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WM Project 10,11,16
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Distribution:
Buckley

(Return to WM, 623-SS)

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 005, Scoping Review of the Basalt Waste Isolation Project (BWIP) Environmental Assessment (EA) Report

Dear Mr. Buckley:

In response to the letter of September 27, 1984, from Mr. Paul J. Edgeworth, we are enclosing the scoping review of the BWIP EA report. We have completed this work within the revised total cost ceiling stated in the letter.

I have enclosed an article on grouting a 700-foot-deep mine which you might find interesting. Please call me if you have any questions on our scoping review.

Sincerely,

ENGINEERS INTERNATIONAL, INC.

V. Rajaram
Assistant Project Manager

VR/ja

Enclosure

cc: M. M. Singh, EI
R. A. Cummings, EI
Sharon Wollett, TCB, NRC

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Grout Stabilizes 700-ft-deep Mine

The OSM used a performance contract to bid the job of grouting a 700-ft-deep mine in Alabama that was closed 10 years ago and is now causing subsidence.

Inge Kummant, McGraw-Hill World News, Atlanta

Despite difficulties with water and gas, a contractor completed on schedule what is believed to be the deepest mine grouting project in the U.S. The nine-month-long, $2.5-million contract stabilized a 700-ft-deep mine adjoining portions of the towns of Graysville and Adamsville in Alabama. In addition to the depth, the 14-acre project is complicated by a rapid water flow through the mine, and highly concentrated methane.

William C. Morrison, a project officer at the Office of Surface Mining (OSM) Technical Center in Pittsburgh, said that mining in this area of the Mary-Lee seam was completed in the early 1970s, but that surface disturbances didn't show until 1978. Because the mine was abandoned before 1977, the problem is eligible for stabilization by OSM.

The surface problems were serious. Fissures opened in the ground and a number of homes and commercial buildings were damaged. Morrison said that mines of this depth usually preclude subsidence at the surface due to the percentage of coal extraction, but in this case there are unique structural qualities in the rock, including an intricate system of geologic faults. "The mine is between a series of faults," he said. "So fortunately, when a section starts to subside, it is somewhat limited to the 800-ft distance between the two fault zones."

A previous attempt to stabilize the mine was made in early 1983 by another contractor, but unexpected high water flows at the mine level and from four aquifers above the mine level were washing away the grout, making it obviously ineffective. OSM terminated the contract and redesigned the project.

For the second attempt, OSM called for a performance contract and specified the strength the grout had to achieve. The contractor, Hydro Group, Inc., of Cranford, N.J., was responsible for developing the mix for water barrier grout and saturation grout, and designed the injection system. OSM specified the pressure grout mix.

Water barrier grout has to set in one hour and achieve full strength, 1,000 psi, in 24 hours. Saturation grout is normal grout, preferably with a little retarder to make it flow further, that reaches 1,500 psi in 28 days. Pressure grout is a 4:1 mixture of fly ash and cement with enough water for it to flow horizontally through the cracks and fissures. No strength was specified.

OSM developed the drilling plan of 26 700-ft-deep holes spaced 350 ft apart, and 128 350-ft-deep holes spaced between 100 ft and 120 ft apart. The agency pinpointed each drilling location, and specified no more than 10 ft of vertical deviation at the bottom of the 700-ft-deep holes.

M.R. Rivers, division manager of the drilling and grouting division of Hydro Group, says only the first hole drilled exceeded the tolerance.

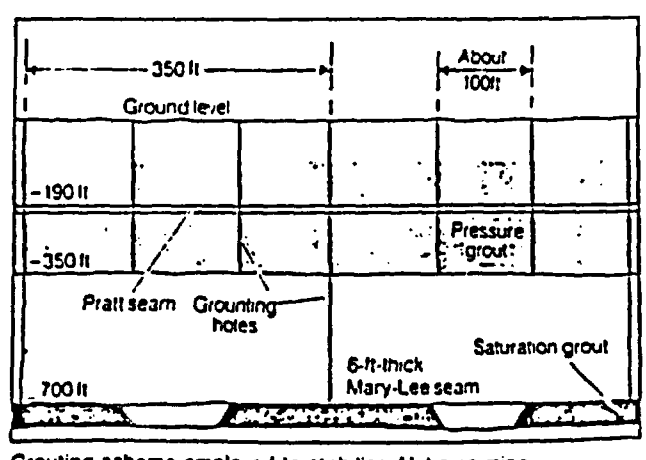
Drilling was complicated by another mined-out seam, the Pratt seam, about 190 ft below the surface. OSM tried to lay out the holes to miss the Pratt void, but holes that hit it had to be reamed out and cased to avoid losing grout into the void.

