Department of Energy
Washington, DC 20585

MAY 17 1994

Mr. Joseph J. Holonich, Director
Repository Licensing & Quality Assurance
Project Directorate
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Reference: (1) Ltr, Shelor to Linehan, dtd 12/14/90
(2) Ltr, Bernero to Bartlett, dtd 7/31/91

Dear Mr. Holonich:

On December 14, 1990, the U.S. Department of Energy transmitted its responses to objections, comments, and questions presented in the U.S. Nuclear Regulatory Commission's Site Characterization Analysis (Reference 1). The Commission's staff evaluated these responses, closing some of the items and creating open items of the remainder (Reference 2). Four of the open items, identified below as enclosures, have been addressed through actions and progress in the program.

The enclosures summarize the administrative records with respect to Site Characterization Analysis Comment 5, and Questions 3, 46, and 56.

The Department believes that the responses provided are sufficient to close Site Characterization Analysis Comment 5, and Questions 3, 46, and 56, and awaits the Commission's confirmation.

If you have any questions, please contact Ms. Sheila Long at 202-586-1447.

Sincerely,

Dwight E. Shelor
Associate Director for
Systems and Compliance
Office of Civilian Radioactive
Waste Management

NHOB 1/1
WM-11
102.7

Enclosures:
1. Administrative Record for
   Site Characterization
   Analysis Comment 5
2. Administrative Record for
   Site Characterization
   Analysis Question 3
3. Administrative Record for
   Site Characterization Analysis
   Question 46
4. Administrative Record for
   Site Characterization Analysis
   Question 56

cc: w\enclosures
R. Nelson, YMPO
T. J. Hickey, Nevada Legislative Committee
R. Loux, State of Nevada
D. Bechtel, Las Vegas, NV
Eureka County, NV
Lander County, Battle Mountain, NV
P. Niedzielski-Eichner, Nye County, NV
W. Offutt, Nye County, NV
L. Bradshaw, Nye County, NV
C. Schank, Churchill County, NV
F. Mariani, White Pine County, NV
V. Poe, Mineral County, NV
J. Pitts, Lincoln County, NV
J. Hayes, Esmeralda County, NV
B. Mettam, Inyo County, CA
M. Delligatti, NRC

Enclosure 1

SCA Comment 5 and Original DOE Response

NRC Evaluation of Original DOE Response

DOE Supplemental Response to NRC Comment 5

Section 8.2.2.1.1.4 Summary of waste package containment.
Issue 1.4: Will the waste package meet the performance objective for containment as required by 10 CFR 60.113.

Section 8.3.5.9 Issue resolution strategy for Issue 1.4: Will the waste package meet the performance objective for containment as required by 10 CFR 60.113?

COMMENT 5

The SCP's revised technical interpretation of "substantially complete containment (SCC)" is closer to NRC's use of the phrase than the interpretation in the CDSCP but it adds a qualifier ("allowing for recognized technological limitations and uncertainties") and introduces a new term ("the set of waste packages") which in turn require explanation.

BASIS

- The qualifier, "allowing for recognized technological limitations and uncertainties," is subject to interpretation, leading to questions about how these limitations and uncertainties would be assessed and quantified.

- The term "the set of waste packages" implies that the associated text applies only to some subset of all the waste packages; otherwise, it would be sufficient to say "the waste packages."

- Table 8.3.5.9-1 proposes that, in the 300-1000 year portion of the containment period, up to 1% of the curie inventory of the breached packages may be released. Also, no more than 0.1% of the total packages may be breached per year. If one assumes that breach is equivalent to release of radionuclides, these two criteria would match the NRC release rate criterion at 1000 years. The staff considers that a more restrictive criterion of containment than 1% of the inventory should apply during the period dominated by fission products.

- The SCP asserts that model simplification will be necessary, and that another level of uncertainty will be introduced thereby, but gives no indication as to how this will affect the demonstration of compliance with the containment requirement.

- There is no indication in Table 8.3.5.16-1 of any plans by DOE to conduct long term waste package performance confirmation tests. The DOE should note that the entire time period from the present to the decision on closure (not just the time period until license application for construction authorization) is available to address reduction of technological limitations and uncertainties regarding the adequacy of design for prediction of containment and release rate performance.

