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Dr. Colin Heath, Director
Division of Waste Isolation
Office of Nuclear Waste Management
U.S. Department of Energy
Mail Stop B-107
Washington, D.C. 20545

Dear Dr. Heath:

Attached are some comments made by NRC contractors, after reviewing "Nuclear Waste Repository in Basalt, Functional Design Criteria" RHO-BWI-CD-38, Rev. 3 and "Nuclear Waste Repository in Basalt, Preconceptual Design Report, "RHO-BWI-CD-35. We are aware that RHO-BWI-CD-35 is outdated and a Conceptual Design Document is nearly completed. Therefore, the comments on RHO-BWI-CD-38 are more relevant since this report established the basis of design for the Conceptual Design.

We thought these comments would be useful to help DOE prepare for discussions during our site visit to BWIP later this month. Therefore, we are forwarding copies to BWIP project offices directly.

Sincerely,

Hubert J. Miller, Chief
High-Level Waste Technical
Development Branch
Division of Waste Management

Enclosure:
As stated

cc: RGoranson
LFitch
*See previous concurrences and distribution list

DIST:

TICKET NO:

OFC	WMHT	*WMHT	*WMHT	*WMHT			
NAME	LHartung:bb	RWright	JGreeves	HMiller			
DATE	09/14/81	9/ /81	9/14/81	9/14/81			

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Detailed Review Comments on
clear Waste Repository in Basa
Project B-301
U.S. Bureau of Mines
Preconceptual Design Report
RHO-BWI-CD-35 February 1980

B

Does this basalt contain significant zeolites that may dehydrate with temperature? Will the zeolites give off steam which would explode the basalt when the temperature exceeds some limit.

B

Most rock loses strength with temperature. Was this fact taken into account?

A

The main ground control issues that need to be resolved are (1) the average and the variability of the ratio of the horizontal to vertical pre-excavation stresses, (2) the effect of variable joint characteristics on the large scale rock mass properties such as deformability, permeability, strength, etc., (3) the optimum orientation of the openings, and (4) the optimum shape of the openings in light of the jointing characteristics.

B

Serious consideration should be given to equipping all hoists with arrestment devices. These devices are mentioned for use on the waste hoist, but there is no general treatment of this subject for all other hoists.

C

Also, consideration should be given for designing an impact absorber at the bottom of personnel shaft as well as the waste handling shaft.

C

Although underground layout may be strongly influenced by stresses or structural features, the line up of shafts should be strongly influenced by the prevailing winds. Intake shafts should be upwind of the waste exhaust shafts.

A

For a depth of 3000 feet and the low extraction ratio planned, the nominal compressive strength of the basalt of 29,000 psi should be adequate to sustain vertical loads due to overburden in the absence of jointing or nonelastic rock mass properties. However, in jointed basalt, it may be difficult to design stable openings or adequate support systems. Is creep a problem for this material at elevated temperatures for 75-150 years?

B

Since core disking has been observed in some boreholes, basalt from the stoarge horizon should be tested to determine if it is burst prone.

B

The concept of multiple canisters in horizontal holes may have merit from a rock mechanics standpoint, depending on the rock structure of the actual site and if the frictional resistance involved in horizontal placement is not too great for practical placement systems. If we assume that the canisters can be transported horizontally and placed horizontally, then the vertical height of rooms could be shorter in which case ribs would be more stable if vertical columnar jointing is present, less rock need be excavated and hoisted and less support required, ventilation velocites would be enhanced reducing rock and air temperatures.

B

p. 19, 1.0.3.2 -- Structural deformation is only one of the many effects that could jeopardize waste retrieval.

NOTE:

A - Directly Relates to Rule
B - Implied in the Rule
C - Technically Significant

A

p. 42 - The retrievable capability for stored waste should be consistent with the requirements of proposed 10 CFR 60. This is 50 years rather than 25 years.

b

pp. 57-60 -- The Geologic complexity of this proposed site is enormous. Indicated closely spaced horizontal and vertical joints and fractures makes guarantees of safe designs for and recovery of storage difficult and uncertain. The jointing, joint-filling possibilities, vesicular zonation, possible stress patterns, etc., are so complex that usefulness of geophysical logs and physical property tests on intact cores is questionable. These tests may give little useful information relative to stresses, strengths, and deformability of the rock masses in any of the subunits within the proposed repository site.

B

The observed core disking in the Grande Ronde Basalt could indicate the presence of high horizontal stress or low material shear strengths or some combination of these factors. This must be determined and evaluated before a design is finalized.

B

p. 68, 1.2.2.8 -- Last sentence in first paragraph. This is a superficial statement and out of context since "sidewall slabbing" is only one of several failure modes, all of which depend on shape, size, and orientation of opening with respect to in-situ stresses and rock discontinuities. Also, the assumption that $\sigma_h = \sigma_v$ needs clarification.

B

Residual stress due to cooling of the basalt floor would certainly be superimposed on the gravity-induced stress. The in-situ stress level is a key design consideration for all of the deep excavation requirements and does not seem to have been afforded the requisite importance in the report.

C

p. 77, fig. 1.2.4.1-2 -- shows that after about 5 years, the tangential stress in the crown (pt. A) of the displacement room results in a S.F. of less than 2 as required in Table 1.2.4.2.2 on p. 81. (80 Mpa x 2 ≃ 22 ksi; yield 28 ksi).

B

p. 127 -- There is no mention of a completely independent power source (diesel generator) for emergency ventilation, lighting, man hoisting, etc., in the event the two trunk line power sources go out together.

C

p. 141, 1.5.1.4 -- Consideration should be given to a false floor instead of a false ceiling in the instrumentation room. There would be less potential damage in the event of a fire, and it would be safer to install and service new equipment.

C

p. 347, 5.2 -- The report states that safety dogs will be provided on the hoisting system to hold the waste carrier in place within the shaft. Experience with safety dogs in the mining industry has shown that inadvertent operation of dogs have caused more problems than dogs have solved. Also, g-forces on emergency decelerations can be very high. Safety dog design is a critical area for consideration. In Germany and the United Kingdom, safety dogs are not used in mining because of the inherent problems with them.

C Trade Study No. H11 recommends two stage blasting, conventional rounds to remove the bulk of the material, and smooth blasting to trim to final line and grade. The desirability of preserving the opening integrity and associated permeability is evident. However, stress concentrations up to a factor of 3 may occur at the boundary of circular openings and may be much higher for other shaped openings. There must be some trade off point between maximum stress concentration permissible and allowable zone of increased permeability. Obviously, under some conditions of in-situ stress, opening geometry and size, stress concentration and rock strength, there may be inherent failure of rock to some depth away from the opening to relieve the stress. If this occurs, permeability will increase and the additional expense and effort for smooth blasting will have been a waste.

B p. H-50 -- Borehole decrepitation can be a very serious problem in terms of long term isolation. Eventual escape of waste into decrepitated rock may permit eventual migration to acquifers.

C p. H-208, 2.5 -- While there are some advantages for the preferred system, the down-shaft pressure of the cooling fluid is a critical design parameter. Some high pressure coils have blown out. How is such an event handled in this design?

B p. H-213 -- The hydrology scenario should be better defined. The expected numbers of aquifers and groundwater inflow during both shaft sinking and excavation will present definite problems such that the hydrology may become the critical item in overall success of the proposed facility. Page H-213 suggests a peak inflow during construction of 2500 gpm. This quantity is indeed substantial.