In the first phase of grouting, Hydro injected about 7,000 tons of rapid-set water barrier grouting at those points in the 700-ft-deep area where water entered and flowed out of the mine. A 1½% slope through the mine created a rapid flow, and the water barrier grout slowed the flow so the saturation grout could take effect.

Hydro pumped about 50,000 tons of controlled saturation grouting through the 26 holes into the voids 700 ft below the surface. "Our objective was not to completely fill the voids," says Morrison, "but to develop large pads of grout that would reduce the span of the mine roof." This was achieved by raising the injection tube in 12-in. steps so that the grout flowed on top of the grout deposited by the previous step, thus building up to the roof of the mine. The coal seam thickness averages 6 ft.

After completing work at the 700-ft level, Hydro drilled the 350-ft-deep holes and pumped in the pressure grout. This grout permeated about 75 ft around the holes and sealed the cracks in the rock.

The contractor also had to take care of the high flow of methane. Several of the 8-in.-dia holes produced as much as 2 million cu ft a day of gas containing 65% to 85% methane. So, to prevent the flammable gas from concentrating around the equipment, Hydro installed vents to disperse the gas 15 ft above ground. ■



Grouting scheme employed to stabilize Alabama mine.

Major Comments on the Basalt Waste Isolation Project (BWIP) Environmental Assessment (EA) Report

1. 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.

2. Contingencies for dealing with geologic uncertainties, such as feeler holes in advance of drifting and a flexible design to permit abandonment of unsuitable areas of the repository, are mentioned. However, there is no assessment of the degree to which these measures will be required during construction and operation of the repository.

3. Possibilities of sudden water inflow have not been quantified, and measures to handle this inflow are not detailed (pages 6-145 and 149). Remedial actions that may be required to handle the inflows resulting from geologic anamolies are not discussed.

4. The manner in which the site characterization program will resolve the data base uncertainties is not detailed. In particular, the representativeness of data obtained from the porthole tests and the integration of this data with other data

obtained from the surface and underground hydrogeologic testing program, is not mentioned.

5. The effects of the shaft drilling program on ground water quality is not mentioned.

6. The Quality Assurance (AQ) program that will be enforced during the drilling and grouting of the exploratory shaft is not detailed. In particular, the effect of drilling fluids on the bond between the grout and the wall rock, and the nature of the seal between the breakout horizon and the permeable zones above and below it, are not discussed.

7. The effect of the tectonic history of the area on repository design is not detailed.

8. The effect of thermal stresses on repository design, operation, and closure (sealing) is not 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.

9. Reliance is placed on backfill to seal the repository openings from the shafts. However, no mention is made of the backfill composition, placement method, density, and the permeability that will be achieved with the backfill.

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

11. Redundancy and reliability of instrumentation used to monitor ground conditions and leakage between the development and confinement ventilation systems is not detailed.

12. There are several inconsistencies within the report. For example, the waste emplacement holes may be 20 feet or 200 feet long, they may be lined or left unlined (has a significant impact on operating costs), and the waste mix could consist either of 100% spent fuel or 50% spent fuel and 50% reprocessed waste.

<u>Concern Categories Used for Detailed Comments</u>

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

2. Incorrect assumption or alternate assumptions have not been considered

3. Incomplete analysis of alternatives

4. Inadequate discussion of uncertainties

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.

Chapter 3 - The Site

3.1 Section 3.2.4, Seismicity of the reference repository location, Page 3-40, paragraph 2, category 3

960.5-2-11, b requires that the intensity of seismicity at the site be significantly less than those generally allowable for the construction and operation of nuclear facilities. In the discussion of microearthquake activity in the area around the reference repository location, there is no mention of the effect of the seismicity on the surface or underground facilities. This should be analyzed to assess if the low-magnitude earthquakes that occur in the basalts are within allowable design limits for the repository.

3.2 Section 3.3.2.2, Alternative ground water flow concepts, Page 3-77, paragraph 2, category 4

960.5-2-10 requires an analysis of the site hydrological conditions. The existing data base, although preliminary, should be analyzed to determine the level of uncertainty regarding conceptual models and ground water flow paths. This will permit an estimation of the ranges of water inflow into the repository, and the isolation capability of the site.

