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COMPLIANCE WITH THE SUBSTANTIALLY COMPLETE CONTAINMENT (SCC) REQUIREMENT AND RESOLUTION OF SITE CHARACTERIZATION ANALYSIS (SCA) QUESTION 47 AND COMMENT 80 (SCPB: N/A)

References: (1) Ltr, Shelor to Linehan, dtd 12/14/90
(2) Ltr, Bernero to Bartlett, dtd 7/31/91
(3) Ltr, Shelor to Holonich, dtd 3/30/94
(4) Ltr, Shelor to Holonich, dtd 5/17/94
(5) Ltr, Shelor to Holonich, dtd 6/10/94
(6) Ltr, Holonich to Shelor, dtd 7/11/94

The purpose of this letter is to provide the additional supplemental responses to Question 47 and Comment 80 of the SCA requested in Reference 6, and to continue dialog between the U.S. Department of Energy (DOE) and the U.S. Nuclear Regulatory Commission (NRC) on the subject of SCC.

On December 14, 1990, DOE transmitted its responses (Reference 1) to objections, comments, and questions presented in the NRC's SCA. The NRC staff evaluated these responses, considered some of the items to be resolved, and created open items of the remainder (Reference 2). Earlier this year, DOE provided supplemental responses (References 3, 4, and 5) to four open items that pertain to the SCC requirement, as contained in 10 Code of Federal Regulations 60.113(a)(1)(ii)(A). In the same letter, DOE also described how it intends to demonstrate compliance with SCC by meeting a new waste package performance goal, achieving mean waste package lifetimes well in excess of 1000 years. The NRC agreed in principle that the proposed performance waste package performance goal is a reasonable implementation of the SCC requirement (Reference 6). The NRC considered SCA Comment 5 and Question 46 to be resolved, and left open parts of SCA Comment 80 and Question 47.

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The enclosures to this letter contain further supplemental responses to Comment 80 and Question 47. The response to Comment 80 provides additional information to address the four specific questions that were posed by the NRC in the July 11, 1994, letter (Reference 6). The response to Question 47 clarifies that DOE still intends to use ANSI N 14.5, the American National Standards Institute Standards for Radioactive Materials - Leakage Tests on Packages for Shipment, as the basis for the definition of waste package failure, in conjunction with the new waste package performance goal. Enclosure 1 to this letter summarizes the administrative record with respect to SCA Comment 80. Enclosure 2 summarizes the administrative record with respect to SCA Question 47.

DOE believes that the enclosed response is sufficient to resolve Question 47, and awaits confirmation of this from the NRC.

It is expected that DOE and NRC will continue discussions on Comment 80 at an upcoming technical exchange on SCC, yet to be scheduled. DOE believes that the response, coupled with those discussions, should provide the basis for resolving Comment 80. DOE requests that the NRC confirm this understanding after the technical exchange.

If you have any questions, please contact Thomas W. Bjerstedt at (702) 794-7590.

for Stephan J. Brocoum
Assistant Manager for
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AMSL:TWB-5059

Enclosures:
1. Administrative Record for SCA Comment 80
2. Administrative Record for SCA Questions 47
3. Scientific Investigation Plan for Metal Barrier Selection and Testing

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Enclosure 1

SCA Comment 80 and Initial DOE Response

NRC Evaluation of Initial DOE Response

DOE Supplemental Response to NRC Comment 80 (3/94)

NRC Evaluation of DOE Supplemental Response

DOE Supplemental Response to NRC Comment 80 (9/94)

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ENCLOSURE 1

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.

COMMENT 80

Some performance goals related to the requirement for substantially complete containment do not appear to be consistent with DOE's revised interpretation of the containment requirement and the intent of the rule.

BASIS

- This comment addresses the subject of performance allocation discussed previously in CDSCP Comment 109. In response to CDSCP Comment 109 (which is closely related to CDSCP Comment 3), DOE extensively revised Section 8.3.5.9 with respect to the allocations of performance to waste package components and the associated quantitative goals for these components. DOE also revised its interpretation of "substantially complete containment." The revised DOE interpretation is in substantial agreement with NRC's intent in 10 CFR 60.113. However, there appear to be inconsistencies among the tentative performance goals. for example, the SCP states that DOE understands substantially complete containment to mean that the waste package will fully contain the total radionuclide inventory. Nevertheless, the stated overall goal for waste package performance is for all failures to be less than 5 percent in 300 yr or less than 20 percent in 1,000 yr (see Comment 44). Other inconsistencies are discussed in Questions 33, 34, 35, 38, and 39.