A p. H-222, Trade Study H22 Backfill System -- This study discusses the backfilling of the underground repository. The purpose of backfilling would be to isolate the waste, limit access to the facility, and limit the spread of waste if the canister system fails. The study suggests the ideal backfill material exactly match the strength properties of the host rock (basalt). This is not commonly practiced in mine support and is technically impossible. The study suggests other criteria for backfilling to seal the repository and shows tabular data on permeabilities of various earth materials and their related porosities (densities). As an example, the tabular data shown in Figure 4.1 would require mechanical compaction to attain the tabulated densities. This will be very difficult to accomplish in the underground repository. The present backfill plan does not include filling of the boreholes or the reaming rooms at the end of the borehole. It would seem important to backfill these to accomplish the objective of the backfilling, that is to minimize mobility of the waste should it escape from the canister.

GENERAL COMMENTS

B The stability of roofs, ribs and canister holes are highly dependent on the joint density and pattern and the ratio of the horizontal stress to vertical stress. For this reason the preconceptual design should provide for several alternate subsurface designs until more is known of the key geotechnical parameters.

C There is no provision for a general shop area to service mining equipment. unless the brief mention of "A maintenance and stores area" includes the shop. A mining operation producing 4 x 10^{6} tons of rock per year requires a major shop area.

C The systems analysis presented does not provide a great deal of confidence that 16000-17000 tons of material/day can be blasted and handled concurrent with implacement of 90-100 canisters/day. This is a formidable task.

B What is the long-term stability of shotcrete in terms of deterioration? For instance, in 25 years after the temperature reaches 130^{o} C.

C Drilling canister implacement holes in the floor parallel to vertical columnar jointing may entail high risk of popouts and bit jamming.

B Since the facility will be at a depth of 3,000 ft (page 57), and the rock temperatue will be 120^{o}F (page 68), air conditioning may be necessary to maintain acceptable working conditions. This is not discussed anywhere in the report. The 120^{o}F figure may be in error, as the actual depth below ground surface is 3,7000 ft, not 3,000 ft, and the rock temperture calculated from the gradient is 1.2^{o}C per 100 ft is 133^{o}f, not 120^{o}F.

B The need for radiation resistant electronics is obvious in certain areas but not specifically mentioned.

A In general, safety factors of two for rooms, pillars, entries, and shafts are too low for such a high risk environment. Also, a safety factor of 1.5 for canister holes would be insufficient if liners are not used. Even then, with such a low safety factor, some liners may be expected to jam during installation.

C Considering the widespread use of diesel equipment in the site self-contained breathing apparatus available for use in escape should be considered.

B The report focuses on compressive strength stress criteria as a principal design consideration. Other strength measures such as shear strength etc., should also be considered.

C It is assumed that all of the mined material hoisted to the surface cannot possibly fit back in the mine. There is no mention made as to the final disposition of this excess material.

B

A likely ground control problem may be the buckling or slabbing of the side walls of openings due to the vertical jointing. The buckling of side walls would probably occur before supports or shotcrete could be placed. The size and the width-to-height ratio of the openings will largely control the degree of this problem. The width of the openings is largely dictated by the functions of the repository and can be assumed to be fixed. An apparently unresolved issue is whether to install the canisters in the floor or in the walls. Side wall buckling becomes less likely as the openings are made less high relative to their width. This conclusion favors installing the canisters in horizontal holes which would permit lower opening heights.

B

System design for communications and monitoring is based on a combined cable. The British and ourselves are using the philosophy that these two systems should be separated because:

(a) Both systems are vital and a common system may be susceptible to a complete failure caused by a failure of either subsystem.

(b) The cable integrity of the data monitoring system will probably be higher (more expensive) than necessary for the communications system. Separate systems allow more flexibility in this respect.

(c) If a coaxial leaky feeder system is used for communications (not specifically mentioned but a possibility) the cable is necessarily vulnerable.

B

Ventilation considerations are intimately tied in with other aspects of mine design. The following questions are raised:

A. Assuming 6 days/week, 3 shifts/day, 22,500 canisters/year and a 6-hour shift, 4 canisters/hour are to be emplaced. Yet, on page H-154, 6 per hour are indicated.

Moreover, on H-154, it is estimated that 10 transporters are involved, each a remarkable 400 hp. If 4 canisters/hour are to be emplaced, why does it take 10 transporters, and why are they 400 hp? The 35-ton backfill trucks (page H-155) are only 255 hp.

B. Passageway dimensions are huge, particularly within the panel itself. For example, canister emplacement rooms are 9-1/2 meters x 6 meters. Why does so much rock have to be removed to emplace a canister not more than 2 ft in diameter? One type of canister is 18-1/2-ft long and it may be difficult to maneuver this around corners. However, there seems to be no reason why the emplacement holes must be at right angle to the emplacement corridor and the emplacement corridor at right angle to the panel access.

C

p. 23, 1.0.4.3 -- If 93,000,000 tons of basalt are to be removed during a 23-year period, about 17,580 tons will have to be hoisted per day. This will require 293 hoisting cycles per day assuming two 30 ton skips operating simultaneously. The report on p. 213 states that the hoist design cycle time is 1.9 min. This figure is way low. If the maximum hoist is 2500 fpm, it will take 1.28 minutes each way at maximum speed. If acceleration, deceleration, loading and dumping time is added, the average cycle time would be closer to 7 minutes. Therefore, 34 hours per day would be required to hoist basalt with no maintenance down time considered.

C p. 23 & 42 (also p. 200, 2.1.5 and p. 331, 4.5) -- Total estimated basalt removed is 93 million tons. If use period is 21 years and retrieval be maintained for 50 years after completion of emplacement, then it is possible that all 93 million tons of basalt could be on the surface at one time and space required for surface storage could be more than twice that shown on Figure 2.1.2, page 194.

B p. 41 - 1.1.5.10 -- Emergency shelters with communication and radiological warning systems could be included here.

C There are some terminology problems. The phrase "capable faults" appears twice on page 61. This phrase is not in the latest AGI Glossary and is unknown to personnel at the Missouri Geological Survey. The terms - inby, outby, headgate, tailgate, and upcast - used in this report are not usually used in hard rock mining.

B p. 68 -- Does sidewall slabbing always occur at .18 of the material for all conditions and rock types?

B p. 73-1.2.4.1 -- First sentence states, "...rock mechanics criteria shall be used to determine allowable canister placement configuration." p. 74, "...which includes definition of density, shape, spacing, etc." These design factors are as much a function of operational and mining constraints as they are rock mechanics criteria. Obviously, the cansiter openings are round, if bored, which is also the optimum shape in elastic mediums with hydrostatic loading.

B p. 79 -- How were the stress criteria chosen? Ascertain the justification for use of rock mass strength of a rock core with diameter equal to one-sixth the span cavity, with h/d = 2 as representing the strength of the rock mass. Is this assumption valid for Basalt with 6-10 fractures per meter? Further assuming a 60-foot span, a practical way to measure the properties of a 10-foot sample has not been proposed.

B p. 80 -- The stress criteria analysis assumes the rock mass is elastic. This is a questionable assumption for a highly jointed, joint filled, material that may have temperature effects on the joint filling.