Chapter 4 - Site Characterization Activities and Expected Effects

4.1 Section 4, Summary, Page no. 4-iv, paragraph 3, category 7

There is no mention of the possibility of drilling and blasting the shaft through the Cohasset member after the shaft has been blind bored and grouted through the overlying members. This relates to Section 960.5-1 a.3, which requires that the ease and cost of siting, construction, operation and closure of the repository be considered. If the candidate repository horizon and flows immediately above and below it can be characterized by direct observation (possible only with drilling and blasting), it will increase the confidence in assessments relating to siting, construction, operation and closure of the repository.

4.2 Section 4.1.1, Field Studies, Page no. 4-1, paragraph 2, category 6

References cited at the end of the paragraph, with the exception of U. S. Nuclear Regulatory Commission (1983), are not listed in the references provided with the EA.

4.3 Figure 4-1, Development of a basic geohydrologic model, Page no. 4-2, figure 4-1, category 7

960.5-2-10, hydrology qualifying condition, requires that the site shall be compatible with the activities required for repository construction, operation and closure. The geohydrologic model does not mention the effect of thermal/mechanical interactions on the movement of ground water, especially in the vicinity of repository openings.

4.4 Section 4.1.1.2.3, Tectonic Modeling, Page 4-5, paragraph 1, category 7

Certainly such modeling will include the acquisition of in situ stress data. The tectonic history of the area should be an important check on the operation of the model (960.5-2-11).

4.5 Section 4.1.1.3.4, Mud effects, Page 4-6, paragraph 2, category 7

Will tests be run drilling with water and air for comparison? Will these tests include hydrochemical effects as well? This section does not describe the tests, and does not mention if the results from these tests will permit assessment of the effect of mud on the sealing program. This assessment is necessary for estimating the ease and cost of siting, construction, operation and closure (960.5-1, a3).

4.6 Section 4.1.1.5, Hydrochemistry, Page 4-7, paragraph 2, category 7

In situ measuring techniques should be tested and evaluated. Hydrochemical and geochemical compositional data are meaningless for modeling without the attendant thermodynamic data.

4.7 Section 4.1.1.5.2, Sampling techniques, Page 4-7, paragraph 5, category 7

Techniques for determining in situ dissolved gas content and composition should be included. Sample characterization and stabilization at the site and characterization again at the laboratory is necessary for proper evaluation of the integrity and representative quality of the sample. The composition of the samples change continually with time due to variation in temperature and pressure, and also due to the porosity, sorptive capacity, and reactivity of the sample vessels.

4.8 Section 4.1.1.5.3, Radionuclide transport, Page 4-7, paragraph 6, category 7

The laboratory sorption studies should include the effects of ambient temperature, pressure, and other thermodynamic properties.

4.9 Section 4.1.1.5.4, Geochemical modeling, Page 4-7, paragraph 7, category 7

The modeling should include water-rock interactions and reactivity. Static equilibrium models are inadequate due to the dynamics of the system and the concentrations of certain elements involved. Professor Denis Norton at the University of Arizona in Tucson has developed a model which was adapted from the PATHCALC model developed by Helgeson at Berkeley. This model can handle nonequilibrium and high concentration situations.

4.10 Section 4.1.2.1, Construction, Page 4-11, paragraph 3, category 4

960.5-2-9 requires that the rock characteristics permit the construction, operation, and closure of the repository. The effect of mud coating the rock fractures in the vicinity of the shaft on the ability to achieve a good bond between the grout and the rock is not discussed. Since the grout is pumped into the annular space between the liner and the hole wall to displace the drilling fluid and form a shaft seal, this effect should be considered. Quality assurance aspects of grout placement, and ensuring the continuity of the liner from the shaft bottom to the top are not discussed. Special considerations for sealing the high permeability zones are not mentioned.

4.11 Section 4.1.2.1.1, Portholes, Page 4-13, paragraph 1, category 7

The placement of only two ports 180° apart will allow the measurement of parameters in only one direction. Four portholes 90° apart would be preferable.

4.12 Ibid. , Page 4-13, paragraph 2, category 4

The 2 in. bore-holes are rather small for collecting useful samples; 3 or 4 in. would be better. The durability of the grout liner seal should be monitored, and various surface treatments should be tested to effect a good bond between the grout and the liner.

