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426.1/DB/84/06/14

JUN 19 1984

MEMORANDUM FOR: Robert J. Wright
Senior Technical Advisor
Repository Projects Branch
Division of Waste Management

FROM: David J. Brooks
Geochemistry Section
Geotechnical Branch
Division of Waste Management

SUBJECT: GEOCHEMISTRY WORKSHOP FOLLOW-UP

At the NRC/DOE-BWIP meeting in Richland, Washington during the week of January 9, 1984, it was agreed that the NRC would provide written clarification on "open items" contained in SD-BWIP-DIC-001 (some of which were presented by BWIP at the meeting). Attached is a set of NRC comments on the "open items" that BWIP indicated needed clarification, and a draft letter of transmittal.

Please discuss with me your plans for review and when you expect to transmit the attached response to BWIP.

David J. Brooks
Geochemistry Section
Geotechnical Branch
Division of Waste Management

WM Record File 101
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DRAFT

Mr. O. L. Olson
U. S. Department of Energy
Richland Operations Office
BWIP Project Office
P. O. Box 550
Richland, Washington 99352

Dear Mr. Olson:

During January 9 - 14, 1984, members of the NRC technical staff and consultants attended a Geochemistry Workshop in order to review the geochemistry program being conducted at the BWIP. The workshop was part of the ongoing technical prelicensing interaction between the NRC geochemistry staff and the Basalt Waste Isolation Project. The purpose of this type of interaction is to identify, early on, potential licensing issues and information needs and to reach agreement on approaches for their resolution during site characterization

At the conclusion of the workshop, the NRC agreed (see Attachment 1, item 4) to comment the "Open Issues" listed in the workshop "Summary Meeting Notes". The list presented at the workshop was extracted verbatum from Table I (Major Open Items) of BWIP document SD-BWI-DIC-001 (Status of Nuclear Regulatory Concerns Pertaining to the Site Characterization Report"). Since the NRC has defined BWIP Geochemistry "Issues" in Table C-2 (pp C-18-21) of the DSCA; the list that was presented at the geochemistry workshop are more appropriatly

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called "Open Items", as was done in BWIP document SD-BWI-DIC-001. Further, the BWIP document SD-BWI-DIC-001 contains two tables of "open items," Table I (which was presented at the workshop) and Table IV. The "table I" material is a new listing of "major open items" that were identified and compiled by BWIP after the conclusion of a June, 1983, meeting held to discuss NRC concerns about the BWIP SCR and have not been previously discussed or commented on by the NRC. Table IV (of the BWIP document SD-BWI-DIC-001) contains other "open items," as raised and discussed by BWIP and the NRC at the June meeting. Therefore, in order to address "open items" completely; comments concerning both Table I (workshop presentation) and table IV ("open items") are contained in Attachments 2 and 3 respectively

Finally, I wish to call your attention to an important observation concerning anticipated redox conditions at the BWIP that was discussed at the workshops, was stated in NUREG-0960 (pp. 5-3, 5-5 and 5-6), and pertains to Attachment 1, "Major Open Item(s)" 2, 3, and 9; and NRC concerns regarding the apparent emphasis of the current BWIP testing program. We have observed through various interactions with the BWIP (including the workshop) that the geochemsitry program is based on the prediction that (1) the ambient groundwater is reducing in nature, and (2) that the post-closure conditions in the nearfield will return to these reducing conditions shortly after closure. Further, the BWIP contends that the addition of fresh, crushed basalt to the waste package

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backfill will serve as a redox buffer and produce a very reducing envirnoment at the surface of the container. By invoking such conditions the BWIP contends that most of the multivalent, redox sensitive radionuclides would be reduced to their less-moble valence states, and assumes credit for low radionuclide solubility and high sorption.

However, the measured redox conditions in BWIP groundwaters are reported to range from oxidizing to reducing (SCR, p 5.1 - 131,6.2-5). Thus it is not clear to the NRC that the ambient repositroy environment can ever be demonstrated to be solely reducing.

Further, even if conditions are shown to be reducing, there would be considerable uncertainty concerning: (1) whether such conditions would return (in the near field) soon after closure; (2) whether it could be demonstrated that the nearfield would remain reducing for all the post-closure period (because the buffering capacity of the added fresh basalt may be exhausted); and (3) whether the desired reducing conditions would necessarily effect radionuclide relase and transport (solubility/sorption). The NRC is concerned that if the assumed reducing environment and its effect cannot be clearly demonstrated, there is considerable risk that the current emphasis of the current test program will fail to provide the necessary assurence of waste

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package performance and radionuclide transport/release required by 10CFR60. Therefore, we are concerned that there may be insufficient applicable data developed under current testing to support a licensing application.