B p. 80 -- What is the justification for calculating the stress at a distance equal to half the side length of the representative volume? Does the stress include thermal induced stress or not?

B pp. 80-81 -- The failure criteria is based on safety factors determined from rock mass strength and assumed in-situ stress. The in-situ stress field should be determined by field investigation for a valid failure criteria.

C What are the assumptions in equations 1 and 2 on pp. 83 and 84? Also, p. 77 - Figure 1.2.4.1-2 -- What are the physics of tangential stress change for point B between 5 and 25 years.

C p. 86 -- How are equations (3) and (5) going to be incorporated into the safety factor determination?

C p. 87 -- Is the "thermal expansion coefficient" related to K_t in equation 1? If not, where does it relate to the stability criteria?

C p. 133, 1.3.5.4 -- The report states "a large portion of excavated material will be returned to the subsurface as cement or backfill." At the maximum only 60 percent could be returned underground. This would require considerable crushing and sizing effort.

C p. 135, 1.4 -- What are redundant ropes and safety devices?

C p. 135, 1.4 -- Consideration should be given to having the shaft sizes uniform. This will enable use of better construction techniques and use of similar equipment in shaft excavation which may eliminate some down-time caused by equipment failures. Further, if the shafts could be similarly equipped, another substantial saving in capital and permanent facilities may result. Equipment failure-rate analysis may also be more favorably approached with identical equipment.

C p. 137, 1.4.7 -- Emergency hoist will carry 20 percent of people underground or 20 people, whichever is greater. Twenty percent of 961 is 192. There seems to be some discrepancy here.

B p. 146, 1.5.10 -- For terminal closure of the site, consideration should be given pneumatic placement of backfill versus hydraulic. Higher densities can be achieved with fewer water handling problems.

B p. 148, 1.6 -- Waste Handling System Design Requirements -- This section briefly discusses the nature of the handling system needed at the repository site. While not stated, it is assumed most of the materials handled will be of high level radioactivity and require remote handling. A subsystem, called "contact storage" is assumed to be a euphemism for low-level radioactive material, which can be directly handled by personnel, is also incorporated in the handling facility but not discussed in the system requirements. There are no technical comments on this section of the report.

C p. 213, 216, 217, 221 -- The concrete thickness of 32 inches to 44 inches seems excessive. Very little benefit is obtained from a thickness in excess of 12 inches because the increased excavation diameter increases rock stress and materials handling requiremnts.

C pp. 248-251, Trade Study No. H23, Personnel and Material Handling System -- The diesel intensive materials handling system is the best of the three options for the materials handling system when flexibility is considered. The disadvantage of diesel is the amount of ventilation which is require with the 120^{o} rock temperatures.

B p. 299, 4.1, Waste Operation -- This section lists the staff requirements for the waste handling facility based on a so-called operations-analysis charts. From these charts there is no way to evaluate the correctness of the staffing as would be possible from a timed flow - process chart of the system.

B The statement on page 306, "Air flow requirements ... present the most significant criteria for sizing the mined openings beyond requirements for the waste transport equipment," should be clarified. Structural design must play a major role.

C p. 310, 4.2.1 -- What is the availability of state-of-the-art technology to remove cuttings from a horizontal reaming operation?

C p. 330, 4.4 -- With 961 personnel underground during one shift, it will take one hour for lowering at the beginning of the shift and one hour for hoisting at the end of the shift (assuming 280-man hoist capacity and a 15 minute cycle time, p. H-216). This may require staggered shifts.

B p. 330 and p. 353 -- To insure the overall safety of the operation, a personnel locator and warning system similar to that being developed by the Bureau of Mines should be considered. The system determines the location of each worker, boradcasts routine messages or warnings in the event of emergency, and through a surface minicomputer, describes an optimized escape plan in the event evacuation is required.

B Disadvantages numbers 2 and 3 in Table 4.14 (H-17) are not correct -- complete grouting is not required, and the system is not limited by depth.

C p. H-19, 6.0, Recommendations -- Contrary to the report, verticality can be maintained when drilling from the surface. Once the first shaft is sunk, backreaming can be done because underground development openings are available for muck removal. Therefore, conventional drill and blast may be used for the first shaft, but other methods should be considered beyond this.

B p. H-25 -- During shaft construction, pumping down aquifers that are deep and in rock with a large interstial flow cannot be relied upon. Only large diameter drilling could cope with this flow, and then how do you line.

C p. H-39 -- Locating all the shafts in the center of the long site dimension appears inadequate when considering the very long underground distances the air must be moved. Pressure losses may require a split shaft at each end, maybe two split shafts (one for each of the two independent systems). Where losses calculated?

C p. H-82 -- Canister hole drilling appears difficult at 176 feet. Bit clearing and cuttings removal in the horizontal position is more difficult than the equipment manufacturer indicates for his proposed cutting rates in basalt. Muck backup and its attendant interference with cutting and hole straightness (stabilizers) are not clearly resolved in the proposal. Gravity will pull down any bit, large or small, stabilized or unstabilized, and interfere with installing the steel liner in at least some of the cases. Hole straightness is even a problem in vertical drilling because of the rotary action of the bit wanting to drill in a long spiral. It seems that a pilot hole would be necessary. Pulling a horizontal raise may be best except for drill-rod wear (it lays on the hole invert and wears against the hard basalt near the bit). Fishing for a lost drill bit will be difficult because it is a new technology in a horizontal hole.

C p. H-95 -- The Ingersoll-Rand plant in Seattle is no longer in operation. Therefore, the equipment mentioned in that letter may, or may not, be available as indicated.

C p. H-125, 1st paragraph -- It is uncertain whether this paragraph really states the correct analysis; we suggest that the pressure distributions be re-examined and the paragraph reworded accordingly. Also, underground fans will need remote (surface) start/stop controls.

C H-130 &
H-132 - It appears that the rail haulage entry in the upper portion of Figure 2 is intake air; however, in Figure 3 it is shown as return air.

C H-131 - A value of 100,000 cfm to a development is a rather large amount, and far beyond what can easily be delivered to a face end with an auxiliary fan and tubing.

C H-131 - Is this 250,000 cfm during mining (3.2.3) divided among 8 headings?

C H-131 - A value of 250,000 cfm during emplacement (3.2.4) will lead to very high pressure drops at the return air passes unless these are unusually large.

C H-133 - The stoppings shown in Figure 4 may not be necessary during the mining phase. Instead the ore passes will have to be blocked.

C H-143 - Velocities in the main airways are too high, particularly in the rail haulage return.

C H-145 - Shaft velocities are too high, particularly in the mine exhaust. However, the solution is to reduce air requirements in the mine, not sinking a larger shaft or more shafts.

C H-146 - Note that high differential pressures between the two mining circuits will require airlocks between them rather than a single door in a bulkhead.

C H-149 - If development proceeds in 2 panels and 84,000 cfm is required to dilute emissions, then 42,000 cfm per panel is required. This is a large quantity to deliver to a face end, if that is the intent.

C p. H-211, 2nd paragraph -- A temperature of 40°F at the bottom of the shaft means about 22.5°F (page H-210, 1000m shaft) at the top. If there is water in the shaft, some heating of the incoming air might be needed to prevent freezing.

C p. H-252-254, Trade Study No. H24, Materials Supply and Storage -- The recommended system should be able to meet the needs of the repository, and trailer load lots will lessen manual materials handling accidents. The trailers may also serve as mini-warehouses to expedite materials handling.

