexibility. It is suggested that the evaluation qualify the limitations of the data describing the extent of the dome, and be more specific about the favorable condition which is not present.

6-24

Section 6.3.1.3.2, Analysis of Favorable Conditions, Page 6-92, Paragraph 6

According to the second line of the Evaluation section, Tables 5-1 and 5-2 give the required physical dimensions of the waste disposal areas and the expected volumes of different types of nuclear waste. Table 5-1 gives the required physical dimensions of the waste disposal area, but neither Table 5-1 nor Table 5-2 provide information about the expected volumes of different types of nuclear waste. The latter information is given in Table 5-3. It is recommended that "Table 5-2" be replaced by "Table 5-3".

6-25

Section 6.3.1.3.2, Analysis of Favorable Conditions, Page 6-92, Paragraph 8

The evaluation in the draft EA is inadequate for the finding that the salt in the Cypress Creek Dome has high thermal conductivity, low coefficient of thermal expansion, and sufficient ductility to seal fractures induced by repository construction, operation, or closure or by interaction among the waste, salt, ground water, and engineered components. There are several concerns with this evaluation. The data base, rock characteristics listed in Table 6-9, is for small samples of anhydrite and rock salt. The evaluation should include consideration of the influence of anomalies, inclusions, brine/gas pockets, etc. in the rock mass on the reported rock properties. The evaluation presented in the draft EA does not include an assessment of the in situ behavior of salt domes, e.g., behavior as influenced by inclusions. Anomalies may provide connection to an external groundwater supply. This is important to shaft sealing considerations particularly with regard to prevention of flooding. The coefficient of thermal expansion for the salt is higher than that for Basalt and Tuff. The draft EA statement on this thermal property needs clarification. 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. The draft EA does not discuss the time required to close fractures. This would impact on retrievability and should be evaluated in detail. It is stated that ductility of salt will hasten consolidation of the crushed salt backfilled into waste emplacement rooms, and consequently the stress state will approach lithostatic conditions in the salt backfilled rooms and surrounding rock formations. Rock salt exhibits sufficient ductility provided it is adequately confined and under sufficient pressure. The crushed salt backfill is neither under sufficient confinment nor under sufficient pressure to exhibit ductility to the extent that it will result in lithostatic conditions in the salt backfilled rooms and immediate surrounding rock formation within a reasonably short period of time. In the absence of relevant experience under repository conditions, this is an optimistic evaluation of the ductility phenomenon and the consequences of longer time delay in this phenomenon should be discussed in the evaluation. It is recommended that the evaluation for this guideline be expanded to discuss the above comments.

6-26

Section 6.3.1.3.3, Analysis of Potentially Adverse Conditions, Page 6-94, Paragraphs 3, 4, 5, 6 & 7

The evaluation in the draft EA is unsupported for the finding that no foreseeable rock conditions is present that would require engineering measures beyond the available technology for the construction, operations and closure of the repository. The evaluation should consider that at least two salt mines and one shaft have been lost in this general area due to mine flooding (Kupfer, 1980). No analysis is presented as to why problems encountered at some salt mines in the general area are not likely to be encountered at this site. There is no discussion of the effects of gas and brine pockets, effects of anomalous zones and impurities, potential existence of faults and shear zones, and effects of thermal degradation of clay in anomalous zones on containment and isolation aspect of the repository. There is no evidence presented to show that scaling and roof falls due to thermally induced stresses can be mitigated by controlling the rock stress. This will impact on disturbed zone estimations. Experience of successful mining in salt domes do not include the thermal conditions expected in the repository. As the potential for the existence of foreseeable rock conditions that could adversely impact on the construction, operation, and closure of the repository does not appear to have been adequately considered, the finding that this condition is not found is unsupported. Particularly, the operation phase includes retrievability which involves technology that has not been demonstrated for the above stated repository conditions. It is recommended that a more comprehensive evaluation be made for this guideline in the light of retrievability considerations.

6-27

Section 6.3.1.3.3, Analysis of Potentially Adverse Conditions, Page 6-94, Paragraphs 9 and 10

The evaluation in the draft EA is inadequately supported for the finding that a potentially adverse condition is present for such phenomena as thermally induced fractures, hydration, brine migration or other phenomena which may affect waste containment or isolation. The evaluation does not state which potentially adverse condition is present. The assessment states that there is a potential for thermally induced fractures, and also states that "ductile (plastic) properties of rock salt will tend to limit the extent of fractures to the disturbed zone of the repository." But the fracture zone is part of the disturbed zone, and the evaluation should clearly state the intended difference between fracture zone and disturbed zone. The evaluation of brine migration does not include any assessment of the migration of large anomalous brine inclusions. The evaluation does not consider the presence of existing anomalous zones in the salt dome and their potential influence on waste isolation. It is recommended that the evaluation be expanded to discuss the above comments and clarify as to which adverse condition is present.

6-28

Section 6.3.1.3.3, Analysis of Potentially Adverse Conditions, Page 6-95, Paragraph 4

The evaluation in the draft EA is inadequately supported for the finding that conditions do not exist such that heat generated by the emplaced waste would significantly decrease the isolation provided by the host rock. This finding is based upon one computational analysis of the effects of heat on natural conditions of the host rock. The thermal analysis is based on the assumption of homogeneous salt containing only microscopic brine inclusions (Section 6.4.2.3.2, Page 6-189). The draft EA recognizes that other sources of water might be present (Section 6.4.2.3.2, page 6-192) and that they will be identified only during site characterization. However, the evaluation in the draft EA does not state as to how large brine/gas inclusions and other anomalies will respond to repository induced thermal loading. This is a particularly important information for shaft sealing considerations with regard to prevention of flooding. The only site data used in the computational analysis are apparently thermal properties from laboratory tests. Furthermore, the analysis is for the Reference Design of the repository, whereas the DOE has proposed a Two-Phase Repository Design Concept. The analysis does not consider the impact of some of the special conditions of this Two-Phase Repository Design; especially the severe restriction placed on the lateral extent flexibility of this site. It is recommended that the evaluation be expanded to discuss the above comments and factor their findings into the conclusions for this guideline.

6-29

Section 6.3.1.3.5, Conclusion For Qualifying Condition, Page 6-95, Paragraph 7

The draft EA states that the Cypress Creek Dome is a massive body of halite. This simplified characterization does not consider the real possibility that the salt dome is likely to have anomalies. In the absence of site specific data to the contrary, this is an overstated conclusion. The statement is made that "It (Cypress Creek Dome) is considered to be capable of accommodating the stresses expected from a repository." This statement appears to be unsubstantiated; there is no reference given. Stress conditions are assumed lithostatic. This is a vital assumption; this information would be important to room design, potential for rock failure and closure rates. It is recommended that the discussion be expanded to address the above concerns and demonstrate the validity of the lithostatic condition assertion by indicating a range of values over which this condition could vary and the statement remain true.