- The SCP (7.2.1.3.2) states that the waste package design requirements "shall be demonstrated to be technical feasible on the basis of reasonably available technology and that the associated costs be reasonable." Further, the waste package designs are constrained in that they "shall not impose requirements on the repository packaging, handling, and emplacement facilities, equipment, or operations that are

beyond reasonably available technology." No explanation is provided about how these design requirements may impact the degree of containment that will be provided by the waste packages.

RECOMMENDATIONS

1. The DOE should provide more detail on the qualifying phrase in their interpretation of SCC so that NRC and DOe can reach an understanding of the phrase that is consistent with the intent of the rule.

2. The DOE should explain the impact introduced by the lack of a quantitative measure of limitations and uncertainties on DOE's demonstration of compliance with 10 CFR 60.113.

3. The DOE should explain the meaning of "the set of waste packages."

4. The NRC and the DOE technical staffs should interact:

   a. To provide the NRC with both a conceptual and a quantitative understanding of the DOE's intent to develop technical solutions to the uncertainties and limitations delineated in Chapter 7 of the SCP regarding containment and release rates, including appropriate confidence limits.

   b. To permit the NRC to evaluate the adequacy of the EBS/waste package program concept and the associated specific plans, milestones, and schedules for accomplishing the objective in 4a.

   c. To develop confidence that with respect to the concept, planning and implementation of the EBS/waste package program, maximum advantage has been taken of opportunities to overcome current technological limitations and to minimize uncertainties in the design, containment and release rate performance of the waste packages.

5. The DOE should explain how the waste package design requirements related to reasonable available technology and reasonable costs will impact the degree of containment provided by the waste packages.

RESPONSE

The comment addresses two specific phrases that are introduced in the interpretation of "substantially complete containment" and asks for an explanation of them.

The first phrase, "allowing for technological limitations and uncertainties," was introduced to emphasize that there are limitations in the state of reasonably available technologies for the fabrication, closure, and inspection of waste packages, especially for processes that will be performed remotely in hot cells; and that there will be uncertainties in the assessments of waste package performance. These uncertainties will arise from many sources, including, 1) the extrapolation of waste package environments over the entire spatial extent of the repository and over unprecedented time periods, 2) the uncertainties in extrapolating the degradation modes and rates of engineered components, and 3) the uncertainties introduced by the variability in the

characteristics of the wasteforms, particularly spent fuel, where most of the fuel to be disposed of will not have been discharged from reactors at the time of repository license application.

The second phrase that is questioned is "the set of waste packages," which the U.S. Nuclear Regulatory Commission reads as implying some subset of all the waste packages. This phrase was introduced to clarify the U.S. Department of Energy (DOE) interpretation that the performance objective for containment is applied to the entire set of waste packages, rather than individually to each package.

In addition, with regard to bullet 3 of the comment basis, the DOE's latest interpretation of "substantially complete containment," which in part states that for long lived radionuclides (greater than 1000 years) the release limit will be 1×10^6 per year and for short lived 1×10^5 per year. This is more severe than requirements called out for the controlled release period. As a result, the major driving force in designing the waste package is to limit release of C-14 gas, which could release approximately 1 to 3 percent of its inventory upon breach. To meet the 1×10^6 goal, therefore, breach during the containment period would be limited to 0.01% of the containers. Bullet 5 of the comment basis indicates concern regarding confirmatory testing. It is DOE's intention to conduct long-term in situ confirmable tests during the repository operating period.

Section 8.2.2.1.1.4 Summary of waste package containment Issue 1.4: Will the waste package meet the performance objective for containment as required by 10 CFR 60.113?

Section 8.3.5.9 Issue resolution strategy for Issue 1.4: Will the waste package meet the performance objective for containment as required by 10 CFR 60.113?

SCA COMMENT 5

The SCP's revised technical interpretation of "substantially complete containment (SCC)" is closer to NRC's use of the phrase than the interpretation in the CDSCP but it adds a qualifier ("allowing for recognized technological limitations and uncertainties") and introduces a new term ("the set of waste packages") which in turn require explanation.

EVALUATION OF DOE RESPONSE

- DOE clarifies that in its interpretation of the performance objective for waste package containment, the term "the set of waste packages" applies to the entire set of waste packages, rather than individually to each package. This portion of the comment is considered closed by the staff.