C

p. H-255, Trade Study No. H25 -- Shaft location alternate layouts are not clear and criteria is not provided on why the choice of Case II is preferred. Even though Case II is preferred, the main report, Figure 2.1 and 2.1.2 appears to use Case I.

C

p. H-282, Trade Study No. H26 -- Figure 8 gives stress changes due to thermal effects. What criteria is the basis of comment that stress changes are within acceptable limits? Does temperature increase of the basalt occur early enough in the repository life to affect ventilation requirements?

NRC-02-81-037
Enclosure #1 to Letter #10

Detailed Comments on Nuclear Waste Repository in Basalt Functional Design Criteria
RHO-BWI-CD-38 Rev. 3 Nov. 1980

Section	Page	Detailed Comments
Introduction B	1	Para. 7 appears to limit site exploration activities (preconstruction) to drillholes at shaft locations. An area of nonpenetration should be defined, e.g., within a 2km radius of the repository, but deep explorations other than at shaft locations will be required to investigate geohydrology outside of the immediate repository area.
1.0 B	4-14	The list of "functions" appears to be comprehensive. However, we feel that it would be beneficial to offer, in this document, some comment on the relative importance of each of the functions, i.e., which of these are considered important to safety and which are merely required for completeness of design. For example - "Transport of retrieved waste from the subsurface to the surface..." vs. "Service roads interconnecting surface facilities."
B		There are also some implicit design assumptions made in this document, e.g., rooms will be closed after storage (i.e., nonventilated), backfill will not be placed until decommissioning, storage will be in vertical holes.
C		It would be useful, if not essential, for this document to have a preliminary chapter discussing the overall design philosophy, to put some perspective on the subsequent detailed specifications. In particular, this should address the procedures by which design features are to be related to radioactive release; hence, our previous comment about the need to define functions important to safety. This

NOTE:
A - Directly Relates to Rule
B - Implied in the Rule
C - Technically Significant

Section	Page	Detailed Comments
		should obviously be carried through in more detail in the main text.
C		This document post-dates the conceptual design for a repository in basalt (CD-35) and some sections have been heavily based on that report. Frequently, the justification for the design criteria can only be found in CD-35, and while we do not believe that this document (CD-38) should be totally self-justifying, the suggestions made above would perhaps add clarity to the logic in the design process.
2.0 A	15	There appears to be some confusion re: the age of waste. Para. 3 specifies 10-year waste, but Fig. 0-1, p.2, shows a possible range of 5-20 year waste. The younger waste would obviously impact the temperature criteria.
B		Last para. defines control zone as extending 2km from the periphery of the underground facilities. This is presumably the high security zone. A zone of controlled activities, particularly resource activities, should extend out from the repository as far as is required to maintain isolation.
B		In Para. 8, the purpose of the control zone is not clear; hence, the values are not supportable. These same numbers have been used elsewhere for other purposes, e.g., to define a "disturbed" zone within which resources are to be quantified.
B	16	How is the requirement of Para. 9 related to the stipulation in Para. 8, p15? This would relate to controlling subsequent human intrusion.
2.7.1 B	20	In Para. 2, seismic design appears to be extremely conservative. The Safety Function Earthquake (SFE) appears to be analogous to the safe shutdown earthquake (SSE) of Nuclear Power Plants. The SSE design level for WPPSS nuclear plants under construction is 0.25g, based on a tectonic

Section	Page	Detailed Comments
		province concept. Lower SSE's have been used on the Hanford reservation and higher ones have been prepared by USGS staff. The matter is currently open and will be addressed shortly in the NRC review of WPPSS operating license reviews. That accelerations are considerably less at depth is well documented in a qualitative way, as in the knowledge that high recorded accelerations at depth have not produced similar damage levels as at the surface. Also, Nevada test site experiments have shown quantitative reductions in acceleration with depth.
NA		Example earthquakes of the magnitude and distance of the SSE (SFE) should be deconvolved through recording site material and reconvolved upward through the repository geologic sequence using dynamic finite element or difference procedures to define localities and amounts of concentrated stress requiring design modification. We view the preliminary SFE parameters of "g" and frequency (HZ) to be too simple and probably too conservative.
2.7.4	21	We assume this is for the operational phase only.
B		The design flood should be given, e.g., maximum probable flood, as well as the elevation of the reference site (600 ft) and the maximum flood elevation.
2.8.1.1 C	22	The term "climatic trends" should be qualified by some time frame. This appears to be oriented to the operational phase rather than post decommissioning.
2.8.2.3 B	23	This seems to be a fundamental statement, i.e., requirements for decommissioning need not be determined seriously until time of closure. There should be some qualifying statement here that indicates that the technical criteria for decommissioning will be evaluated at time of construction, at least in preliminary form. It appears that the issue is being avoided. Can requirements (postulated) be met today?

Section	Page	Detailed Comments
2.8.2.3 A	23	Overall performance of the repository may depend upon how well penetrations through the natural barriers (shafts) can be sealed. Sealing methods and anticipated competence of seals may significantly affect the repository design. For instance, if shafts cannot be sealed with a high degree of confidence, it is possible to minimize adverse effects of leaky shaft seals by special design measures. Decommissioning activities and requirements should not wait until the time of closure, as indicated.
2.9.3 C	25	This paragraph is extremely weak and indicates no understanding of rock support. It should simply be stated that the rock support must be maintained in the "as installed" condition, which presumably meets some design criteria.
2.9.6 C	25	This section creates problems. We assume that canister handling vehicles will contain "motors, drive motors" or "gear trains," and these are surely essential items (see 2.9.1 for specifying redundancy of equipment). In some of these sections, we feel that the document tries to be too detailed. Inspection of exhaust air shafts may be quite difficult!
2.10 C	26	Note the assumption of "proven technology." This deserves to be placed up front as introductory comment.
2.10.3 B	28	In section 2.10.3.1, the design layouts are related to "geology, hydrology." We assume that somewhere there is a requirement for the design to be related to release of radionuclides to the biosphere, i.e., shaft location may be critical with respect to potential groundwater flow paths and radionuclide travel.
B		Arrangement should be made to optimize the degree of containment. Therefore, master plan should address potential release pathways.