We appreciate the opportunity to review the Geochemistry program and hope our comments will be useful to BWIP's ongoing characterization efforts. If you have any questions, please contact David Brooks (FTS 427-4603) or R. John Starmer (FTS 427-4240)

David Brooks
Geochemistry Section
Geotechnical Branch
Division of Waste Management

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Document Name:
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Requestor's ID:
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Author's Name:
David Brooks

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LETTER TO MR. O. L. OLSON

Attachment #1

Open Items:

[redacted]

2. NRC will prepare a written request for basalt test material to be used in investigations under way at the Oak Ridge National Laboratory (ONRL). BWIP will evaluate these requests and respond to NRC.

3. NRC requested that an opportunity be provided for the NRC resident representative to understand and review the system of documentation that controls current geochemical testing. At a later time the NRC may wish to review certain test procedures or other pertinent documents. The department of Energy agreed to advise NRC on the acceptability of this request.

4. During early February, NRC will provide written comments on the BWIP responses to the "Open Issues" listed in the meeting notes. The NRC comments will be directed toward the appropriateness of the BWIP responses in describing the approach(es) to issue resolution.

5. During the waste package workshop attention will be given to the BWIP-proposed definition of "solubility", contained in the meeting notes.

O. L. Olson, DOE-RL
January 12, 1984

Robert J. Wright, NRC
January 12, 1984

ATTACHMENT #2

GEOCHEMISTRY "MAJOR OPEN ITEMS" [(FROM TABLE 1 (SD-BWIP-DIC-001) AND PRESENTED AT THE NRC/BWIP GEOCHEMISTRY WORKSHOP, 9-13 JAN. 1984)]

ITEM 1 (BWIP STATEMENT): "The BWIP needs to expand its presentation to the NRC of plans (testing and analysis) regarding approaches to bounding or limiting the geochemical data requirements for site characterization, experimental assumptions, experimental design, experimental methods, approaches to data analysis, and detailed milestones."

NRC COMMENT: This item is a paraphrase of some NRC concerns expressed in Section 5.3, p. 5-3 and Section 5.5, p. 5-13 of the DSCA. Aspects of this item are related to NRC Issue 3.3 and 3.4 (See DSCA Table C-2, p. C-19). BWIP is making progress in addressing this concern. However, in the absence of detailed test plans that need to be reviewed, NRC is unable to comment on the progress. Further, while "bounding" may limit data collection to site-specific conditions, we do not consider that "bounding" necessarily leads to "limiting the geochemical data requirements for site characterization."

****

ITEM 2 (BWIP STATEMENT): "The BWIP, as part of its site characterization effort, must develop a sufficient data base to adequately define site redox conditions through time and their effect on radionuclide solubility/sorption. These data are basic to the evaluation of the site isolation capability and to the waste package/repository seal design effort"

NRC COMMENT: This item is a paraphrase of some NRC concerns expressed in Section 5.3.1, p. 5-4; Section 5.5.1, p. 5-14; and Section 5.5.2, p. 5-15 of the DSCA. Aspects of this item are related to NRC issues 3.1, 3.2, and 3.8 (See DSCA Table C-2, p C17, C18, C19 and C20). BWIP is making progress in addressing this concern. However, the primary BWIP reference is Jacobs and Apted (1981). This is not a proper reference, as it is an abstract of a paper that was presented orally and therefore can not be reviewed in detail. It would be advantageous for BWIP redox conditions to be as reducing as posible so that radionuclide species will be reduced, and credit can be taken for enhanced solubility/sorption retardation effects and reduced canister corrosion. Further, it appears that there is interest in demonstrating conditions that will reduce uranium (which dominates spent fuel) to the plus four state (Refer to viewgraphs WP8401-2, 3, 4, 5, 6, 13, 14, and WP8303-37, 89A). However,

the BWIP must recognize that many groundwaters, although they could be equilibrated with relatively reducing surrounding rock, nevertheless possess little buffering capacity (because of the small amount of disolved total iron). For example the median reported value of Fe in BWIP groundwater is 10^{-5} moles (SCR, p. 5.1-116). Further, it is not clear to the NRC that (1) the ambient repository environment can ever be demonstrated to be reducing; (2) if it is reducing, such conditions will return soon after closure; (3) after closure, it will be reducing for all of the post-closure period because the buffering capacity of the (added) basalt may be exhausted; and (4) these conditons would necessarily effect radionuclide release and transport (solubility/sorption). There are a number of factors that make predictions, based on redox conditions concerning cannister corrosion, and radionuclide speciation and associated solubility/retardation uncertain:

a. The effects of gamma radiation and, after a breach of containment, alpha radiation, may result in the continuous generation of oxygen from the radiolysis of water;

b. The production of hydrogen, whose presence might lead to reducing conditions could escape from the very near-field as a result of its large diffusivity;

c. The oxygen buffering capacity of the basalt may be limited to fresh surfaces. However, the basalt sufaces will have been exposured to air during the operational period and hot moist air until complete resaturation and thus could have little or no buffering capacity.

d. The reducing capacity of the solution may not produce the desired radionuclide speciation and associated decrease in solubility and increase in sorption;

e. The development of accurate Eh sensors and the application of laboratory Eh determinations or theoretical calculations to the repository environment has yet to be demonstrated; and

f. The concept of a system waste Eh, even if meaningful redox potential values can be measured in dilute groundwater systems, is questionable.