4.13 Section 4.1.2.1.4, Underground Facility, Page 4-16, paragraph 1, category 7

Figure 4-7 is referenced as a layout drawing of the underground facility, but the Phase II shaft is missing.

4.14 Section 4.1.2.2.2.1, Borehole tests, Page 4-19, paragraph 1, category 4

960.5-1-10 requires that the hydrological characteristics at the site be compatible with repository construction, operation, and closure. The feasibility of drilling slant holes into the flow tops, and the representativeness of geohydrologic data obtained from these holes are not mentioned. The manner in which the data from these holes will be correlated with data obtained from surface-drilled holes should be described.

4.15 Section 4.1.2.2.2.3, Chamber tests, Page 4-20, paragraph 2, category 7

The effect of heat and humidity on the permeability of the rock mass can be determined by bulkheading and filling the chamber with hot water. This aspect of the test is not discussed (960.5-2-10).

4.16 Section 4.1.2.2.3.8, Room-scale enlargement/mine-by tests, Page 4-21, paragraph 6, category 7.

The effect of heat on the stability of repository rooms could be evaluated by incorporating heaters in the room-scale enlargement/mine-by tests. This has not been considered as required in 960.5-2-9.

4.17 Section 4.1.2.2.3.9, Container hole drilling test, Page 4-21, paragraph 7, category 5

Canister emplacement holes of either 20 feet or 200 feet are mentioned in chapter 5, however, only a 46-foot-deep hole is proposed for the canister hole drilling tests.

4.18 Section 4.2.1.1, Geology, Page 4-25, paragraph 4, category 7

A more detailed explanation is needed regarding the borehole seismic monitoring techniques to be used and the coordination with the drilling activity.

4.19 Section 4.2.1.2.2, Ground water, Page 4-26, paragraph 3, category 7

The baseline water quality and changes to the quality due to mud loss or aquifer mixing are not being monitored. This should be done in order to delineate the effect of shaft drilling on ground water resources.

4.20 Section 4.2.4, Alternative site characterization activities that would avoid adverse impacts, Page 4-37, paragraph 4, category 3

The discussion of alternatives to shaft boring does not fully analyze all the possible methods. Data from RRL-2 indicate that only minor zones of high permeability are encountered in the Cohasset and Umtanum flows. Hence, consideration should be given to the possibility of drilling and blasting through these flows after the overlying formations have been drilled and lined by the shaft boring method.

Chapter 5 - The Repository and the Regional and Local Effects of Locating a Repository at the Site

5.1 Section 5, Summary, Page no. 5-iv, paragraph 5, category 1

There is no basis for the statement that the radiological dose to the public from an operating repository is comparable to that of a nuclear power station. This relates to Sections 960.5-1, a.1 and 960.5-1, a.2 which require that the releases must conform to 10CFR20, 10CFR60, and 40CFR191 provisions and the public must be adequately protected. It must be demonstrated that the radiological dose will conform to these guidelines.

5.2 Section 5.12, Description of existing conceptual design, Page no. 5-6, paragraph 2, category 4

The constructibility of, and retrieval from 200 ft long horizontal placement holes must be demonstrated. This relates to Section 960.5-1, a.3 which requires that the repository construction must be technically feasible. Adequacy of backfill materials must also be demonstrated.

5.3 Section 5.1.2.1.2, Ventilation, Page no. 5-13, paragraph 7, category 7

Adequate redundancy of the instrumentation system must be provided. Proper quality assurance procedures must be followed in the installation, monitoring, and maintenance of instrumentation under elevated temperature conditions. This relates to Section 960.5-1, a.1 which states that releases of radioactive materials to restricted and unrestricted areas during repository operation must meet the safety requirements of 10CFR20, 10CFR60, 40CFR191, Subpart A.

5.4 Section 5.1.2.1.5, Nonradwaste control and disposal, Page no. 5-18, paragraph 2, category 7

No contingency plan has been proposed for counteracting any catastrophic inflows of water into the repository.