Section	Page	Detailed Comments
2.10.6 C	30	Ventilation air requirements for men will be dominated by equipment requirements, we suspect; particularly in the construction air flow.
2.11	31	How do these criteria relate to EPA requirements? This should be checked.
B		Para. 1 relates to prevention of "off-site" exposures. It is important to clearly define the limits of the site. Is it the security fence, Hanford Reservation Boundary, or other boundary?
3.1.2 B	33	All "site-generated" waste does not include retrieved waste from underground storage. In any case, why is this listed under utility tie-ins?
3.3 C	34	Size of "shielded lag storage area" should be defined, and related to daily arrival of waste. (See p53 where it is indeed specified.)
3.6 C	37	It is our interpretation that backfill will not be placed until decommissioning (see p.47, 5.10.3). If so, then the requirement stated in Para. 4 for storing excavated rock to be used as backfill is untenable. The whole concept of backfilling/scheduling needs evaluation.
4.0 C	38	In Para. 1, has it been determined that the area of shafts is critical to containment? What does this vague statement mean? Simple cost considerations will dictate the same, or is a more stringent rule to be set?
B		Para 2, could be more detailed, including mention of grouting to seal fracture zones. This needs to be tied in more carefully to the containment requirements at decommissioning, stated in 4.8.
B		Para. 1 indicates that the number and area of shafts should be kept to a minimum to reduce the potential for release. This may or may not be true

Section	Page	Detailed Comments
		depending upon the actual design. It is more important to locate and design shafts and connecting tunnels to minimize potential release pathways; for instance, positioning of shafts to take advantage of natural flow gradients of groundwater.
4.1 C	38	Is the requirement to have one waste shaft for packages and a second waste shaft for drums, or one shaft for both? The former has many advantages.
4.2 C	38	Other options for backfill handling need to be addressed, e.g. large boreholes.
4.4 C	39	Usually the same shaft would be used for personnel access.
4.7 C	39	Should the performance of the emergency shaft equal that of the personnel access shaft rather than "good mining practice"?
4.8 B	39	This should be reviewed in some detail, including the reference of Taylor and Others (1980). Questions include: (a) Why is the plugged length 300 meters? (b) What is the relationship of the sand/bentonite to the concrete plugs? (c) Collaring the seals will also disturb the rock; what is the function of rock grouting here? (d) How is the lining designed to permit partial removal? Over 300 m length this would be rather unpractical. (e) How does the lining within the aquifer zones accommodate the seals/plugs?
C		This section is probably too detailed, and attempts to be too specific without providing either justification or clarity. It needs to be rewritten.
		This seems to be very specific compared to other sections of this docu-

Section	Page	Detailed Comments
B		ment. Have concrete plugs at aquifers and compacted sand and bentonite at other locations been shown to be the best method of sealing? How do you place an effective concrete plug outside of the shaft liner in the aquifer zones? How would high water pressures and possible water inflow outside of shaft liner affect the placement of cement plugs and sand/bentonite seals?
5.1 C	40	Suggest incorporation of a drawing to show required location of experimental panel with respect to main repository. OR Guidelines for locating same.
C		Suggest the requirement for one completely developed panel as a "buffer" or "reserve" is a minimum requirement. This would depend on the assumptions with respect to geological continuity and unforeseen flaws.
5.2.3 C	42	Location of underground explosives magazines should be stipulated with respect to storage areas and ventilation circuits.
5.3 B	43	The function of the "pillar rock" used to separate storage panels from main accessway is confusing; i.e.: (a) How is it intended to effectively increase the "radionuclide migration distance"? This is meaningless unless tied into the overall design including shaft locations. (b) On p.48, temperature limits are specifically defined for entries during operational storage phases. Therefore, the statement "minimize the temperature buildup..." has no meaning. The design must satisfy the conditions specified on p.48.
5.4 B	43	See our comment on p.40, Sec. 5.1 and reference to ESTF in this section.
5.9 C	44	Does "...storage rooms shall be secured..." mean completely closed off?

Section		Page	Detailed Comments
5.10.1	B	45	We are not sure what is meant by "temperatures of all barrier materials shall be acceptable if the cladding temperature limit is not exceeded."
5.10.3	B C	47	Define the role of backfill in terms of "permanent room support." What is the sizing of the crushed basalt? Again, very detailed specifications are given, but no logic for design. Some specifics are given, but others are left out. Rationale for much of this information is lacking and should be referenced or stated. For instance, what is size distribution of crushed basalt? Is 10 to 15 percent water content the optimum for compaction? How much compaction is required? How are fractures caused by excavation of the rooms to be sealed?
5.10.4	B	47	This doesn't correspond to shaft sealing procedures given in section 4.8 and is not clear. This is not clear. The "Taylor and Others (1980)" reference must be reviewed. This whole concept (plugging) needs a lot of work.
5.11.1	C	47	It is difficult to comment on these temperature criteria without knowing the context or on what they are based. The logic presented appears reasonable, however. Presumably the conceptual design (CD-35) will provide back up material and should be cross-referenced.
5.11.2	C	48	The whole concept of safety factor, if it is to be used, needs some explanation, particularly with respect to the strength values specified on p.49. Comments include: (a) There is no discussion on how rock stresses at "critical locations" are to be calculated (p.48) (b) For a room of span 18 feet, the sample size stipulated on p.49 would be 6 feet long by 3 feet

Section	Page	Detailed Comments
		diameter. A sample of this size cannot be strength-tested directly, and the formula given on p.50 presumably is intended to relate small scale lab testing to the stipulated sample size. This seems to be an irrational approach. (c) The basis for the rock stress safety factors, Table 5-1, is not presented and it is not clear how these numbers are related to the objectives stipulated on p.48. (d) The values chosen appear to be low in an area where conservatism could readily be built in to the design. (e) The relationship between values stipulated for operational, retrievable and terminal phases is not clear. Are these values mutually exclusive?
5.11.3 C	50	Appears to be an error in Formula (1) The right hand side of equation should be $A(\frac{\sigma_3-p}{\sigma_c})^k$ CD-35 should be reviewed to check the basis for these formulations and their applicability to Hanford basalt. These should be validated in situ, or a plan made to do this.
7.1 B	59	Refer to previous comment re: sizing of basalt for backfill. No guidelines are given. Also, the concept of subsurface storage of basalt is introduced. We do not understand this nor how it differs from backfill. In Fig 7-1, p.60, a concept of aggregate subsurface preparation is also introduced. Some explanation would be useful.
7.3.1 C	61	The "Principle of compartmentalization" should be explained. Is this separation of circuits or other in situ control system?

Section		Page	Detailed Comments
7.3.2	C	64	Air velocity quoted for haulage ways (800-1500 fpm) is high for conveyor ways.
7.4		64	Check reference "Burchsted and Others (1976)." No comment on detailed specifications, p.65.
	B		It is not clear in the discussion on ventilation how accidental contamination of the mine air supply is to be treated. Are air filters to be provided on the exhaust? Point 2 in 7.7.1 on p.73 may allude to this.
7.5.2	B	66	Description of the normal power supply system as "may be subject to frequent, normally unpredictable interruptions of varying duration" seems to be unacceptable.
7.7.1	B	74	The only reference to rock monitoring is provided in the last point in this section and in our view is completely inadequate. The assumption is made: (a) That acoustical detectors will provide the data required to monitor the performance of the repository. (b) That rock movements of a magnitude that can be detected and distinguished will occur. The Hecla system was set up to monitor rockbursts and has proved to be only partially successful. It is our view that the repository design should preclude activity of this type. It is our view that other monitoring such as - rock displacement - rock stress - rock temperature would provide more valid and useful data.
7.9.1	B	77	This does not include any discussion of disposal of retrieved waste canisters either for experimental purposes or because of defective packaging.