6-30

Section 6.3.1.6, Dissolution, Page 6-102

DOE's treatment of dissolution appears to be incomplete in that it does not include, here or on page 3-32, post-Miocene dissolution suggested by a 2-foot void at the caprock/salt interface. A similar void, described by Werner, 1984 and discussed in the Richton dome draft EA, is reported to represent post-caprock formation dissolution. Kreitler and Dutton, 1983, in their study of east Texas salt domes, arrive at similar findings. The caprock void is important in determining the age and rate of dissolution (Kreitler and Dutton, 1983). It may be a remnant of the dissolution that caused the overdome depression at Cypress Creek and may therefore be significant, or it may be unrelated to the depression and may represent a separate dissolution episode.

Because caprock voids occur in many interior salt domes (Kreitler and Dutton, 1983), NRC suspects that additional voids may be present in other caprock positions. Their distribution may be an important consideration in evaluating dissolution. Uncertainties presented here indicate another basis for finding the potentially adverse condition to be present for 960.4-2-6, (c), Dissolution. Amending the appraisal of dissolution to include these uncertainties should be considered . If the details of the role of the caprock void in evaluating dissolution cannot be obtained, the resulting uncertainties should be presented in the final EA.

6-31

Section 6.3.1.6, Dissolution, Page 6-102

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

6-32

Section 6.3.1.6 Dissolution, Page 6-102, Paragraph 2

The DOE's analysis of dissolution, both here and on page 3-32, contains assumptions and uncertainties which may make the estimates of dissolution rates lower than can be calculated from reasonable alternative considerations. Variations in caprock thickness are significant in estimating dissolution rates (Netherland, 1976 & Bodenlos, 1970). The DOE states that from 36 to over 600 feet of caprock have been encountered, but the actual caprock thickness can only be inferred because the angle at which the caprock was drilled is unknown. If an analysis similar to the one used, which assumed 175 feet of caprock, assumes 600 feet of caprock, the dissolution rate is 44 cm/1000 years. This is nearly four times greater than the rate reported by DOE. Such a rate is not to be taken as a realistic value but only to underscore the level of uncertainty inherent in the DOE's analysis. This uncertainty results in another basis for finding the favorable condition to be not present for 960.4-2-6 (b), Dissolution. The DOE should reconsider its use of the caprock thickness method in determining dissolution rate estimates and include the uncertainties and assumptions of that method in the final EA.

6-33

Section 6.3.1.6 Dissolution, Page 6-102, Paragraph 3

The DOE's statement that overdome drainage is dominantly controlled by the lithology of surficial deposits, both here and on page 3-7, conflicts with Kolb, et al., (ONWI-467) who suggest dissolution-related collapse of overdome sediments controls the development of overdome drainage patterns. Differential collapse may be responsible for the anomalous change in the course of Cypress Creek over the dome (Figure 3-2, page 3-3). The NRC considers that differential collapse may be indicative of spines of salt movement and anomalous zones in the salt similar to those reported by Hosman (1978). These features are important to surface facility design, mining operations, the amount of salt available to house the repository and the potential for future differential collapse. These uncertainties affect 960.4-2-6, C, Dissolution, 960.4-2-3 (b)(1), Rock Characteristics and 960.5-2-9, (b)(1), (b)(2) and (c)(4), Rock Characteristics. The DOE should consider other causes for the course of Cypress Creek over the dome and the potential impact to the repository should dissolution effects or alternate active control mechanisms be operative at the site.

6-34

Section 6.3.1.7 Tectonics, Page 6-107, Paragraph 1

DOE's treatment of the origin of Perry Basin is not sufficient to enable NRC to evaluate its influence on groundwater travel times or dome growth (halokinesis) and dissolution rate estimates. NRC agrees that Perry Basin is too large to simply be a salt withdrawal basin for the dome, but alternative interpretations of its origin are not presented by DOE here or on page 3-29. The Perry Basin is a major structural feature and is important in that variations in lithology and structural features within the thickened hydrologic units may result in groundwater travel times different from those in the same units just outside Perry Basin. Kreitler and Dutton (1983) suggest that the volume of salt that flowed into the dome, the amount of salt lost to dissolution and the timing of these processes may best be determined by studying the closure of the adjacent rim syncline. NRC considers that because the estimated volume of salt removed from the basin exceeds the estimated volume of salt in the dome, this volume difference may be attributable to dome dissolution. The uncertainties regarding the Perry Basin affect DOE conclusions for 960.4-2-7, (c)(6), Tectonics and 960.4-2-6, c, Dissolution. The DOE should consider including a more complete description of the Perry Basin and its potential impacts on groundwater travel and dissolution in the final EA. In addition, rim syncline thickness should be considered in estimating rates of dome growth.

6-35

Section 6.3.1.7, Tectonics, Page 6-106, Paragraph 1

NRC's Review of DOE's calculations of expected ground accelerations near the epicenter of the maximum earthquake (magnitude 5.3) are in disagreement with those cited. For distances less than 15 kilometers, calculations using equation 7 of the cited reference (Nuttli and 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.

6-36

Section 6.3.1.7 Tectonics, Page 6-107, Paragraph 1

The DOE's omission of a description of the F-8 Fault, both here and in Section 3.2.5.1, Faulting, and its associated faults does not enable the NRC to evaluate its influence on the development of Perry Basin and subsequently on groundwater travel times. ONWI-120, v. 6, pages 12-88, 12-106 and 12-107 describes Fault F-8, and another possibly related fault, beneath the Perry Basin axis. Page 12-123 continues to mention younger, possibly antithetic, faults in the Wilcox Group. This fault complex, located near and beneath the dome overhang, is important to understanding groundwater travel times near the dome and may also contribute to an explanation for the saline anomaly near the dome. The NRC suggests that these uncertainties question the basis for DOE findings with respect to 960.4-2-7, (c)(6), Tectonics. DOE should consider including a discussion of the F-8 Fault complex in its discussion of structural features and the effect of these faults in its groundwater analyses.

6-37

Section 6.3.1.8.3 Analysis of Favorable Conditions, Pages 6-109 and 6-110

The text states that "from the edge of the salt stock, the likely path is into the Lower and Upper Claiborne Units. TDS concentrations for these units range from 20,600 milligrams per liter to fully saturated brine (Section 3.3.2.2), well in excess of the 10,000 parts per million needed to satisfy the conditon." However, the text is not consistent in the presentation of TDS concentrations for the Upper Claiborne.

The draft EA concludes that groundwater along the likely path of radionuclide travel to the accessible environment contains more than 10,000 parts per million (ppm) total dissolved solids and, therefore, the corresponding favorable condition (960.4-2-8-1(b)(2)) is present at the Cypress Creek site. Based on information in the draft EA and supporting documents, however, the NRC concludes that DOE's conclusion regarding the favorable condition is not adequately supported and may not be consistent with information provided in the draft EA.

