Department of Energy
Washington, DC 20585

AUG 31 1992

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

Dear Mr. Holonich:

The U.S. Department of Energy (DOE) transmitted its responses to the objections, comments, and questions presented in the U.S. Nuclear Regulatory Commission's (NRC) Site Characterization Analysis (SCA) by letter dated December 14, 1990. The NRC staff evaluated these responses, closing some comments and creating open items of the remainder by letter dated July 31, 1991. DOE used discussions at the April 28-29, 1992 technical exchange on scenario development, screening and construction of complementary cumulative distribution functions as a basis to determine whether or not documentation could be brought forth to resolve SCA open items pertaining to DOE's performance assessment (PA) program. Moreover, NRC staff recognized the opportunity and encouraged DOE to produce such documentation (enclosure 1).

Enclosures (2) through (8) of this letter summarize the administrative record with respect to Comments 100, 104, 106, 108, 110, 112, and 113 pertaining to the Site Characterization Plan (SCP) Section 8.3.5.13, Total System Performance. These enclosures include additional documentation to provide the basis for resolving these open items. With this submittal, DOE considers these open items to be closed.

Two items in Enclosure (1) warrant comment or clarification. The first item pertains to the statement that DOE has "...made changes to its PA program baseline, as described in the 1988 SCP." We believe the staff is referring to the PA program's use of expected partial performance measures (EPPM). In fact, at the time of the technical exchange, DOE had yet to complete the documentation that would alter the Site Characterization Program Baseline (SCPB) to reflect that EPPMs are not currently being used. Discussion at the technical exchange made clear that, operationally, the PA program has ceased to use EPPMs.

The second item pertains to NRC's continued admonitions to report changes to the SCPB and study plans in Site Characterization Progress Reports (PR). Changes to the SCPB are reported in PRs,

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as are the status for preparation and review of study plans, NRC's reviews of approved study plans, and the status of SCA open items. If NRC staff finds it difficult to identify these changes, then ways to remedy this problem and other expectations relative to the PR may be an appropriate topic to include as part of a future DOE/NRC management meeting. Because PRs are produced twice a year, each edition will always be at least six months behind the current program. DOE seeks to minimize any lag time beyond six months, but delays have occurred in producing the document nonetheless.

If you have any questions, please contact Priscilla Bunton of my staff at (202) 586-8365.

Sincerely,

Linda J. Desell

for John P. Roberts
Acting Associate Director for
Systems and Compliance
Office of Civilian Radioactive
Waste Management

Enclosures:
(1) NRC letter to DOE dated June 30, 1992
(2) Administrative Record for SCA Comment 100
(3) Administrative Record for SCA Comment 104
(4) Administrative Record for SCA Comment 106
(5) Administrative Record for SCA Comment 108
(6) Administrative Record for SCA Comment 110
(7) Administrative Record for SCA Comment 112
(8) Administrative Record for SCA Comment 113

cc: w/ enclosure
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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

JUN 30 1992

Mr. John P. Roberts, Acting Associate Director
for Systems and Compliance
Office of Civilian Radioactive Waste Management
U.S. Department of Energy, RW 30
Washington, D.C. 20585

Dear Mr. Roberts:

SUBJECT: SUMMARY FROM THE APRIL 28-29, 1992, TECHNICAL EXCHANGE ON SCENARIO DEVELOPMENT AND SCREENING AND CONSTRUCTION OF A COMPLEMENTARY CUMULATIVE DISTRIBUTION FUNCTION

The purpose of this letter is to transmit the summary for the April 28-29, 1992, technical exchange between the Nuclear Regulatory Commission and the U.S. Department of Energy (DOE). Representatives from the State of Nevada, affected units of local government, and DOE program participants also participated in the technical exchange.

The focus of the technical exchange was to discuss technical and regulatory issues related to the methods for developing and screening scenarios in geologic repository performance assessments (PAs) and the construction of a Complementary Cumulative Distribution Function (CCDF). The technical exchange addressed the current operational definition of scenarios, how scenarios are to be generated from elemental processes and events, what initial set of processes and events should be considered in PAs, and appropriate methods for screening scenarios. The technical exchange also addressed the use of a definition of scenarios that is consistent with the logic needed to construct a CCDF, and the use of expected partial performance measures to guide site characterization. The treatment of human intrusion was discussed and whether it is appropriate to treat human intrusion separately from the processes and events that are included in a CCDF.

Based on the discussions held during the technical exchange, both the NRC and DOE staffs agreed that a number of the staff comments related to PA in DOE's 1988 Site Characterization Plan (SCP) could possibly be closed. However, before the comments in question can be closed, DOE will have to prepare documentation that describes its basis for asserting closure of the NRC comments and the NRC staff will need to review it.

Finally, it should be noted that during the technical exchange, the Department disclosed that it had made changes to its PA program baseline, as described in the 1988 SCP. The staff found that DOE had made these changes without providing the NRC benefit of earlier discussions. Although adjustments are expected to be made to DOE's site characterization programs, including PA, as the respective programs mature, 10 CFR Part 60 requires that DOE identify and describe the changes, if any, to its baselined site characterization programs.