Section	Page	Detailed Comments
7.10.4 B	80	This design basis subsurface flood should be checked. It is presumably based on site specific data. How does mine inflow - if it exists - affect the placement of canisters and canister barriers? Are any provisions to be made for mine depressurization, such as drainage holes drilled from the repository? If permeability is extremely low, will poor depressurization result in stability problems? What is the basis for the design subsurface flood of 2500 gpm?
7.11 C	82	This section contains no discussions on security re: underground storage of explosives or transport in the mine.
7.12.2 C	84	We do not understand the basis for the "design basis rockfall."
7.12.5 C	86	Para. 6. should be discussed in terms that can be related to a mining scale operation.
7.13.3.1 C	92	Para. 2, relating to mine vehicle fuel supply, underground storage, seems to be rather inflexible.
8.0 B	94-107	This whole section is rather brief, which is okay considering the purpose of this document. However, Section 8.5 relating to conditions within the storage horizon is extremely short. Some estimates of geohydrologic conditions at the repository level must be made to determine mine inflows, design dewatering/depressurization systems, etc. We have not seen any order of magnitude estimates of vertical hydraulic conductivity of the repository layer, which is probably the single most important geohydrologic parameter.

NRC-02-81-037
Enclosure #2 to Letter #11

Detailed Review Comments on
Nuclear Waste Repository in Basalt
Project B-301
Preconceptual Design Report
RHO-BWI-CD-35 February 1980

A. MAIN TEXT

	Page	Section	Detailed Comments
N.A	15	1.0	Note specification of concurrent mining and storage operations. This imposes the need to assume that the exploratory procedures and/or pre-mining pilot investigations preclude mining - caused unacceptable events (e.g., water inflows). This overlap is further detailed on p. 18, et seq.
C	20	1.0.4.1	Surface facilities do not represent the only interface with the environment, necessarily.
B	23	1.0.4.2	This implies that there should be no exploration drill holes except at shaft locations.
B	24	1.0.4.5	Pumping, emergency systems are not discussed.
A	25	1.1	Retrieval is specified for up to 25 years. However, in 10 CFR 60, Subpart E, retrieval is specified for a period of up to 50 years after termination of waste emplacement.
B	30	1.1.2	Ventilation is a principal function of the shaft system (provided for on p. 32).
C	34	1.1.3.2	Is there a need for temperature control during retrievable period?
C	34	1.1.3.5	Is final geologic suitability verification provided during initial mining?
A	56-61	1.2.2.4	The geologic description on pp. 56-61 describes a very jointed rock mass. There is no detailed comment here on the proposed repository horizon (Umtanum unit) or how its properties, thickness, etc., satisfy design requirements. Also, there is no discussion of variability of properties laterally.

NOTE:
A - Directly Relates to Rule
B-- Implied in the Rule
C - Technically Significant

	Page	Section	Detailed Comments
B	57	1.2.2.4	In Figure 1.2.2.4-1, no comment is provided on which flows or interbeds are laterally continuous or discontinuous.
C	58	1.2.2.4	What is the significance of the thickness of surficial sediments? What are the important considerations, i.e.: - surface structures? - shafts, siting? - hydrology? In paragraph 4, if the surficial deposits are unconformable with the underlying basalts, a contour map of the top-of-basalt may not necessarily approximate the bedrock structure.
A	61	1.2.2.5	Note limited knowledge of confined aquifers in deeper basalts. Bottom line of all the hydrology is (1) prediction of size of potential inflows occurring unexpectedly during mining operations and (2) long-term hydrology for containment purposes. We are unable to draw any conclusions on these from the data presented.
B	63	1.2.2.5	In Table 1.2.2.5-1, the hydraulic properties of the media can not be interpreted unless the aquifer thickness is known. The use of specific storage (Ss) would be more meaningful. For unconfined aquifers, the storage capability of the media should be expressed as specific yield (Sy), which is less than or equal to the porosity. Storage coefficients for the Hanford and Ringold Formations are inconsistent with the given porosities.
B	65	1.2.2.5	In Paragraph 3, in the columnar sections of basalt flows, the dominant attitude of fracturing is vertical. Since the given hydraulic conductivity is for the horizontal direction, its value should be considered a lower bound on the vertical hydraulic conductivity (see also p. H-294). In Paragraph 5, physical properties of the columnar sections and interflows of the Saddle Mountains Basalt are inferred from tests in the Grande Ronde Basalt. In situ tests of the Saddle Mountains Basalt apparently have not been performed.

	Page	Section	Detailed Comments
C	66	1.2.2.5	The existence of artesian pressures in the lower confined aquifer suggests that it is not in hydraulic communication with the upper confined aquifer. Therefore, the distribution of water potentials in the lower unit do not necessarily have the same trend as the upper unit.
A	70	1.2.3.1	There is a statement that potential radionuclide pathways will be identified. Conceptual design does not evaluate long term containment. This appears to be a critical ommission which should be addressed in some way. At least the limitations of this document should be outlined.
B	73	1.2.4	Procedures for the analysis and design of the rock mechanics aspects of underground excavations should be identified for application in the conceptual design stage. Also, rock mechanics for repository layout should be integrated with hydrogeological aspects to optimize potential flow paths.
C	76-77	1.2.4.1	What is relevance of these figures? The data appears to be gratuitous information whch is not connected to the design performance.
C	78	1.2.4.2	There are no references to justify temperature and stress criteria. Temperature and induced thermal stress limits should consider effect on regional stability, i.e., induced seismicity. Temperature criteria should include stability and migration path development associated with premature cooling, e.g., partial retrieval.
C	79	1.2.4.2.2	What is justification for representative volume for estimating rock mass strength, as core size 1/6 of span. This is too definite. Does this imply core of 1 m diameter for 6 m span? How can a volume be 1/6 of a length?
C	80	1.2.4.2.2	First paragraph is not clear. Presume we are talking about a distance into the rock mass = 1/2 of something. What is the side length of the representative volume? We consider this approach to be too simplistic. What about blast damage effects and consequent support needs? Other potential surface instability type failure mechanisms exist for which empirically base criteria will need to be developed (e.g., in experimental chamber).

	Page	Section	Detailed Comments
C	81	1.2.4.2.2	Table 1.2.4.2.2 slightly clarifies representative volume (not core). What is the lining material and why is the required F of S so high (10)? Believe the "**" are in wrong place. "***" indicates confusing use of shotcrete/concrete. How are these safety factors determined? F of S = 1 implies failure/failing condition. Surely this is not acceptable. Requires demonstration by analysis showing both stress/ displacement histories.
C	82	1.2.4.3	What is association between past underground construction practices/empirical design methods and long-term containment analysis. It is, however, essential that analytical design evaluation techniques have been validated. How much is, or will be known about high temperature behavior of deep, massive basalts, and the hydrological consequences? We believe that this may be a very key portion of this report. It should be possible to specify here for later application in conceptual design, the types of analytical modeling that can be carried out for: ● Sensitivity studies, ● Design optimization (when better data is available) e.g., - transient thermal conditions - regional scale modeling of induced thermal stresses - local opening stability as a function of shape and layout.
C	83-84	1.2.4.4.1	Is there justification/reference for equations (1) and (2)?
C	86	1.2.4.4.2	Why define values of JRC at this stage?
C	86	1.2.4.4.3	Note that equation (5) is suggested, whereas equations (1) and (2) are more definitely stated.
C	83-86	1.2.4.4.1 -1.2.4.4.3	These sections should note that the equations are empirically based and that the stated parameter values need to be checked and/or modified according to experimental tests in situ to suit local conditions.