5.5 Section 5.1.2.2.6, Main drift (access) functions, Page no. 5-20, paragraph 6, category 7

Adequate redundancy of the instrumentation system must be provided. Proper quality assurance procedures must be followed in the installation, monitoring, and maintenance of instrumentation under elevation temperature conditions. This relates to Section 960.5-1, a.1 which states that releases of radioactive materials to restricted and unrestricted areas during repository operation must meet the safety requirements of 10CFR20, 10CFR60, 40CFR191. Also, pressure differentials caused by heated confinement air and cooler development air must be accounted for in the ventilation design.

5.6 Section 5.1.2.2.7, Waste placement panels, Page no 5-21, paragraphs 4-5, category 7

There is no indication of the factors that will be considered in designing the ventilation system. Since basalt contains silica, drill-and-blast operations will produce a substantial amount of silica dust. The development ventilation system must be able to keep the dust level below MSHA regulations. Cooling requirements of the confinement ventilation must be considered in its design. This is related to section 960.5-2-5, c.1 which requires that all Federal, State, or Local environmental requirements be met.

5.7 Ibid, Page no. 5-22, paragraph 3, category 6

There is no reference cited as to whether the canisters have been designed against corrosion, given the unknown in situ conditions.

5.8 Ibid, Page no. 5-22, paragraph 4, category 6, 7

The ability of the container to resist rock pressures (from rock wedges in the emplacement hole) is not mentioned. The placement density, and method of backfill placement are not mentioned. These are important in assessing their permeability and overall performance.

5.9 Ibid, Page no. 5-22, paragraph 5, category 7

There is no mention of the retrievability option, or how it will be achieved, if necessary.

5.10 Section 5.1.3, Ongoing engineering studies, Page no. 5-23, paragraph 3, category 4

Special attention must be given to support systems in the confinement exhaust. This drift must remain open at all times, although personnel may not be present. This drift is also susceptible to thermal spalling due to alternate heating and cooling that may take place during retrieval (if necessary).

5.11 Ibid, Page 5-24, paragraph 2, category 7

It is not mentioned why the short placement holes are preferable to long holes. It appears that this option is being considered for ease of construction and retrieval. This is related to Section 960.5-1 a.3 which requires that repository construction and operation must be feasible.

5.12 Ibid, Page 5-24, paragraph 5, category 5

A detailed repository layout is being studied using 100 percent spent fuel, whereas earlier in the report the design is based on 50 percent spent fuel and 50 percent reprocessed waste. This inconsistency will result in a problem in terms of total heat load.

5.13 Table 5-1, Summary of expected effects from construction and operation of a repository at the Hanford site, Page 5-27, category 4, 7

Under the Hydrology category, the possibility and mitigation procedures for sudden inflows of ground water have not been mentioned. This is related to Section 960.5-2-10.a which requires that the geohydrologic setting be compatible with repository construction, operation, and closure operations.

Under the Occupational Safety Category, there is no basis to the statement that employee radiation will remain well below all allowable limits.

5.14 Section 5.2.1.3.6, Radiological, Page no. 5-34, paragraph 4, category 7

There is no mention of radiation dose if a canister breach occurs, especially during retrieval (if necessary).

Chapter 6 - Suitability of the Site for Site Characterization and for Development as a Repository

6.1 Section 6.0 Summary, Page 6-viii (Rev), paragraph 10, category 4

The Current compliance status does not seem to relate to the Qualifying condition.

6.2 Ibid, Paragraph 12, category 4

Compliance has not been established in this instance.

6.3 Section 6.3.1.1.2 Evaluation process, Page 6-42, paragraph 4 category 7

This is the only response given for the Qualifying condition and it is only a general discussion of activities and procedures. No detailed discussion is offered in response to the qualifying condition. It would appear that there is no evidence to offer to qualify the site.

6.4 Section 6.3.1.1.3 Favorable condition, Page 6-45, table 6-1, category 4

Of the results presented, the approach of Clifton et. al. is the most reasonable. The probabilistic approach will ultimately have to become acceptable. Do these models consider starting their travel times within the interior of the basalt flow?

6.5 Ibid, Page 6-43 (Rev), paragraph 5, category 7

Though the conclusion is implied, it is not stated that at this time the site does not possess the first favorable condition for the purposes of the EA.

6.6 Ibid, Page 6-46, paragraph 1, category 7

The statement that the necessary data will be collected during site characterization is unsatisfactory for purposes of this EA. It must be concluded that this site does not possess the second favorable condition. There is no schedule or program outline offered for collecting the necessary data.