In Section 6.3.1.8.3, the draft EA states that concentrations of total dissolved solids in groundwater in the Upper Claiborne Unit, along the assumed travel path, range from 20,600 ppm to a fully saturated brine. Yet the water quality section that Section 6.3.1.8.3 references in support of this conclusion does not identify likely paths of radionuclide travel or the expected quality of groundwater along these paths. Instead the Water Quality section states in Table 3-16 (p. 3-79) that the concentration of total dissolved solids in groundwater within the Upper Claiborne Unit ranges from 3,120 to 197,000 ppm. Consequently, the conclusion stated in Section 6.3.1.8.3 regarding high concentrations of total dissolved solids along travel paths appears to be inconsistent with the water quality information that is the reported basis for the conclusion.

In Table 3-16, Section 3.3.2.3, page 3-A, the Cook Mountain Formation, which is part of the Upper Claiborne Unit is reported to have TDS values that range from 3,120 to 197,000 milligrams per liter.

In addition, Section 6.3.1.1.2, page 6-73 states that "the structural complexity around the dome flanks is somewhat uncertain, hence the potential for significant upward or downward flow along the flanks is uncertain." This suggests that if water moves up along the sides of the dome it could encounter water of less than 10,000 milligrams per liter TDS. If either of these situations are possible a favorable condition of groundwater with 10,000 parts per million or more of total dissolved solids along any path of likely radionuclide travel to the accessible environment cannot be reached. The final EA should address the water quality discrepancies and discuss the water quality of other likely flow paths.

6-38

Section 6.3.1.8.5, Table 6-11, Page 6-106, Assessment Results

The draft EA states that the geohydrologic setting has been shown to favor repository performance in that estimated horizontal ground-water travel times through the salt stock perimeter pillar are at least 107,000 years. However, Section 6.3.1.1, Assumptions and Data Uncertainty (p. 6-70) states,..."it is not clear if there is any potential for movement of ground-water through the salt stock of Richton Dome. There are no studies or data documenting significant fluid occurrence or movement in the interior of salt domes." Therefore, the DOE should determine if Darcy flow in salt is possible prior to making travel-time calculations.

6-39

Section 6.3.1.8, Human Interference and Natural Resources, Page 6-111, Paragraph 5

DOE's claim that the potentially adverse condition is not present does not adequately consider uncertainties associated with the 5 exploratory boreholes that penetrate the repository horizon. The DOE states that the potential effects of the boreholes on waste isolation remain to be evaluated, but concludes that the potentially adverse condition is not present. This appears to be a contradictory statement. Page 6-111, paragraph 1, describes a computer code (BORHOL) which has determined that dissolution around the boreholes will diminish with time. However, the next sentence says that maximum dissolution would increase the borehole diameter from about 13½ inches to 7½ feet. In addition, BMI/ONWI-547, pages 89-91 presents a sample problem using the BORHOL computer code and data suitable for a generic salt site. The results indicate that after about 3 years, the borehole radius has increased from an initial value of 0.1 m to more than 25 m. This also appears to disagree with the previous draft EA statement. On page 6-114, paragraph 3, DOE claims that the surface locations of the boreholes are well known, and the subsurface locations and conditions can be determined. NRC considers that these statements do not satisfactorily assess the associated uncertainties. Boreholes are not always easy to find on the surface even only a few years after drilling. Re-entering boreholes to completion depth is also not assured. Borehole closure and collapse can be expected to have occurred since drilling, and re-entry techniques cannot assure probe drift out of the borehole.

These uncertainties provide a partial basis for finding the potentially adverse condition to be present for 960.4-8-1, (c)(3), Human Interference and Natural Resources. DOE should consider these uncertainties in their evaluation and incorporate them into the final EA.

6-40

Section 6.3.2.4, Geologic Setting, Page 6-134, Paragraph 6

The paragraph on rock characteristics states that "no potentially adverse conditions are found regarding rock characteristics." Section 6.3.1.3.3, paragraph (2), p. 6-95 concludes that one potentially adverse rock characteristic condition is present. This contradiction may be rectified in the final EA.

6-41

This comment was incorporated elsewhere in the comment package.

6-42

Section 6.3.3.2.2, Statement of Qualifying Condition - Assumptions & Data Uncertainty, Page 6-148, Paragraph 2

The statement that design parameters are considered conservative for room closure computation needs supporting evaluation. The reference used for this evaluation, Pfeifle (1983 (ONWI-450)), however, presents only laboratory-derived creep parameters and does not indicate a basis for choosing "conservative" design parameters for room closure computation. Furthermore, a discussion has not been presented to show that the creep parameters from laboratory testing data would still be conservative, if extended to the in-situ field conditions. The statement is therefore inadequately supported. It is recommended that further supporting evidence be given for this statement.

6-43

Section 6.3.3.2.3, Analysis of Favorable Conditions, Page 6-148, Paragraph 6

The evaluation in the draft EA needs clarification to support a finding that the favorable condition is not present for a sufficiently thick and laterally extensive host rock to ensure safe repository construction, operation, and closure. However, this finding is changed in Table 6-14 to indicate that a favorable condition is present. The finding listed in Table 6-14 (Page 6-158) should be revised to be consistent with the conclusion stated in the Draft EA text (Page 6-148). The evaluation states that horizontal flexibility is available for a multiple level repository. There are two concerns with this statement. First, the data base is not sufficient for the stated evaluation. Second, the evaluation does not state which favorable condition is not present. Major gas pockets and/or brine pockets encountered during construction will require changes in the repository layout. In the Cypress Creek Dome, the lateral extent of the dome is limited, and this will restrict the lateral flexibility that is needed to accommodate any change in the repository layout because of the presence of anomalous zones, gas and/or brine pockets. It is recommended that the limitation of the data base be qualified and the finding clarified.

6-44

Section 6.3.3.2.3, Analysis of Favorable Conditions, Page 6-148, Paragraph 9

The draft EA finding that a favorable condition is present for the requirement of minimal artificial support for underground openings during repository operation and retrieval phase is inadequately supported and needs further justification. The evaluation of this finding is based upon mining experience in other Gulf Coast salt domes. There are two concerns here. First, the commercial salt mining experience may be biased. For example, if mining conditions are such that minimal artificial support is not sufficient in a particular drift, mining would stop and move elsewhere. A repository in the dome may not have that freedom of movement. Second, the salt mining experience does not include thermal effects on artificial support. The evaluation does not discuss the effects of temperature on roof and rib failures (slaking, spalling, etc.) and the resulting support requirements. Also, there is no discussion on the thermal mechanical behavior of rock bolts. Emplacement rooms will not be backfilled for one year leaving ample time for waste heat to cause thermal loading about the room and support package (bolts). The ventilation paths will have to remain open through areas adjacent to waste emplacement panels. Also, the evaluation does not address the isolation of shafts from elevated temperatures and does not demonstrate that seal systems can maintain their integrity under thermal effects during the life of the repository. The evaluation in the draft EA may be expanded to include the effects of repository induced thermal-mechanical loading on support requirements, and provide further justification for the draft EA finding.