	Page	Section	Detailed Comments
B	87	1.2.4.4.4	Laboratory determined values are considered of low reliability. These should be determined by back-analysis from large-scale tests carried out in a test facility.
A	96	1.2.7.1	These design requirements are operational only. Long-term containment is not addressed.
C	96	1.2.7.1.1	The relevance of the DBE to the design requirements for underground openings should be noted.
C	97	1.2.7.1.3	Does this rockfall really cover the probable range of events?
C	102	1.2.7.2.1	Key elements in underground fire situations are the vulnerability of mobile equipment (fuel, hydraulics, tires) and the consequent smoke problem.
N.A	110	1.2.9.3	Maintenance of underground openings as described will presumably be limited by definition to operation phase.
N.A.	113	1.2.10.1.1	Note that design life of repository is only 75 years. This could be interpreted as not meeting the requirements of 10 CFR 60.
C	122	1.2.11.1	Quality Assurance Levels I and II list should include surveillance systems which monitor the physical state of the subsurface facility.
C	136	1.4.1	Where do position indicators indicate? Need upcoming overwind security for retrieval operations, e.g., jamming guides, humble hook, etc. Also, need slack rope protection.
C	136	1.4.3	"Minimum number of trips" is meaningless. If you have a large enough shaft and cage you can hoist everyone at once! A time criterion based on accident scenario analysis would be better. Need clean air security for personnel shaft and also for accident retrieval and maintenance in all shafts.
B	139	1.5	Note key sentence in paragraph 1, "Variation of the geologic horizon. . ." What variation can be tolerated for long-term radionuclide isolation? The methodology for determining this

Page	Section	Detailed Comments
B 139	1.5	variability and responding appropriately is very important. In a sense, this is the final design. How does NRC provide surveillance/ licensing function?
C 143	1.5.4.1	This kind of information is gratuitous, since specific temperature limits have already been established and the layout, by analyses, must therefore conform to those criteria.
C 144	1.5.6	Again, specific temperature limits have been established.
C 144-145	1.5.6	Many complex operational problems underlie this discussion, e.g., hole location with enough accuracy for placement and retrieval.
C 146	1.5.10	What existing technology and equipment exists to backfill tunnels to this standard?
NA 147	1.5.10	Is it intended to remove all "disturbed rock"? Surely that "disturbs" more rock, and so ad infinitum.
C 171	1.7.5.3	Where will basalt temperatures be measured? This is a sweeping statement.
A 172	1.7.5.3	The microseismic system is unlikely to be able to discriminate between normal repository activity, including drilling or tunnel boring, and anything other than a major rock burst. What is its purpose and value? The rock monitoring system should include strategic arrays of groundwater pressure monitors, extensometers, temperature and stress meters, in addition to a complete 3-D array of acoustical detectors. This will allow an evaluation of geotechnical stability, and heat and groundwater movements before and after terminal closure.
A 182	1.7.8.3	There is an assumption that "high pumping capacity" will not be required during the main operational period. This pre-supposes either (1) the reliable exclusion of unexpected inflows of significant volume during routine mining operations, which in turn is either making a generic statement about the hydrology of the repository horizon formation or presuming a sequence of development that precludes

	Page	Section	Detailed Comments
A	182	1.7.8.3	such a problem, or (2) requires an effective separation of mining area from storage areas. The design basis should be clear. Is there such a thing as a Design Base Inflow (DBI)?
C	192	2.1.1	Groundwater contamination originating at the repository (i.e., from radioactive waste) could eventually contaminate the onsite water supply wells. It may be advisable to locate water supply wells offsite.
C	201	2.1.5	In Figure 2.1.5, it is probable that a bucket-wheel reclaimer will not be able to operate on the basalt waste pile. Also, loading skips at shaft head is a novel process requiring a storage pocket and loading flask. Spillage would be a major hazard. What provision is made to dump the skip at the shaft bottom. This needs considerable clarification (no details shown on Figure 2.2.2, p. 212).
C	203	2.2	In Figure 2.2-1, intake air is split between (a) mine (b) waste circuits, which violates the requirement for two independent ventilation systems (p. 137). Also, the flow down the service shaft seems to be high and exceeds the maximum air velocity previously specified on p. 164.
C	205	2.2	In Figure 2.2-2, this appears to be overkill. Waterstop should not be necessary if shotcrete is left rough.
C	206	2.2	Note choice of Koepe Winders, especially regarding: - location accuracy (especially with two in balance) - slack rope.
C	209	2.2	Safety of operation and maintenance simultaneously, even with a steel curtain, is questionable. More discussion needed on holding of conveyances to prevent rope relaxation. Shaft top "stop and catch" devices are needed. What is the fourth hoist? Where does the service conveyance run? Why not use the main hoists for examination. Much more detail is needed.

	Page	Section	Detailed Comments
C	211	2.2.2	Have the problems of operating both hoisting and lowering basalt within the same time frame been treated at a preconceptual design level at all? Is dust a particular problem in the waste air circuit, as distinct from in the mine in general?
C	217	2.2.4	What will remain in the shaft? Will they use rope guides for the maintenance conveyance? What does a "minor loading facility" mean?
C	221	2.2.5	Why use fixed guides in a ventilation shaft? Ropes would do well and can easily be replaced if contaminated. In Figure 2.2.5, utilities are installed where they cannot be serviced from either permanent conveyance.
C	224	2.3	There appears to be considerable confusion in the timing of the backfilling operations. Other statements (CD-38) have indicated that backfilling would not take place until placement was complete. Is this in an individual panel only? If backfilling is done during retrieval period, then the subject of re-mining backfill must be addressed. Clarification is needed.
C	226	2.3	Delicacy of ventilation balances is pointed out. If this is of regulatory interest, the system will also have to assure continuity of function in the event of mechanical or electrical failure. What does the last sentence of second paragraph mean?
		A	Are "Areas of noticeable groundwater inflow" tolerable at all? Need to record such events and monitor flow.
C	232-234	2.3.2	Technical objectives seem underdefined at this stage. Applications of experimental chamber could include long-term baseline calibrations for surveillance instruments and study of long-term stability of heavily instrumented trial openings with computer modeling to refine design criteria.

	Page	Section	Detailed Comments
C	238	2.3.4	Paragraph 2 references "site exploration and acceptance," but indicates serious pressure on placement rate if a panel is found to be unsuitable.
C	242	2.3.5	How are basic support requirements defined?
C	256-257	2.4.1.5	Related to shaft head load/unload, there is conflict here between positioning/fixing conveyances for accuracy of loading equipment operation and risk of inducing slack rope and losing drum friction. Presumably the drawing is diagrammatic and there will be no possibility of BIC's toppling at all, least of all into the adjacent shaft compartment.
C	259	2.4.1.6	Whole subject of regulation of hoist designs, etc., is cursorily treated.
C	272-277	2.5.1	Whole discussion of backfill handling is oversimplified.
C	279	2.5.3	Can HEPA filters cope with dust/moisture?
C	306	4.2	Support looks very conservative. How does it relate to criteria for temperature/stress?
C	307	4.2	Idle panel has important regulatory benefits. However, we are still uncertain as to the condition of panels during retrievable storage. What does "made ready for retrieval" mean?
C	312	4.2.1	Drilling accuracy near horizontal is questionable.
C	314	4.2.2	Grouting of the backfill/rock contact should be considered as an integral part of the backfilling design.
C	315	4.2.2	Terminal backfill placement during initial closure is likely to be the most cost effective procedure, but the question of relative safety is not adequately addressed for the alternatives. The degree of support required by the fill has not been demonstrated with respect to closure, re-mining and retrieval operations. This whole discussion is extremely simplistic.

