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30 October 1984
Ref. No. 1148-004
Letter No. 060

Waste Management Engineering Branch
Division of Waste Management
U. S. Nuclear Regulatory Commission
Washington, DC 20555

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

Subject: Contract No. NRC-02-84-002, Modification No. 2 to Task Order 004, Scoping Review of the Nevada Nuclear Waste Storage Investigations Project (NNWSI) Draft Environmental Assessment (EA) Report

Dear Mr. Buckley:

Please find enclosed the scoping review comments on the NNWSI draft EA. As per your requirements, the review consists of two parts - the detailed comments and the major comments. Also attached at the end of the report is a listing of the concern categories used for the detailed comments. Three document reviews are also being sent with this report.

I trust you will find everything in order. If you have any questions or comments, please feel free to call me or Dr. Singh.

Sincerely,

ENGINEERS INTERNATIONAL, INC.

Swapan Bhattacharya

Swapan Bhattacharya
Lead Mining Engineer

SB/ja

Enclosure

cc: Ms. Sharon Wollett
M. M. Singh
Robert A. Cummings

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Selected Major Comments on the Nevada Nuclear Waste Storage Investigations Project (NNWSI) Draft Environmental Assessment (EA) Report

1. The report appears to be most deficient in one of the areas that is of greatest concern to NRC, that is, with regard to radionuclide travel times to the accessible environment. The accuracy of the ground water flux magnitude used in the calculations is highly questionable, as are the values of many rock hydrologic parameters. The likelihood of perched aquifers in the unsaturated zone is neglected. Furthermore, the model and results presented are a gross oversimplification of the expected hydrologic environment and are simply not acceptable as realistic estimates.

2. There is admittedly a lack of evidence that could demonstrate the likelihood of tectonic events and therefore the statements such as, "the likelihood that any (of) these scenarios will occur at Yucca Mountain within the next 10,000 years is judged to be small" is unfounded, and must be considered as pure conjecture. The data seem to suggest that potential exists for fault movement and volcanism in the future; however, considerable uncertainty exists with regard to the timing of these events. It is apparent from the discussions in this report that not enough studies have been performed to resolve this uncertainty, and plans for future studies have not been defined.

3. Familiarity with geologic and hydrologic conditions at the Yucca Mountain site is claimed on the basis of weapons-testing activities conducted at the Nevada Test Site (NTS). Although experience gained during these studies is quite valuable, conclusions cannot be based on these unless the data and documents are referenced directly. It is accepted that much of the data may be classified; nevertheless, some of this information should be made public so it can be ensured that the assumptions and procedures adopted are valid under the present conditions.

4. Experience gained at G-Tunnel with respect to rock minability and stability has been used heavily in the text to support site qualifying conditions. Such comparisons would only be valid if it is established with sufficient confidence that the Rainer Mesa welded tuffs have similar properties to the portion of the Topopah Spring Member being considered for repository development. Although, some similarities in the two formations have been demonstrated, a comprehensive analysis of similarities and dissimilarities for a wide range of physical properties is required.

5. Considerable uncertainty remains in establishing the role of lithophysal cavities in determining the competence and stability of the Topopah Spring Member. The definition of "relatively lithophysae-free" tuff currently refers to less than 15 to 20 percent lithophysae content. There is no data to support this definition. A portion of

the Topopah Spring formation is said to have the above characteristic (p. 6-173). However, the lateral continuity of this characteristic can hardly be established on the basis of few boreholes or even the Exploratory Shaft. Presentation of definite plans for resolving this uncertainty is required.

6. Data related to insitu stress fields in the Yucca Mountain site, and particularly in the Topopah Spring horizon are non-existent. In the absence of such data, the stability analyses and model studies for the proposed repository excavations cannot be considered realistic.

7. The discussion provided on the subject of retrievability of waste (p. 5-31) lacks detail and requires considerable elaboration and further studies.

8. The report acknowledges uncertainties resulting from a limited geologic/geohydrologic data base, and the lack of data on thermal and coupled effects. However, a thorough analysis of the existing data base to make the findings, required by Appendix III of the Siting Guidelines, is not provided.

9. The manner in which the site characterization program will resolve the data base uncertainties is not detailed. The rock properties to be tested are simply stated; no details on the tests themselves are provided, however.

10. The effect of thermal stresses on repository design, operation, and closure (sealing) is not fully detailed. In particular, the effect of these stresses on canister stability within the emplacement hole, and on difficulties during the retrieval phase of repository operations, are not discussed.

11. Brief mentions have been made on the sealing of boreholes and shafts. However, no details are provided with regard to composition, density, permeability, and placement of the seal material(s).

12. There is no mention of the possibility of handling a breached canister during the retrieval phase of repository operations.

13. There is an abundance of statements made in the report that are not supported by documentation. Some of the references cited could not be found in the reference lists. Also, many of the documents referenced are yet unreleased. Many assumptions are questionable, as are some analysis techniques.

Concern Categories Used for Detailed Comments

The following is a list of concern categories suggested by NRC for the review of the NNWSI draft EA. As far as possible, these categories have been adhered to in the detailed comments. There were some comments, however, that did not fit the descriptions of these concern categories.

1. Inadequate data base or inadequate consideration of available data.

2. Incorrect assumption or alternate assumptions have not been considered.

3. Incomplete or inadequate analysis.

4. Uncertainties within the text.

5. Inconsistencies within the text

6. References cited in text are not in list of references, or are not available for review.

7. Discussion of important aspects is omitted for missing figures or tables.

Selected Detailed Comments on the Nevada Nuclear Waste Storage Investigations Project (NNWSI) Draft Environmental Assessment (EA) Report

COMMENT NUMBER

2-1 Section 2.1 Regional Setting of Yucca Mountain.
Page 2-3, paragraph 3
Inadequate documentation (Concern Category (CC) 6)

Reference is made to the age of the rock in the area but no support or documentation is offered. Such information is important in unraveling the complex igneous stratigraphy of the area, as required under DOE siting Guidelines 960.4-2-3: Rock Characteristics. The method of age determination should be documented for future reference so that comparisons can be made to a standard base.

2-2 Section 2.1 Regional Setting of Yucca Mountain
Page 2-5, paragraph 2
Inadequate documentation (CC 6)

Dates of historical volcanic activities are provided without adequate references. Such information is important under DOE Guidelines 960.4-2-3: Rock characteristics.

As mentioned above a standard is needed for comparison of rock ages. At the very least the method of age dating should be mentioned.

2-3 Ibid.

Page 2-5, paragraph 3

Unsupported assumption (CC 2)

The age of faulting and volcanism are compared but no support is offered for the conclusion. This information is important with respect to DOE siting Guideline 960.5-2-11: Tectonics. This basis must be established and documented in order to avoid confusion in more detailed analyses.

2-4 Ibid.

Page 2-5, paragraph 5

Inadequate documentation (CC 6)

The hydrology of this area of the Great Basin is characterized in some detail with no supporting documentation. This is required under DOE siting Guideline 960.5-2-10: Hydrology. The source of the data base must be established to avoid confusion in more detailed discussions which follow.

2-5 Ibid.

Page 2-8, paragraph 1

Incorrect assumption (CC 2)

The statement that most surface water at low elevations evaporates before it seeps deeply into the ground implies, based on the discussion earlier in the same paragraph, that surface water must seep hundreds of feet below the surface to be captured by the ground water environment before it is lost to evaporation. Our experience indicates that precipitation need only seep a few feet into the ground to be captured by the capillary fringe. This is related to DOE siting Guideline 960.5-2-10: Hydrology.

2-6 Ibid.