- In its response, DOE has further amplified the phrase "allowing for technological limitations and uncertainties" by its emphasis on the limitations of available technologies for the production, closure and inspection of waste packages. DOE notes that uncertainties will arise from many sources, including (1) the "extrapolation of waste package environments over the entire spatial extent of the repository and over unprecedented time periods," (2) the "uncertainties in extrapolating the degradation modes and rates of engineered components," and (3) the "uncertainties introduced by the variability in the characteristics of the waste forms..." However, DOE does not explain how technological limitations and uncertainties might impact its demonstration of compliance with 10 CFR 60.113.

- The NRC staff considers this comment closed as to the definition of the term "the set of waste packages," but open as to the other issues of this comment.

DOE Supplemental Response

The U.S. Nuclear Regulatory Commission (NRC) stated in NUREG-1347 concerning substantially complete containment (SCC), that "The revised DOE interpretation is in substantial agreement with NRC's intent in 10 CFR 60.113." The staff noted, however, that further explanation was needed to address the impact of technological limitations and uncertainties on compliance with 10 CFR 60.113. The Department of Energy (DOE) discussion in the Site Characterization Plan (SCP) was based on a waste package design which relies on a thin-wall, single-barrier, corrosion-resistant container. The current waste package design emphasizes a larger, multi-barrier waste package emplaced in a drift rather than a borehole.

As stated in the DOE Response to NRC Comment 80, dated March 30, 1994, the DOE plans for the development of this waste package are to include the consideration of design alternatives and take into account technological limitations and uncertainties. The plans provide for obtaining a substantial body of technical and scientific information, including short- and long-term materials testing, in situ testing, model development, environmental studies, and performance evaluations, as well as fabrication studies and prototype testing. These studies are detailed in the Waste Package Implementation Plan (YMP/92-11 Rev. 0, ICN 2), which was sent to the NRC on August 2, 1993 (letter, Roberts to Holonich).

The impact of the technological limitations and uncertainties will be dramatically reduced by the multi-barrier approach, since each barrier will be subject to independent processes. For example, for technological limitations, if the probability of a container (barrier) with a non-detected failure ranges between 0.001 and 0.01, then the probability of a waste package with two barriers having non-detected failures would range from one part in one million to one part in ten thousand. The R&D program includes the determination of the upper bound of non-detected failures as a result of fabrication, closure and inspection for each barrier.

DOE plans to demonstrate that compliance with its performance goal will include the waste package development effort, comprehensive design verification, performance assessment, and performance confirmation programs. The DOE, therefore, believes that the multi-barrier design approach will provide confidence that the 10 CFR 60.113 requirements will be met and that the impact of technological limitations and uncertainties on compliance will be small and manageable.

Enclosure 2

SCA Question 3 and Original DOE Response

NRC Evaluation of Original DOE Response

DOE Supplemental Response to NRC Question 3

Section 8.3.1.4.1.1 Activity: Development of an Integrated Drilling Program
pages 8.3.1.4-24/26

QUESTION 3

What rationale was used for selecting the total area that may be needed for repository development?

BASIS

o In response to CDSCP Question 49, the SCP does not provide sufficient basis for the investigation of area with adequate flexibility in repository development or for demonstrating that the area to be characterized is representative of the planned expansion area.

o The development of an integrated program must be based on the total area needed for the repository. The SCP states that the area needed for repository development is judged to be 1,420 ± 210 acres, based on uncertainty in the areal power density of 40 to 80 kw/acre (p. 6-227). Furthermore, as much as 300 additional acres may be needed to ensure availability of adequate area for contingency (p. 6-227). Therefore, the final repository may encompass up to 1,930 acres. It is not specified in the SCP how much area is contained within the repository perimeter drift shown in Figure 8.3.1.4-2.

o The area coverage rationale for development of the systematic drilling program is based on the CPDB (conceptual perimeter drift boundary) as stated on p. 8.3.1.4-89.

RECOMMENDATION

The SCP updates should address the total area requirements, including the area required for adequate flexibility in the repository development, in planning the site investigation program.