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ENCLOSURE 1

As I stated in my May 26, 1992, letter, the staff expects DOE to describe these changes in its semi-annual Progress Reports, in accordance with the requirements of 10 CFR 60.18(g). By not doing so, the Department makes it difficult to achieve early and effective consultation from the NRC staff during the pre-licensing phase.

Should you have any questions regarding this summary, please contact Michael P. Lee (301/504-2421, FTS 964-2421) of my staff.

Sincerely,

Joseph J. Holonich

Joseph J. Holonich, Director
Repository Licensing and Quality
Assurance Project Directorate
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosure: As stated

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ENCLOSURE 2

SCA Comment 100 and DOE Response (12/14/90)

NRC Evaluation of DOE Response (7/31/91)

Additional Information Relevant to SCA Comment 100 Open Item

Section 8.3.5.13 Total System Performance

COMMENT 100

There are two problems with the sequences for faulty waste emplacement (pp. 8.35.13-32 to 33): (1) sequences for faulty waste emplacement establish the initial condition for the repository at time of closure and should not be included in the set of scenarios, and (2) the sequences are so limited, it is not clear that the site characterization program will acquire the data to analyze the likelihood and consequences of such initial defects.

BASIS

- Sequences related to faulty waste emplacement establish the initial condition of the repository at the time of closure. The likelihood of such sequences could be used to establish the "most likely" configuration of the ensemble of waste packages in the repository or to establish a set of initial repository configurations with their associated probabilities. In either case such configurations would be acted upon by all postclosure scenarios, so a treatment of the initial repository configuration(s) as a separate scenario(s) is incorrect, because such combinations would be precluded.

- There is no clear indication that the sequences cited in this part of the SCP are sufficiently complete to assure that the data required to analyze the given examples and other sequences related to human error will be acquired during site characterization.

- Human reliability analyses have been performed for the repository system, but are not cited here as the basis for the set of sequences listed (e.g., Harris, 1985).

- Some important sequences are omitted, e.g.: (1) canisters are emplaced in such a way that the air gap which is an integral part of the design for the package is eliminated by drilling the hole too small, tilting the canister in the hole, or placing the canister in the hole off-center; (2) extraneous materials may be introduced into the repository during construction or operation which will help to mobilize the radionuclides, enhance corrosion, or otherwise adversely affect performance.

RECOMMENDATIONS

- Use these sequences to establish (by modeling) the initial configuration for the repository; do not use these sequences as objects parallel to scenarios. Prudent engineering practice would dictate instituting design, operational, and QA controls sufficient to reduce the occurrence of this type of sequence to a level sufficiently low so as not to affect materially the performance of the repository.

- Systematically analyze human reliability in terms of the effect on postclosure performance to assure that all required data are obtained during site characterization. This could be provided in a periodic update.

REFERENCES

Harris, P.A. et al., "High-Level Waste Preclosure Systems Safety Analysis Phase 1, Final Report," NUREG/CR 4303 (July 1985).

RESPONSE

The list of sequences is intended to cover the events and processes that may need to be included in the scenarios that will eventually be modeled for assessing compliance with regulations. Among the items in the list are events and processes that can probably be eliminated in the future as data are collected and analyses are done; such items are included for completeness, i.e., to cover as completely as possible the events and processes that may need to be modeled. Sequences for faulty waste emplacement are among those that are likely to be eliminated, because the U.S. Department of Energy (DOE) plans, as a routine matter of sound engineering practice, to institute design, operational, and quality assurance controls to reduce the occurrence of this type of sequence. Preclosure systems analyses would, as suggested by the U.S. Nuclear Regulatory Commission comment, be part of this practice.

One reason for the effort to make the list complete is to stimulate suggestions for additions to the list. For that reason the DOE welcomes the two suggestions for additional sequences associated with faulty waste emplacement.

Section 8.3.5.13 Total System Performance

SCA COMMENT 100

There are two problems with the sequences for faulty waste emplacement (pp. 8.35.13-32 to 33): (1) sequences for faulty waste emplacement establish the initial condition for the repository at time of closure and should not be included in the set of scenarios, and (2) the sequences are so limited, it is not clear that the site characterization program will acquire the data to analyze the likelihood and consequences of such initial defects.

EVALUATION OF DOE RESPONSE

- DOE does not respond directly to the NRC staff's suggestion that faulty waste emplacement be treated as an initial condition rather than as an event to be included in a scenario analysis.

- The NRC staff considers this comment open.

Additional Information Relevant to SCA Comment 100 Open Item

The list of sequences for faulty waste emplacement, which were developed with a bias toward the barrier method of scenario construction, do describe initial conditions, in agreement with the comment. They should not be included in the set of scenarios. Rather, such initial conditions are expected to be described by a distribution function addressing the initial state of all containers. Such a distribution function will not be developed in site characterization; it is, after all, a design and operations issue. As such, it is expected to be developed empirically from quality-assurance procedures and training exercises preparatory to first waste emplacement and by systematic inspections after emplacement. The list of alternative sequences for mis-emplacement should be included in a distribution function that describes departure from standard emplacement. Since the exact mode of container emplacement remains to be resolved, any specific models (ours and NRC's) of faulty emplacement are premature, except as speculative exercises for developing methods for estimating such distribution functions.