Page 2-8, paragraph 2

Incorrect assumption (CC 2)

The statement that the bedded tuff and valley fill aquifers transmit water chiefly through interstitial pores as opposed to fractures in welded tuff and volcanics implies that the former are homogeneous and isotropic. This is certainly not true--water in this region would be transmitted also through frac-

tures and along fault planes where they exist and otherwise through natural channels. The resolution of this question is of key importance in characterizing ground water flow regions in the area, as required under DOE siting Guideline 960.5-2-10: Hydrology.

This may be resolved by field measurements and characterization via core drilling.

2-7 Section 2.2.5 Selection of the target repository host rock

Page 2-43, Table 2.7

Reference not available (CC 6)

The four candidate rock units of the Yucca Mountain have been ranked against one another on the basis of different comparison factors. The Topopah Spring unit is top-ranked in all but one category. Examination of drill core from the Yucca Mountain site did not support these conclusions on certain categories, however. In addition, in the absence of detailed thermo-mechanical analysis on the rock units, it is doubtful how such ranking could be arrived at. This issue is fundamental to DOE siting Guideline 960.5-2-9: Rock Characteristics. The

methodology adopted to arrive at these rankings needs to be examined. Johnstone and Peters (1984) should contain this information; however, it is not yet available.

2-8 Ibid.

Page 2-41,paragraph 3

Inadequate analysis (CC 3)

Calculation of ground water travel time through rock units assumed porous flow and did not include effects of heat. Alternative flow paths through fractures and faults are decidedly viable, and heat may have a marked effect on flow rates. The analysis procedure should be altered to take these into consideration. This is relevant to DOE Site Guideline 960.5-2-10: Hydrology.

3-1 Section 3.1.3 Hydrologic conditions

Page 3-31, paragraph 4

Insufficient discussion (CC 3)

The assertion is made that detailed studies of ground water movement in the area are in progress or are planned. However, no schedule or plan to do the work is offered.

3-2 Section 3.1.3.1 Surface Water

Page 3-31, paragraph 5

Inconsistencies within text (CC 5)

The statement that "No perennial or intermittent streams occur at or near Yucca Mountain," is in conflict with statements made later in the same section regarding run-off and drainage from Yucca Mountain. The term intermittent should be defined, as it could include the drainage from occasional storms. This is relevant to DOE Siting Guidelines 960.5-2-8 and 960.5-2-10.

3-3 Ibid.

Page 3-32, paragraph 1

Inconsistencies within text and Inadequate documentation (CC 5 and CC6)

The statement that "the terminal playas may contain standing water for days or weeks" is in conflict with the statement made earlier in Section 2.1, page 2-8, paragraph 1 that "At lower elevations, including Yucca Mountain, most, if not all, precipitation evaporates before it is able to seep deeply into the rocks." Both of these statements are unsupported. Documentation is needed and field measurements would

go a long way to resolving the conflict. This comment is relevant to DOE siting Guidelines 960.5-2-8 and 960.5-2-10.

3-4 Section 3.1.3.2 Ground water

Page 3-32, paragraph 2

Inadequate documentation and Omissions (CC 6 and 7)

Unsupported statements are made regarding the hydraulic connection at depth of many topographic basins and the general direction of ground water flow in the region. Many discharges are mentioned from the Death Valley system, but none of them are characterized. An environmental assessment of a repository in this area demands that all discharges from the ground water system be identified, located, and characterized in as much detail as possible from existing data. The nature of the natural ground water in the area should also be determined so that its reactivity with the host rock can be determined. This aspect is related to DOE Siting Guideline 960.5-2-10.

3-5 Ibid.

Page 3-35, paragraph 1

Insufficient discussion

The valley fill aquifers are identified as the chief sources of ground water for the area, but there is no discussion of the projected demand, the rate of recharge, the total capacity, or the rate of depletion of this source. It cannot be assumed that conditions will remain static at the surface or below. Such changes must be anticipated and projections made to determine the adequacy of supply from the valley fill aquifers. This is relevant to DOE Siting Guideline 960.5-2-10: Hydrology.

3-6 Ibid.

Page 3-35, paragraph 4

Insufficient discussion

It is not clear whether the area referenced refers to the entire recharge area or just the area of the Yucca Mountain Site. It should also be checked to compare precipitation of the past two or three years with that of previous years when the jet stream went north. The reference cited (Montazer and Wilson, 1984) may supply the information; however, it is not available for review.

3-7 Ibid.

Page 3-35, paragraph 4

Inadequate documentation (CC 6)

Ground water travel times are cited but not documented or supported. This information is critical to the suitability of the Yucca Mountain Site. Calculations and/or references should be presented. Travel times cited for the saturated zone are relatively short. This is relevant to DOE siting Guideline 960.5-2-10, Hydrology.

3-8 Ibid.

Page 3-36, paragraph 1

Uncertainty within text (CC 4)

It is stated that ground water travel will be "possibly through alluvium". It is important to determine whether ground water does indeed flow through alluvium to the south-southeast because it may be the difference between a favorable or adverse condition. The supposition that ground water from the overlying aquifers does not enter the more highly pressurized carbonate aquifer is probably a good one; however, should there be a connection, matrix diffusion could still operate to contaminate

the lower aquifer. This is critical with regard to DOE Siting Guideline 960.5-2-10: Hydrology. It is therefore important to gather some hydrologic data on the carbonate aquifer. The complex faulted structure in the area offers the possibility that ground water could intersect the host rock and possibly even the surface, to create springs. Both the structure and hydrology of the area will have to be carefully determined in detail, because the carbonate and other aquifers are highly transmissive. This would of course result in short travel times, which could disqualify the site.

3-9 Section 3.1.3.3 Present and projected water use in the area

Page 3-37, paragraph 2

Insufficient data (CC 1)

Table 3-4 is referenced and it gives estimates for demand and facilities for production, but no projections are offered regarding the capacity of the present aquifers being tapped. This is important information because when the valley fill aquifers are exhausted, it may become necessary to penetrate deeper aquifers in search of irrigation water.

Since this could become an unfavorable condition for the site, the projected time when this may become necessary is important.

4-1 Section 4.1.1.1 Borehole drilling

Page 4-3, paragraph 1

Unsubstantiated assumptions (CC 2)

Several assumptions have been made without substantiation of how these were arrived at. Defined plans should be presented with adequate documentation to support these assumptions.

4-2 Section 4.1.1.2 Geophysical surveys

Page 4-5, paragraph 1

Inadequate documentation (CC 6)

No documentation is provided on the seismic reflection surveys that were apparently conducted at Yucca Mountain. Further details are required to ensure that such action will not affect future sealing capability of the repository. This is of relevance under DOE Siting Guideline 960.5-2-9: Rock Characteristics.

4-3 Section 4.1.1.4 Field experiments in preexisting G-Tunnel facilities

Page 4-7, paragraph 1

Inadequate documentation and uncertainty within text (CC 6 and 4)

It is stated that the welded tuff encountered in the G-Tunnel has thermal and mechanical properties similar to some of the welded tuffs at Yucca mountain. No documentation is provided to support this statement. Also, the statement does not make certain which units at Yucca mountain are similar to these tuffs. This is important from the standpoint of extrapolation of G-Tunnel data to repository design. This is relevant to DOE Siting Guideline 960.5-2-9: Rock Characteristics.

4-4 Section 4.1.1.5 Reclamation of areas disturbed by field studies

Page 4-7, paragraph 2

Uncertain statement and Omissions (CC 4 and 7)

It is stated that the specific sealing requirements including the grout formulation will be determined using drill core data. However, no details are provided regarding what tests are planned to deter-

mine compatibility of grout with the rock mass, taking into account the fracture characteristics of the rock mass. Also, since some of the boreholes penetrate the repository horizon, the grout material may be subjected to heat loading due to waste storage. Specific tests planned to ensure that grout integrity under heated conditions is maintained have not been outlined. Additionally, Quality Control measures to be adopted during borehole sealing have not been addressed. These aspects are to be considered under DOE Siting Guidelines 960.5-2-9 and 960.5-2-10. Some reference to the types of tests planned and QC/QA should be made to resolve this issue.