RESPONSE

The total repository area estimates documented in the Site Characterization Plan (SCP) were based on approximations of the initial power output at time of emplacement of 62,000 MTHM of spent fuel, 7,360 MTHM of defense high-level waste (DHLW), and 640 MTHM of West Valley high-level waste (WVHLW). Spent fuel was represented as a 60:40 mixture (by weight) of pressurized water reactor (PWR)- and (BWR)-type waste, respectively. Average age for spent fuel was taken to be 10 years out-of-reactor with average burnups of 33 GWd/MTHM for PWR waste and 27 GWd/MTHM for BWR was assumed to be representative. Based on the average burnups, initial thermal outputs of 1.14 kW/MTHM for PWR waste and 0.91 kW/MTHM for BWR waste were calculated for 10-year-old waste. Similarly, 0.20 kW/container (corresponding to 40-year-old waste) was taken as representative of the proposed 15,030 containers of DHLW and WVHLW. The initial total power output of the entire waste inventory is therefore approximately 68,000 kW, as given by

SF: $((0.6 \times 1.14) + (0.4 \times 0.92)) \times 62{,}000 = 65{,}000$ kW

DHLW and WVHLW: $0.20 \times 15{,}030 = 3{,}000$ kW

Using the concept of equivalent energy density (EED), the design-basis areal power density (APD) of 57 kW/acre established in the Unit Evaluation Study (Johnstone et al., 1984) was scaled to 53.5 kW/acre for the 10-year-old, 60:40 spent fuel mixture discussed above. Similarly, application of the EED concept to DHLW and WVHLW predicted that an APD of 115 kW/acre would deposit the same amount of energy through 1,000 years as the design-basis APD of 53.5 kW/acre calculated for spent fuel.

Based on the scaled APDs presented above, area requirements were calculated as follows:

SF: (65,000 kW)/(53.5 kW/acre) = 1,215 acres, and

DHLW: (3,000 kW)/(115 kW/acre) = 26 acres.

In addition, the area needed for shops, mains, training areas, exploratory shaft facility, etc., based on the SCP Conceptual Design Report (SNL, 1987) underground layout was estimated to total 148 acres. Also, in order to eliminate the need to develop fractional-length drifts due to the irregular shape of the perimeter drift, 34 acres were allocated to account for the square-peg-round-hole effect. Thus, the total acreage needed for the repository was estimated to be approximately 1,420 acres.

Addressing the uncertainty in the above area estimation, the design variable APD was identified as the primary factor contributing to variations in area estimates. Assuming that the probable values for the area needed can be represented by a normal distribution and that a two sigma distance from the mean of the distribution corresponds to the area required for an upper limit APD of 80 kW/acre, a 210 acre uncertainty (one sigma deviation) was applied to the above area estimation (i.e., 1,420 ± 210 acres). This value of uncertainty for the needed area is merely an assumed number, and is only useful in showing that the relationship of the area needed to area available is sensitive to uncertainty. Thus, any conclusions based on this value of uncertainty should be qualified with the understanding that the 210 acres may not represent an accurate assessment of the area uncertainty.

Ongoing studies of area requirements have refined the model used in the SCP. Among the factors addressed in these studies are a more realistic approximation of the waste characteristics (age and burnup) as received at the repository, an updated spent fuel and DHLW inventory projection, a change in APD-scaling techniques, and a re-examination of the baseline repository design from the standpoint of site flexibility. The results of revised area calculations will be included in Yucca Mountain Project Status Reports, issued approximately every six months during site characterization. Design changes that are part of Advance Conceptual Design will go through the appropriate review process and may be summarized in future Site Characterization Progress Reports.

REFERENCES:

Johnstone, J. K., R. R. Peters, and P. F. Gnirk, 1984. Unit Evaluation at Yucca Mountain, Nevada Test Site: Summary Report and Recommendation, SAND83-0372, Sandia National Laboratories, Albuquerque, N. Mex. SCP Chapter 12678

H.R. MacDougall, L. W. Scully, and J.R. Tillerson (Compilers). Site Characterization Plan Conceptual Design Report. Sandia National Laboratories, SAND84-2641, September 1987.

SNL (Sandia National Laboratories), 1987. Site Characterization Plan-Conceptual Design Report, SAND84-2641, compiled by H.R. MacDougall, L.W Scully, and J.R. Tillerson, 6 volumes, Albuquerque, N. Mex., September.

Section 8.3.1.4.1.1 Activity: Development of an Integrated Drilling Program, pp. 8.3.1.4-24/26

SCA QUESTION 3

What rationale was used for selecting the total area that may be needed for repository development?