ENCLOSURE 3

SCA Comment 104 and DOE Response (12/14/90)

NRC Evaluation of DOE Response (7/31/91)

Additional Information Relevant to SCA Comment 104 Open Item

Section 8.3.5.13 Total System Performance

COMMENT 104

The Ross sequences appear to be based entirely on spent fuel as the waste form; since these sequences presumably form a basis for the site characterization program, it is not clear that important scenarios that may be peculiar to vitrified HLW have not been omitted.

BASIS

- **Sequences 68, 72, and 83 specifically mention "cladding" or "Zircaloy cladding," which is characteristic of spent fuel.**
- **No sequences specifically for vitrified HLW were identified.**

RECOMMENDATIONS

- **Reconsider scenario analysis for the site characterization program with the likelihood that a significant amount of vitrified HLW will be deposited in the repository.**
- **Augment or modify the site characterization program, performance allocation, and hypothesis testing strategy as necessary to effectively treat vitrified HLW.**

RESPONSE

The response to Comment 95 discusses the U.S. Department of Energy approach to scenario development. Vitrified high-level waste (HLW) will be considered. The program should not need modification (recommendation two of the comment) to do this; see, for example, Section 8.3.5.10 of the Site Characterization Plan. See also the response to Comment 95.

Section 8.3.5.13 Total System Performance

SCA COMMENT 104

The Ross sequences appear to be based entirely on spent fuel as the waste form; since these sequences presumably form a basis for the site characterization program, it is not clear that important scenarios that may be peculiar to vitrified HLW have not been omitted.

EVALUATION OF DOE RESPONSE

- The NRC staff commented that DOE based its scenarios on spent-fuel waste form only, and neglected any ramifications of vitrified HLW. DOE replied that it will consider vitrified HLW within the context of its general scenario selection procedure that considers all important processes.

- The NRC staff considers this comment open because DOE did not respond directly to it in terms of definite scenarios and other appropriate augmentation of the site characterization program. Closure can occur if such augmentation is provided in DOE's iterative performance assessment and semiannual SCP Progress Reports.

Additional Information Relevant to SCA Comment 104 Open Item

DOE has presented to the NRC staff at the DOE-NRC Technical Exchange in Albuquerque on April 28-29, 1992, the approach that will be followed by the DOE in the iterative assessment of the total system performance of the Yucca Mountain site. This assessment consists of defining the possible external events and/or processes which could affect the containment or isolation of the waste (i.e., scenario classes); developing event trees for each of the scenario classes to identify the possible scenarios; defining the processes and conceptual models which describe the post-closure behavior of the near field and far field environments; and defining the parameter ranges (including initial and boundary conditions) applicable to the physical/chemical processes that are considered. The definition of the nature and properties of the waste form would fall in the category of defining the initial conditions for the analysis.

While the Ross sequences presented in the SCP do not explicitly specify vitrified HLW, DOE's analysis will include all candidate waste forms in the assessment of the total system and sub-system performance measures. The use of vitrified HLW or spent fuel as the waste form is not controlled by the selection of a particular scenario, it is more affected by the chosen initial condition. As both waste forms are intended to be emplaced, both waste forms will be considered in the assessment of postclosure performance. During the iterative PA process, it is likely that some components of the containment and isolation system may receive more focus than others due to the principal objectives of each iteration. For example, early iterations which focus on evaluating waste package and repository ACD and LAD and prioritizing waste package and near field testing will emphasize the engineering barrier and related aspects of the PA.

The degree to which the site characterization program may be influenced by the waste form considered will be evaluated during the iterative PA program. In the initial iteration just completed by Sandia National Laboratories (SNL) and Battelle Pacific Northwest Laboratories (PNL), SNL considered spent fuel waste forms only while PNL considered both spent fuel and vitrified HLW. The PNL analyses for particular scenarios affecting containers containing either spent fuel or vitrified HLW illustrate the point that the particular container selected for analysis has an initially assigned waste form with an initially specified radionuclide inventory that changes over time. As the iterative PA program progresses, these analyses will become more inclusive. Upon completion of the internal review of these documents and the required revisions, these documents will be released to the NRC, the state, and other interested parties.

Additional Information Relevant to SCA Comment 104 Open Item (continued)

In conclusion, DOE will address spent fuel, vitrified HLW, and all other waste forms to be used in the repository in the iterative performance assessments which have been recently initiated. The waste form analyzed essentially defines the initial condition of the analysis, it is not an explicit scenario class. The omission of vitrified HLW from the Ross sequences should not be interpreted as an indication that only spent fuel will be considered; it represents more that the nature of the source term is not considered a scenario but an initial condition of the system.

ENCLOSURE 4

SCA Comment 106 and DOE Response (12/14/90)

NRC Evaluation of DOE Response (7/31/91)

Additional Information Relevant to SCA Comment 106 Open Item

ENCLOSURE 4

Section 8.3.5.13 Total System Performance

COMMENT 106

There appears to be a missing coupling term in equation 8.3.5.13-12B; this equation is the primary basis for calculating liquid-phase radionuclide transport to the accessible environment.