4-5 Section 4.1.2 Exploratory Shaft

Page 4-10, paragraph 2

Inadequate documentation (CC-6)

The schedules for exploratory shaft activities are provided without any documentation on where these estimates were derived from.

4-6 Section 4.1.2.1 Exploratory Shaft construction

Page 4-18, paragraph 2

Inadequate documentation (CC 6)

The planned depth of the Exploratory Shaft (ES) with reference to the depth of the Topopah Spring horizon is presented. However, no documentation or stratigraphic column is provided to verify these depths. This is important from an isolation/containment standpoint, and relates to DOE Siting Guidelines 960.5-2-9 and 960.5-2-10.

5-1 Section 5.1.1.1 The Surface Facilities

Page 5-5, paragraph 4

Inadequate documentation (CC 6)

It is stated that "the underlying material along the east side of Yucca Mountain is considered suitable for conventional foundations for construction of the surface facilities". This statement is not supported by soil properties data or foundation characteristics. No reference is quoted either. This is relevant to DOE Siting Guideline 960.5-2-8. Surface Characteristics.

5-2 Section 5.1.1.2 Access to the subsurface

Page 5-9, paragraph 1

Inadequate documentation and Incorrect Assumption (CC 6 and 2)

The rationale for selecting the ramp access concept of subsurface access is not documented, nor fully explained. Furthermore, although the final decision is yet to be made regarding mode of access, the impact analysis has assumed the ramp access mode. An adequate impact analysis should consider all possible alternatives. This is relevant under DOE Siting Guideline 960.5-2-9: Rock Characteristics.

5-3 Ibid.

Page 5-9, paragraph 2

Omissions (CC 7)

The figure referenced in this paragraph does not distinguish between the locations of the waste emplacement ramp and the mining ramp. In addition, the repository itself is not shown.

5-4 Section 5.1.1.3

Page 5-9, paragraph 3

Inadequate documentation (CC 6)

The statements on depth of water table and hydrological condition of the unsaturated zone are unreferenced. These are critical items with regard to DOE Siting Guidelines 960.5-2-10: Hydrology, and should be suitably documented.

5-5 Ibid.

Page 5-12, paragraph 2

Inadequate documentation (CC6)

No documentation is provided for the conceptual design work alluded to here. Presumably this is contained in Jackson, 1984. This document is currently unreleased and consequently unavailable for review.

5-6 Section 5.1.2.2 Waste emplacement

Page 5-30, paragraph 1

Uncertainty in text (CC 4)

The engineered barriers to be used during waste emplacement are described in somewhat uncertain terms. Considering the criticality of radionuclide

migration potential from waste canisters, more definite statements are in order.

5-7 Section 5.1.4 Decommissioning and closure

Page 5-32 paragraph 2

Reference not available (CC 6)

Sealing techniques proposed for shafts and other underground openings are supposedly included in Fernandez, 1983. This reference was not available for review. This aspect is critical to long-term postclosure isolation/containment of radionuclides.

5-8 Section 5.2.1 Geologic impacts

Page 5-33, paragraph 2 and 3

Reference not available (CC 6)

Several general conclusions are provided related to mining and stability of openings, and referenced to St. John, 1983; Hustrulid, 1984; and Dravo, 1984a, 1984b. These documents are not available for review and consequently the conclusions provided cannot be verified. These items are relevant to DOE Siting Guidelines 960.5-2-9: Rock Characteristics.

5-9

Section 5.2.1.2 Operation

Page 5-34, paragraph 1

Uncertainties within text (CC 4)

It is stated that "no physical or chemical characteristics of either.... tuff or the.... environment to suggest that the isolation capability of the host rock could be reduced because of the heat and radiation generated. . . ". The logic of the statement appears to be misleading, since it does not necessarily follow from the above statement that isolation capability is indeed assured. This is relevant to DOE Siting Guideline 960.5-2-9: Rock Characteristics.

5-10

Section 5.2.2.1 Water use

Page 5-35, paragraph 1

General

The observation that the aquifers which underlie the Yucca Mountain site are abundant producers is indeed positive for the site from an operational standpoint, but considering the scarcity of water in Nevada, it would also be a positive factor for irrigation of crops. The reported quality of the water is good, and water is rapidly becoming more

valuable in that part of the country. This could become an unfavorable condition when considering the possibility of future human intrusion.

5-11

Section 5.2.2.3 Flooding

Pages 5-35, paragraph 4

Inadequate discussion

Consideration is only given to flooding of surface facilities during construction. There is no mention of potential flooding of the underground workings or surface facilities during operation or after closure. This is a particularly sensitive point because containment at the Yucca Mountain site is based on its location above the saturated zone. Considering the high transmissivity of the host rock and underlying saturated aquifers, a flood could present a definite hazard. The potential for flooding and prevention or mitigation should at least be mentioned, and hopefully discussed as one of the weak points of this site.

5-12

Section 5.2.2.4 Potential for future exploitation of ground water

Page 5-36, paragraph 2

Inadequate discussion

The conclusion that the valleys would be preferable to the mountains for ground water withdrawal is probably true, but in the long term, regulated exploitation of the aquifers will limit the density of wells which could force ranchers into the higher elevations to get well permits. The faults shown between Yucca Mountain and the adjacent valleys may prevent ground water movement to wells in the valley and necessitate exploitation of Yucca Mountain aquifers. Regardless of location of withdrawal, as stated earlier in the EA, the aquifers are all considered to be connected and highly transmissive; therefore hydrologically they must be considered as a unit for purposes of contamination potential. Future exploitation also brings up the question of the impact of unloading these structural blocks on isostatic balance. A determination must be made whether or not exploitation could result in increased seismicity.

5-13 Section 5.2.9.2 Repository operation

Page 5-70, paragraph 2

Reference not available (CC 6)

Most of the conclusions drawn with regard to radiation hazards during the operations phase appear to be referenced in Dennis et al., 1983. This document is currently unavailable for review and the statements made in the text cannot be verified.

5-14 Ibid.

Page 5-70/71, paragraph 5

Omissions

The statements made with regard to public response to radiation are purely judgemental and not backed by any analysis at all. It is agreed that the potential for such hazard is not high; however, some minimal analysis must be done to resolve this issue.

5-14 Ibid.

Page 5-71, paragraph 2

Reference not available

The quantitative values provided in Tables 5-30 and 5-31 for each accident scenario were supposedly

derived in the reference Jackson et al., 1984. This document is unavailable for review and the validity of the values provided cannot be verified. This item is relevant to DOE Siting Guidelines 960.5-2-9 and 960.5-2-10.

6-1 Section 6.2.2 Preclosure system guidelines

Page 6-84 Paragraph 3

Inadequate support

The statements made regarding mode of radionuclide transport should be backed by calculations or reference. These calculations are probably presented in latter sections, however, no reference to those sections is made.

6-2 Ibid.

Page 6-86, paragraphs 2 and 3

Inadequate support

It is stated unequivocally that high winds or other weather phenomena are not likely to transport radionuclides to the accessible environment. No data are provided to substantiate this contention. This is critical from the standpoint of containment/isolation of nuclear waste.