EVALUATION OF DOE RESPONSE

- DOE's response is a summary of information presented in Appendix M of the SCP-CDR for estimation of the total repository area (Site Characterization Plan- Conceptual Design Report, SAND84-2641, H.R. MacDougall, L.W. Scully, and J.R. Tillerson (compilers), Albuquerque, NM, 1987). DOE commits to present results of revised area calculations in Yucca Mountain Project Status Reports.

- DOE's response does not explicitly address the issue of area needed for adequate flexibility in repository development, in planning the site characterization program. The SCP noted that 300 additional acres might be needed to ensure availability of adequate area for contingency (p.6-227). Appendix M also recommended qualifying a minimum of 300 additional acres to establish additional lateral flexibility.

- The calculations presented in support of the response to this question assume an average age of spent fuel to be 10 years out-of-reactor. However, the SCP (p. 7-21) states that the average age of the spent fuel will steadily decline and will be down to the 5-yr minimum during the last several years of operation.

- Progress toward closure of this question will require DOE to submit the proposed area calculations in Yucca Mountain Project Status Reports. The staff can then compare the area calculations to the area which DOE intends to qualify for repository development through the site characterization program.

- The NRC staff considers DOE's response incomplete and therefore considers this question open.

DOE Supplemental Response

To ensure interface ties between possible repository design concepts and the developing ESF Title II designs leading to subsurface construction, the DOE directed the CRWMS/M&O to develop a design analysis document. This document was issued on February 24, 1994 and titles "ESF/Repository Interface - Integrated Layout Description" (Calc No. BC000000-01717-0200-00003, Rev. 00). Under this analysis, the potential repository area was re-addressed in broad terms to ensure that modified ESF exploration and testing interface with areas that may be needed for flexible areal power density design scenarios. The following assumptions were used in combination:

Utilize the primary area identified by previous work.

Analyses earlier than the SCP, for example, the 1986 Environmental Assessment, outline an area larger than depicted in the SCP conceptual design based on a specific areal power density. To allow a wider consideration of thermal loading and flexibility in layout options, these analyses are bound only by 10 CFR 960 criteria.

Utilize TSw2 Thermomechanical Unit for the potential repository horizon.

The location of an upper boundary for the potential repository horizon is created by the requirement (10 CFR 960.4-2- 5 (d) to provide a minimum overburden of 200 m. It is recognized, however, that 10 CFR 960.4-2-5 (b) (1) states a favorable overburden to be at least 300 m. To maximize the area for testing and exploration the disqualifying condition of 200 m was assumed.

An upper stratigraphic control is not presently clearly defined, however uncertainty about differences in permeability and rock quality make it prudent to assume the TSw1/TSw2 contact as the upper limit of the repository design as long as the 200 m minimum overburden requirement is observed.

Fault Avoidance.

To the extent practical, locate potential repository openings to avoid faults that traverse a major portion of the emplacement area. Avoidance is assumed to be adequate using a 60 meter offset from a projection of the main surface trace to the repository level, except that 120 meters should be used on the west side of the Ghost Dance Fault.

Standoff from vitrophyre.

To prevent heating of the TSw2/TSw3 interface to a temperature above the SCP thermal goal of 115 degrees C, it was assumed that the emplacement areas would not be allowed to be closer that 40 m from that interface and that the majority of the emplacement area should be at least 60 m above this vitrophyre interface.

Assume a waste stream:

- 68,200 kW output at the time of emplacement total,
- 65,000 kW from spent fuel (SNF),
- 3200 kW from defense high-level waste (DHLW).

Areal thermal loading (ATL)

Rather than adopting a specific ATL as a design basis it was assumed that the potential repository layout should be flexible and use all of the primary definable area under the above assumptions. This area would then be calculated for the determination of the lower limit of ATL. Higher levels of thermal loading could then be imposed on the outlined area selectively and for reasons other than explored area limitations.

Enclosure 3

SCA Questions 46 and Original DOE Response

NRC Evaluation of Original DOE Response

DOE Supplemental Response to NRC Question 46

Section 8.3.5.9 Issue resolution strategy for Issue 1.4: Will the waste package meet the performance objective for containment as required by 10 CFR 60.113? (Tentative goals for release from the waste packages) p. 8.3.5.9-19 Para 3.