- As tentative goals to address the substantially complete containment requirement, the SCP states 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 the post-containment period. Accordingly, DOE has established the tentative criterion that release of these isotopes (listed in Table 8.3.5.10-3b) from the waste packages will be controlled such that their annual rates of release are less than 1 part in 1,000,000 for those isotopes present in sufficient quantity in the 1,000-year inventory. It further states that DOE has elected to limit releases of all other radioactive isotopes to an annual release rate of less than 1 part in 100,000 of the current inventory of that isotope in the waste packages.

- While the first goal stated above is a stringent one for controlled release, it may not be consistent with NRC's interpretation of "substantially complete containment" because the NRC has not set numerical limits on the release of radionuclides during the containment period.

- The second goal is clearly unacceptable and inconsistent with the containment requirement inasmuch as it would permit a rate of release during the containment period greater than that permitted during the post containment period.

- **As indicated in Table 8.3.5.9-1, the goal of less than 0.001 for the fraction of containers failed in any given year in the 300 to 1000 year timeframe appears inconsistent with the containment requirement.**

RECOMMENDATION

Establish goals which are consistent with the requirement for "substantially complete containment." While the first goal may be adequate, the second goal is judged to be unacceptable.

RESPONSE

This comment addresses a perceived inconsistency between some of the Site Characterization Plan performance goals and the revised interpretation of the containment performance objective and the intent of the rule. Specifically, the goal for containing radionuclides that are not important, because of their relatively short half-lives during the post-containment period, "is judged to be unacceptable."

Because the containment performance objective is stated in qualitative terms, the U.S. Department of Energy (DOE) finds it necessary to provide a quantitative interpretation to establish a basis for design and a "yardstick" for judging compliance. In searching for a basis for this interpretation, DOE turned to the U.S. Nuclear Regulatory Commission (NRC) record for guidance. From the standpoint of public health and safety, it was determined that those radionuclides that have the greatest potential for reaching the accessible environment were those that would be present in the engineered barrier system following the containment period. Therefore, the containment performance goal for those isotopes was established that is a factor of ten more stringent than that required during the post-containment period (10^6 vs 10^5 controlled release limit).

On the other hand, for those radionuclides that decay rapidly and are therefore not likely to reach the accessible environment, DOE relied on the wording used by the NRC in NUREG-0804, for guidance. Specifically, the statement that "It is expected that ... release during the containment time (will be) limited to a small fraction of the inventory present." This is in contrast to the wording in the post-containment performance objective, when the inventory of concern is "that calculated to be present at 1,000 years following permanent closure." For quantitative guidance, DOE concluded that the "one part in 100,000 per year of the inventory" of any radionuclide, as used in the post-containment objective, qualified as a "small fraction" and was therefore consistent with the intent of the rule regarding containment.

REFERENCES:

NRC (U.S. Nuclear Regulatory Commission), 1983c. Staff Analysis of Public Comments on Proposed rule 10 CFR Part 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories, NUREG-0804, pp. 518-520.

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. 8.5.9-19, Para. 3.

SCA COMMENT 80

Some performance goals related to the requirement for substantially complete containment do not appear to be consistent with DOE's revised interpretation of the containment requirement and the intent of the rule.

EVALUATION OF DOE RESPONSE

- DOE considers that the numerical goals stated in this section are consistent with the intent of NUREG-0804 which states "It is expected that ... release during the containment time (will be) limited to a small fraction of the inventory." While this may be true, NUREG-0804 does not give any further amplification of what the performance expectation is that would provide useful guidance to DOE.

- The NRC staff has not defined explicitly acceptable limits for the release of radionuclides during the containment period; however, the staff has an ongoing effort to develop guidance on the meaning of "substantially complete containment" which, when complete, may aid in resolving this issue.

- The NRC staff considers this comment open.

DOE Supplemental Response to NRC Comment 80

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 inconsistencies existed among the tentative goals based on the desire to limit the release of radionuclides from the Site Characterization Plan (SCP) waste package design, which relies on a thin-wall, single-barrier, corrosion-resistant container.

The DOE now proposes a new performance goal in place of the previous goals, 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 means that the number of failures at the initial tail of the distribution, i.e., during the containment period, will be very small. This is consistent with the containment requirement and the intent of the rule. The performance goal will be reflected in lower-level barrier functions and performance measures being developed.