BASIS

- The matrix/fracture coupling terms represented by lambda subscript 1 for the advective coupling constant and by lambda subscript 2 subscript i for the diffusive coupling constant both appear in equation 8.3.5.13-12A but only the diffusive coupling constant appears in equation 8.3.5.13-12B. This lack of reciprocity in coupling could be inadvertent or it could be deliberate, based on unstated assumptions about the size of these terms. If deliberate, the basis should be stated.

- Equation 25 of the cited reference (Wilson and Dudley, 1987), which appears parallel to equation 8.3.5.13-12B of the SCP contains both coupling terms.

- The importance of these coupling terms in determining system performance is cited repeatedly, pp. 8.3.5.13-62,-71, and -75.

RECOMMENDATION

DOE should clarify equations 8.3.5.13-12 and make any adjustments necessary in the plans for site characterization that could result from changing these fundamental equations describing radionuclide transport through the primary geologic barrier.

RESPONSE

Equations 8.3.5.13-12A and 8.3.5.13-12B in the Site Characterization Plan (SCP) represent one of two cases outlined in Wilson and Dudley (1987). In Equations 24 and 25 of that paper, the advective coupling term does appear symmetrically: $\lambda_1 (C^i_b - C^i_m)$ in Equation 24 and $\lambda_1 (C^i_f - C^i_b)$ in Equation 25. The definition of C^i_b is

$$C^i_b = C^i_f \text{ if } \lambda_1 > 0,$$
$$= C^i_m \text{ if } \lambda_1 < 0$$

Thus, SCP Equations 8.3.5.13-12 are written for the case $\lambda_1 > 0$, which represents water being transferred from fractures to matrix.

While the SCP text was incomplete because of the omission of the second case, the computer program TOSPAC described in Wilson and Dudley (1987) contains both cases, and the arguments following SCP Equations 8.3.5.13-12 do not depend on the omission.

REFERENCES:
Wilson, M.L., and A.L. Dudley, 1987. Radionuclide Transport in an Unsaturated, Fractured Medium, in Flow and Transport Through Unsaturated Fractured Rock, D.D. Evans and T.J. Nicholson, (eds.), American Geophysical Union, Washington, DC

Section 8.3.5.13 Total System Performance

SCA COMMENT 106

There appears to be a missing coupling term in equation 8.3.5.13-12B; this equation is the primary basis for calculating liquid-phase radionuclide transport to the accessible environment.

EVALUATION OF DOE RESPONSE

- DOE acknowledged that the SCP was in error, and that the missing term should be included as stated by the NRC staff. However, DOE also states that the discussion following the equation in error did not depend on the omission, so no changes to site characterization are necessary. The NRC staff disagrees. It is the NRC staff's view that the missing term should have led to entries in the Hypothesis Testing Table that are not there and should have affected the performance allocation program.

- The NRC staff considers this comment open.

Additional Information Relevant to SCA Comment 106 Open Item

We reiterate the previous acknowledgement that the SCP was incomplete because of the inadvertent omission of the second case in Equations 8.3.5.13-12A and 8.3.5.13-12B. The complete equations were known at the time and given in papers referenced in that section of the SCP (Wilson and Dudley, 1987; Dudley et al., 1988). The advective coupling term is not specifically called out for study in the Hypothesis Testing Tables or the Performance Allocation Tables as noted by the NRC staff. The DOE acknowledges this oversight as well. The DOE position however, is that the advective coupling term will be evaluated in studies having to do with characterizing fracture flow which are called out in the SCP.

As can be seen from Equation 8.3.5.13-15, the advective coupling term has no adjustable parameters; the advective coupling term represents the amount of water transferred between fracture flow and matrix flow, so if fracture flow and fracture/matrix interaction are understood, the quantifying of advective coupling is possible.

Supplemental References

Dudley, A.L., R.R. Peters, J.H. Gauthier, M.L. Wilson, M.S. Tierney, and E.A. Klavetter, 1988. Total System Performance Assessment Code (TOSPAC) Volume 1: Physical and Mathematical Bases, SAND85-0002, Sandia National Laboratories, Albuquerque, NM.

ENCLOSURE 5

SCA Comment 108 and DOE Response (12/14/90)

NRC Evaluation of DOE Response (7/31/91)

Additional Information Relevant to SCA Comment 108 Open Item

ENCLOSURE 5

Section 8.3.5.13 Total System Performance

COMMENT 108

The use of the EPPM (expected partial performance measure) to screen scenarios and to establish goals for the performance allocation used to guide site characterization may be justified on a theoretical basis, but does not appear to be appropriately implemented in the SCP.

BASIS

- DOE has responded to NRC comment 92 on the CDSCP by providing further explanation of the mathematical substantiation for the use of the EPPM. Pages 8.3.5.13-16 to 18 provide an expanded mathematical basis for the use of EPPMs in screening scenarios.