There is considerable risk that the test program will fail to provide the necessary assuarance of waste pacakage performance and radionuclide transport/ release required by 10 CFR 60, if the program neglects testing under more realistic (oxic) conditions. If the assumed reducing conditions and their

effects cannot be substantiated, there may be insufficient applicable data developed under the current testing plan to support a licensing application.

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ITEM 3 (BWIP STATEMENT): "The BWIP needs to develop a sufficient data base to support the contention that the basalt groundwater and geochemical environment is benign. The NRC feels that this conclusion is premature because of the limited data available, the problems with determining uncontaminated downhole measurements, and outstanding questions on the interpretation of data."

NRC COMMENT: This item is a paraphrase of some NRC concerns expressed in Section 5.2 pp. 5-2 and 5-3 of the DSCA. Aspects of this item are related to NRC issues 3.8 and 3.9 and involve both system conditions and reactions (See DSCA Table C-2, pp. C-20 and C-21). Progress is being made by BWIP to address this concern (for further comment refer to Item 2, and Attachment 4, comment number 6).

****

ITEM 4 (BWIP STATEMENT): "The BWIP needs to present to the NRC how they have or intend to extrapolate data for short-term laboratory scale

experiments to the prediction of long-term repository behavior. In particular, the uncertainties involved in this extrapolation must be evaluated."

NRC COMMENT: This item is a paraphrase of some NRC concerns expressed in Section 5.3.3, p. 5-8 of the DSCA. Aspects of this item are primarily related to NRC issues 3.1, 3.2, 3.4, 3.8, and 3.9 (see DSCA Table C-2, pp C-17,(C-18, C-19 and C-20). Based on workshop discussions, steady-state arguments will be used as a means of extrapolition. However, steady-state arguments pertain only to very slow moving or no flow systems where steady-state conditions can predominante. BWIP has yet to demonstrate what flow conditions will predominate.

****

ITEM 5 (BWIP STATEMENT): "The BWIP needs to present to the NRC how they plan to establish the reliability of the thermodynamic data used in geochemical modeling. Because repository conditions will be changing through time and space, the prudent approach includes models to determine solubility under the whole range of possible conditions, and experimentally verifying thermodynamic phase boundaries pertinent to solubility relationships."

NRC COMMENT: This item is a paraphrase of some NRC concerns expressed in Section 5.5.1, p. 5-14 of the DSCA. Aspects of this item are related to NRC issues 3.1 (See DSCA Table C-2, pp. C-17, C-18). Progress is being made in addressing this concern. However, it should be noted that this concern was expressed based on the NRC's perception (gained from its review of the BWIP SCR treatment of solubility) that BWIP is going to use a thermodynamic/modeling approach as the basis for "solubility" arguments. Thus, for clarity, this concern should read "If BWIP intends to rely on thermodynamic data the BWIP needs..."

However, it should be stated that if BWIP is going to rely on an empirical approach, a great deal of emphasis will have to be placed on demonstrating that site geochemical conditions have been adequately bounded. Further, while the NRC considers that BWIP's short-term needs can be adequately met through empirical studies, the NRC considers that over the long term, approaching repo. tory closure, an adequate thermodynamic data base should be established so that as more information is gathered concerning boundary conditions over the long-term, long-term modeling can be done with a greater amount of confidence.

****

ITEM 6 (BWIP STATEMENT): "BWIP should approach determination of radionuclide solubility from both oversaturation and undersaturation."

NRC COMMENT: This item is a paraphrase of some NRC concerns expressed in Section 5.5.1, p. 5-14 of the DSCA. Aspects of this issue are related to NRC issue 3.1 (DSCA Table C-2, pp. C-17, C-18). Progress is being made in addressing this concern. However, it appears that the BWIP program is emphasizing determinations from undersaturation (even though BWIP states on page IV-8 Table IV of SD-001 that coming from undersaturation is likely to be impossible (See Attachment 4, comment 3). While coming from undersaturation may be adequate for preliminary scoping studies, the NRC considers that these data are likely not to be adequate for licensing since it could be argued that these data represent some metastable steady state condition that could be exceeded given enough time. Thus the values from undersaturation would represent a low bound and, without some evidence from oversaturation, there would be no way of telling how realistic it is. The point is that if the solubility determinations from both over and under saturation were close, it would suggest how close to equilibrium the measurements are. And, if the values are not close, then a more conservative value could be used.