6-45

6.3.3.2.3, Analysis of Favorable Conditions, Page 6-148, Paragraph 11

This section evaluates characteristics of the host rock which impact on support requirements for underground openings and concludes that a favorable condition is found. The evaluation does not state whether the effect of the virgin rock temperature has been considered. An earlier study (Stearns-Rogers, 1981, ONWI-283) has identified virgin salt temperature as an important geotechnical factor for engineering feasibility evaluations with regard to room closure. Temperatures reported by Law Engineering, 1983, (ONWI-289) vary considerably for the Cypress Creek (110°-118°F), Vacherie (127°F-136°F), and Richton (122°F) dome sites, and are all much higher than the value of 100°F used for ventilation studies in the Stearns-Roger 1984 report. It is recommended that evaluation be expanded to discuss the uncertainties in the in situ temperatures at repository horizons and include the temperature effect on room closure and stability analysis.

6-46

Section 6.3.3.2.4, Analysis of Potentially Adverse Conditions
Page 6-149, Paragraph 4

The evaluation in the draft EA is inadequate to support a finding that a potentially adverse condition is not present for the requirement of engineering measures beyond reasonably available technology in the construction of shafts and underground facilities. The evaluation is based upon Gulf Coast Salt mining experience. It is stated that shaft sinking can be accomplished by using reasonably available technology, freezing. The evaluation presented underestimates the potential problems associated with shaft freezing. The evaluation also does not discuss the affect of freezing - thawing on the disturbed zone. The report by D'Appolonia (ONWI-255, 1981) identifies several disadvantages of freezing with regard to long-term sealing particularly where a thick fractured caprock is present. This report states that "it is doubtful that freezing will be successful in a thick, fractured caprock." This report is not referenced in the draft EA. No evaluation is presented with regard to the effect of thermal loading on in situ characteristics and conditions of the salt. If canister emplacement occurs before construction is completed, thermal effects may influence the underground facility construction procedure by requiring extensive remedial work to maintain the openings in the passageway. This may affect retrieval considerations. The effects of repository thermal loading on host rock may also require unique construction techniques. In addition, the steel shaft liner and the seal must remain effective in preventing flooding to satisfy possible retrieval requirement until permanent closure. Given the fairly lengthy total time from shaft liner installation until permanent closure, uncertainties may exist regarding the ability of the steel shaft liner to provide adequate protection if exposed to repository induced thermal loading without requiring unique maintenance efforts. This becomes a critical factor in the two-phase concept repository design. It is recommended that the evaluation presented in the draft EA be expanded to discuss the above comments and to include mining experience in mines operating under temperature regimes similar to the Cypress Creek Dome temperature environment expected after emplacement of waste and immediately before decommissioning.

6-47

Section 6.3.3.2.4, Analysis of Potentially Adverse Conditions, Page 6-149, Paragraph 5

The draft EA finding that a potentially adverse condition is present with regard to maintenance of underground openings needs clarification. The evaluation presented in the Draft EA does not state what the potentially adverse condition is. The evaluation states that only routine remedial maintenance of subsurface conditions of the site will be required; this should not pose potentially adverse condition. Extensive maintenance is most likely required in the vicinity of shear zones and major anomalies or inclusions within the dome. Experience in Gulf Coast salt mines as documented by Kupfer (1980) suggests that anomalous zones which would require extensive maintenance may be encountered. In addition, the experience is from mining operations without the adverse condition of possible thermal load generated by emplaced waste, prior to closure of the repository. Therefore, extensive maintenance of underground openings may be required in some areas of the repository. It is recommended that the evaluation in the final EA be expanded to discuss the potential for extensive remedial maintenance operations needed in addition to the routine maintenance operations required for the underground openings during the repository operation and closure.

6-48

Section 6.3.3.2.4, Analysis of Potentially Adverse Conditions, Page 6-149, Paragraphs 7, 8, 9 and 10

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

The evaluation in this section states that creep closure of salt may pose difficulty in retrieval but that other factors (thermal decrepitation, brine migration, and radiation effects) are not expected to cause problems. The evaluation does not address re-excavation of the storage rooms. From the thermal distribution calculations (Figure 6-6, p. 6-190, Figure 6-7, p. 6-191) it appears that extensive sections of the rooms near 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 Table 3-5, p. 3-37 at 100°C (Pfeifle, 1983, ONWI-450, page 31, Figure 4-2) suggests that the unconfined compressive strength of salt at 100°C could be as low as 10 MPa. Section 3.2.6.1.2 suggests an in situ vertical stress of 16 MPa based on reasonable assumptions. It appears that the salt near the emplacement holes may have to be cooled down significantly or that extremely heavy support measures will be required to re-excavate the emplacment rooms.

The second paragraph of this section states that the potential for thermal decrepitation of rock adjacent to the canister is minimal. This statement is considered inadequately supported for several reasons. First of all, Lagedrost and Capps (1983 (ONWI-522)) point out explicitly the difficulty of obtaining acceptable test samples from the very weak Richton Dome core provided. The Richton Dome samples on which decrepitation tests have been performed were stronger than the average rock salt in the cored section. The possibility of decrepitation due to heterogeneities within the salt rock was not considered. Furthermore, the thermal decrepitation tests were performed on unloaded samples. Given the very substantial reduction in strength with increasing temperature and the potential heterogeneity of the in situ rock mass, it is likely that thermal decrepitation would be more severe for in situ rock salt around the canister holes.

The migration of brine towards the waste package is a factor not only in corrosion of the waste overpack but also in changing the position/orientation of the canister. If a brine-filled cavity develops around a waste package, the waste package is likely to change position. This would cause overcoring complications.

The discussion in the draft EA deals with difficulty in retrieval under repository conditions. The draft EA identifies principal geomechanical factors having to do with retrieval, but addresses only those conditions that are expected to exist in the immediate vicinity of the waste canister. While the very-near-field conditions are important, particularly for locating canisters, describing their orientation, and physically reaching and extracting them, conditions more remote from the canister will greatly influence remining and retrieval operations. These operations may have to be carried out in thermally-elevated conditions that will pose ventilation, mining, and radiological and safety problems and/or will require sophisticated remote mining, rock handling and possibly roof support installation equipment with cooled and shielded enclosures for the operator and all support personnel. This type of equipment remains to be developed. In addition, operators proficient in using such equipment under repository retrieval conditions will need to be trained. The discussion presented does not address the effect of the potential presence of gas and brine pockets on retrieval. It is recommended that the evaluation presented be expanded to address the above comments.

6-49

Section 6.3.3.2.4, Analysis of Potentially Adverse Conditions, Page 6-150, Paragraph 3

The evaluation presented needs further analysis to support the draft EA finding that the potentially adverse condition, i.e. existing faults, shear zones, pressurized brine pockets, etc. is present. The second sentence of the first paragraph of the evaluation states that the extent to which such features may be present at Cypress Creek Dome is unknown. On the basis of generic evidence, i.e. past experience in Gulf Coast salt mines, it must be expected that such potentially adverse condition might be present, but more information is required to draw a firm conclusion in this regard. It is recommended that the evaluation be expanded to address the severity of the problem and present an analysis of the potentially adverse condition.