- Although equation 8.3.5.13-9 provides a sufficient condition (sum of EPPMs over all scenario classes is less than or equal to 0.01) for compliance with the EPA standard, the performance allocation table for Issue 1.1 (Table 8.3.5.13-8) erroneously departs from the more-or-less well founded mathematical basis by: (1) stating goals in terms of individual EPPMs instead of the sum; (2) setting goals as high as 0.2 for individual EPPMs; and (3) stating goals for EPPMs for objects (release scenario classes) that are not scenarios or scenario classes in the sense used to derive the mathematical substantiation for the use of EPPMs. As a consequence, meeting the goals stated in this performance allocation table will not assure compliance with the regulation and resolution of the issue.

- Page 8.3.5.13-18 (first paragraph). DOE discusses how an upper bound for an EPPM can be constructed and then used to screen out potentially disruptive agents. However, the discussion does not consider the possibility that many individually insignificant EPPMs could be screened out but whose sum might be significant. For example, if the screening criteria is that an EPPM be less than 10^6, and if 10,000 EPPMs are screened out, their sum might conceivably be as large as 0.01 (the limit in Equation 8.3.5.13-9).

RECOMMENDATIONS

- Assure that the tentative goals listed on Table 8.3.5.13-8, if met, will guarantee compliance with the containment standard.

- Reconsider the performance allocation for Issue 1.1 with the proper use of EPPMs or some other valid mathematical approach and adjust the site characterization program accordingly.

- State that, in applying the screening methodology, it is necessary to check that the sum of <u>all</u> EPPMs screened out must be less than 0.01.

RESPONSE

The comment seems to imply that the U.S. Nuclear Regulatory Commission expects assurance that meeting the tentative goals in Table 8.3.5.13-8 of the Site

Characterization Plan (SCP) will "guarantee compliance with the containment standard." If this interpretation of the comment is correct, two misunderstandings apparently need to be discussed. First, attainment of a performance allocation goal does not guarantee compliance. In the absence of site-characterization data, the allocations are based on reasonable expectations that, if met, the allocations are likely to lead to a successful demonstration of compliance. Second, SCP Table 8.3.5.13-8 is not the place to look for those reasonable expectations, which are embodied in the goals for parameters. For example, the goals in Table 8.3.5.13-9 express the expectations that the unsaturated zone will contribute to the successful demonstration of compliance. Combining the values for the parameters, entries shown there suggest that radionuclide releases from the zone would be below regulatory limits for the accessible environment; further goals, shown in SCP Table 8.3.5.13-17, direct the site-characterization program toward acquiring more detailed data that will enhance the compliance strategy outlined by the values in SCP Table 8.3.5.13-9. Similar examinations of other tables in SCP Section 8.3.5.13 would show additional details of the expectations that are the basis for the direction provided to the characterization program.

The appearance of expected partial performance measures (EPPMs) greater than 0.01 in SCP Table 8.3.5.13-8 is not an indication that the site will fail. As this comment recognizes, SCP Equation 8.3.5.13-9 provides a sufficient condition, not a necessary condition. Some of the EPPMs shown in SCP Table 8.3.5.13-9 can be larger than 0.01 without failure. The table suggests that, given the current state of knowledge of the site, at least some of the EPPMs may turn out to be larger than 0.01 and that others of them have little likelihood of being larger than 0.01. As the "less than" signs point out, the U.S. Department of Energy (DOE) expects that the EPPMs will all be smaller than the values in the table. Just how much smaller they can currently be expected to be is suggested by the values for individual parameters in other tables. (In the example cited above, the values in SCP Table 8.3.5.13-9 suggest that the EPPM for the water pathway in scenario class E will be substantially smaller than 0.01.) And, as SCP Section 8.1.2.2 points out, the individual-parameter values may be changed or discarded as the program provides more definitive understanding of the processes on which the performance allocation relies.

As the comment points out, omitted scenario classes could, in principle, contribute to the EPPM sum. In constructing the performance allocation, the DOE used a list of scenario classes covering the sequences that currently might be expected to present a potential for significant radionuclide releases. This list may, of course, eventually be shown to omit some significant release pathways and mechanisms; in fact, an important task for site characterization is to make possible a list that can, with confidence, be considered complete. The current list is thought to be complete enough to serve as a starting point for quantitative performance allocation. DOE does not see how the table would be improved by an attempt to check the sum of EPPMs for all classes omitted from the table. Such a check would require identifying all omitted classes. Even if that were possible in principle, it still would not be "necessary" to show that the EPPMs were less than 0.01, because 0.01 is not a necessary limit. See also the response to Comment 43.

Section 8.3.5.13 Total System Performance

SCA COMMENT 108

The use of the EPPM (expected partial performance measure) to screen scenarios and to establish goals for the performance allocation used to guide site characterization may be justified on a theoretical basis, but does not appear to be appropriately implemented in the SCP.

EVALUATION OF DOE RESPONSE

- DOE states that "[the] attainment of a performance allocation goal does not guarantee compliance. In the absence of site characterization data, the allocations are based on reasonable expectations that, if met, the allocations are likely to lead to a successful demonstration of compliance."