QUESTION 46

It is stated that DOE considers it appropriate to require that release of isotopes with long half-lives from the waste packages be controlled at a stricter standard during the containment period than during post-containment period.

What is the basis of this statement?

BASIS

Isotopes with long half-lives will have practically the same inventory during the containment period (300 to 1,000 yr) as at the beginning of the post-containment period. On the other hand, strictly controlling the release of shorter-lived isotopes during the containment period will assure (safe) substantial reduction in the inventory of the short-lived isotopes (through radioactive decay) prior to the beginning of the post-containment period.

RECOMMENDATION

Justification for requiring stricter control on the release of long-lived isotopes during the containment period should be provided.

RESPONSE

From the standpoint of effect on public health and the environment, the stricter control of long half-life isotopes during the containment period is excessive. However, the U.S. Department of Energy (DOE) has done this to live within the spirit of "substantially complete containment." When a clearer definition of substantially complete containment becomes available, DOE will respond appropriately. See also the response to Comment 80.

Section 8.3.5.9 Issue resolution strategy for Issue 1.4: Will the waste package meet the performance objective for containment as required by 10 CFR 60.113? (Tentative goals for release from the waste packages) p. 8.3.5.9-19, Para. 3

SCA QUESTION 46

It is stated that DOE considers it appropriate to require that release of isotopes with long half-lives from the waste packages be controlled at a stricter standard during the containment period than during post-containment period.

What is the basis of this statement?

EVALUATION OF DOE RESPONSE

- DOE indicates that it has done this to live within the spirit of "substantially complete containment" as interpreted by DOE; however, it will "respond appropriately" when a clearer definition of "substantially complete containment" becomes available.
- The NRC staff has an ongoing effort to clarify the meaning of "substantially complete containment."
- The NRC staff considers this question open.

DOE Supplemental Response

DOE has eliminated release goals from performance goals for substantially complete containment. Therefore, the concern over stricter controls on the release of long-lived isotopes has been overtaken by events.

The U.S. Nuclear Regulatory Commission (NRC) stated in NUREG-1347 concerning substantially complete containment (SCC) that "The revised DOE interpretation is in substantial agreement with NRC's intent in 10 CFR 60.113." The staff noted, however, that inconsistencies existed among the tentative performance goals. The Department of Energy developed these tentative goals based on a desire to limit the release of radionuclides from the Site Characterization Plan (SCP) waste package design, which relied on a thin-wall, single-barrier, corrosion-resistant container.

As stated in DOE Supplemental Response to NRC Comment 80, dated March 30, 1994 (letter, Shelor to Holonich), DOE proposes a new performance goal in place of the previous goals, applicable to the waste package design concepts now being developed that is focused on containment of radionuclides within intact waste packages. The goal is to achieve mean waste package lifetimes well in excess of 1,000 years. This is consistent with the containment requirement and the intent of the rule.

Plans to demonstrate compliance with this performance goal, and therefore, with the containment requirement, will include the multiple-barrier waste package development effort, comprehensive design verification, performance assessment, and performance confirmation programs described in the Waste Package Implementation Plan (YMP/92-11, Rev. 0, ICN 2).

DOE believes that the multiple-barrier design approach will provide adequate confidence that the containment requirements will be met. DOE's approach to meeting the NRC SCC requirement is focused on containment with a performance goal of extended waste package lifetimes. The approach is consistent with NRC's emphasis on containment during the initial postclosure period. DOE believes that this approach, which does not contain goals for release rates of long-lived isotopes, but embodies a very conservative waste package design, will provide the NRC with the basis required for it to find that compliance has been achieved with reasonable assurance.

Enclosure 4

SCA Question 56 and Original DOE Response

NRC Evaluation of Original DOE Response

DOE Supplemental Response to NRC Question 56

Section 8.4.2.1.2 Principal data needed for preclosure performance evaluations and design/Preclosure tectonics data needs, page 8.4.2-15

QUESTION 56

What is the justification for selecting a tolerance of 5 cm fault displacement?

BASIS

o If a 5 cm fault displacement does occur at the emplacement area, the container may be subjected to extension, shear, and bending stresses due to borehole deflection. Containers may be damaged during this deformation process. Also, high stress in the container may accelerate corrosion and consequently compromise its design function. It has not been demonstrated in the SCP that the current design of the air gap between the waste package and the borehole wall (or liner) will accommodate the movements along discontinuity planes.

o The SCP states that stability of emplacement borehole openings is of concern during preclosure and for the 1,000-year period after closure (Section 7.4.1.1). It also recognizes the possibility of translational movement of rock blocks into the emplacement holes. However, the potential adverse impact of these types of movement does not appear to be reflected in assuming a tolerance of only 5 cm.