6.7 Section 6.3.1.1.5, Favorable condition, Page 6-46, paragraph 1, category 7

The number of problems outlined in the brief discussion are sufficient to conclude that such a system cannot "be readily characterized and modeled with reasonable certainty".

The conclusion should be stated that for purposes of this EA, the site does not possess the third favorable condition.

6.8 Section 6.3.1.1.6 Favorable condition, Page 6-48, paragraph 3, category 7

It would appear from data presented elsewhere that the site does possess the fourth favorable condition, but that is not established in this discussion.

6.9 Section 6.3.1.1.7 Favorable condition, Page 6-52, table 6-3, category 7

There are no references for the sources of this data. The progressive drill and test hydrologic evaluation sequence is mentioned but not described. Generally, unless careful attention is paid to the stratigraphy, this type of approach is not rigorous. Individual aquifers must be isolated for meaningful results.

6.10 Section 6.3.1.1.10 Potentially adverse condition, Page 6-54, paragraph 9 category 1

This discussion is non-responsive since the currently available data is not adequately considered.

6.11 Section 6.3.1.1.12 Potentially adverse condition, Page 6-56, paragraph 4, category 1

It would appear, from the discussion and data presented elsewhere that the site does possess the third adverse condition. All numerical models of ground water flow are based on the assumption of continuous flow through a uniform medium; although discontinuities can be accounted for, they do present a significant problem. Obviously, this site is heterogeneous and discontinuous, making it extremely difficult to model.

6.12 Section 6.3.1.1.13 Disqualifying condition, Pages 6-57, paragraph 2, category 1

The discussion mentions the problem of insufficient data; however, the succeeding discussions bring out quite clearly the status of knowledge wi*h respect to ground water travel times. There is nothing wrong with presenting such data along with an attendant statistical confidence level. It would appear from the data presented thus far that the site does not possess the disqualifying condition.

6.13 Section 6.3.1.1.13.2 Radionuclide releases, Page 6-60, paragraph 3, category 1

Again it appears that there is a reluctance to present the existing data with attendant uncertainties in a conclusive manner. There does appear to be good evidence that the system guideline will be met.

6.14 Section 6.3.1.1.13.3 Reducing data uncertainty, Pages 6-60, paragraph 4, category 1

This program seems to be well laid out in response to previous comments and it is obvious that more time is needed to gather sufficient data to make definitive statements--this is the purpose of the Site Characterization Program. What should be presented is existing data with the attendant uncertainties. To a large extent that has been accomplished in the previous two sections, although it was not presented in that fashion.

6.15 Section 6.3.1.1.14 Conclusion on qualifying condition, Pages 6-62, paragraph 5 category 7

A qualified conclusion is drawn that the site probably will qualify under this guideline. This is reasonable and the uncertainties are exposed and acknowledged. The conclusion would be more meaningful, however, if a confidence level could be attached to it.

6.16 Section 6.3.1.3.3, Favorable condition, Pages 6-75, paragraph 2, category 4

The probability of encountering a flow top, and mitigation procedures to be undertaken if a flow top is encountered have not been mentioned. This relates to Section 960.4-2-3, b 1 which requires that the host rock be sufficiently thick and laterally extensive to allow significant flexibility in selecting the depth, configuration, and location of the underground facility to ensure isolation.

6.17 Ibid, Pages 6-77, paragraph 3, category 3

A 90 percent confidence level has been calculated for the dense interior thickness below the vesicular zone for the Cohassett flow throughout the basin. The total number of data points is fifteen, of which only three are within the Reference Repository Location. The knowledge about this thickness is therefore limited. The validity of the statistical analyses also needs to be checked. This is also related to Section 960.4-2-3, b 1.

6.18 Pages 6-80, paragraph 2, category 7

Details of countermeasures, if local thinnings are encountered in the dense interior should be discussed such that isolation is ensured under Section 960.4-2-3, b 1.

6.19 Ibid, Pages 6-80, paragraph 4, category 3, 7

Thermal induced stresses have not been considered in the evaluation of the thickness of the disturbed rock zone. There is also no mention of any thermo-mechanical modeling prior to in situ testing. Thermal stresses may extend the disturbed rock zone. This relates to Section 960.4-2-3, b 1.

6.20 Ibid, Page 6-82, paragraph 2, category 3

It is not clear as to whether thermo mechanical modeling has determined that the excavation-and thermal-induced tangential stresses will close radial fracture apertures. This is related to Section 960.4-2-3, b 1.