****

ITEM 7 (BWIP STATEMENT): "The BWIP should measure radionuclide solubilities as a function of temperature for critical important solid phases and aqueous species."

NRC Comment: This item is a paraphrase of some NRC concerns expressed in Section 5.5.1, p. 5-14 of the DSCA. This item is related to NRC concerns contained in NRC issue 3.1 (See DSCA table C-2, p. C-19). BWIP is making progress in dealing with this concern. However, it is not clear that these data will be adequate (See response to Item, 5 and 6). Further, while a list of "key" radionuclides was presented during the workshop (viewgraph WP 3802-100A), little information was presented on the plans of BWIP to characterize the source term or any of the critical solid phases with respect to the aqueous speciation of radionuclides.

****

ITEM 8 (BWIP STATEMENT): "The BWIP should include in the Site Characterization Plan (SCP) an evaluation of pH buffering couples other than $H_4SiO_4^-$ that are found in the reference BWIP groundwaters (e.g., HCO_3/CO_3, H_2O/OH^-)."

NRC CCOMMENT: This item is a paraphrase of some NRC concerns expressed in Section 5.2, p. 5-3 of the DSCA. Aspects of this item are related to NRC issues 3.8 and 3.9 (See DSCA Table C-2, pp. C-20, C-21). BWIP is making progress in addressing this issue. (For further comment refer to Attachment 4, "NRC Response/Clarification" number 21).

****

ITEM 9 (BWIP STATEMENT): "The BWIP needs to present to the NRC how they have or intend to address the uncertainties associated with radionuclide solubilities and associated geochemical parameters: T, P, redox, pH, groundwater flow, and composition. Until the uncertainties associated with the above parameters are significantly reduced, little confidence can be place in preliminary quantitative assessment regarding the extent that solubilities of certain radionuclide species have been bounded sufficiently to demonstrate satisfaction of the proposed EPA standard for those nuclides."

NRC COMMENT: This item is a paraphrase of some NRC concerns expressed in Section 5.2, p. 5-6 and Section 5.3.1, p. 5-14. Aspects of this item are related to NRC issues 3.1, 3.3, 3.4, and 3.8 (See DSCA Table C-2, pp C-19

and C-20). (For further comment refer to responses to items 1, 2, 6 and 7).

****

ITEM 10 (BWIP STATEMENT): "The BWIP should complete an investigation of the origin of the fluoride in the goundwaters and the control by the host rock. The fluoride levels in Grande Ronde groundwaters may be high enough to increase the canister corrosion rates and actinide solubilities."

NRC COMMENT: This item is a paraphrase of some NRC concerns expressed in Section 5.3.1, p. 5-5. Aspects of this item are related to NRC issues 3.1, 3.6, 3.7, 3.8 and 3.9 (See DSCA Table C-2, p. C-17, C-18, C-19, C-20 and C-21). BWIP is making progress in addressing this concern. However, the important point is that estimates of solubility require that the cumulative contributions by all important complexing ligands be accounted for.

****

ITEM 11 (BWIP STATEMENT): "The discussion BWIP provided on whether radionuclide releases are leach limited or solubility limited should be

expanded to support BWIP's solubility limited radionuclide release approach."

NRC COMMENT: This item is a paraphrase of some NRC concerns expressed in Section 5.2, p. 5-3 of the DSCA. Aspects of this item are related to NRC issue 3.1 (See DSCA Table C-2, p C-17). BWIP is making progress in addressing this concern. However, the NRC considers that the leach limited case is applicable to flow systems where advection predominates; whereas the solubility limited case pertains to slow moving systems where steady state conditions can predominate. BWIP has yet to demonstrate what flow conditions will predominate. Further, the "solubility" experiments that have been performed so far have focused on determing the steady-state concentrations of radionuclides under a variety of different temperaturs, with (synthetic) groundwater and glass or glass & basalt solid starting materials. As would be expected, the presence of basalt (rock) tends to lower the "solubility" of radionuclides in groundwater due to sorption type reactons. It is the present position of the NRC that if credit is being taken for "solubility", then influencing machinisms which either lower or raise the "solubility limit" must be treated separately (as suggested in viewgraph WP 8401-13).

