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United States Government | Department of Energy

memorandum

DATE: July 8, 1988

REPLY TO
ATTN OF: RW-222

SUBJECT: Interpretation of Substantially Complete Containment

TO: Program Review Group
Attn: Steve Brocoum, Chairman

Attached is the proposed revision to Section 8.3.5.9 of the Site Characterization Plan (SCP). This version incorporates inputs from the Licensing Branch, Regulatory Compliance Branch, Surface Facilities and Waste Package Branch, the NNWSI project (including LLNL) and Weston. We feel that this version represents a satisfactory and reasonable interpretation of Substantially Complete Containment and is consistent with comments received from NRC.

In order to expedite the implementation of this updated interpretation, we have attached a "Comment Response Form" for use by the Integration Group (IG) to insure that the recommended resolution is incorporated into the SCP.

If you have any questions, please contact me at FTS 896-9322.

H. Jackson Hale

H. Jackson Hale, Acting Chief
Surface Facilities and
Waste Package Branch

clh for Donald Alexander

Donald J. Alexander, Acting Chief
Regulatory Compliance Branch

Edward P Regnier

Edward Regnier, Acting Chief
Licensing Branch

Attachment

cc: S. Kale, RW-20
R. Stein, RW-30
K. Gertz, Nevada
R. Jackson, Weston
M. Frei, RW-22
L. Skousen, WMPO
L. Ballou, LLNL
R. Morissett, SAIC

NH03

Wm-11 102.8

COMMENT RESPONSE FORM

Comment No.

1. Name J. Hale
2. Organization DOE-HQ
3. Phone No. 586-9322
4. Date 7/8/88
5. Chapter 8
6. Section 8.3.5.9
7. Page 1
8. Paragraph

9. Comments:

Comments have been received on the CD-SCP which criticize the DOE Interpretation of substantially complete containment, as defined in 10 CFR 60.113. The most noteable of these is from the NRC point paper (Comment 3) which indicates that the interpretation is inconsistent with the NRC's intent in 10 CFR 60.113 and inappropriate to guide the waste package testing and design program.

10. Proposed Resolution:

Attached is a modified DOE interpretation of substantially complete containment suitable for replacement of the current text in the CD-SCP, Section 8.3.5.9

11. Final Disposition:

12. Verify Final Resolution:

WG Chair	Date	IG	Date	PRG (if necessary)	Date

ISSUE RESOLUTION STRATEGY FOR ISSUE 1.4

Will the waste package meet the performance objective for containment as required by 10 CFR 60.113?

Regulatory Requirement

The NRC regulations set a performance objective for the waste packages to provide containment of the high-level waste (HLW) during the period after closure of the repository when the temperatures and radiation levels are highest. The performance objective for containment (10 CFR 60.113(a)(1)(ii)) is "the engineered barrier system shall be designed, assuming anticipated processes and events, so that: (A) Containment of HLW within the waste packages will be substantially complete for a period to be determined by the Commission taking into account factors specified in 60.113(b) provided that such period shall not be less than 300 years nor more than 1,000 years after permanent closure of the geologic repository...".

For the purposes of this discussion, the waste package is defined, in 10 CFR 60.2, as "the waste form and any containers, shielding, packing and other absorbent materials immediately surrounding an individual waste container." Chapter 7 contains graphic representations of typical waste package configurations, identifying specific waste package components.

Technical Interpretation

DOE understands substantially complete containment to mean that the set of waste packages will fully contain the total radionuclide inventory for a period of 300 to 1,000 years following permanent repository closure, allowing for recognized technological limitations. Implementation of this understanding will be based solely on reliance on the waste package as the major component of the engineered barrier system. The container is the primary barrier of the multiple barrier system for the purpose of containment of radionuclides. The waste package will be designed to be resistant to the degrading effects of the repository environment under anticipated processes and events. Containment will be based on the ability of the waste package, by virtue of its intrinsic properties and design, to maintain a continuous, sealed barrier around the waste.

DOE intends to design the waste packages to provide total containment of radionuclides for a period of 300 to 1,000 years after permanent closure of the repository. However, in a practical sense, considering the large number of waste packages, the large area of the repository horizon, and the long time period involved, it is not possible to precisely predict or demonstrate the endurance of an individual waste package and it is reasonable to expect that some small number of packages will prematurely lose containment. DOE will develop and conduct a test program to collect the necessary information that will

enable the designers to select materials and design the waste packages in a manner that will reduce the incidence of failure during the containment period to a reasonable minimum.

DOE expects that the performance of the waste package during the containment period will be best achieved by minimizing the residual uncertainties. The residual uncertainties in predicting performance are due to several factors: (1) the inherent limitations associated with manufacturing, handling, and emplacement operations, (2) the uncertainty in developing a complete understanding of the behavior of waste package materials, and (3) the uncertainty in predicting the future environment of each waste package. These factors are recognized by the NRC in NUREG-0804 (pp. 519-20), where it is stated that:

> "the staff does not intend that the containment time requirement be achieved absolutely for all of the waste (i.e., absolute proof of zero release for 1,000 years is not required). It is expected that containment of the waste will be substantially complete, with release during the containment time limited to a small fraction of the inventory present. It is intended that the waste package design have a high reliability, taking into account anticipated processes and events that would affect package performance. It is realized that a small fraction of the approximately 100,000 packages will be breached before 1,000 years due to variations in materials manufacturing processes, etc., that can only be estimated using statistical procedures. Similarly, a significant fraction of the packages may remain intact for much longer than 1,000 years".