6-50

Section 6.3.3.2.6, Conclusion for Qualifying Condition, Page 6-151, Paragraph 4

The conclusion states that "The salt at Cypress Creek Dome is clean and uniform", and in the same paragraph it is stated that "The clean and uniform composition and massive characteristics of the Cypress Creek Dome salt will require minimal artificial support." These statements are inadequately supported. In the Assumptions and Data Uncertainty section, p. 6-92, 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 representaive of the entire salt stock." The conclusion that the Cypress Creek Dome is a clean, uniform and massive salt is based on results from one boring. It is recommended that the evaluation be expanded to present data to support the statements that the salt at Cypress Creek Dome is clean and uniform or modify the conclusion to reflect the possible presence of anomalies.

6-51

Section 6.3.3.3.4, Analysis of Adverse Condition, Page 6-153, Paragraph 6

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, the evaluation is brief. Clearly in salt, ground water inflow is an important concern, not just as a pumping problem but as it effects the 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 fracture and possibly by open cavities, there are uncertainties that freezing will be successful (D'Appolonia, 1981). Furthermore, the large number of holes required for freezing and the ground disturbance resulting from the freezing/thawing cycle may significantly increase the hydraulic conductivity of the ground around the shaft (e.g., NUREG/CR-2854, Page 46). Evaluation of the above uncertainties has not been presented. The assessment should discuss the risks of using ground freezing to prevent ground water inflows and indicate other methods that could be used to seal the shafts should ground freezing prove impracticable.

6-52

Section 6.3.3.4.1, Statement of Qualifying Conditions, Page 6-154, Paragraph 9

This section evaluates projected effects of expected tectonic phenomena on repository construction, operation or closure. The evaluation process, however, does not include the potential effect of seismic activity on liquefaction of overburden materials. Liquefaction could cause problems which may be important to construction of surface facilities foundations and shaft construction and operation. In Chapter 3 it is stated that the site is within a wooded marsh in the Cypress Creek flood plain. However, no site-specific data are available on geomechanical properties of the overburden. From the conditions described in Chapter 3 it appears liquefaction may be a possible mechanism at Cypress Creek. It is recommended that the final EA consider liquefaction potential at Cypress Creek and either demonstrate that it should not be an important factor or address its potential effects on construction and operation.

6-53

Section 6.3.3.4.4, Analysis of Potentially Adverse Condition, Page 6-155, Paragraph 10

The evaluation presented in this section does not address the possibility of the occurrence of potential damage modes that would increase permeability of the salt rock mass or disturb borehole or shaft seals during seismic events. A seismically induced compression-dilation wave will be propagated along the shaft axis developing unit strains in the rock wall along which the wave progresses. The shaft sealing material between the seal bulkhead and the rock wall must be capable of responding to the strain without loss of integrity and bonding to preclude failure of the seals. Failure of the seal may compromise the geologic isolation of the nuclear waste by providing a path of increased permeability to allow acceleration of the transport of radionuclide to the accessible environment. The draft EA finding that a potentially adverse condition is not present has not been adequately supported. The evaluation should be expanded to adequately demonstrate the appropriateness of the finding for all potential damage modes.

6-54

Section 6.4.1, Preclosure Radiological Assessment for Cypress Creek Dome, Page 6-164

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, with the processing of 17000 gallons per day of radioactive liquid wastes (Table 5-1) and with the management of the low-level wastes generated on site. Spent fuel when removed from the reactor has a layer of radioactive crud on its outer surfaces that provides a source term for fuel handling operations even if no leaky fuel pins are present. Leaky fuel pins are present in most spent fuel pools and must also be disposed of.

In the contamination found in spent fuel pool water the predominant radionuclides are usually Cesium-134, Cesium-137, Cobalt-58, Cobalt-60, and Ruthenium-106, depending upon the history of the spent fuel and the pool water. It is suggested that the final EA present an assessment that addresses the source terms originating in the various cleaning, handling, packaging, and processing operations that might be conducted in the Waste Handling and Packaging Facility, the expected emissions after cleanup in the HVAC and any other gaseous waste handling systems, and the resulting radiological impacts in the environment (cf NUREG-0695)

6-55

Section 6.4.1.2, 10 CFR Part 20 Calculation, Page 6-167

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

6-56

Section 6.4.1, Preclosure Radiological Assessment, Page 6-164 to 6-173

Neither the preclosure or 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 a subsequent comment).

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

6-57

Section 6.4.1, Preclosure Radiological Assessment, Page 6-164 to 6-173

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

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

6-58

Section 6.4.1.2, 10 CFR 20 Calculations Pages 6-167 to 6-169

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 (NUREG/CR-3602) from commercial rather than spent fuel. The 0.01 percent discharge failure rate supported by NUREG/CR-3602 does not consider the effects of shipping, consolidation, and other anticipated operations on the spent fuel. In light of this higher value, it is not clear that the low pin failure rate (and associated confidence level) and assumed Poisson distribution are justified in the 10 CFR 20 calculation. For the final EA, a more representative set of fuel pin failure assumptions should be considered (e.g., Section 6.4.1.2.2 of DOE/RW-0012).

6-59

Section 6.4.1.3, 40 CFR 191 Calculation, Page 6-171

The meteorological data base identified in this section (Reference NOAA, 1971) is not the same as that identified in Section 6.2.1.4. The use of meteorological data from Mobile, AL 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 (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 Jackson, MS (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, and that true annual average conditions be calculated and compared to the approximations to ensure consistency.

6-60

Section 6.4.1.4, Accident Calculations, Table 6-26, Page 6-178

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 found (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. It is suggested that Table 6-26 be reviewed and revised as appropriate.

6-61

Section 6.4.2, Preliminary Postclosure Performance Assessment Pages 6-173 to 6-227

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

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

6-62

Section 6.4.2.3, Preliminary Subsystem Performance Assessments, Pages 6-184 6-227

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. An estimate of the uncertainty in these factors has not been included in the draft EA.

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

6-63

Section 6.4.2.3.2, Fluid Conditions In Salt, Page 6-189

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

6-64

Section 6.4.2.3.1, Thermal Conditions, Pages 6-186 to 6-189

Confidence in the waste package thermal analysis may be overstated. Neither the magnitudes nor the effects of uncertainties in thermal analysis 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. 6-16 in the draft EA, it can be estimated that a difference of 30°C or less in peak overpack temperature can change the calculated corrosion by up to a factor of 2. The effects of uncertainties in the thermal analysis on waste package lifetime should be considered in the final EA.

6-65

Section 6.4.2.3.2, Fluid Conditions in Salt, Page 6-189, Paragraph 1

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

6-66

Section 6.4.2.3.2, Fluid Conditions in Salt; Analytical Approach, Page 6-189, Paragraphs 2 to 5

The BRINEMIG code used in the draft EA to calculate brine accumulations due to thermally induced brine migration is based on a number of assumptions that limit the applicability of its results (see detailed comment 6-21). Results from BRINEMIG are used in support of the geochemistry favorable condition (3) favorable condition (4) and potentially adverse condition (1) and rock characteristics potentially adverse condition (2). These uncertainties regarding BRINEMIG and the application of its results should be considered when evaluating the evidence relevant to these conditions.