6.21 Ibid, Page 6-82, paragraph 3, category 4

An estimate can be provided as to the depth of the failure zone based on geology and thermomechanical modeling. This is also related to <u>Section 960.4-2-3, b 1</u>, in terms of ensuring isolation.

6.22 Ibid, Page 6-82, Paragraph 4, Category 4

Complete reliance is placed on sealing materials to reduce the radionuclide travel time through shafts. However, seal materials have not been tested under repository conditions. This is also related to <u>Section 960.4-2-3, b 1</u> in terms of ensuring isolation.

6.23 Section 6.3.1.3.4, Favorable condition, Page 6-83, paragraph 1, category 4

There is no basis to the statement that the requirements of <u>Section 960.4-2-3b, 2</u> will be met. It must be shown whether hydrothermal alteration does in fact seal fractures under repository conditions.

6.24 Ibid, Page 6-83, paragraph 4, category 7

Feasible design measures must be outlined to protect areas near emplacement rooms and container which are affected by high thermal expansion coefficients. This is related to <u>Section 960.4-2-3b, 2</u>.

6.25 Ibid, Pages 6-89, paragraph 4, category 1

A plan must be outlined about how data obtained from in situ tests will be used for determining the host rock isolation capability. This is related to Section 960.4-2-3b, 2 in terms of interactions between waste, host rock, ground water, and engineered components.

6.26 Section 6.3.1.3.5, Potentially adverse condition, Page 6-89, paragraph 5, category 1

It must be demonstrated how temperature-induced effects do not require engineering measures beyond reasonably available technology. This is related to the adverse condition stated in Section 960.4-2-3c,1.

6.27 Ibid, Page 6-90, paragraph 3, category 1

Thermal effects that are mentioned should be studied at the at-depth test facility. These directly relate support requirements and isolation capability, Section 960.4-2-3c,1.

6.28 Ibid, Page 6-92, paragraph 1, category 4, 7

In situ tests for determining the performance of epoxy and cement grouts under heated repository conditions must be carried out. This also relates to Section 960.4-2-3c, 1 in terms of isolation capability.

6.29 Ibid, Page 6-92, paragraph 2, category 4, 7

In situ tests for determining the performance of reinforcement/support systems in terms of different thermal expansion properties must be discussed.

6.30 Section 6.3.1.3.6, Potentially adverse condition, Page 6-94, paragraph 1, category 3, 4

The basis for determining the minimum dense interior thickness based on the thermally induced stresses needs to be defined. Also, the effects of thermal loading on the development of large-scale shear fractures should be defined. This relates to the potentially adverse conditions stated in Section 960.4-2-3c, 2.

6.31 Ibid, Page 6-95, paragraph 4, 5, category 4

Uncertainties exist as to whether shrinking of the smectite clay infilling, and the attendant higher fracture permeability will cause a water inflow to the canister. There is also the possibility of development of a high vapor pressure. If a canister breach occurs, the radionuclides may be carried away from the storage location. This is related to Section 960.4-2-3c, 2 which states that dehydration of mineral components may be a potentially adverse phenomenon.

6.32 Section 6.3.1.3.7, Potentially adverse condition, Page 6-98, paragraph 4, category 4

The effects of a combination of geology, hydrology, and thermal properties that may produce heat loads which can decrease the isolation potential of the host rock must be studied in the ADTF. This is very important for site suitability and is related to the adverse condition stated in Section 960.4-2-3c, 2.

6.33 Section 6.3.1.3.9, Conclusion on qualifying condition, Page 6-99, paragraph 5, category 7

Changing the repository layout if the dense interior thins out will disrupt operations and may result in environmental impacts if they are not properly sealed off. Guidelines should be formulated for such occurrences. This is related to Section 960.4-2-3b.

6.34 Section 6.3.2.3, Conclusion on qualifying condition, Page 6-131, paragraph 2, category 7

Conceptual design of the seal system must be provided, including sealing materials, method of placement, and placement density. Behavior of the seal materials under high temperature repository conditions must be evaluated. This relates to Section 960.4-1.

6.35 Seciton 6.3.3.2.3, Favorable conditions, Page 6-134, paragraph 4, category 4

All candidate repository horizons have the problem of lateral variability. One cannot move from one horizon to another easily. All data about the RRL has been collected from only three boreholes within the RRL. This is related to Section 960.5-2-9.