6-3 Section 6.3.1.1 Geohydrology

Page 6-99, paragraph 2

Inadequate support and reference not available (CC 6)

The conservative nature of the assumptions used in certain conceptual models is cited, but not presented. These models will have to be examined to confirm their conservatism. These models are said to be presented in Montazer and Wilson, 1984. This document is not available for review, however. The validity of the models are critical with respect to hydrologic analyses presented later and is relevant to DOE Siting Guideline 960.5-2-10: Hydrology.

6-4 Ibid.

Page 6-100, paragraph 2

Inadequate support

A ground water flow time of 20,000 years from the repository to the accessible environment is mentioned but not supported. As this is critical to the qualifying condition, the assumptions and calculations must be checked. This is relevant to DOE Siting Guideline 960.5-2-10: Hydrology.

6-5 Ibid,

Page 6-100, paragraph 3

Inadequate support

The low magnitude of ground water flux and high retardation capacity of the geologic system are mentioned, but not supported. The low magnitude of ground water flux undoubtedly ignores flooding. Supporting data should be cited or references given. This is relevant to DOE Siting Guideline 960.5-2-10: Hydrology.

6-6 Ibid.

Page 6-100, paragraph 4

Inadequate support

Data should be cited or references given to support the conclusion that only three radionuclides would be released at the accessible environment during the next 10,000 years. This is relevant to DOE Siting Guideline 960.5-2-10: Hydrology.

6-7 Ibid.

Page 6-100, paragraph 3

Inadequate support

The radionuclide release from the engineered barrier system referenced in Section 6.3.1.2 is not supported in that section. This is critical to determination of a favorable condition and data must be presented or references cited. Under the circumstances, the conclusion that "the Yucca Mountain site meets the qualifying conditions for geohydrology" is not established.

6-8 Ibid.

Page 6-101, paragraph 5

Inadequate support

Ground water travel times cited are referenced to discussions under "Disqualifying Condition". The assumptions cited in that section are not adequately supported, therefore these ground water travel times are not established.

6-9 Ibid.

Page 6-102, paragraph 2

Unsupported conclusion

Because of the inadequacies stated above, the conclusion is not valid. Supporting data will have to be presented and confirmed before the conclusion can be validated that the site possesses the first favorable condition.

6-10 Ibid.

Page 6-102, paragraph 4, Inadequate documentation (CC 6)

The statements regarding changes in hydraulic conditions, although reasonable and believable, are not supported. The data must be presented or references cited.

6-11 Ibid.

Page 6-103, paragraph 2

Inadequate analysis (CC 3)

The conclusion and supporting arguments ignore the factor which could have the greatest impact on hydrologic conditions--seismicity. Changes in

hydrologic conditions are directly related to seismicity and should be discussed as such. The second favorable condition cannot be claimed until this analysis is completed. This favorable condition is related to the Postclosure Technical Guidelines 960.4-2-1: Hydrology.

6-12 Ibid.

Page 6-103, paragraph 4

Inadequate documentation (CC 6)

Familiarity with geologic and hydrologic conditions at the Yucca Mountain site is claimed on the basis of weapons-testing activities conducted at the Nevada Test Site. Although experience gained during these studies is quite valuable, conclusions cannot be based on these unless the data or documents are referenced directly. It is accepted that much of the data may be proprietary, however, it has to be ensured that the assumptions and procedures adopted are valid under the present objectives. This is relevant to DOE Siting Guidelines 960.5-2-9 and 960.5-2-10.

6-13 Ibid.

Page 6-104, paragraph 4

Inconsistency with supporting document (CC 5)

It is stated that a relationship between lithology and permeability for tuffs at the Pahute Mesa was demonstrated by Blankennegel and Weir, 1973. Examination of the reference document did not yield a clearcut definition of this relationship. Since the next statement is contingent upon the validity of this contention, further clarification is necessary.

6-14 Ibid.

Page 6-106, paragraph 1

Uncertainties within text (CC 4)

The statement that the distribution of transmissive zones may be determined from the relationship between fracture frequency and lithology proposed by Scott et al., 1983, should be substantiated by the methodology expected to be adopted. In any case, this should not preclude hydrologic testing on stratigraphic units, as appears to be the intent. This is relevant to DOE Siting Guidelines 960.5-210: Hydrology.

6-15 Ibid.

Page 6-107, paragraph 2

Conflicting statements

The third favorable condition states that the geohydrology can be "readily characterized and modeled with reasonable certainty". The conclusion that the Yucca Mountain site meets this favorable condition" is in conflict with its own supporting arguments. Within the "Conclusion" paragraph itself it is stated that "development of flow and transport models is always difficult and always accompanied by a degree of uncertainty". It states further within the paragraph that the modeling techniques must "incorporate uncertainty analysis". The first paragraph in the "Eva.ı on page 6-103 begins by stating that "The geologic setting is relatively complex,"; also cited are "many periods of structural deformation" and "weapons-testing activities". It is stated in the second paragraph under "Evaluation" that the "material properties used to model the geohydrology... vary substantially" and that "the physics of moisture movement in unsaturated, fractured rocks is complex and not well understood". Later on page 6-104 it is stated quite correctly that "More work remains to be done in characterizing

the hydrology of the saturated and unsaturated zones". On page 6-105 the unsupported statement is made that "porous flow through the matrix, rather than fracture flow, dominates under the prevailing flux. Therefore, flow through this unit can be modeled with less difficulty than through unsaturated units in which fracture flow may predominate". On page 6-106, the first paragraph states that "Ground water flow in the saturated zone at Yucca Mountain is mainly through fractures" and that "attempts at defining the position or geometry of hydrostratigraphic units based only on testing results have not been successful". Further on page 106 it is admitted that only "a range that limits the possibilities of flow conditions at Yucca Mountain can be defined with reasonable confidence", that "more sophisticated hydrologic computer models" are needed, and that "Statistical methods will be used to determine the sensitivity of hydrologic flow conditions to the uncertainty in data and models". The ultimate goal of all this is a "most likely condition". The four simultaneous conditions of flow which must be taken into account (unsaturated, saturated, matrix, and fracture) present a formidable challenge for modeling. The models themselves are based on assumptions of continuous, uniform flow

conditions and do not incorporate discontinuities that represent changes in flow conditions such as saturated versus unsaturated, and thus the interfaces are not known. These conditions do not conform to the spirit of being "readily characterized and modeled with reasonable certainty". Therefore, the Yucca Mountain site does not appear to meet the third favorable condition.

C-16 Ibid.

Page 6-108, paragraph 1

Reference not available and Inadequate data (CC 1)

The effective porosity data derivation is explained in Gee, 1984, which is not available for review. In addition, the value quoted is based on only three sample values and is indirectly derived from moisture content values. A great deal of emphasis, therefore, cannot be placed on these values. The statement - "total porosities. . .range from 32 to 47 percent are similar to those reported for the unit as a whole" is unreferenced.

6-17 Ibid.

Page 6-108, paragraph 3

General

The Calico Hills nonwelded unit underlies the host rock (Topopah Springs). Although the deep aquifers may be the shortest route for radionuclides to reach the accessible environment since the host formation is in the unsaturated zone, this may not be the case should the host rock become saturated as a result of tectonic movement.

6-18 Ibid.

Page 6-109, paragraph 2

Inadequate documentation (CC 6)

Hydraulic gradients are presented, but no support is offered. Data should be presented or references cited. This is relevant to DOE Siting Guideline 960.5-2-10: Hydrology.

6-19 Ibid.

Page 6-110, paragraphs 2 and 4

Inconsistencies within text (CC 5)

In paragraph 2 the saturation is said to vary from 10 to 80% due to the low porosity and permeability

of the matrix. In paragraph 4 it is stated that "the spatial distribution of saturation probably is relatively uniform in the host rock and immediately surrounding units". Data tend to support the earlier statement, while the latter is unsupported. A determination must be made of the actual conditions. This is relevant to DOE Siting Guideline 960.5-2-10.