6-67

Section 6.4.2.3.3, Page 6-189,Paragraph 6

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

6-68

Section 6.4.2.3.3, Waste Package Performance, Subpart 2, Brine Flow Rate, Page 6-192/196, Paragraph 5

Brine migration with a threshold thermal gradient below which flow does not occur has not been demonstrated to be the expected condition, contrary to the position taken in the draft EA. Although a number of investigators support the concept of a threshold thermal gradient (e.g., Jenks and Claiborne, 1981), others do not (e.g., Roedder and Chou, 1982). Because this 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.

6-69

Section 6.4.2.3.3, Waste Package Performance, Subpart 4, Page 6-196

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 the 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 final EA should consider the possibility of radiation-induced changes to the waste form and canister materials.

6-70

Section 6.4.2.3.3, Waste Package Performance, Subpart 3, Page 6-196
Continuing Paragraph

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

6-71

Section 6.4.2.3.3, Waste Package Performance, Page 6-202, Paragraph 1

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

6-72

Section 6.4.2.3.3, Waste Package Performance, Page 6-202, Paragraph 3 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 O_2, and sulfide formation (see comment 6-21). The waste package performance assessments are used in support of findings for the geochemistry qualifying condition, favorable condition (4) and potentially adverse condition (1). To support the conservatism claimed in the draft EA, these factors should be considered.

6-73

Section 6.4.2.3.3, Waste Package Performance, Pages 6-192 to 6-206
Radiation Field, Figures 6-11 and 6-12

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

6-74

Section 6.4.2.3.3, Waste Package Performance, Pages 6-192 to 6-206

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

There are two sources of potential error with regard to the brine composition. They both stem from the assumption that the reason that the thermally migrating, inclusion brine will be of low (< 200 ppm) Mg content as it contacts the waste package is that the in-situ, initial Mg content of the inclusions is low. For reasons outlined in detailed comment 6-70, 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 brine composition, it 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 considered. 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.

6-75

Section 6.4.2.3.3, Waste Package Performance, Page 6-202

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 waste 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 allowarce.

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 EA waste package performance assessment. In the absence of definitive experimental results, the uncertainties in the choice of corrosion process should also be considered.

6-76

Section 6.4.2.3.3, Waste Package Performance, Page 6-202

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

6-77

Section 6.4.2.3.3, Waste Package Performance, Pages 6-192 to 6-206

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 of the salt, this becomes a dominating factor in the accuracy of the predictions. The thermal conductivity of the salt is affected by the content of non-salt materials, 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 medium as a homogeneous isotropic material and, therefore, does not account for the effects of non-salt materials.

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

Temperature is one of the most important characteristics associated with the waste package and one which establishes a feedback between materials performance and the immediate host medium. The temperature affects the brine migration rates, the chemical composition of the brine, package degradation mechanisms and, therefore, package lifetime. The temperature gradient in the vertical direction is expected to contribute to brine flow 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 960.4-2-7, 960.4-2-2, and 960.4-2-3). Any uncertainties that do exist in the analysis should be considered.

6-78

Section 6.4.2.3.3, Waste Package Performance, Pages 6-192 to 6-206

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 more than 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 pre-closure rate, data by Braithwaite and Molecke (1980) may be used. They found that 1018 steel placed in contact with crushed salt at 100°C, in the presence of 100 percent relative humidity, gave a uniform corrosion rate of 0.15 mm/yr. Over a 50-year period this would translate to a metal loss of 0.75 cm, assuming a conservative linear rate of corrosion. Braithwaite and Molecke also cite data from Project Salt Vault (Bradshaw et al., 1971) in which a low-carbon steel was exposed to synthetic salts containing 0.5 percent water at 200-300°C. The uniform corrosion rate was 0.1 mm/yr. In 50 years this would give a metal loss of 0.5 cm, which is in reasonable agreement with their own study. More recent work (PNL-4250-5, 1984) shows that a range of ferrous materials exposed for 3 months at 150°C to salt containing 30% brine had a penetration rate of about 0.3 mm/yr. In 50 years, the metal loss would be approximately 1.5 cm. This is a significant fraction of the corrosion allowance 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.) Additionally, the temperatures could become high enough (and the ambient pressure low enough) to vaporize the brine water near the waste packages. 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.

6-79

Section 6.4.2.3.3, Waste Package Performance, Pages 6-192 to 6-206, WAPPA Analysis

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 currently available from ONWI, and the other codes, have not been released. The version of these codes that were used should be identified and released as part of the supporting documentation identified above.

6-80

Section 6.4.2.3.3, Waste Package Performance, Pages 6-196 to 6-202

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. In the discussion of waste package boundary conditions, transient excess radial and axial pressures are assumed to be 25% and 35%, respectively, of the static lithostatic pressure. However, this does not appear to be consistent with the curves in Figure 6-14, which shows the variation in axial and radial stresses for the first 18 years after burial, starting at time zero.

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

6-81

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 lower values ... These data may be no more or no less applicable for this preliminary analysis."

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

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

The uncertainties in the nuclide solubilities, combined with uncertainties in brine flow rate, and total accumulated brine appear not to have been specifically included in the assessment of whether the engineered barrier system will meet the controlled release rate performance objectives (10 CFR 60.113). These uncertainties should be specifically considered in the final EA performance assessment.

6-82

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

Inconsistencies in the amounts of radionuclides tabulated in the draft EA suggest calculational errors in estimates of the maximum concentration of nuclides at the waste packages and release rates for a single package that has failed at 300 years. For example, the inventories for C-14, I-129, and Cm-244 (among others) in Table 6-27, when expressed in terms of grams per package, do not appear to agree with those in Table 6-33. 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 related comment) 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.

6-83

Section 6.4.2.3.4, Release Rate from the Engineered Barrier Subsystem, Page 6-206, Paragraph 2

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 final EA should also consider the intrusive brine scenario in the evaluation of radionuclide releases.

6-84

Section 6.4.2.3.4, Release Rate from the Engineered Barrier Subsystem, Page 6-206, Paragraph 2

There are a number of uncertainties regarding the solubility data used in the draft EA. These include the uncertain nature of the data itself and the effects of Eh and pH (see detailed comment 6-20). Since there is no site-specific data, as asserted in the draft EA, and all available solubility data are uncertain, the final EA should use more demonstrably conservative values. The draft EA notes that there are measured solubilities that would be more conservative than the WISP values, but they are not used.

6-85

Section 6.4.2.3.4, Release Rate From the Engineered Barrier Subsystem, Page 6-206, Paragraph 4

The statement that "dissolution of cesium-137 would be limited by dissolution of the matrix" is not correct based on 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) (see detailed comment 6-71).

6-86

This comment was incorporated elsewhere in the comment package.

6-87

Section 6.4.2.3.5, Geologic Subsystem Performance, Page 6-215, Paragraphs 2/5

The conclusions presented under Performance of Shaft Seals are not supported by recorded experience. According to the preliminary analyses presented, ground-water flow around and through the shaft seal system will likely be very small. However, recorded experience indicate that at least two salt mine shafts have been lost in the Gulf Coast area due to water dissolution around the shaft (Kupfer, 1980). The analyses do not explain or predict such failures.

