REQUEST FOR ADDITIONAL INFORMATION (RAI)
Volume 3—Postclosure Chapter 2.2.1.2.2—Event Probabilities
(DEPARTMENT OF ENERGY'S SAFETY ANALYSIS REPORT Sections 2.3.6.6, 2.3.6.8.4, 2.2.2.3)

The information in the following RAIs is needed to verify compliance with 10 CFR Part 63.114.

RAI #1

Provide a transparent technical basis to demonstrate that the event trees and fault trees used to calculate the early failure probabilities of the waste package and drip shield adequately represent all potentially significant failure sequences.

(a) Provide additional justification for how DOE identifies potential event sequences that could lead to early failure of the waste package or drip shield and the criteria used to exclude event sequences from further analysis in the associated event trees.

(b) Provide additional justification for how DOE considers nominal human actions in the processes identified in SNL (2007a), sections 6.3 and 6.4. State what human actions, if any, were excluded from the event sequences, and provide the criteria used as bases for these exclusions.

Basis: In SAR Section 2.3.6.6.3.2, DOE states that probability for early failure of the waste package was determined by event tree/fault tree analysis using the specific event trees and fault trees found in SNL (2007a). Similar methodology was used to calculate the probability for early failure of the drip shield, as stated in SAR, Section 2.3.6.8.4.3.2. The technical basis for identifying the actions in these analyses does not adequately describe how DOE identifies the selected sets of actions in the event sequences and how DOE excludes other potential actions from the event sequences. In addition, although DOE has identified processes that could lead to early failure (SNL, 2007a, Sections 6.3 and 6.4), DOE must justify why it excluded nominal human actions (i.e., those that do not lead directly to waste package and drip shield defects) that could contribute to reliabilities for the six identified processes.

RAI #2

Clearly state why the sum of the means of the probability distributions for the respective undetected defects that could lead to early failure do not equal the mean of the overall probability distributions for undetected defects in the waste package and drip shield (i.e., the early failure probabilities).

<u>Basis</u>: In SAR, Sections 2.3.6.6.3.2.1-2.3.6.6.3.2.6, DOE provides the mean values of the probability distributions for the six events that could lead to early failure of the waste package. The sum of the means of the probability distributions for these six events does not equal the mean value for the overall probability of an undetected error in the waste package (i.e., the early

failure probability), which is given in SAR, Section 2.3.6.6.3.2.7. The same statement is true for the drip shield (where there are four events that could lead to early failure), referencing SAR, Sections 2.3.6.8.4.3.2.1-2.3.6.8.4.3.2.5.

RAI #3.

Justify use of the following data, given in SNL (2007a), to calculate the early failure probabilities:

(a) Use of the value from Swain and Guttmann (1983, Item 2, Table 20-10) for the events

(i) CHECK_BM_FLAW in the event tree for evaluating improper base metal selection for the waste package outer corrosion barrier

(ii) WELD_FILLER_ISP-WP in the event tree for evaluating weld filler material defects in the waste package outer corrosion barrier

(iii) CHECK_BM_FLAW_DS in the event tree for evaluating improper base metal selection for the drip shield

(iv) WELD_FILLER_ISP-DS in the event tree for evaluating weld filler material defects in the ~~waste package outer corrosion barrier~~ drip shield.

Basis: These events are recovery actions that correct the failure of the prior event in the respective sequences. It may be more appropriate to use Swain and Guttmann (1983, Table 20-22). The events are used for the probability calculations found in SAR, Sections 2.3.6.6.3.2.1-2.3.6.6.3.2.6 for waste package early failure probability and SAR Sections 2.3.6.8.4.3.2.1-2.3.6.8.4.3.2.4 for drip shield early failure probability.

(b) Use of the low mean values from Benhardt et al., (1994) for the events

(i) HT_OPERATOR_ERROR in the event tree for evaluating improper heat treatment of the waste package outer corrosion barrier;

(ii) SNORKEL_ATTACHMENT_FAIL in the event tree for evaluating improper heat treatment of the waste package outer corrosion barrier

(iii) HT_OPERATOR_ERROR in the event tree for evaluating improper heat treatment of the waste package outer corrosion barrier lid

(iv) WP-LPB-OPERATOR in the event tree for evaluating low-plasticity burnishing treatment of the waste package outer corrosion barrier lid

(v) HT_DS in the event tree for evaluating improper heat treatment of the drip shield

(vi) HT_OPERATOR_ERROR in the event tree for evaluating improper heat treatment of the drip shield

(vii) DS_EMP_ANN in the event tree for evaluating improper emplacement of the drip shield

Basis: Because DOE has not provided a detailed analysis of factors such as equipment design, operating environment, and operator training, it may be more appropriate to use nominal mean values from Benhardt et al., (1994). DOE should justify the use of low mean values. The events are used for the probability calculations found in SAR, Sections 2.3.6.6.3.2.1-2.3.6.6.3.2.6 for waste package early failure probability and SAR, Sections 2.3.6.8.4.3.2.1-2.3.6.8.4.3.2.4 for drip shield early failure probability.