ATTACHMENT 3

NRC RESPONSE/CLARIFICATION* OF SCR/DSCA OPEN ITEMS TABLE IV

(SD-BWI-DIC-001)

DEFINED BY NRC/BWIP JUNE 13-17, 1983

1. From Table IV, P IV-2

"ITEM REFERENCE: Section 5.4.2, page 5-12, paragraph 3"

"NRC COMMENT: "Plans to characterize the stratigraphy and mineralogy below Grande Ronde Basalt were omitted from the SCR."

"STATUS: Open"

"BWIP RESPONSE: BWIP disagrees with the need to characterize the stratigraphy and mineralogy below the Grande Ronde, thousands of feet below the candiate horizons. This issue needs further clarification. It is BWIP's opinion that obtaining this information would not significantly alter estimates of repository performance. The objectives of such characterization could be met by data from

petroleum exploration wells currently being drilled in the vicinity of the Pasco Basin and through geophysical studies. BWIP feels that it is important to understand the stratigraphy below the candidate repository layer but does not feel it is cost-effective and technically justified to drill wells to depths of 10,000 to 15,000 feet to assess the "very deep" stratigraphy. The BWIP would like clarification from the NRC regarding how extensive an investigation program they envision."

*NRC RESPONSE/CLARIFICATION: "... Grande Ronde ..." is a typographical error. This sentence should read "... repository horizon ..."

****

2. From Table IV, Page II-8

"ITEM REFERENCE: Chapter 5, page 5-9"

"NRC COMMENT: In fact, the resolution of geochemical issues is not to be presented by the DOE until FY87 and FY88 (SCR, page 17.3-1 and Table 17-12). The NRC staff does not consider this aspect of DOE's

plan to be timely. The progress of each work element that contributes to the resolution of an issue should be published sufficiently early during site characterization and in enough detail to permit the NRC staff and other peer reviewers to provide constructive, timely commentary."

"STATUS: Open"

"BWIP RESPONSE: The BWIP and DOE will publish, in such documents as the SCP, the adopted approach to resolution of geochemical issues for NRC review long before FY87. In addition, updates on progress on resolving these issues will also be available to NRC in a timely manner for comment on a continuing basis before FY87. However, final resolution is not required or expected before this FY87/FY88 time frame. This interpretation of "resolution" needs further clarification."

*NRC RESPONSE/CLARIFICATION: Agreed, the "NRC comment" that "the progress of each work element ... should be published sufficiently early ..." is clearly parallel to the "BWIP "response" that "... updates on progress ... will also be available to NRC in a timely manner ..."

****

3. From Table IV, Page IV-8

"ITEM REFERENCE: Chapter 5, Page 5-14, paragraph 2, item 1"

"NRC COMMENT: Item 1. The NRC staff believes that solubility determinations (steady-state condition) should be approached from both oversaturation and under saturation."

"STATUS: Open"

"BWIP RESPONSE: There are serious questions concerning the feasibility of approaching solution equilibrium from undersaturation. The time necessary to achieve equilibrium may be unrealistically long. Identification and synthesis of solid phases required to perform solubility studies from undersaturation may not be possible. The approach to solubility determinations to be used by the BWIP will be documented in the BWIP."

*NRC RESPONSE/CLARIFICATION: The NRC considers approaching solubility determinations from both over and under saturation to be desirable for determining the uncertainty in the determination with regard to approaching

equilibrium. However, if as it is stated, there are serious problems associated with determinations coming from undersaturation, it is the present position of the NRC that coming from oversaturation could be considered conservative as long as competing mechanisms such as sorption were clearly excluded from the results. However, it should be emphasized that there would be no way of telling how conservative the results are in the absence of experiments coming from undersaturation.

****

4. From Table IV, Page IV-8 and IV-9

"ITEM REFERENCE: Chapter 11, page 11-10, items 1, 3, and 10"

NRC COMMENT: Item 1. Use of baseline geochemical data as a "natural experiment." There should be use of the baseline information which must be gathered during characterization of the prevailing in situ geochemical conditions as a "natural experiment."

"STATUS: Open"

"BWIP RESPONSE/CLARIFICATION: It is not clear if the "natural experiment" refers to "geochemical condition," "characterization of conditions," or "baseline information." The BWIP will be including in the SCP a discussion of in situ, diagenetic alteration of Columbia River basalts as evidence for expected alteration of basalt after emplacement of nuclear waste. Thus, site characterization data will be used as a "natural analog" for long-term basalt alteration. A discussion of how the natural analog studies will be used to support waste package design will be included in the SCP, Chatper 6. The NRC will provide additional written clarifications."

*NRC RESPONSE/CLARIFICATION: The intent of the NRC comment is to suggest that if the "... baseline (data) information also represents a 'natural experiment' ...," it should be discussed in detail as a natural analogue as discussed in Regulatory Guide 4.17, Section 6.4.