6-20 Ibid.

Page 6-111, paragraph 2

Uncertainty within text (CC 4)

The statement made regarding a possible capillary barrier between the Topopah Spring and Calico Hills units, although logical, is highly speculative and needs to be demonstrated by calculations. As stated, the finding cannot be used to support any conclusion. A similar statement is made in paragraph 3 regarding the downward flow of water from the Paintbrush to the Topopah Spring unit. More concrete evidence is needed. These are relevant to DOE Siting Guideline 960.5-2-10: Hydrology.

6-21 Ibid.

Page 6-114, paragraph 2

Inconsistency within text (CC 5)

The statement that "large volumes of fluids have been lost during drilling in this unit" is indicative of a high density of faults and fractures and extremely heterogeneous structure. This is in conflict with earlier statements that the formation is relatively uniform and of low porosity and permeability with uniform distribution of saturation which could readily be modeled. Loss of circulation as described here occurs only when an extreme discontinuity is encountered such as a fault, fracture, cavern, or channel.

6-22 Ibid.

Page 6-115, paragraph 2

Unsupported conclusion

The conclusion that "the Yucca Mountain site possesses all five of the favorable conditions for disposal in the unsaturated zone" is not established based on previous comments regarding some of the conditions.

6-23 Ibid.

Page 6-118, paragraph 5

Inadequate documentation (CC 6)

The statement that the repository block is relatively free of faulting is not supported. Also, a strong statement such as this should not be made on the basis of only few coreholes since smaller faults may be present that have not heretofore been encountered. This issue should be resolved to satisfy DOE Siting Guidelines 960.5-2-9 and 960.5-2-10.

6-24 Ibid.

Page 6-118, paragraph 5

Inconsistency within text (CC 5)

The statement that "Movement along a fault cutting the repository is not likely to have a significant effect on flux of water through the host rock," should be qualified. As it stands, the statement is somewhat contradictory to the statement about development of springs at Ash Meadows. The apparent conflict should be resolved.

6-25 Ibid.

Page 6-119, paragraph 2

Inadequate documentation (CC 6)

The statement that "Matrix flow rather than fracture flow occurs because matrix potential (suction) is higher in the matrix than in the fractures" is not supported. The statement could be misleading and should be qualified as to the conditions which must prevail for this to occur.

6-26 Ibid.

Page 6-119, paragraph 3

Inadequate support

All statements presented are pure conjecture with no data or references presented to support the arguments. The arguments are general in nature; and although under the right circumstances they may prove to be true, for purposes of this EA the specific conditions of this repository site must be characterized using geochemical and hydrological data from the site itself. The composition of rocks and fluids in equilibrium with each other must be modeled to determine how changes in the thermodynamic conditions could affect the effective porosity.

6-27 Ibid.

Page 120, Paragraph 4

Unsupported conclusion

The conclusion stated is not supported by the arguments presented for the reasons stated above; therefore, it is not established that the Yucca Mountain site does not possess this potentially adverse condition.

6-28 Ibid.

Page 6-122, paragraph 4

Unsupported conclusion

The concluding paragraph is internally contradictory. The unfavorable condition refers simply to the presence of dikes, faults, shear zones, etc., which could complicate modeling efforts. The contention that they are there but are of little consequence is not justified. These adverse structural conditions admittedly do exist at the site, and the difficulties which they present to modeling and characterization are discussed in comment 6-11 which discusses the third favorable condition. Most numerical flow models assume continuous flow through uniform media, and although

it is possible to account for discontinuities, this presents a significant problem which must be dealt with for the model to be valid. The conclusion that the Yucca Mountain site does not possess the third adverse condition is not established. In fact, the evidence suggests that it does possess the third adverse condition.

6-29 Ibid.

Page 6-123, paragraph 2

Omission (CC 7)

Table 6-5 is cited but not available for review.

6-30 Ibid.

Page 6-124, paragraphs 5 and 6

Inadequate consideration of data (CC 1)

Two possible techniques for estimating ground water flux are presented. The first method is empirical and is shown to yield a value of 4.5 mm/yr. (This is an optimistic estimate, since on p. 2-14, paragraph 7 and in Scott et al., 1983, the range is shown to be 150 to 200 mm/yr). The second method yields a value of 1 mm/yr based on hydraulic conductivities of the Topopah Spring unit. Pre-

sumably the hydraulic conductivities were measured from core samples although no such clarification is provided. Between the two estimates, the latter (and lower) value is accepted. There are several problems with this choice:

- not conservative enough
- the accuracy of the hydraulic conductivity data is questionable since the Topopah Springs unit is extremely variable and a single conductivity value may not be appropriate
- saturation of the matrix for the Topopah Spring was stated to be between 10 to 80% in the small volume of sample measured; it is not unreasonable to assume that fracture flow will predominate
- flow through faults and other geologic anomalies not considered
- effect of perched aquifers in the unsaturated zone, if any, not considered

- changes in hydrologic system with time not considered.

The value of the ground water flux is used to calculate travel times and is therefore critical from the containment/isolation demonstration viewpoint. A more reliable estimate of the parameter is imperative. This concern is relative to DOE Siting Guideline 960.5-2-10: Hydrology.

6-31 Ibid.

Pages 6-128 to 6-129

Inadequate analysis and Inadequate consideration of data (CC 3 and 4)

The derivation of travel time is heavily dependent on the value of parameters such as hydraulic conductivity and effective porosity, which are far from reliable as shown earlier. The analysis for ground water travel times is too simplistic. The calculation for matrix flow ignores any potential for fracture flow (locally) which would be several orders of magnitude higher, and also assumes a continuous medium which admittedly does not exist at this site. This assumption, however, is conservative as discontinuities generally result in longer

travel times. More importantly, the variability in saturation of the matrix was documented earlier in the EA as ranging from 10 to 80% in the small volumes of sample measured. Is it not, therefore, reasonable to ask if, in the site as a whole, saturation doesn't exist locally where fracture flow will predominate with extremely high hydraulic conductivities? The very nature of water movement is inhomogeneous following the path of least resistance. The difference in, and proximity of, the Zeolitic unit versus the Vitric unit of the Calico Hills formation may be explained in this way. A statistical study is needed to determine the density of faults, joints, fractures, etc. which are not accounted for in the models, but which could cause saturation locally. The possibility of perched aquifers has already been mentioned earlier in the EA. The assumptions of the model are not listed, and the limits of error and uncertainty are not discussed. Such factors are essential to determining the validity and applicability of the model. There is no discussion of directional permeabilities or of standard deviations of the operative data used. Loss of circulation during drilling alluded to earlier is an indication that fractures and voids

may be ubiquitous and that models of matrix flow would not be applicable.

6-32 Ibid.

Page 6-128, paragraph 11 (last)

Misprint

The data presented in the right hand column is for the "vitric" Calico Hills nonwelded unit and not for the "zeolitic" unit as shown.

6-33 Ibid.

Page 6-129, paragraphs 6 and 7

Insufficient data (CC 1)

The calculations for hydraulic gradient and hydraulic conductivity are each based on two (2) data points. Obviously, very little reliance can be placed on values generated on the basis of such scanty data. These data are used later for ground water travel time calculations; therefore, they have serious implications. Considerably more data needs to be collected to address this disqualifying

condition under DOE Siting Guideline 960.5-2-10: Hydrology.

6-34 Ibid.

Page 6-130, paragraph 1

Unsupported assumption (CC 2)

The effective porosity value for the Yucca Mountain tuff is too generalized, and lacks documentation.

6-35 Ibid.