	Page	Section	Detailed Comments
C	315	4.2.2	Note the use of keyed bulkheads, but why is the shape arched? Are high hydraulic pressures anticipated? What is the in situ testing program?
C	318	4.2.3	The relationship between increase in temperature with time and the design is not clear. This discussion of the increasing hazards of retrieval is not substantiated.
C	334	4.5.2	Paragraph 3 states that "normal operations will not cause a significant disruption of the groundwater flow regime." This statement is tenuous since little hydrologic data exists for the deep confined aquifer. Furthermore, the vertical hydraulic conductivity is unknown.
C	345	5.2.1	Note reference to exploration boreholes external to entablature - this is a concept in conflict with earlier statements about limited penetrations of the geologic barrier.
C	346	5.2.2.1	Will rock monitoring really help routine operational safety?

B. TRADE STUDIES

C	H-22	2.0	Disagree that psychological impression of lining is of significance, but agree with lining recommendations in general.
B	H-30	2.0	Vertical hydraulic conductivity within basalt flows has not been established by in situ tests.
B	H-60	4.0	Surely retrieval requirements cannot be allowed to weaken long-term isolation quality.
C	H-65	1.1	Comments on vertical extent limitations on repository--"effectively eliminates long vertical boreholes for storage"? Why does it not also eliminate multilevel operations?
B	H-73	2.2	Second statement appears to destroy credibility of the results, i.e., differences in - layout - waste type - gross thermal loading - room shape.

	Page	Section	Detailed Comments
C	H-73	2.2	We don't agree that data as presented indicates layout 7 is optimum. Also, other three layouts analyzed are not discussed (see H-72). This interpretation is confused.
C	H-77	2.2	In Figure 5b, curve A is missing.
B	H-83	2.0	How can backfilling between a horizontal hole liner and the rock be effectively achieved?
B	H-88	3.0	Regarding elimination of reaming room, do they have any idea how hard it will be to keep the holes clean? Should NRC mandate blind holes?
C	H-103	1.1-1.2	Concrete lining seems conservative; its function should be defined. Why eliminate 18-30 inches of concrete and replace with 6 inches of shotcrete?
	H-108	4.0	This is a simplistic discussion with no substantiation. Whole discussion of support is confused and objectives are not clearly stated.
B			Paragraph 3 says that they give up on controlling induced permeability in storage room. This is confusing, i.e., why fill or support at all other than for tactical safety reasons?
B	H-115	2.1-2.2	They are still conceding that permeability control is not necessary within storage panels. Presumably this is consistent with the required backfill properties.
C	H-118-119	4.0	Regarding excavation method recommendations, certain areas (plugs) need the very best and water jet kerfing seems to be a good thing and is very competitive with TBM's.
C	H-145	5.0	Conflict is noted between ventilation pressure needs and shaft size for sealing purposes. Guidance may be needed on respective merits of: • more fans • more shafts • larger shafts.
B	H-157-158	2.1	Is maximum depth set by construction safety and is density of placement limitations based on stress? Is there a major offsetting increase in inherent containment ability?

	Page	Section	Detailed Comments
B	H-163	3.1	This notes problem of staying within the flow, i.e., entablature may be only 120' thick. This page is a good, short discussion of the unknowns.
B	H-164	3.2	Use of Umtanum as a primary isolation barrier is questioned (see also H-166).
B	H-213	4.0	Note estimate of peak inflow at 2500 gpm during mining phase and 400 gpm on waste side.
B	H-221	4.0	We disagree with effectiveness of microseismic monitoring as a primary system for control. Is it to be installed in repository horizon only?
C	H-224	2.0	Permeability controls the velocity (or specific flux) of the fluid. The meaning of "global hydraulic resistance" is unclear.
C	H-278	4.4.1	In last line, rejection of development of both sides of main access is unsubstantiated. Would need new waste airway, but mine accessway and rail drift could be reused.
C	H-284	4.5	Development/proving sequence is discussed. Both alternatives "offer significant advantages if unsure of the rock and hydrologic conditions."
C	H-292	3.0	Note acknowledged lack of hydrological data and speculative nature of inflow prediction.
D	H-294	3.0	In bullet #2, how do they find the "vesicular" units so they know they have to grout them? This inflow analysis appears to be suspicious, i.e., - What is it saying about permanent inflow potential? - What is the flood potential? This must be bounded. In Paragraph 2, the fractured media is assumed isotropic with respect to hydraulic conductivity. K is assigned a value of 10^{-9} MS^{-1}, which was apparently obtained from in situ testing in vertical boreholes. Such tests are an effective measure of the horizontal hydraulic conductivity, but are relatively insensitive to vertical hydraulic conductivity. The columnar sections of basalt flows are

Page	Section	Detailed Comments
H-294 TS	3.0	predominantly jointed in the vertical direction, and therefore, vertical hydraulic conductivity may be much greater than that in the horizontal direction. By assuming an isotropic media with hydraulic conductivity equal to the horizontal (lower) value, a nonconservative approach is taken to the problem. Therefore, the calculated groundwater inflows are likely to be underestimated. For example, if vertical K is an order of magnitude greater than horizontal K, the calculated inflow is one order of magnitude too low (see also H-30). Paragraph 4 states that most flow into the repository will be in a vertical direction, and thus our concern regarding the analysis. Permeability of rock between lower aquifer and repository horizon should be defined.
H-295 B	3.0	Paragraph 2 states that the "lower aquifer is assumed to be reduced in pressure from 1100 to 500 meters of water near the end of the repository's life (25 years)." The assumptions that lead to this conclusion are not given. By only considering flow from the lower aquifer into the repository, a nonconservative approach to the problem is taken and the calculated groundwater inflows are likely to be underestimated. What are the long-term isolation design features with respect to groundwater flow and radionuclide release?

SEP 14 1981

WMHT: 3109.4

Dr. Colin Heath, Director
Division of Waste Isolation
Office of Nuclear Waste Management
U. S. Department of Energy
Mail Stop B-107
Washington, DC 20545

Dear Dr. Heath:

Attached are some comments made by NRC contractors, after reviewing "Nuclear Waste Repository in Basalt, Functional Design Criteria" RHO-BWI-CD-38, Rev. 3 and "Nuclear Waste Repository in Basalt, Preconceptual Design Report," RHO-BWI-CD-35. We are aware that RHO-BWI-CD-35 is outdated and a Conceptual Design document is nearly completed. Therefore, the comments on RHO-BWI-CD-38 are more relevant since this report establishes the basis of design for the Conceptual Design.

We thought these comments would be useful to help DOE prepare for discussions during our site visit to BWIP later this month. Therefore, we are forwarding copies to BWIP project offices directly.

Sincerely,

Hubert J. Miller, Chief
High-Level Waste Technical
Development Branch
Division of Waste Management

Enclosure:
As stated

cc: R. Goranson
L. Fitch

Distribution:

WMHT file
WMHT r/f
CF
NMSS r/f
WM r/f
JBMartin
REBornwing
LFHartung & r/f
RJWright
JTGreeves
MJBell
CLPittiglio

OFFICE	WMHT	WMHT	WMHT	WMHT			
SURNAME	LFHartung:lmc	RJWright	JTGreeves	HJMiller			
DATE	9/10/81	9/ /81	9/ /81	9/ /81			