****

5. From Table IV, Page IV-9

"NRC COMMENT: Item 3. Experimental data from available literature on montmorillonite suggest that this material may not be stable under expected repository conditions. (paraphrased)"

"STATUS: Open"

"BWIP RESPONSE: See the BWIP comment on mineralogical changes due to heat, item reference page 11-9, item 1, 2, and 3. The NRC should provide the reference literature as the basis for discussion/clarification of this item."

*NRC RESPONSE/CLARIFICATION: As requested, the following references are provided:

1. "Status ... SCR" SD-BWI-DIC-001, PII-27.

2. Hydrothermal Stability of Potential Clay-Based Buffer Materials: A Review, G. W. Bird, AECL-TR-199, 1982.

3. The Distribution and Identification of Mixed-Layer Clays in Sedimentary Rocks, C. E. Weaver, Am. Mineral. 41, 202, 1956.

4. Sentinal Gap Basalt Reacted In A Temperature Gradient, R. W. Charles and Bayhurst, G. K., LA-9481-MS, 1983.

****

6. From Table IV, P IV-9

"NRC COMMENT: Item 10. The basalt-groundwater and geochemical environment is stated to be benign. Because of the limited data available, the problems with determining uncontaminated down-hole measurements, and outstanding questions on the interpretation of data, this statement appears to be premature. (paraphrased)"

"STATUS: Open"

"BWIP RESPONSE: This statement in the SCR refers to canister corrosion and is supported by data presented therein. The BWIP is currently expanding and improving its data base. All data and test results to date still confirm this statement. The statement in the SCP will be clarified to assure that the reader is aware that the statement is referring only to canister corrosion."

*NRC RESPONSE/CLARIFICATION: Many groundwaters, although they may be equilibrated with relatively reducing surrounding rock, nevertheless possess little buffuring capacity because of the small amount of dissolved

"total iron" which they carry. In addition, with respect to canister stability, the affects of radiolysis products on canister corrosion are not discussed.

****

7. From Table IV, P IV-9 and 10

"ITEM REFERENCE: Section 6.0, page 6.0-1, paragraph 3"

"NRC COMMENT: "Unresolved geochemical issues will be addressed in Section 6.8."/3."

"STATUS: Open"

"BWIP RESPONSE: Unresolved geochemical issues will be addressed in Chapter 15 of the SCP."

*NRC RESPONSE/CLARIFICATION: The point of the NRC concern is that "unresolved geochemical issues ..." are not covered in chapter 6 Section 6.8.. The SCR Section 6.8 (Summary of Unresolved Issues) referenced Chapter 15 and did not summarize anything.

****

8. From Table IV, P IV-10

"ITEM REFERENCE: Section 6.1.5, page 6.1-20, paragraph 2"

"NRC COMMENT: Experimental evidence indicates ... the clay minerals (see Section 6.3)."/5,7 16 -- "These pressures are not effective for controlling mineral stability."

"STATUS: Open (Agreed)"

"BWIP RESPONSE: A more detailed discussion of the effects of temperature and pressure on clay mineral degradation (dehydration versus hydrothermal reaction mechanism) will be included in the SCP."

*NRC RESPONSE/CLARIFICATION: The NRC concern is that "these pressures ..." are not effective for controlling mineral stability at high temperatures/repository conditions. The NRC considers that the kinetics of the alteration of montmonillonite/bentonite to illite will be enhanced.

****

9. From Table IV, P IV 10

ITEM REFERENCE: Section 6.1.5, page 6.1-21, Figure 6-8

NRC COMMENT: Figure 6-8./4, 6

STATUS: Open (Agreed)

BWIP RESPONSE: A more detailed discussion of fracture filling will be included in the SCP. Figure 6-3 will be deleted.

*NRC RESPONSE/CLARIFICATION: The NRC concern is that figures or tables generally represent a "smothering" of data or are another way of stating or presenting a conclusion and therefore should be referenced to a specific RHO (or other document) where that data and a supporting rational for the conclusion can be reviewed in detail by the NRC.

****

10. From Table IV, P IV-10

"ITEM REFERENCE: Section 6.1.5, page 6.1-22, paragraph 3"

"NRC COMMENT: "The fractures generally contain ... "/3. 4"

"STATUS: Open (Agreed)"

"BWIP RESPONSE: Additional data on fracture and vesicle filling will be included in the SCP."

*NRC RESPONSE/CLARIFICATION: The NRC concern is that there is no reference for this statement. The succeeding statements are referenced to (1) Benson and Trague (1979) and Smith et. al. (1980); however, it is not clear on what the opening sentence is based.