At the August 24, 1993, DOE/NRC Technical Exchange on Substantially Complete Containment, the DOE discussed its current waste package design activities. The DOE is developing a number of waste package design concepts which incorporate multiple barriers with more than one failure mode. The emphasis is placed on the multi-purpose canister waste package as a result of a recent baseline change to the CRWMS Requirements Document and the system requirements documents. This approach permits the peak of the failure distribution of the combined waste package to be reduced and the distribution itself extended in time. Thus, the fraction failed at 1,000 years will be extremely small, on the order of 1%. The design concepts do not currently take credit for the additional containment provided by spent fuel cladding and spent fuel and high-level waste glass canisters.

The waste package and repository design options being considered will have an effect on the containment of radionuclides. These options include thermal loading, emplacement mode, canister size, and engineered packing and backfill materials. SCC, therefore, is a primary consideration in ongoing design studies.

The DOE plans for the development of this waste package 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 evaluation, as well as fabrication studies and prototype testing. These studies are detailed in the Waste Package Implementation Plan (WPIP) (YMP/92-11, Rev. 0, ICN 2), which was sent to the NRC on August 2, 1993. Interim Change Notices 1 and 2 to the WPIP are included herein.

The DOE plans to demonstrate compliance with its performance goal and therefore with the containment requirement, will include the waste package development effort, comprehensive design verification, performance assessment, and performance confirmation programs.

The DOE's approach to meeting the NRC SCC requirement is focused on containment with a performance goal of extended waste package lifetimes. This approach is consistent with NRC's emphasis on containment during the initial postclosure period. The DOE believes that this approach, coupled with 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.

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

WASTE PACKAGE IMPLEMENTATION PLAN

CHANGE HISTORY

REV. NO.	ICN NO.	EFFECTIVE DATE	DESCRIPTION OF CHANGE/ICN
0		02/17/93	Initial Issue
0	1	09/15/93	Addition of missing page 4-26.

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

WASTE PACKAGE IMPLEMENTATION PLAN

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Carl P. Gertz, Project Manager — Date
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The process of PA follows that shown in Figure 1-1. The process is an iterative one with loops through the process until a design is achieved that meets the requirements.

4.4.2 INPUTS

The PA process starts with a set of assumptions regarding the performance of each of the barriers and a tentative allocation of that performance to meeting the requirements. A first cut was provided in the SCP. The next step will be to provide a review of these allocations, based upon the approach provided in Table 4.1-1, with the addition of the performance of other containment barrier materials suggested by the design and materials testing efforts. Models will be developed that describe the degradation of the waste forms and the containment barrier materials. This effort is described in Section 4.4.3. The model development effort is strongly tied to the materials testing and submodel development activities described in Section 4.3. Input will also be provided by long-term performance testing of the containers, as well as in situ testing. These activities are also described in Section 4.3.

The PA effort is also closely linked to the design effort, particularly for the selection of materials, material geometries, and environmental scenarios. The fabrication history of the prototype containers and the various barriers will also be reviewed to confirm that the specifications have been met. Particular attention will be paid to the non destructive and destructive examination of closures for microstructural stability, as described in Section 4.3.2.

Another important input into the PA effort is the set of environmental scenarios to consider over the repository lifetime. As noted in Section 2.6, the repository environment will evolve over time. The likely scenarios will need to be considered and assessed for their impact on the performance of the barriers. The conditions on the surface of the WPs will be dependent upon the environment as altered by the decay heat from the WPs and the design of the EBS.

4.4.3 MODEL DEVELOPMENT

The hierarchal framework for model development was discussed in Section 4.4.1. This framework requires the development of performance parameter submodels, such as WP containment breach (and breach rate) and waste form release. These model hierarchies, which are tied to issue resolution, are shown in Figure 4.4-1 and 4.4-2.

The goal of this effort is the development of detailed mechanistic models that adequately describe each degradation and release mode identified in Figures 4.4-1 and 4.4-2, as well as the other portions of the system that need to be modeled. Using the inputs described above, conceptual models will first be developed. These will be supported by the testing program which includes mechanism characterization, service condition determination, and accelerated tests. The models will be enhanced as results from these test programs become available. Performance predictions can then be made that can be tested using confirmation tests.