Page 6-131, paragraph 4

Incomplete data (CC 1)

Absolute values are not possible to predict due to the paucity of data, the heterogenous nature of the media through which the flow paths run, and the nature of the models and their assumptions. The travel times thus calculated are tenuous at best, and limits of error should be shown for the basic data and carried through the calculations. This entire scenario which is intended to demonstrate that the disqualifying condition does not apply to the Yucca Mountain site is predicated upon the assumption that the host horizon will remain unsaturated. Considering the wide range of

saturation data collected thus far (10 to 80%), alternative assumptions should be considered. The structure is admittedly complex and springs and perched aquifers are known to occur. Despite the scarcity of water in such arid environments, it is well known that the majority of erosion is due to water from flash floods. Such an event does not occur regularly, but rather sporadically and catastrophically. The nature of the drainage system both above and below the surface is similar--it is not uniform and responds rapidly to occasional drastic variations in conditions. For these reasons, the analysis of the travel times in response to the disqualifying condition must include a study of the cyclic nature of flash floods and seismicity, and their potential impact on travel times. It is obvious from the analysis of the saturated zone that if the repository horizon were to become saturated, the resulting travel times would not exceed that required by the disqualifying condition.

6-36

Ibid.

Page 6-132, paragraph 2

Inconsistencies within text (CC 5) and Unsupported conclusion

The statement that "Analysis of field and laboratory data indicates that the expected pre-waste-emplacement ground water travel time at Yucca Mountain along all paths of radionuclide travel from the disturbed zone to the accessible environment exceeds 1000 years" is in conflict with the statement on page 6-106, paragraph 1 that "attempts at defining the position or geometry of hydrostratigraphic units based only on testing results have not been successful". The conclusions which have been reached regarding travel times are based primarily on conceptual models and not upon concrete field data. This makes the conclusion that the site is not disqualified under DOE Siting Guideline 960.5-2-10 tenuous. The formation of zeoloites is a natural result of ground water flow through vitric materials--a search for zeolites in the presumed vitric portion of the Calico Hills unit may shed some light on whether or not the zone has been saturated previously.

6-37 Ibid.

Page 6-132, paragraphs 3 and 4

Inadequate discussion

The several hydrologic tests mentioned sound interesting but there is no description offered, or discussion of locations, schedules, objectives, or how the results will be interpreted. Of particular interest is the planned "bulk permeability test" which is supposed to test a larger volume of rock than a borehole test. It is not clear why such a test is necessary or what limitations there are on standard borehole tests which have been performed for years. If data from previous borehole tests are limited, then this should have been discussed during the evaluation arguments and it could bring all previous arguments into question. Can the testing of an isolated block be considered to be representative? There is no mention of plans to estimate effective porosity, to study the density of fault, fractures, or fissures, or to search for zeolites in the presumed vitric zone. The latter seem more important than those listed because of the difficulty of conducting and controlling hydrologic tests

in the unsaturated zone, and the problem of interpretation. All these should be given due consideration in order to fully satisfy the requirements of DOE Siting Guideline 960.5-2-10: Hydrology.

6-38 Section 6.3.1.3 Rock characteristics

Page 6-171, paragraph 4

Reference unreviewed (CC 6)

The statement that "the repository host rock can accommodate expected mechanical and thermal stresses after closure" is very strongly stated and needs verification. The reference cited Johnstone et al., 1984, has not been reviewed.

6-39 Ibid.

Page 6-172, paragraph 1

Inconsistency within text (CC 5)

The statement "As noted in Section 6.3.1.1, this steam condenses a short distance from the canisters" is inconsistent since no such discussion was found in that section.

6-40 Ibid.

Page 6-172, paragraph 1

Reference not available (CC 6)

The statement that fracture flow is not expected in the repository host rock should be verified. The reference cited -- Montazer et al., 1984 -- is not available for review. Furthermore, the estimated flux of less than 1 mm/yr has been criticized in earlier comments.

6-41 Ibid.

Page 6-173, paragraph 1 and 2

Inadequate data (CC 1)

The cutoff percent with respect to lithophysal content is unverified. It is stated that emplacement in the Topopah Spring Member is proposed for the densely welded portion containing less than 15 to 20 percent lithophysae. How can the lateral consistency of the lithophysal zones be determined on the basis of few boreholes? What guarantee is there that 10% and 30% lithophysal zones cannot coexist within the same horizon? It is also stated that "at what percentage the lithophysae become a concern will be determined during site

characterization." No definite plan or methodology has been proposed, however. The effect of the lithophysae is of paramount importance in characterizing the stability of the proposed repository in tuff, and should be carefully studied to satisfy the requirements of DOE Siting Guideline 960.5-2-9: Rock Characteristics.

The reference cited -- Mansure and Ortiz, 1984... is unavailable for review, and needs to be checked.

6-42 Ibid.

Page 6-175, paragraph 2

Reference unavailable (CC 6)

A three-dimensional geological model is referenced (Nimick and Williams, 1984), and several important data, such as, thickness and lateral extent of host rock, are quoted. These need to be checked; however, the document is not available for review.

6-43 Ibid.

Page 6-179, paragraph 2

Inadequate documentation (CC 6)

Data on thermal conductivity and thermal expansion, and the statement that thermal expansion will not

generate enough stresses to cause rock mass fracturing are unsupported and undocumented. These data and conclusions are extremely critical in evaluating the stability characteristics of the proposed repository openings under thermal loading, as required by DOE Siting Guideline 960.5-2-9: Rock Characteristics.

6-44 Ibid.

Page 6-180, paragraph 2

Inadequate documentation (CC 6)

Several statements and data provided in relation to elastic behavior of the Topopah Spring unit are unsupported and undocumented. Furthermore, reference has been made to several rock mechanic tests currently under way; however, no details or documentation on these are provided.

6-45 Ibid.

Page 6-81, paragraph 2

Uncertainty within text (CC 4) and Inadequate documentation (CC 6)

Several statements are made in this paragraph that lack preciseness and certainty, and are totally undocumented. These statements include:

- the chemical environment is benign....to corrosion and leaching of waste package?

- "the rock is expected to be strong"

- "heat is predicted to cause limited facturing around the waste emplacement borehole"

- "rock fracturing is expected to have minimal impact on containment and isolation"

- "thermally induced rock fracturing....appears to be solvable with reasonably available technology".

The degree of uncertainty is quite apparent from the statements and the need for confirmation of these have been acknowledged and emphasized in the text. However, no definite plans or schedules are presented to resolve these uncertainties.

6-46 Ibid.

Page 6-181, paragraph 4

Unsupported conclusion

The conclusion that Yucca Mountain does not possess this potentially adverse condition is unacceptable for the reasons pointed out above (comment 6-45).

6-47 Ibid.

Page 6-186, paragraph 3

Reference not available (CC 6)

The contention that thermal loading will give rise to minimal porosity/permeability changes needs to be verified by reviewing the cited reference.... Braithwaitz and Nimick, 1984. This is an important statement with respect to containment/isolation assurance required under DOE Siting Guideline 960.5-1-9: Rock Characteristics.

6-48 Ibid.

Page 6-187, paragraph 4

Inadequate documentation (CC 6)

The statement - "radionuclides are insoluble in water vapor" is unsupported and undocumented. This

determination is very important in ensuring radionuclide isolation and containment, and is therefore important.

6-49 Ibid.

Page 6-188, paragraph 1

Reference not available (CC 6)

A very important conclusion is referenced in Mondy, 1983, regarding the free convection liquid water transport of radionuclides. This document is unavailable for review and should be checked for the analyses.