It is recommended that the discussion presented be expanded to explain how shaft failures such as those that have occured in the past can be predicted and/or avoided.

6-88

This comment was incorporated elsewhere in the comment package.

6-89

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

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 relavency of the information presented to the Cypress Creek Dome site.

6-90

Section: Appendix 6-A, Estimation of the Extent of the Distubed Zone, Pages A-2, A-3, Paragraphs All

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 excavations (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 openings 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 as (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...". In Appendix II, page 32b, it is 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 (6-15)." On this same page it is stated " . . . .

this friability might imply openings, porosity, and even permeability that might extend for 10 to 30 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 disturbed zone be modified as appropriate to reflect the results of the evaluation.

Chapter 6 References

Adams, P.B., 1984, "Glass Corrosion: A record of the Past? A Predictor of the Future?," Journal of Non-Crystalline Solids 67, 193.

Anthony, T.R., and H.E. Cline, 1972, "The Thermomigration of Biphase Vapor-Liquid Droplets in Solids, "Acta Metallurgica, 20, 247-255.

Acre American, Inc., 1977, National Strategic Oil Storage Program, Weaks Island Mine Geotechnical Study, Vol. 2, U. S. Federal Energy Administration, Washington, D. C.

Bailey, W.J., and M. Tokar, 1984, Fuel Performance Annual Report for 1982, Golder Associates, 1977, "Report to Gulf Interstate Engineering Co. on Geotechnical Study of Cote Blanche Island Salt Mine," Vol. II

Beavers, J., N. G. Thompson, and R. N. Parks, 1984). "Stress Corrosion Cracking of Low-Strength Carbon Steels in Candidate High Level Waste Repository Environments," Battelle Columbus Laboratory Report, No Number.

Bodenlos, A. J., 1970, Caprock Development and Salt-Stock Movement, in Kupfer, D.M. ed., The Geology and Technology of Gulf Coast Salt, A Symposium, School of Geoscience, LSU, Baton Rouge, LS, pp. 73-86C.

Bradshaw, R. L., et al., 1971, "Project Salt Vault: A Demonstration of the Disposal of High Activity Solidified Waste in Underground Salt Mines," Oak Ridge National Laboratory Report, ORNL-4555.

Braithwaite, J.W., and M. A. Molecke, 1980, "Nuclear Waste Canister Corrosion Studies Pertinent to Geologic Isolation," Nuc. and Cham. Waste Management, 1, 37-50.

Chambre, P.L., T.H. Pigford, and S. Zavoshy, 1983, "Solubility-Limted Dissolution Rate in Ground Water," Trans. Am. Nucl. Soc., v. 41, p. 53.

Cline, H.E., and T.R. Anthony, 1971, "The Thermomigration of Liquid Droplets Through Grain Boundaries in Solids, Acta Metallurgica 19, 491-495.

D'Appolonia Consulting Engineers, 1983, "Sealing Considerations for Repository Shafts in Bedded and Dome Salt" ONWI-255.

Draft Environmental Assessment, Yucca Mountain Site, Nevada Research and Development Area, Nevada, 1984, U.S. Department of Energy Report DOE/RW-0012.

Ertec, 1983a, "Regional Ground-Water Flow Near Richton Dome, Mississippi: Annual States Report for Fiscal Year 1982," ONWI-456, 147p.

Ertec, 1983b, "Midyear FY83 Richton Dome Screening and Suitability Review," ONWI-484, 104p.

Garrels, R.M., and C.L. Christ, Solutions, Minerals, and Equilbria, Harper and Row, New York, 1965.

Golder Associates, 1977, "Report to Gult Interstate Engineering Co. on Geotechnical Study of Cote Blanche Island Salt Mine," Vol. II.

Gray, W.J., 1979, "Gamma Radiolysis Effects on Grande Ronde Basalt Groundwater," in Scientific Basis for Nuclear Waste Management VII, G.L. McVay, ed., (North-Holland, New York) 1981, v. 26, pp. 147-152.

Gray, W. J. and S. A. Simonson, 1984, "Gamma and Alpha Radiolysis of Salt Brines" Presented at Materials Research Society Meeting, Scientific Basis for Nuclear Waste Management, Boston, MA.

Hohlfeder, J.J., 1979, "Salt Block-2--Description and Results", Sandia National Laboratories, Albuquerque, NM, SAND 79-2226.

Hosman, R. L., 1978, Geohydrology of the Northern Louisiana Salt-Dome Basin Pertinent to the Storage of Radioactive Wastes: A Progress Report, USGS Open-File Report, 27 p., November.

Hubbard, N. et al., 1984, "The Composition and Stratigraphic Distribution of Materials in the Lower San Andres Salt Unit 4," in Scientific Basis for Nuclear Waste Management VII, G.L. McVay, ed., (North-Holland, New York v. 26, pp.405-415.

INTERA Technologies, Inc., 1984, "Second Status Report on Regional and Local Ground-Water Flow Modeling for Richton and Cypress Creek Domes, Louisiana," prepared for the Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus, OH

INTERA Technologies, Inc., 1984, BORHOL: A Computer Code to Evaluate Dissolution, Precipitation, Creep, and Temperature Effects in Boreholes in Salt, BMI/ONWI-547, prepared for the Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus, OH.

Jansen, G., 1984a, "Performance Analysis of Conceptual Waste Package Designs in Salt Repositories," Scientific Basis for Nuclear Waste Management VII, Vol. 26, G. L. McVay, Editor, New York, Elsevier Publishing.

Jansen, G., 1984b, Expected Waste Package Performance for Nuclear Waste Repositories in Three Salt Formations, Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus, OH, August.

Jenks, G.H., and H.C. Claiborne, 1981, Brine Migration in Salt and its

Implication in Geologic Disposal of Nuclear Waste, Oak Ridge National Laboratory, Oak Ridge, TN, ORNL-5818.

Johnson, L.H., 1982, "The Dissolution of Irradiated UO_2 Fuel in Groundwater," Atomic Energy of Canada Limited, Pinawa, Manitoba, Canada, AECL-6837.

Kolb, C.R., J.C. Holmes, and J.J. Alford, 1983, The Quaternary Geology of Vacherie Salt Dome, North Louisiana Salt Dome Basin, ONWI-467, prepared by Institute for Environmental Studies, Louisiana State University, for Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus, OH.

Kreitler, C.W., and S.P. Dutton, 1983. Origin and Diagenesis of caprock, Gyp Hill and Oakwood Salt Domes, Texas, Report of Investigations 131, Bureau of Economic Geology, University of Texas at Austin.

Kupfer, D. M., 1980, "Problems Associated with Anomalous Zones in Louisiana Salt Stocks, U.S.A. "Fifth International Symposium on Salt, Hamburg, Germany, May-June 1978, Northern Ohio Geological Society, Cleveland, Ohio, Vol. 1, pp. 119-134

Lagedrost, J. F. and W. Capps., 1983, "Thermal Property and Density Measurements of Samples taken from Drilling Cores from Potential Geologic Media", ONWI-522.