The models will, to the extent possible, include the variability of the material being degraded. If complete mechanistic understanding cannot be obtained, then partial understanding will be sought. This follows the approach given in ASTM C 1174-91, described in Section 4.1. Lastly, if neither full nor partial mechanistic understanding is possible, then bounding models will be utilized. Validation will be performed for each

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CHANGE HISTORY

REV. NO.	ICN NO.	EFFECTIVE DATE	DESCRIPTION OF CHANGE/ICN
0		02/17/93	Initial Issue
0	1	09/15/93	Addition of missing page 4-26.
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WASTE PACKAGE IMPLEMENTATION PLAN

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WASTE PACKAGE IMPLEMENTATION PLAN

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SCA COMMENT 80

Some performance goals related to the requirement for substantially complete containment do not appear to be consistent with DOE's revised interpretation of the containment requirement and the intent of the rule.

EVALUATION OF DOE SUPPLEMENTAL RESPONSE

- In the March 30, 1994, supplemental response to this comment, DOE proposes a new performance goal in place of its previously stated goals. This new goal is to achieve mean waste package lifetimes that are well in excess of 1,000 years through the use of a multibarrier approach. DOE predicts that the multibarrier approach will yield failures on the order of one percent at the end of the containment period.

- DOE's new performance goal resolves the NRC staff concerns about the inconsistent DOE performance goals, but does not completely address the NRC staff concerns about the consistency between the DOE performance goal and the intent of the rule. In principle, the NRC staff considers that the new DOE performance goal is a reasonable implementation of the SCC requirement. However, the staff considers that the following additional information is needed to completely resolve SCA Comment 80:

  - Has DOE allowed for waste package failure mechanisms in the containment period other than those discussed in NUREG-0804 when the substantially complete containment requirement was promulgated? In NUREG-0804 it was stated that "it is realized that a small fraction of the approximately 100,000 packages will be breached before 1000 years due to variations in materials, manufacturing processes, etc. that can only be estimated using statistical procedures." It was also recognized that some projected failures might be attributable to modeling uncertainty - particularly as it relates to the long-term extrapolation from prelicensing accelerated corrosion tests. The NRC staff would be concerned about causes for waste package failure other than those contemplated when the rule was promulgated.

  - 10 CFR 60.21(c)(11)(D) requires an analysis of the effectiveness of engineered barriers against release of radioactive material to the environment, including a comparative analysis of alternatives to the major design features that would provide more radionuclide containment. What are DOE's plans concerning a comparative analysis of the alternatives to the major design features of waste packages that would provide more containment during the containment period?

  - What will be the expected distribution, with respect to time, of these predicted failures and the expected mean waste package lifetime? In

generation rate and the fission product contributions to hazard can be compensated for by containment times in the range of several hundred to 1,000 years." Therefore, the NRC staff is particularly concerned about the potential for waste package failures that might occur shortly after permanent closure when these uncertainties might be still be very significant.

- What are the expected consequences (in terms of estimated radionuclide releases) of the waste package failures that occur during the containment period? The NRC staff considers that waste package "failures" that result in a substantial portion of the radionuclides remaining contained within the waste packages during the containment period is closer to the intent of the SCC requirement than catastrophic waste package failures that result in substantial releases of radionuclides during the containment period. The NRC staff also considers that the release of radionuclides during the containment period should, at least for long lived isotopes, be significantly less than the release of radionuclides permitted during the post-containment period.

o The NRC staff considers this comment resolved as to the inconsistency between DOE performance goals, but open as to the possible inconsistency between the DOE performance goal and the intent of the rule.

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

DOE Supplemental Response to NRC Comment 80 (9/94)

Response

In the U.S. Nuclear Regulatory Commission (NRC) evaluation of the previous U.S. Department of Energy (DOE) supplemental response, the NRC staff agreed in principle that the new waste package performance goal is a reasonable implementation of the SCC requirement. However, the staff also stated that additional information is needed to completely resolve Comment 80. The NRC asked four specific questions, which are addressed below.

- Has DOE allowed for waste package failure mechanisms in the containment period other than those discussed in NUREG-0804 when the substantially complete containment requirement was promulgated?