- In the SCP discussion of performance allocation, the overall licensing strategy is defined as "the basis for current DOE plans to show compliance with regulatory requirements." Performance allocation goals, in turn, are assigned by DOE using values consistent with the licensing strategy for the issue involved. In light of this, the NRC staff considers that the performance allocation goals should be chosen so that, given the right conditions, meeting these goals should guarantee compliance with the regulations.

- DOE states that, although some EPPMs are greater than 0.01 in Table 8.3.5.13-9, this is not an indication that the site will fail. DOE expects all EPPMs will be smaller than their table values. Additionally, DOE does not see the need to check the EPPM contribution of all omitted scenario classes because the condition such that the EPPM sum for all scenarios is less than 0.01 is only a sufficient condition.

- The NRC staff considers that the use of the EPPM and Equation 8.3.5.13-9 have been misapplied in the performance allocation table for Issue 1.1 (SCP Table 8.3.5.13-8) as stated in the comment. It is not clear to the NRC staff how the formulation of Equation 8.3.5.13-9 was applied to Table 8.3.5.13-8.

- The NRC staff considers this comment open.

Additional Information Relevant to SCA Comment 108 Open Item

The expected partial performance measures (EPPMs) were used in the SCP as interim guidance for helping to determine what quantities need to be measured and what concepts need to be investigated during site characterization. These quantities and concepts are listed in the performance-allocation tables, which also list goals that the DOE feels are likely to allow the repository system to comply with regulations if the goals are met. One of the tables, Table 8.3.5.13-8, states goals by assigning a series of upper bounds to EPPMs, values which can express sufficient conditions, as explained in Section 8.3.5.13. The performance-allocation tables do not, of course, list all the necessary conditions for showing compliance. Several pages in the SCP, Section 8.3.5.13, describe the reasoning behind the construction of the tables and the assignments of goals. The DOE does not plan to use EPPMs in future revisions and redirection of the site-characterization program, because it will be able to use more elaborate tools that were not available when the SCP was written--primarily methods for calculating complementary cumulative distribution functions (CCDFs).

Since the SCP was written, the DOE has acquired some new data and has carried out additional calculational exercises that rely on CCDFs instead of EPPMs. The exercises and the data have provided some new insights--e.g., priorities for site characterization--but they have not given reason to question the bases for the performance-allocation tables.

The DOE expects to continue to share such insights with the NRC staff and other interested parties in future technical exchanges.

ENCLOSURE 6

SCA Comment 110 and DOE Response (12/14/90)

NRC Evaluation of DOE Response (7/31/91)

Additional Information Relevant to SCA Comment 110 Open Item

Section 8.3.5.13 Total System Performance

COMMENT 110

The response to CDSCP comment 90 indicates that human intrusion is intended to be left out of the calculation of the CCDF, but the SCP text is unclear as to how human intrusion will be handled.

BASIS

- The DOE Responses to NRC Point Papers document (U.S. DOE, 1988) clearly states: "Releases initiated by human activities will be considered separately. A CCDF accounting for human activities must be separate from a CCDF for natural processes and events because the scenario classes associated with human activities are likely to be highly speculative and would easily dominate a single CCDF."

- However, on page 8.3.5.13-1, the SCP states that the EPA standard, which reads, in part: "..., based upon performance assessments, that the cumulative releases of radionuclides to the accessible environment for 10,000 years after disposal from all significant processes and events that may affect the disposal system..." while on page 8.3.5.13-2 the text states:

  "The phrase significant processes and events that may affect the geologic repository is interpreted as meaning likely natural events and such other processes and events that could affect a geologic repository and are sufficiently credible to warrant consideration. Significant processes and events that may affect a geologic repository may either be natural processes and events or processes and events initiated by human activities other than those licensed under 10 CFR Part 60. Processes and events initiated by human activities may only be found to be sufficiently credible to warrant consideration if it is assumed that: (1) the monuments provided for by this part are sufficiently permanent to serve their intended purpose; (2) the value to future generations of potential resources within the site can be assessed adequately under the applicable provisions of this part; (3) an understanding of the nature of radioactivity, and an appreciation of its hazards, has been retained in some functioning institutions; (4) institutions are able to assess risk releases resulting from human-induced disruptions of a repository; and (5) relevant records are preserved, and remain accessible, for several hundred years after permanent closure."

  The above text clearly indicates DOE's intent to include events derived from human activities in the calculation of the CCDF, if the five assumed conditions are met. Ross sequences 31 through 53 and especially Ross sequences 40 and 44 for direct exposure through waste excavation, indicate this type of scenario is under consideration for calculation of the CCDF.

- As mentioned in Table 8.3.5.13-3 and elsewhere, scenario category A-2 "direct release associated with human intrusion" indicates DOE is considering this type of scenario to plan for acquiring data for the resolution of this issue.

- On page 8.3.5.13-24 in discussing "The U.S. Department of Energy approach to constructing the complementary cumulative distribution function" the SCP states: "Disruptive scenario classes will also be developed for the analysis... These scenario classes would also include those developed for human interference activities discussed earlier (sic)." Many, if not most, readers would conclude that some human intrusion scenarios would be used to calculate the CCDF.