RECOMMENDATION

The SCP updates should provide:

o A justification for the 5 cm allowance for fault displacement.

o An analysis of the effects of potential fault displacement on the stability of exploratory shaft facilities, drifts, ramps, emplacement boreholes, and liners.

o An evaluation of the effect of potential change in corrosion rate of containers due to changes in stress.

o The design of emplacement holes and the corresponding ESF tests, taking into account potential effects of displacements along faults.

RESPONSE

No detailed analyses have been performed to establish a 5-cm tolerance for fault displacement. The tolerance was established using engineering judgment coupled with the proposed design requirements for an air gap around the waste package. The tolerance is intended to provide general guidance for defining the resolution of information required to be collected.

The experimental program for evaluating the potential effects of displacement along faults would be defined as the results of the Exploratory Shaft Facility Alternatives Study become available.
The capabilities of models to assess the stability of underground openings are

expected to improve through an iterative approach that closely couples the results of laboratory and field experiments with the model development process. Analysis of several model types would be completed in an iterative manner.

Section 8.4.2.1.2 Principal data needed for preclosure performance evaluations and design/Preclosure tectonics data needs, p. 8.4.2-15

SCA QUESTION 56

What is the justification for selecting a tolerance of 5 cm fault displacement?

EVALUATION OF DOE RESPONSE

- DOE explains that "the 5 cm fault displacement tolerance was established using engineering judgment and proposed design requirements for an air gap around the waste package. DOE also notes that the experimental program for evaluating the potential effects of displacement along faults would be defined as the results of the Exploratory Shaft Facility Alternatives Study become available."

- The relation between the experimental program for evaluating the potential effects of fault displacement and the Exploratory Shaft Facility Alternatives Study is not clear to the NRC staff.

- DOE does not describe specific plans aimed at justifying an acceptable tolerance for fault displacement.

- Progress toward closure of this question may result from DOE's submittal of the Exploratory Shaft Facility Alternatives Study if the information responding to this question is contained in the report of that Study.

- The NRC staff considers DOE's response to this question incomplete and therefore considers this question open.

DOE Supplemental Response

Although Question 56 itself remains pertinent, DOE believes that proposed changes in emplacement mode have rendered much of the previous discussion inapplicable.

In DOE's initial response to the Site Characterization Analysis (December 1990), the following was stated: "No detailed analyses have been performed to establish a 5-cm tolerance for fault displacement. The tolerance was established using engineering judgment coupled with the proposed design requirements for an air gap around the waste package. The tolerance is intended to provide general guidance for defining the resolution of information required to be collected." In other words, fault displacements of more than 5 cm that are observed in exploratory facilities are to be recorded. In addition, these displacements are to be taken into account in determining the probability of future fault displacements of more than 5 cm in a repository. Smaller displacements are deemed to be too small to be reliably distinguished.

Changes in the baseline emplacement mode explained in our supplemental response to Comment 80 (letter, Shelor to Holonich, dated March 30, 1994), greatly increase the conservation of the 5 cm tolerance. The SCP design called for thin-walled waste packages in boreholes that provided only a small emplacement clearance. As a result, the design was relatively intolerant of fault displacement through the boreholes. In contrast, the current baseline emplacement mode is large waste packages in an emplacement drift. Drift emplacement will provide a clearance of 1 m or more between waste packages and the drift wall, so a displacement of 5 cm will not cause contact of the packages with the walls. Several backfill options are being considered, with granular tuff being the primary option. For this concept, fault displacement loads will not be transferred to the waste packages. Thus, a change in the state of stress of the waste packages as a result of the fault displacement is expected to be minimal, and change in the corrosion rate of the waste packages is not anticipated.

DOE believes that the 5 cm tolerance is conservative. However, the tolerance is subject to revision. Study Plan 8.3.1.8.2.1 (Analysis of Waste Package Rupture Due to Tectonic Processes and Events), which has been sent to the NRC addresses the question of fault displacements. The tolerance will be revised in light of the results of this study.