  DOE Response

  DOE is considering a variety of failure mechanisms during the containment period other than those noted in NUREG-0804. These include oxidation, general and localized corrosion, stress corrosion cracking, hydrogen attack, galvanic attack, microbiologically-influenced corrosion, as well as mechanical failures due to rock fall and tectonic events. These mechanisms are being utilized to estimate the number of failures that could occur for a variety of thermal loads of the repository. The R&D programs that support these activities have been described in the Waste Package Implementation Plan (letter from Roberts to Holonich dated August 2, 1993), the Metal Barrier Selection and Testing Scientific Investigation Plan (enclosure 3), and the Study Plan on the Analysis of Waste Package Rupture Due to Tectonic Processes and Events (letter from Shelor to Holonich dated December 1992). These documents have been made available to the NRC staff.

- What are DOE's plans concerning a comparative analysis of the alternatives to the major design features of waste packages that would provide more containment during the containment period?

  DOE Response

  DOE has included as part of its container development program an evaluation of the potential of alternate metal barriers and non-metallic barriers that would provide enhanced isolation during the containment period. The materials being considered include some of the new nickel-base and titanium alloys. The major effort in non-metallic barriers is the evaluation of oxide ceramic materials, however, other systems such as

coatings and the use of graphite have been considered. The present effort is to determine what materials have superior corrosion resistance and adequate mechanical strength that could be coupled with a metal overpack for handling and emplacement. This will be followed by the fabrication of small-scale samples that would be evaluated for corrosion and mechanical performance. These efforts are described in the Site Characterization Plan, the Waste Package Implementation Plan, the Metal Barrier Selection and Testing Scientific Investigation Plan, and the Non-Metallic Barrier Scientific Investigation Plan. These documents have been made available to the NRC staff.

The comparative analysis of the alternates will be performed utilizing existing codes, such as the Yucca Mountain Integrating Model (YMIM) from LLNL, and the Repository Integrating Program (RIP) from Golder Associates. This analysis will be conducted as part of the waste package preliminary design process.

- What will be the expected distribution, with respect to time, of these predicted failures and the expected mean waste package lifetime?

DOE Response

DOE is currently completing Advanced Conceptual Design phase for waste packages. The next phase, Title I design, is scheduled to begin on October 1, 1994. Thus, the design detail upon which to base waste package failures upon is not available at this time.

However, DOE has performed some preliminary calculations based on one particular design concept that includes a nickel-base inner corrosion-resistant barrier and an outer carbon steel corrosion-allowance barrier. These preliminary failure calculations were based only upon the carbon steel corrosion-allowance barrier utilizing the correlations given in Total System Performance Assessment-1993, An Evaluation of the Potential Yucca Mountain Repository (M&O Document B00000000-01717-2200-00099-Rev. 1, March 1994) (letter from Milner to Holonich dated July 27, 1994). Calculations for the inner corrosion-resistant barrier await corrosion data. Time-temperature-relative humidity data were provided by LLNL (T.A. Buscheck, J.J. Nitao, and S.F. Saterlie, in High Level Radioactive Waste Management: Proceedings of the Fifth International Conference, (1994) pp. 592-610) to include the effect of relative humidity on container corrosion. Failure times were calculated for a range of thermal loads. These results indicate that the design goal of a mean waste package lifetime well in excess of 1,000 years will be met with the outer corrosion-allowance barrier alone, consistent with our

defense-in-depth approach. Failure distributions from these failure times, along with the expected mean container lifetimes, will be determined and sensitivity studies will be performed.

The expected mean waste package lifetime will be determined when the design is better defined and when data from the container material corrosion test program become available. However, DOE expects that the number of waste packages that fail during the containment period will be very small, <1%, because of the robust nature of the multi-barrier design. The mean failure time will be long compared to the containment period.

- What are the expected consequences (in terms of estimated radionuclide releases) of waste package failures that occur during the containment period?

DOE Response

DOE is currently completing Advanced Conceptual Design phase for waste packages. The next phase, Title I design, is scheduled to begin on October 1, 1994. Thus, the design detail upon which to base waste package failures and the consequences of failures is not available at this time.