6.36 Section 6.3.3.2.4, Favorable condiiton, Page 6-137, paragraph 4, category 4

Support requirements due to the heat load from the waste should be studied in the ADTF. There must be provision in the support system design to provide remedial support to the waste panels if necessary during the operating and retrievability phase of repository operations. This relates to the support requirements of Section 960.5-2-9b, 2.

6.37. Section 6.3.3.2.5, Potentially adverse condition, Page 6-138, paragraph 2, category 4

All candidate horizons have the problem of lateral variability. Changing the storage horizon will disrupt all operations and there is no guarantee that the new horizon will be more suitable because the data base is meagre. This relates to the flexibility in design statement in Section 960.5-2-9b, 1.

6.38 Section 6.3.3.2.8, Potentially adverse condition, Page 6-142, paragraph 3, category 4, 7

Possibility of thermal spalling exists in the confinement exhaust during retrieval due to alternate heating and cooling and the presence of 50 year old support. This is related to the provision of thermally induced fracturing in Section 960.5-2-9c, 4.

Borehole liners have not been mentioned in any earlier section. The cost of using borehole liners must also be considered.

6.39 Section 6.3.3.2.9, Potentially adverse condition, Page 6-142, paragraph 4, category 1

Available case histories must be studied to assess the procedures for handling water inflows. This is related to Section 960.5-2-9c, 5.

6.40 Ibid, Page 6-143, paragraph 2, category 4

Apparently the strengths of flow top and breccia implied here are intact rock strength obtained from drill core. The rock mass strength in situ may be different. Also, there is no indication of any water inflow calculations based on the hydraulic conductivities to assess the probabilities and types of inflows that may occur. This relates to Section 960.5-2-9c,5.

6.41 Section 6.3.3.2.10, Disqualifying condition, Page 6-145, paragraph 1, category 7

Roof support in ventilation drifts must be maintained such that these drifts are open at all times, so that adequate ventilation is maintained. This is also related to the health and safety aspects of Section 960.5-2-9d.

6.42 Ibid, Page 6-145, paragraph 3, category 4

There is no basis to the statement that the volumetric flow rate is going to minimal. This is also related to the health and safety aspects of Section 960.5-2-9d.

6.43 Section, 6.3.3.2.10.3, Water inflow under high pressure, Page 6-149, paragraph 5, category 4

Procedures for investigation of anomalous zones, if encountered, have not been outlined.

6.44 Section 6.3.3.3.6 Potentially adverse condition, Page 6-154 (REV), paragraph 5, category 7

The conclusion that this potentially adverse conditions does not exist at the Hanford Site is not supported. Although it is widely known that control measures are available for such conditions, these should be specified and outlined in some detail for review.

6.45 Ibid, Page 154, paragraph 6, category 7

The nature of the cement grout to be used between the casing and shaft wall should be specified.

6.46 Section 6.3.3.3.7 Conclusion on qualifying statement, Page 6-154 (REV), paragraph 7, category 7

The conclusion that the qualifying condition appears to be met is unsupported. Although, based on current knowledge, this conclusion is probably true, the pertinent data and references should be cited for review.

6.47 Section 6.3.4.1.3 Conclusion on qualifying condition, Page 6-160 (Rev), paragraph 2, category 7

There are no references for the sources of data.

6.48 Section 6.4.1.4.4 Estimated dose consequences from hoist drop incident, Page 6-167, paragraph 2, category 7

The conclusion that data from the impact test made on glass would be conservative relative to impact on spent fuel is not supported.

6.49 Ibid, Page 6-168, category 7

In the accident analysis, mitigation procedure for the retrieval of a breached canister has not been considered. Provision must be provided for this scenario.

6.50 Section 6.4.2.2.2 Calculations of radionuclide fluxes to the accessible environment, Page 6-173, paragraph 1, category 2

The assumption "that the waste package design can meet the regulatory requirements for containment time," is not justified.

6.51 Section 6.4.2.3.1.2 Model inputs and assumptions, Page 6-178, paragraph 3, category 7

The conditions and limitations of the model are properly laid out, but the implications of the assumptions should be explained more fully or even quantified. There is no mention of plans for building a data base nor is there any discussion of methods of calibrating the model using field data. Integration of the model and the field testing program are paramount to achieving a reasonable performance assessment.