6-50 Section 6.3.1.7 Tectonics

Page 6-225, paragraph 4

Reference not available (CC 6)

The inference that no major tectonic or volcanic event is likely in the next 10,000 years is supposedly provided in Carr, 1984. Due to the critical nature of this conclusion, the reference should be examined to ensure the validity of the analysis. This is relevant to DOE Siting Guideline 960.5-2-11: Hydrology.

6-51 Ibid.

Page 6-227, paragraphs 3 and 4

Inadequate analysis (CC 3)

This analysis procedure for assigning probabilities to basaltic eruptions and surface faulting is too simplistic and is of limited value. Rigorous statistical treatment of data and uncertainty analyses will be required to correct the situation. This is relevant to DOE Siting Guideline 960.5-2-11: Tectonics.

6-52 Ibid.

Page 6-233, paragraph 1

Unsupported Conclusion and Inadequate analysis (CC 3)

The conclusion provided in this section does not appear to follow from the data presented. The data seems to suggest that potential exists for fault movement and volcanism in the future; however, considerable uncertainty exists with regard to the timing of these events. It is apparent from the discussion in this section that not enough studies have been performed to resolve this uncertainty. In

the absence of such studies, it is quite easy to state that the site does not possess the potentially adverse conditions.

6-53 Ibid.

Page 6-234, paragraph 1

Inadequate documentation (CC 6)

The statement made regarding the likely formation of a lake due to basaltic eruptions and its subsequent draining is hypothetical and imaginative at best. No basis or supporting studies are presented to verify it. Also, a "slight" rise in water table is hypothesized without providing any magnitude. Considering the criticality of such events, it is imperative that the potential for tectonic activities be adequately analyzed to verify these statements. This is a specific requirement of the DOE Siting Guideline 960.5-2-11: Tectonics.

6-54 Ibid.

Page 6-234, paragraph 2

Unsupported conclusion

The conclusion provided here is not valid in the light of the uncertainties highlighted above.

6-55 Ibid.

Page 6-237, paragraph 1

Unsupported conclusion

The conclusion that Yucca Mountain does not possess the sixth potentially adverse condition is unsupported and does not follow from the discussion provided. Many statements such as those made on page 6-234 (paragraph 4), and page 6-236 (paragraphs 1 and 3) are too uncertain to draw any conclusions from. Further analysis will be required to support this conclusion.

6-56 Section 6.33 Preclosure technical guidelines

Page 6-261, paragraph 1

Unsupported conclusion

The discussion provided in this section is not sufficient to support the conclusion that the surface characteristics of the site do not adversely impact repository facilities. The discussion is largely conjectural and no analysis has been performed to satisfy this qualifying condition. Various accident scenarios and their impacts should be examined in detail to meet this qualifying condition.

6-57 Section 6.3.3.2 Rock characteristics

Page 6-267, paragraph 2

Inadequate documentation (CC 6)

The statement that the "welded tuff unit (in the G-Tunnel has) characteristics similar to those expected in the repository horizon" is unsupported and undocumented. The G-Tunnel site is far removed from the Yucca Mountain site and any analogies in rock conditions should be verified by testing and analyses. The age and lithology of the respective formations should be compared and individual physical properties of the units separately compared. This is critical to the requirements of the DOE Siting Guideline 960.5-2-9: Rock characteristics.

6-58 Ibid.

Page 6-266, paragraph 3

Omission (CC 7)

The cited reference...Brasier et al., 1983-- is not included in the chapter 6 reference list.

6-59 Ibid.

Page 6-269, paragraph 1

Inadequate documentation (CC 6)

The statement that no anomalies are expected to have significant adverse effects on waste isolation and mine stability is not adequately supported. The Yucca Mountain formations are intensely faulted and presence of perched water zones cannot be precluded. In view of these, the statement above appears to be somewhat premature. Much further exploration and characterization will be required to support this statement.

6-60 Ibid.

Page 6-274, paragraph 4

Reference not available (CC 6)

The ground support estimates are provided and Dravo, 1984a, is referenced for pertinent calculations. This document is unavailable for review. Since the ground support aspect critical to room stability assurance as required by DOE Siting Guideline 960.5-2-9, these calculations and analysis procedures should be verified.

6-61 Ibid.

Page 6-275, paragraph 3

Reference not available (CC 6)

The reference--St. John, 1984... is unavailable for review and should be examined to verify the statement provided on rock bolt support design.

6-62 Ibid.

Page 6-278, paragraph 1

Omission (CC 7)

Lucas and Adler, 1973, is referenced but not provided in the reference list.

6-63 Ibid.

Page 6-278, paragraph 2

Inadequate documentation (CC 6)

NTS tunnel experience is undocumented, therefore, it is unacceptable as support for EA conclusions.

6-64 Ibid.

Page 6-280, paragraph 3

Omission (CC 7)

St. John, 1983, is referenced but not included in reference list.

6-65 Ibid.

Page 6-281, paragraph 3

Reference not available (CC 6)

The statement that the repository host rock is not subject to thermally induced dehydration and hydration should be verified. Bish et al, 1984, referenced here, is unavailable for review. This is an important aspect in assuring host rock stability in response to thermal loading.

6-66 Ibid.

Page 6-283, paragraph 4

Reference not available (CC 6)

The findings reported by Dravo, 1984b, regarding mining through fault zones are extremely critical in assuring the stability of repository openings. This document is not available for review, and the claims made cannot be verified.

6-67 Ibid.

Page 6-285, paragraph 2

Omission (CC 7)

Tyler and Vollendorf, 1975, is cited but not found in reference list.

6-68 Ibid.

Page 6-285, paragraph 2

Inadequate analysis (CC 3) and Inconsistencies within text (CC 5)

The ratio between vertical and horizontal stress fields, as reported by Healy et al., 1983, is based on 6 hydrofracture tests and not 12 measurements as indicated in the text. Healy et al., 1983, furthermore does not provide mean and standard deviation values. The stress ratios at G-Tunnel are compared with this data and an inference has been made that repository openings should remain stable. However, the target repository horizon is in the Topopah Spring member, which is above the water table, and all of the measurements made by Healy et al. were below the water table. Furthermore, all results are from one borehole only, thereby assuming lateral uniformity of stress fields. For these reasons, the

conclusion drawn is judged tenous and requires further analysis. Many more stress measurements will be required before such comparisons can be attempted.

6-69 Ibid.

Page 6-287, paragraph 1

Omission (CC 7)

Tillerson and Nimick, 1984, is referenced but not found in the reference list. Consequently, the controlled blasting experience referred to in the text cannot be verified.

6-70 Ibid.

Page 6-287, paragraph 2

Unsupported conclusion

In view of the arguments provided earlier regarding the lack of evidence that the G-Tunnel experience is directly applicable to repository design, the inadequate stress measurement results, and omissions, the conclusion that Yucca Mountain is not disqualified on the basis of rock characteristics disqualifying condition cannot be substantiated. Further analysis is required.

6-71 Section 6.3.3.3 Hydrology

Pages 6-290 and 6-291

Misnumbered pages

The number on these pages is reversed.

6-72 Ibid.

Page 6-291 (290), paragragh 2

Incorrect assumption (CC 2)

The statement that "no aquifers exist between (the host rock) and the land surface" is unsubstantiated since perched aquifers are likely to be present between the repository horizon and the surface. This should be verified in order to satisfy the qualifying condition under DOE Siting Guideline 960.5-2-10: Hydrology.

6-73 Ibid.

Page 6-291 (290), paragraph 3

Unsupported conclusion

The admittedly complex structure beneath Yucca Mountain and the "intensely fractured" condition of the Topopah Springs member would indicate that very extensive engineering and complex technology will be

required to excavate, stabilize, and maintain a repository in this horizon. There are no supporting arguments offered for this conclusion and it is definitely not established. Therefore the conclusion that "the Yucca Mountain site meets the requirements of the qualifying condition for this guideline" is not established.