- Page 8.3.5.13-23 (last paragraph). DOE states: "The scenarios and scenario classes associated with human activities are often highly speculative and often do not involve significant impacts on the variables important to waste isolation. Therefore, the specification of highly speculative, low-impact human activity-related scenarios and scenario classes ... will not be allowed to dominate the testing program." There is no discussion of how to deal with human activities which might involve significant impacts.

RECOMMENDATIONS

- Develop a consistent, rational approach to the resolution of issue 1.1 such that human intrusion scenarios are included in the calculation of the CCDF or such that these scenarios are excluded in such a way that compliance with the EPA standard can be demonstrated.

- Make appropriate adjustments to the site characterization program, if any, corresponding to the revised issue resolution strategy.

REFERENCES

U.S. Department of Energy, Letter from S. Rousso, DOE, to H. Thompson, Jr., NRC; Subject: Issuance of the Site Characterization Plan (SCP) for the Yucca Mountain Site to the U.S. Nuclear Regulatory Commission, December 28, 1988, 4pp. plus 3 enclosures, including "Responses to NRC Point Papers on Site Characterization Plan/Consultation Draft."

RESPONSE

The assignment of probabilities to human activities 10,000 years in the future will be a speculative task, no matter how vigorously site characterization pursues the data needed for modeling. It may well be useful, therefore, to devote special attention to the contribution to the CCDF made by predictions of human activity, perhaps by constructing CCDFs with and without human activity. The U.S. Department of Energy (DOE) understands that the manner in which performance modeling can account for such a highly unpredictable factor, that is, the vagaries of human behavior, is being considered by U.S. Environmental Protection Agency in the repromulgation of 40 CFR 191. This appears to be a subject requiring meetings and other interactions between DOE and the U.S. Nuclear Regulatory Commission . See also the response to Comment 95.

Section 8.3.5.13 Total System Performance

SCA COMMENT 110

The response to CDSCP comment 90 indicates that human intrusion is intended to be left out of the calculation of the CCDF, but the SCP text is unclear as to how human intrusion will be handled.

EVALUATION OF DOE RESPONSE

- DOE's response indicates neither acceptance of the NRC staff's interpretation of the requirements of EPA's HLW standards nor any concrete proposal by DOE for evaluating the significance of potential human activities. Instead, DOE indicates that "meetings and other interactions" between DOE and NRC are needed.

- The NRC staff is willing to meet with DOE on this subject. If DOE disagrees with the standards (as appears to be the case), then it should raise the issue with EPA as the standards are being revised.

- The NRC staff considers this comment open.

Additional Information Relevant to SCA Comment 110 Open Item

The DOE and NRC staff agree that the assignment of probabilities to possible human activities that could affect the long-term containment and isolation of the waste is a highly speculative task. The question of whether human intrusion activities are sufficiently credible to warrant consideration in the construction of the total system CCDF is open at the present time.

The DOE concurs with the NRC in 10 CFR Part 60 in the classification of human intrusion as an "unanticipated" event. The DOE also concurs with the NRC approach to screen unlikely events including human intrusion, based on the release estimates for that scenario.

The DOE has discussed this topic with NRC and EPA staff. DOE has presented EPA with recommendations regarding the implementation of the EPA standard as well as suggested revisions to the repromulgation of 40 CFR 191 in order to clarify the intent of EPA. The DOE concurs with the NRC that unlikely human intrusion should not be included in the CCDF, but should have a separate test for compliance. The DOE has expressed this to the EPA.

In the total system PA iteration recently completed by SNL and PNL, human intrusion was considered by both groups. Conditional CCDFs for human intrusion were calculated and human intrusion was folded into total system CCDFs. The DOE can fold human intrusion into systems CCDFs, but still questions the usefulness or wisdom of doing so.

In conclusion, the DOE will follow the requirements of final 40 CFR 191 regulations concerning human intrusion activities occurring over the 10,000 year period of regulatory concern.

ENCLOSURE 7

SCA Comment 112 and DOE Response (12/14/90)

NRC Evaluation of DOE Response (7/31/91)

Additional Information Relevant to SCA Comment 112 Open Item

Section 8.3.5.13 Total System Performance

COMMENT 112

There is a gap in the discussion of the treatment of state variables as constants or as random variables.

BASIS

Page 8.3.5.13-8 (third paragraph). DOE states that a state variable can be treated as a constant if its coefficient of variation (the ratio of the standard deviation to the mean) is "very small" but may have to be treated as a random variable if its coefficient of variation is "nearly one or larger." There is no discussion of the case where the coefficient of variation is not small but is less than one (e.g., 0.5).

RECOMMENDATIONS

- Introduce the term "coefficient of variation" for the ratio discussed in the paragraph. This is standard statistical nomenclature.
- Be more explicit about the conditions for treating a state variable as a constant.
- State that a state variable must be treated as a random variable whenever it fails to satisfy the conditions for treating it as a constant.

RESPONSE

The phrase "If the ratio is nearly one or larger" on page 8.3.5.13-8 of the Site Characterization Plan should read "If the ratio is not very small."