Law Engineering Testing Company, 1982, "Gulf Coast Salt Domes, Geologic Area Characterization Report Mississippi Study Area," Vol. VI and Vol.VII, ONWI-120.

Law Engineering Testing Co., 1983, "Geothermal Studies of Seven Interior Salt Domes" ONWI-289.

Letco, 1983, "Salt Caprock and Sheath Study," ONWI-355

Lindberg, R.D. and D.D. Runnells, 1984, "Ground Water Redox Reactions: An Analysis of Equilibrium State Applied to Eh Measurements and Geochemical Modeling," Science 225, 925.

McCauley, V.S. and G.E. Raines, 1984, Expected Nuclear Waste Repository Near-Field Performance in Three Salt Basins, Part II: Brine Migration," Battelle Memorial Institute, Office of Nuclear Waste Isolation, Columbus, OH.

McNulty, E. G., "Expected Nuclear Waste Repository Near Field Performance in Three Salt Formations," Part 1, BMI/ONWI, to be published.

Mellegard and Senseny, 1983, "Exponential - Time Creep Law for Avery Island Salt," ONWI-329.

National Research Council, 1984, Review of the Scientific and Technical Criteria for the Waste Isolation Pilot Plant (WIPP).

Netherland, Sewell and Associates, Inc., 1976, Geologic Study of the Interior Salt Domes of Northeast Texas Salt-Dome Basin to Investigate their Suitability for Possible Storage of Radioactive Waste Material, prepared for Union Carbide Corp., Nuclear Division.

Nuclear Regulatory Commission, Technical Position on "Determination of Radionuclide Solubility in Groundwater for Assessment of High Level Waste Isolation.", November 1984.

NUREG 0695, 1980, "Environmental Impact Appraisal Related to the Renewal of Materials License SNM-1265 for the Receipt, Storage, and Transfer of Spent Fuel," concerning the Morris Operation.

Nuttli, O.W., and R.B. Herrmann, 1978, Credible Earthquakes for the Central United States, Miscellaneous Paper S-73-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Ogard, A. and others, 1981, "Are Solubility Limits of Importance to Leaching," Scientific Basis for Nuclear Waste Management, Vol. 3, J. G. Moore, Editor New York, Plenum Press.

Panno, S.V., and P. Soo, Brookhaven National Laboratory, 1984, "An Evaluation of Chemical Conditions Caused by Gamma Irradiation of Natural Rock Salt," in Review of Waste Package Verification Tests, P. Soo, ed., for Nuclear Regulatory Commission, NUREG/CR-3091, Appendix A.

Pederson, L.R., D.E. Clark, F.N. Hodges, G.L. McVay, and D. Rai, 1984, "The Expected Environment for Waste Packages in a Salt Repository," in Scientific Basis for Nuclear Waste Management VII, G.L. McVay, ed., (North-Holland, New York) v. 26, pp. 417-426.

Pfeifle, T. W., K. D. Mellegard, and P. E. Senseny, 1983, "Preliminary Consitutive Properties for Salt and Non Salt Rocks from Four Potential Repository Sites", ONWI-450

Pigford, T.H., 1983, "Waste Isolation System Panel (WISP) Report: A Study of the Isolation System for Geologic Disposal of Radioactive Wastes," National Academy of Sciences, Washington, D.C.

Pigford, T. H. and others, 1983, "A Study of the Isolation System for Geologic Disposal of Radioactive Wastes," National Research Council, Washington, DC, National Academy Press.

PNL-4250-5, 1984, Semiannual Progress Report.

Roedder, E., and I.M. Chou, 1982, "A Critique of 'Brine Migration in Salt and its Implications in the Geologic Disposal of Nuclear Waste', Oak Ridge National Laboratory, Report 5818, by G.H. Jenks, and H.C. Claiborne", United States Geologic Survey, Open File Report 82-1131.

Roedder, E., 1984, "The Fluids in Salt," American Mineralogist 69, 413-439.

Sastre, C., 1984, "Review of the Thermal Analysis of the Environmental Assessment for the Swisher Repository in Salt," Brookhaven National Laboratory Letter Report NWM-MF-8.

Sastre, C. and T. Sullivan, 1984, "Review of Radiation Dose Rate Data Contained in the Environmental Assessment for a Salt Repository at the Swisher Site," MW,-MF-9.

Sastre, C., Pescatore, C., and Sullivan, T. Waste Package Reliability, NUREG/CR-0997, BNL-NUREG-51553, 1985 (to be published).

Seabrook, J. B., N. J. Grant, and Dennis Carney, 1950, "Hydrogen Embrittlement of SAE 1020 Steel," Trans-AIMME, 189, 1317-1321.

Shornhorst, J. R., 1982, "Engineered Waste Package Conceptual Design, Defense High Level Waste (Form 1), Commercial High Level Waste (Form 1) and Spent Fuel (Form 2) Disposal in Salt, AESD-TME-3131.

Stearns-Roger Services, Inc., 1981, Engineering Feasibility Studies for Candidate Salt Domes: National Waste Terminal Storage Repository No. 1, Special Study No. 5 ONWI-283.

Stearns-Roger Services Inc., 1984, Engineering Factors and Costs for RWM Repository Site Selection for Richton Dome, Perry Counter, Miss. ONWI - (current name - Stearns Catalytic Corp).

Stumm, W., 1966, Redox Potential as an Environmental Parameter; Conceptual Significance and Operational Limitation" in Advances in Water Pollution Research, Proceedings of the Third International Conference held in Munich, Germany, September 1966. Vol 1, O. Jaag and H. Liebermann, co-chairmen, Water Pollution Control Federation, Washington, D. C.

Stumm, W., and J.J. Morgan, 1981, Aquatic Chemistry, John Wiley and Sons, New York.

Strickert, R. G. and D. Rai, 1982, "Predicting Pu Concentrations in Solutions Contacting Geologic Materials," Scientific Basis for Nuclear Waste Management, Vol. 6, S. W. Topp, Editor, New York, Elsevier Publishing.

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

Turner, D. B., 1967, Workbook of Atmospheric Dispersion Estimates, Public Health Service, Publication 999-UP-26, Robert A. Taft, Sanitary Engineering Center, Cincinnati, Ohio.

"U.S. Nuclear Regulatory Commission Draft Generic Technical Position, Waste Package Reliability," 1984, Notice of Availability: Federal Register, Volume 49, Number 218, Page 44694.

U.S. Nuclear Regulatory Commission Report NUREG/CR-3602 (PNL-4817).

U.S. Nuclear Regulatory Commission, 1982, "Evaluation of Alternative Shaft Sinking Techniques for High-Level Waste (HLW) Deep Geologic Repositories", Prepared by Golder Associates for NRC, NUREG/CR-2854.

Waite, D.A., 1984, Preclosure Radiological Calculations to Support Environmental Assessments, BMI/ONWI-541, prepared by Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus OH.

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