****

11. From Table IV, P IV-11

"ITEM REFERENCE: Section 6.1.5, page 6.1-22, paragraph 3"

"NRC COMMENT: "... smectite seems to occur ... illite occurs unevenly through the section."/3, 4"

"STATUS: Open (Agreed)"

"BWIP RESPONSE: The data presented in the SCP on vertical zonation of secondary minerals will be appropriately qualified and referenced."

*NRC RESPONSE/CLARIFICATION: NRC withdraws comment "4" (unsupported assertion), but considers that the subject of secondary minerals is indaequately covered in the SCR ("comment 3").

****

12. From Table IV, P IV-11

"ITEM REFERENCE: Section 6.3.2, page 6.3-9, paragraph 1"

"NRC COMMENT: ..., Weaver (1979) has compiled studies ... lesser extent, chlorite./3"

"STATUS: Open"

"BWIP RESPONSE: The discussion by Weaver (1979) is of interest but not directly applicable to the basalt environment. Therefore, no further discussion of these data are warranted."

*NRC RESPONSE/CLARIFICATION: The NRC considers the data of Weaver (1979) is relevant to BWIP discussions and helps explain the BWIP observation that illite is a natural constituent of the BWIP host mineralogy. Further, the NRC considers that further discussion of these data and/or similar work, if it exists, should not be excluded from future discussions.

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13. From Table IV, P IV-1

"ITEM REFERENCE: Section 6.4.1, page 6.4-1, paragraph 3"

"NRC COMMENT: ...; Giggenbach, (1981)./15, 16 -- Reference doesn't really apply to subject discussed."

"STATUS: Open"

"BWIP RESPONSE: See the response to NRC reference item page 6.4-1, the exact pages of Giggenbach are pages 405, 406."

*NRC COMMENT/CLARIFICATION: After review of Giggenbach, pages 405 and 406, the NRC withdraws its comment.

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14. From Table IV, P IV-1

"ITEM REFERENCE: Section 6.4.2, page 6.4-7, Table 6-16"

"NRC COMMENT: Table 6-16. /6, 7, 9, 10 -- "Results not relevant for conditions."

"STATUS: Open"

"BWIP RESPONSE: These groundwater compositions were chosen for use in sorption studies because of their compositional differences and because they represent two potentially important groundwaters. Alternative compositions were carefully considered before choosing those being used. The supporting data for choosing these compositions will be given in Section 5.2.3.1.2 of the SCP. The testing and analysis method will be referenced."

*NRC RESPONSE/CLARIFICATION: The concern of the NRC is that these compositions are not relevant to the higher temperature conditions anticipated in the environment of the nearfield.

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15. From Table IV, P IV-12

"ITEM REFERENCE: Section 6.4.2, page 6.4-7, Table 6-17"

"NRC COMMENT: Table 6-17. /6, 7, 9, 10 -- "Results are not relevant for conditions."

"STATUS: Open"

"BWIP RESPONSE: The supporting data, testing techniques, and analytical methods are given in a reference to be added to Section 6.5 of the SCP. See comments for Table 6-16 for statements on alternative not considered, and results not relevant for conditions."

*NRC RESPONSE/CLARIFICATION: The NRC concern is that the conditions relevant to those anticipated in the nearfield have not been considered. Further, tables of this nature should be referenced to a specific RHO document that can be reviewed in detail (see also NRC Response/Charification #9).

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16. From Table IV, Page IV-12

"ITEM REFERENCE: Section 6.8, page 6.8-1"

"NRC COMMENT: 6.8 SUMMARY OF UNRESOLVED ISSUES (all)./3"

"STATUS: Open"

"BWIP RESPONSE: The discussion of unresolved issues is included in Chapter 15. This section in Chapter 6 only identified where these issues will be discussed in the SCP. References to appropriate test plans will be included in those discussions."

*NRC RESPONSE/CLARIFICATION: The concern of the NRC is that SCR Section 6.8 "SUMMARY OF UNRESOLVED ISSUES" contains no summary information on issues.

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17. From Table IV, P IV-21

"ITEM REFERENCE: Section 15.3.1, page 15.3-15, paragraph 1, W.1.4.A, Status"

"NRC COMMENT: Solubility data are more useful than leach rate ... waste package./4, 16 -- This is not a generally true statement. Leach rate could be more useful in that it may set an upper bound."

"STATUS: Open"

"BWIP RESPONSE: Preliminary laboratory results of hydrothermal tests demonstrate that solubility, not leach rate, is the controlling effect in a waste package containing backfill in basalt. The position that solubility is important is also reflected in attention to interactions (10 CFR 60) and in the NRC position paper on Radionuclide Speciation and Solubility determination received by DOE 1/28/83."