However, as noted above, DOE has performed some preliminary calculations of container lifetimes on one design concept. These preliminary calculations indicated that the design goal will be met, and, therefore, that the release of radionuclides during the containment period will be small. The expected consequences of failure in terms of radionuclide release can be estimated using an upper bound of failures (i.e., 1%), during the containment period. For gaseous release of C-14 as carbon dioxide, the fraction releasable was given in the SCP as 10% of the inventory. No retardation by the host rock was assumed. Thus, if these failures and releases are distributed over 1,000 years, the fractional release per year would be one part in one million or one-tenth (10%) of the controlled release rate limit (CRRL). For species such as Cs-137 and Sr-90 that exist at a concentration of about 2% in the gap and grain-boundary as the fast release fraction, the fractional release per year would be two parts in ten million, or 2% of the CRRL, assuming that all of the cladding had failed. Thus, for these upper bound estimates, the releases during the containment period will be much lower than those permitted during the post-containment period. In addition, the offsite dose to the public will be very small. Better estimates will be generated when the waste package design is better defined during Title I and when more corrosion data are available to support the failure analyses.

Enclosure 2

SCA Question 47 and Initial DOE Response

NRC Evaluation of Initial DOE Response

DOE Supplemental Response to NRC Question 47 (6/94)

NRC Evaluation of DOE Supplemental Response

DOE Supplemental Response to NRC Question 47 (9/94)

ENCLOSURE 2

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

(Performance allocation) p. 8.3.5.9-23 para 2.

QUESTION 47

It is stated that some preclosure container breaches will escape detection and that a very small fraction of containers will breach during containment. Further, it is stated that these breaches may not constitute failure since failure is defined as a breach large enough to allow significant air flow (1×10^{-4} atm-cm^3/s) into the container. It is also stated that this test is a general standard accepted by the nuclear industry.

What is the origin of the stated definition of a failure? What is the basis for its applicability for canisters containing HLW? What segment of the nuclear industry accepts it as a general standard? For which component(s) is this standard used?

BASIS

Breaches constitute failure of containment. Such breaches and their effect on performance must be known to judge whether containment is "substantially complete."

RECOMMENDATIONS

o Present plans for testing and demonstrating that canisters with breaches of the size stated will meet all preclosure radioactive release requirements imposed on canisters with no breaches.

o Present plans for testing and demonstrating that the composite of canisters with and without breaches of the size stated will meet the postclosure radioactive release requirements ("substantially complete containment" and "gradual release").

o Present plans for testing and demonstrating that breaches of the size stated will not propagate or increase in time during the containment and post containment periods.

RESPONSE

This definition of failure is preliminary and would be assessed during definition of "substantially complete confinement."

The performance goals would be incorporated in the waste package design requirements document.

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 (Performance allocation) p. 8.3.5.9-23, Para. 2

SCA QUESTION 47

It is stated that some preclosure container breaches will escape detection and that a very small fraction of containers will breach during containment. Further, it is stated that these breaches may not constitute failure since failure is defined as a breach large enough to allow significant air flow (1 x 10-4 atm-cm3/s) into the container. It is also stated that this test is a general standard accepted by the nuclear industry.

What is the origin of the stated definition of failure? What is the basis for its applicability for canisters containing HLW? What segment of the nuclear industry accepts it as a general standard? For which component(s) is this standard used?

EVALUATION OF DOE SUPPLEMENTAL RESPONSE

- In the June 10, 1994, supplemental response to this question, DOE has clarified that the SCP definition of waste package failure was based on American National Standards Institute (ANSI) standard N 14.5 (American National Standard for Radioactive Materials - Leakage Tests on Packages for Shipment), but has not clarified what definition of failure will be used with DOE's new performance goal or the basis of this new definition of failure for waste packages containing HLW.

- The NRC staff considers this question open. Since waste package lifetimes can not be computed without at least one criterion for failure, the NRC staff considers that it is incomplete to develop a goal for waste package lifetimes without a criterion or criteria for waste package failure. The current view of the NRC staff is that one possible criterion for waste package failure is any penetration through all of the waste package barriers. However, other criteria for waste package failure (e.g. the SCP criterion based on ANSI standard N 14.5) might also be acceptable, providing the consequences of the failure (see the administrative record for Comment 80) are reasonable. In order to resolve Question 47, the staff needs to know what is DOE's current definition of waste package failure.

generation rate and the fission product contributions to hazard can be compensated for by containment times in the range of several hundred to 1,000 years." Therefore, the NRC staff is particularly concerned about the potential for waste package failures that might occur shortly after permanent closure when these uncertainties might be still be very significant.