6-74 Section 6.3.3.4 Tectonics

Page 6-297, paragraph 4

Inconsistency (CC 5)

The same results are referenced to two different reports. The statement about peak acceleration of 0.4 is also quoted on page 6-296, paragraph 4. Neither of the reports are available for review; consequently, the determination of the original source of the data cannot be made. More care should be taken in documentation.

6-75 Section 6.3.4 Preclosure system guideline

Page 6-304, paragraph 2

Inadequate documentation (CC 6)

The statement that "existing technology is available for drilling long, horizontal, large-diameter

tunnels in rock" is both vague and undocumented. The discussion does not say what technology, applied where and under what conditions, and what is meant by "long", quantitatively. Reference is also made to a development program under way to test this technology, and no further details are provided. Such vague and unsubstantiated statements serve very little purpose in the reporting of EA findings.

6-76 Ibid.

Page 6-307, paragraph 1

Unsupported conclusion

No cost analysis has been presented or references to substantiate the conclusion that associated costs are reasonable to other available and comparable siting options. Some preliminary cost analyses should be performed to meet the requirements of the preclosure system guideline.

6-77 Section 6.4.2.2 Subsystem descriptions

Page 6-317, paragraph 3

Uncertainty within text (CC 4) and Unsupported conclusion

The statement that ground water flow to the accessible environment would be mainly through fractures

is uncertain and hypothetical. No evidence is presented to support this contention. In addition, the statement that "the flow is confined to the rock matrix" is based on the assumption that unsaturated conditions predominate. Discussions concerning this assumption have been presented earlier.

6-78 Ibid.

Page 6-318, paragraph 2

Alternative assumption (CC 2)

Carbon, iodine, and technetium may be transported faster than ground water flow due to diffusion if the rate of ground water migration is low. This alternative should be incorporated in the analysis.

6-79 Section 6.4.2.3 System preliminary performance assessments

Page 6-319, paragraph 1

Inadequate documentation (CC 6)

The definition of the "disturbed zone" and its extent is not substantiated by hard data. Calculations and analysis procedures performed to arrive at the quantitative limits should be provided. This is

a key parameter that should be clearly defined in satisfying isolation/containment issues under DOE Siting Guideline 960.5-2-9 and 960.5-2-10.

6-80 Ibid.

Page 6-319, paragraph 2

Alternative assumption (CC 2)

The assumption of uniform corrosion is tenuous--corrosion is seldom uniform due to the galvanic effect. Electrochemical cells generally develop which result in concentrated corrosion causing pitting at much accelerated penetration rates. It is surprising that no mention is made of cathodic protection or sacrificial oxide layers. The use of a 10,000 year canister life is not conservative, especially in light of the above observation.

6-81 Ibid.

Page 6-319, paragraph 2

Inadequate analysis (CC 3)

The analysis procedure for estimating canister life is too simplistic and has little credibility. The confidence interval for the range 3,000 to 30,000

years is not provided; however, for an expected value of 10,000 years the scatter is too wide to be statistically significant.

6-82 Ibid.

Page 6-321, paragraph 2 and 3

Questionable assumption (CC 2) and Unsupported conclusion

Throughout the text the ground water flux value in the unsaturated zone has been assumed to be 1 mm/yr. We have strong reservations about this value. To make matters worse, in this analysis, it is taken to be 0.5 mm/yr. Input data should not be altered to suit the results.

Further, in paragraph 3, the statement that "release rates from the engineered barrier system may range from zero to 2×10^{-5} per year, a conservative but realistic value would be about 1×10^{-8} per year" is totally unsubstantiated and hypothetical. Adequate statistical treatment of data is warranted.

6-83 Section 6.4.2.4 Preliminary system performance assessment

Page 6-326, paragraph 3

Inadequate analysis (CC 3)

The description of the repository in Figure 6.4.2.2 is so oversimplified as to render the performance assessment essentially useless. The description of the present knowledge of the subsystems as on a level of the above figure is an admission that insufficient knowledge is available to make a valid performance assessment. Apparently more time is needed to gather sufficient information to make a reasonable performance assessment. The same applies to the mathematical relationships used to quantify the conceptual model.

6-84 Section 6.4.2.5 Comparisons with regulatory performance objectives

Page 6-331, paragraph 3

Inadequate discussion

It should be pointed out that concentrated nonuniform corrosion could progress at a very rapid rate--for purposes of this discussion, that rate may be equivalent to instantaneous rupture. This

possibility is apparently a matter of concern as stated in the last sentence "decrease in travel time of this magnitude could also lead to disqualification of the site according to the 10CFR 960, Geohydrolcgy Disqualifying Condition". Sufficient emphasis has not been directed to this issue, however.

6-85 Ibid.

Page 6-338, paragraph 2

Inadequate conclusion

Consideration of the need for water in light of the present economy only is not sufficient. The population growth in the U. S. may be great enough that within a century or two the water resources beneath Yucca Mountain may become exceedingly valuable. This discussion should be expanded to cover this possible eventuality.

EI DOCUMENT REVIEW SHEET

FILE NO.

DOCUMENT: BMI/ONWI-522, "Thermal Property and Density Measurements of Samples Taken from Drilling Cores from Potential Geologic Media," Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus, Ohio, December 1983.

REVIEWER: A. Mukherjee

DATE APPROVED:

DATE REVIEW COMPLETED: 23 October 1984

SIGNIFICANCE TO NRC WASTE MANAGEMENT PROGRAM

This document provides some preliminary test results of thermal property measurements on drill cores from candidate repository formations in salt and basalt only. No specimens from tuff formations were tested, however.

BRIEF SUMMARY OF DOCUMENTS:

Rock cores from seven potential repository sites, including salt and basalt, were tested to determine the density, steady-state conductivity, enthalpy, specific heat, heat capacity, thermal diffusivity and linear thermal expansion. A total of 59 samples were studied. Test temperatures varied between room temperature and 500°C. Ranges for the above parameters were determined. However, no tuff samples were tested.

PROBLEMS, DEFICIENCIES OR LIMITATIONS OF REPORT

This report deals with samples from salt and basalt formations. Therefore, this document is of no significance for the evaluation of repositories in tuff.

EI DOCUMENT REVIEW SHEET

FILE NO.

DOCUMENT: NVO-196-27 (DE84007255), "A Peer Review of the Nevada Nuclear Waste Storage Investigations: August 24-28, 1981," J. F. T. Agapito & Associates, Inc., Grand Junction, Colorado, February 1984.

REVIEWER: A. Mukherjee

DATE APPROVED:

DATE REVIEW COMPLETED: 23 October 1984

SIGNIFICANCE TO WASTE MANAGEMENT PROGRAM

This report will provide the NRC waste management program with an understanding of the ongoing investigations at the NTS. This will help in evaluating the present status of the investigations at NTS.

BRIEF SUMMARY OF DOCUMENTS

A peer review of the ongoing studies at the Nevada Test Site was conducted between August 24-28, 1981. This report details the comments and recommendations that were the result of the review. Response of the NNWSI are also presented. The review was divided into three panels, namely, geological/hydrological panel, geotechnical/geoengineering panel, and environmental studies panel.

The geological/hydrological panel reported that the ongoing investigation was excellent, however, there was a lack of hydrologic information. Also, a definite need for co-ordinated project management was indicated. Specific recommendations were made for geological, geophysical, geochemical, and geohydrological testing.

The geotechnical/geoengineering panel reported that this investigation program lacks sufficient focus and definitions of priorities to meet the critical, national objective of safe disposal of the waste. The recommendations included specific investigation areas and a need for co-ordinated project management.