*NRC RESPONSE/CLARIFICATION: The NRC considers that the leach limited case is applicable to flow systems where advection predominates; whereas the solubility limited case pertains to very slow moving or no flow systems where steady state conditions can predominate. BWIP has yet to demonstrate what flow conditions will predominate. Further, it is not clear why this argument relies on "...a waste package containing backfill in basalt" unless the backfill is expected to reate a flow system near the cannister that does not reflect the site flow system. Finally, it is the present position of the NRC that if credit is being taken for "solubility," then competing mechanisms which either lower or raise the "solubility limit" must be treated separately.

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18. From Table IV, P IV-21

"ITEM REFERENCE: Section 15.3.1, page 15.3-17, paragraph 3, Status"

"NRC COMMENT: However, insufficient data are available ... expected repository conditions. /16, 18 -- What are the expected repository conditions? Ref.?"

"STATUS: Open"

"BWIP RESPONSE: Repository-specific conditions are defined in Chapters 6 and 11 of the SCR, and reference contained therein, as well as Chapter 5 (hydrochemistry). Cross references will be supplied in the SCP."

*NRC RESPONSE/CLARIFICATION: The concern of the NRC is the lack of specific RHO references in SCR Section 15 that address expected repository conditions and that also contain a rationale for expecting those conditions.

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19. From Table IV, P IV-21, 22

"ITEM REFERENCE: Section 15.3.1, page 15.3-18, paragraph 1, Plans"

"NRC COMMENT: The behavior of these waste forms ... conditions expected for the repository./16, 21 -- Very general. What about resolving uncertainties in K_ds?"

"STATUS: Open"

"BWIP RESPONSE: K_ds are discussed in W.2.4.A and although not specifically excluded, are not considered relevant to this work element. BWIP's program included work on determining the uncertainties in K_ds. Planning for resolution of this item is under way and will be included."

*NRC RESPONSE/CLARIFICATION: The concern of the NRC is that no reference to a test plan or operating plan is provided. The NRC needs specific references that can be reviewed in detail.

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20. From Table IV, P IV-22

"ITEM REFERENCE: Section 15.3.3, page 15.3-53, W.3.1.A"

"NRC COMMENT: Statistical techniques for extrapolating data over time./None -- Has DOE systematically considered the limitation of an approach that is 'fundamentally based on expert scientific opinion?'"

"STATUS: Open"

"BWIP RESPONSE: It is not clear what NRC means by this statement, additional information is needed on why this preliminary approach is limiting."

*NRC RESPONSE/CLARIFICATION: A concern of the NRC is (1) that an approach that is "fundamentally based on expert scientific opinion" relies heavily on the breadth of scientific opinion solicited and thus could be a serious source of contention throughout the characterization/licensing process and (2) it is not clear that this approach was to be "preliminary," and therefore what approach would be taken after the "preliminary" analysis is completed.

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21. From Table IV, P IV

"ITEM REFERENCE: Appendix page 11, paragraph 2, page 12, paragraph 9, section 6.1, page 6.1-15, paragraph 4"

"NRC COMMENT: Disturbed rock zone ... BWIP defines the disturbed rock zone at the 100°C isotherm ... Engineered system ... 100°C " isotherm./--"To what degree might mineral alteration occur at temperatures below 100°C? It is stated in the SCR that the interstitial glassy mesostasis is the 'most reactive' basaltic phase with the groundwater at low-temperature (less than 300°C) hydrothermal conditions."

"STATUS: Open"

"BWIP RESPONSE: The expected alteration minerals for basalt are the same at 100°C and at 50°C (Giggenbach, 1981). The persistence of glassy mesostasis at ambient temperature conditions is evidence that complete alternation of basalt, to form the most stable alteration minerals, has not occurred over the several million years since the formation of the basalt. The alteration of existing basalt is probably due to the partial alteration reaction of the glassy

mesostasis, and this is supported by preliminary laboratory data (Apted and Myers, 1982). Raising repository temperatures from ambient to 100°C will cause the rate of this reaction to increase. This rate increase, however, should not be significant relative to the hundreds of years under consideration due to the thermal pulse from waste emplacement. Thus, the alteration of basalt will not be greatly different between 100°C and ambient temperature of the repository."

*NRC RESPONSE/CLARIFICATION: The NRC concern is that the establishment of the "disturbed rock zone at the 100°C isotherm" by BWIP does not objectively consider the increase in the rates of reaction for expected alteration minerals for basalt. For example, Krauskopf (1979, p.8) suggests that a "useful qualitative rule" is that an increase in 10 degrees (Celsius) will result in an increase of a factor of two or three in reaction rates. Also it is likely that the "persistence" of the glassy mesostasis is the result of its isolation from (circulating) groundwater. Finally, if the "rate" increase is not significant, as suggested by the persistence of the glassy mesostasis, then the capacity of the glass to buffer the redox conditions of the system (within a time frame signficant to the repository) would become questionable.