- What are the expected consequences (in terms of estimated radionuclide releases) of the waste package failures that occur during the containment period? The NRC staff considers that waste package "failures" that result in a substantial portion of the radionuclides remaining contained within the waste packages during the containment period is closer to the intent of the SCC requirement than catastrophic waste package failures that result in substantial releases of radionuclides during the containment period. The NRC staff also considers that the release of radionuclides during the containment period should, at least for long lived isotopes, be significantly less than the release of radionuclides permitted during the post-containment period.

o The NRC staff considers this comment resolved as to the inconsistency between DOE performance goals, but open as to the possible inconsistency between the DOE performance goal and the intent of the rule.

DOE Supplemental Response

The definition of "substantially complete containment" was addressed in the response to SCA Comment 80. In that response, the DOE stated that a new performance goal has been established which focused on containment of radionuclides. The goal is to achieve mean waste package lifetimes well in excess of 1,000 years. This means that the number of failures at the initial tail of the failure distribution over time, i.e., during the containment period, will be very small. The DOE will achieve this performance goal through the use of multiple barriers with more than one failure mode. This permits the peak of the failure distribution of the combined waste package to be reduced and the distribution itself to be extended in time. Thus, the fraction failed at 1,000 years will be extremely small, on the order of 1%. This new approach, which focused on containment, is consistent with the NRC's emphasis on containment rather than release during the containment period.

The definition of failure originally provided in the Site Characterization Plan (air flow of 1×10^{-4} atm-cm^3/s) was qualitative and conservative. It was based on ANSI N 14.5 (American National Standard for Radioactive Materials - Leakage Tests on Packages for Shipment), recognizing that acceptance testing would be performed at significantly lower allowable leakage rates, usually less than 1×10^{-7} atm-cm^3/s. This latter level of testing is applicable for spent fuel shipping casks. For reasonable assumptions of waste package failures, the SCP leakage rate yielded release of C-14 well below the one part in 100,000 release rate limit and well below the offsite dose limits given in 40 CFR Part 191.

The DOE plans for the development of the current waste package designs, 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 evaluation, 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).

The DOE plans to demonstrate compliance with its performance goal, and therefore with the containment requirement, 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 adequate confidence that the containment requirements will be met. The DOE approach to meeting the NRC SCC requirement is focused on containment with a performance goal of extended waste package lifetimes. This approach is consistent with NRC's emphasis on containment during the initial postclosure period. The DOE believes that this approach, which does not contain goals for container failures 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.

Section 8.3.5.9 Issue resolution strategy for Issue 1.4: Will the waste package meet the performance objectives for containment as required by 10 CFR 60.113? (Performance allocation) p. 8.3.5.9-23, para.2

SCA QUESTION 47

It is stated that some preclosure container breaches will escape detection and that a very small fraction of containers will breach during containment. Further, it is stated that these breaches may not constitute failure since failure is defined as a breach large enough to allow significant air flow (1 x 10E-4 atm- cu cm/s) into the container. It is also stated that this test is a general standard accepted by the nuclear industry.

What is the origin of the stated definition of a failure? What is the basis for its applicability for containers containing HLW? What segment of the nuclear industry accepts it as a general standard? For which component(s) is this standard used?

EVALUATION OF DOE RESPONSE

- DOE indicates that their definition of failure is preliminary and will be assessed pending further definition of "substantially complete containment."
- DOE did not provide any additional information related to testing and demonstrating that containers with breaches can meet the subsystem performance requirements.
- The NRC staff considers this question open.

DOE Supplemental Response to NRC Question 47 (9/94)

Response

The purpose of this response is to clarify that the U.S. Department of Energy (DOE) intends to use the American National Standards Institute (ANSI) Standards for Radioactive Materials - Leakage Tests on Packages for Shipment, ANSI N 14.5, as the definition of waste package failure.

In the Site Characterization Plan DOE defined a failed waste package as one which has a breach large enough to allow significant air flow ($1x10^{-4}$ atm-cm^3/s or greater). In the supplemental DOE response to the U.S. Nuclear Regulatory Commission (NRC) that was transmitted by letter of June 10, 1994 (Shelor to Holonich), DOE explained that the above definition of failure is based on ANSI N 14.5. The June 10 letter also described the new DOE waste package performance goal of achieving a mean waste package lifetime well in excess of 1,000 years. However, DOE did not clearly state that this failure definition will be used with the new waste package performance goal.

This response confirms that DOE intends to use the ANSI N 14.5 definition of failure (a breach large enough to allow air flow of $1x10^{-4}$ atm-cm^3/s or greater) in conjunction with the new waste package performance goal (a mean waste package lifetime well in excess of 1,000 years).

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