More specifically, these uncertainties can be divided into preclosure and postclosure considerations. During the preclosure repository operation, DOE will manufacture waste packages in accordance with detailed design specifications. Waste packages will be loaded, sealed, inspected, and moved through the repository surface and subsurface facilities, and be emplaced into boreholes for final disposition, using detailed operating procedures. DOE will have in place a quality assurance program, including quality control (QC) procedures, which will ensure that emplaced waste packages meet detailed material, fabrication, closure, surface finish, and handling specifications. Even with a fully qualified QC program, however, it cannot be assured, with absolute certainty, that packages with undetected flaws will not be emplaced. Throughout the preclosure period, appropriate monitoring will be conducted as part of the performance confirmation program to ensure that the waste packages "are functioning as intended and anticipated", and the number of packages with flaws are held to a reasonable minimum.

During the postclosure period, the performance of any waste package cannot be accurately predicted over the long time period of the performance objective due to the problems associated with demonstrating the mechanisms of all possible material degradation

modes under the range of future environmental conditions and the difficulties in extrapolating short-term experimental data to predict long-term performance. Therefore, it is the goal of the waste package program to provide for complete containment, allowing for only residual uncertainties. DOE will minimize the uncertainties associated with the technical limitations for the postclosure period through a defense-in-depth concept. This concept introduces conservatism in demonstrating waste package performance through bounding assumptions, utilizing multiple barriers to limit container degradation and waste form releases, and evaluating alternative materials and designs.

Design Basis

DOE will design the waste packages to provide total containment of the enclosed waste for the containment period under the full range of anticipated repository conditions. In addition, DOE will utilize design features of the waste package to ensure, for any waste packages that prematurely fail, that (1) a large fraction of the radioactivity will be contained within the ensemble of the waste packages for the duration of the containment period and (2) any radioactivity released from the set of waste packages will be released at a very low rate, relative to the total inventory. Therefore, the waste packages will be designed to provide a reasonable expectation that, should any individual waste package fail at any time following permanent closure, releases of radioactivity from the engineered barrier system will occur at very low rates.

DOE has developed a performance allocation process which is the basis for the testing program. The process is designed to reduce uncertainties in demonstrating waste package containment through a comprehensive in-situ and laboratory testing program. The performance allocation process identifies the system elements which contribute to the demonstration of substantially complete containment and which provide assurance that releases of HLW occur at very low rates. These elements include the engineered environment, the waste containers, and the waste forms. The performance allocation process also establishes the sensitivity allowed in testing parameters and explains the needed evaluations and assessments to show that uncertainties are minimized. Finally, the process considers possible material or design alternatives which may be utilized to supplement or replace the reference design. These alternatives include selection of various container materials and the use of alternative designs such as inner liners to contain significant radioactive gases and diffusion barriers to limit the inflow of water and the egress of radionuclides. However, for the purposes of the test program, the duration of the containment period, the fraction of the radioactivity that can be retained within the set of waste packages, the number of waste packages that can be reasonably expected to provide total containment, and the rate of release from any failed waste packages during this period cannot be reasonably determined until the site is sufficiently

characterized and additional information regarding the performance of waste packages subject to the conditions of the site are available.

Testing Program

In recognition of the limitations and uncertainties that prevent achieving complete containment, design and materials testing activities have been developed to quantify the expected performance of the waste packages. In order to build a comprehensive testing program, DOE has developed quantitative estimates of system performance as a first step in the testing, design, and performance assessment process. It is important to note that these estimates are tentative. Their sole purpose is to allocate importance to each of the system elements, and thus, enable DOE to develop an acceptable testing program. The detailed allocations to each of the system elements is discussed later in this section.

The technological limitations inherent in package fabrication, closure, and inspection are addressed in the process reliability assessments that will be conducted in support of resolving Issue 4.3 (Section 8.3.4.4).

Additional limitations associated with the repository handling and emplacement operations that may have an effect on subsequent containment performance are discussed in conjunction with Issues 1.11 and 4.4 (Section 8.3.2.5).

The waste package materials testing activities are designed to aid in evaluating the uncertainties in the behavior of the materials under anticipated repository conditions. Those activities associated with the container materials are discussed in this section. The waste form testing activities are described under Issue 1.5 (Section 8.3.5.10). Similarly, uncertainties will exist in the characterization of the near-field environment. The activities aimed at quantifying the remaining uncertainties are described under Issue 1.10 (Section 8.3.4.2).

Inherent in the resolution of the containment issue is the requirement to predict the performance of the waste packages over the entire duration of the containment period. This will require predictive models that cannot be fully validated and will therefore contain addition residual uncertainties. The models that support predictions of the container performance are discussed in this section. Waste form and overall waste package performance assessment models, including sensitivity analyses, are described under Issue 1.5 (Section 8.3.5.10).