Section 8.3.5.13 Total System Performance

SCA COMMENT 112

There is a gap in the discussion of the treatment of state variables as constants or as random variables.

EVALUATION OF DOE RESPONSE

- Although the DOE response addresses the logical gap in the discussion, it does not satisfy the NRC recommendations.

  (1) Since the "coefficient of variation" (CV) is the standard term for the ratio of a random variable's standard deviation to its mean, this term should be used.

  (2) Apparently, there are two conditions for treating a state variable as a constant: (i) if the CV is very small or (ii) if the "results of a calculation" are not sensitive to changes in the state variable. The first condition is explicitly stated but the second condition must be inferred from the last sentence in the third paragraph. Since condition (i) implies condition (ii), it should be explicitly stated that condition (ii) is the defining criterion. Furthermore, "results of a calculation should be replaced by "performance measure" and some attempt should be made to define what is meant by "not sensitive."

  (3) Once the conditions for treating a state variable as a constant are clearly stated, it should be explicitly stated that a state variable which fails to satisfy these conditions must be treated as a random variable. This will serve the purpose of treating all ambiguous state variables as random variables, thus preventing a situation where a state variable with a significant contribution to the uncertainty of a performance measure is treated as a constant.

- The NRC staff considers this comment open.

Additional Information Relevant to SCA Comment 112 Open Item

The DOE agrees with the points made by the NRC. As the NRC noted, the important consideration in determining whether a state variable may be treated as a constant is whether the system response, as quantified by the EPA performance measure, is sensitive to changes in the variable. Intuitively, the question is whether variation over the plausible range of the variable changes the performance measure significantly. It is difficult to give precise definitions of "sensitive" and "significant" at this early stage of the performance assessment of Yucca Mountain. It is expected that appropriate definitions will evolve as we learn more about the system and how to model it.

ENCLOSURE 8

SCA Comment 113 and DOE Response (12/14/90)

NRC Evaluation of DOE Response (7/31/91)

Additional Information Relevant to SCA Comment 113 Open Item

Section 8.3.5.13 Total System Performance

COMMENT 113

The definition of the unit step function is not consistent with the definition of the CCDF.

BASIS

- On page 8.3.5.13-5, the CCDF is defined as

  $G(m) = Pr\ \{M > m\}$

  This implies that there is no contribution to the CCDF if $M = m$.

- On page 8.3.5.13-9, $G(m)$ is represented as

  $G(m) = \Sigma[u(m-m)]$, where $u(x)$ is the unit step function defined by

  $u(x) = 0$ if $x < 0$

  $u(x) = 1$ if $x \geq 0$

  This implies that there might be a contribution to $G(m)$ if $M - m$ (if $Pr\ [M - m] > 0$)

RECOMMENDATION

Change the definition of the unit step function to

$u(x) = 0$ if $x \leq 0$

$u(x) = 1$ if $x > 0$

RESPONSE

The comment is correct; it would be more consistent to define the unit step function by:

$u(x) = 0$ if $x \leq 0$, 1 if $x > 0$

The issue, however, is merely whether, at a discontinuity, the complementary cumulative distribution function should be considered to have the lower or higher value; the resolution of this issue should have no impact on determining the regulatory compliance of the site.

Section 8.3.5.13 Total System Performance

SCA COMMENT 113

The definition of the unit step function is not consistent with the definition of the CCDF.

EVALUATION OF DOE RESPONSE

- Although DOE agrees that it would be "more consistent" to define the unit step function as stated in the NRC recommendation, DOE does not state whether or not it will change its definition of the unit step function. If DOE does not change its definition, then the definition will remain inconsistent with the definition of the CCDF on page 8.3.5.13-5 and might lead to ambiguity in determining the regulatory compliance of the site.

- In the second sentence of its response DOE seems to imply that the definition of the unit step function will have "no impact on determining the regulatory compliance of the site." This is not correct. For example, suppose that $M < 1.0$ with probability 0.8 and $M = 1.0$ with probability = 0.2. Since

  $$Pr(M > 1.0) = Pr(M > 10.0) = 0,$$

  the site satisfies the containment standard given by equation 8.3.5.13-2. However, if the definition of $u(X)$ given on page 8.3.5.13-9 is used, then $G(1.0) = 0.2$ and the containment standard is <u>not</u> satisfied.

- The NRC staff considers this comment open. A step toward closure may be inclusion of this topic for discussion at a future NRC-DOE interaction on the generation of the CCDF.

Additional Information Relevant to SCA Comment 113 Open Item

While the NRC's comment is technically correct, the important point to note is that the definition of the unit step function given in the SCP is more conservative than the one recommended by the NRC. An example of this conservatism was given by the NRC in their evaluation of the DOE's response to the SCA. They gave an example of a situation in which use of their step function would imply compliance with the EPA standard, whereas use of the SCP's step function would imply noncompliance. However, if the site is so close to the compliance boundary that its suitability for a repository hinges on whether the normalized release is exactly one or infinitesimally greater than one, then the site is probably not suitable. For this reason, the DOE prefers to use the more conservative definition.