RAI #4

Provide a criterion-based definition of what constitutes handling damage of the waste package, which supports the early failure scenario in the performance assessment.

Basis:

In SAR, Section 2.3.6.6.3.2.6, DOE defines handling damage as "…visible gouging or denting of the waste package surface that may jeopardize the performance of the Alloy 22 outer corrosion barrier." This definition does not provide a technical basis to determine what level of handling damage may affect the postclosure performance of the waste package, for either the early failure or nominal scenario. Elsewhere (SNL, 2007b), DOE specifies that potential scratches (i.e., removal of material) should be limited to a depth of 1.6 mm, and dents (i.e., displacement of material without removal) should have a width of at least five times the depth. There is no clearly specified technical basis that demonstrates potential damage at or below these thresholds would not affect performance significantly, or determines that damage at or exceeding these thresholds would result in conditions used for the early failure scenario in the performance assessment.

RAI #5

Provide additional justification for the probability value for a camera not detecting damage to an emplaced waste package.

Basis:
DOE proposes to use a camera to remotely detect damage to the waste package surface that may occur during emplacement (SNL, 2007a, as referenced in SAR, Section 2.3.6.6.3.2.6). For the probability that the damage is not detected, DOE gives a mean value of 2.50×10^{-3} and error factor of 3. This value is defined as a human error event with a value taken from Swain and Guttmann (1983): the "error of commission in check-reading analog meter." DOE has not sufficiently justified how the error probability for "check-reading analog meter" appropriately estimates the error in using a camera to examine the waste package surface for damage. In addition, the error estimate has not considered the potential for mechanical failure of the camera or such factors as a partially degraded visual image. The error estimate and associated

uncertainty also does not account for the potential inability of the camera to visualize the entire waste package surface, including the part resting on the pallet.

RAI #6

Describe follow-up actions that will be taken if damage to the waste package is remotely detected with the camera, and justify the expected reliability of such actions, if warranted.

Basis:
In SNL (2007a), as referenced in SAR, Section 2.3.6.6.3.2.6, DOE does not describe actions that will be taken if damage to the waste package that may occur during emplacement is visually detected. If DOE relies on the likelihood of damage correction to support the postclosure performance assessment, then the technical basis should be developed for the corrective actions and associated reliabilities of such actions.

RAI #7

Provide additional justification for using nuclear fuel assembly handling as an analogue for estimating the probability of waste package damage during handling and emplacement.

Basis:
To evaluate the probability of damage during waste package emplacement, DOE used damage to nuclear fuel assemblies during their handling as an analogue because "…fuel assembly-handling activities are performed in a nuclear environment representative of the highly controlled conditions under which handling of the waste package is expected to occur" (SNL 2007a, as referenced in SAR Section 2.3.6.6.3.2.6). However, waste package handling during emplacement will involve numerous above-ground and underground operations that are not encountered during fuel assembly handling. DOE has not provided an appropriate technical basis to conclude that: (i) the tasks, in terms of type and complexity, associated with waste package emplacement are analogous to fuel assembly handling and (ii) the operating environment in the repository during emplacement is comparable to that in which fuel assemblies are handled in a nuclear power plant.

RAI #8

Provide additional justification for the calculated probability of drip shield emplacement failure.

Basis:
The only emplacement error that DOE identified for the drip shield is improper interlocking between adjacent plates such that there is a gap (SNL 2007a, as referenced in SAR, Section 2.3.6.8.4.3.2.4). DOE intends to use a camera to remotely monitor the emplacement of the drip shields. Concerns about how this action will be reliably estimated are contained in RAI 5.

Additionally, each event in the DOE event sequence that leads to improper drip shield emplacement is a human error event. DOE apparently assumes that no equipment or mechanical errors will occur during drip shield emplacement. This assumption should be supported by a technical basis that demonstrates mechanical or equipment reliability is not a significant component of the drip shield emplacement failure analysis.

References

Benhardt, H.C., Eide, S.A., Held, J.E., Olsen, L.M., and Vail, R.E. 1994. Savannah River Site Human Error Data Base Development for Nonreactor Nuclear Facilities (U). WSRC-TR-93-581. Aiken, South Carolina: Westinghouse Savannah River Company.

SNL (Sandia National Laboratories). 2007a. Analysis of Mechanisms for Early Waste Package/Drip Shield Failure. ANL-EBS-MD-000076 REV 00. Las Vegas, Nevada: Sandia National Laboratories.

SNL 2007b. Total System Performance Assessment Data Input Package for Requirements Analysis for DOE SNF/HLW and Naval SNF Waste Package Overpack Physical Attributes Basis for Performance Assessment. TDR-TDIP-ES-000009 REV 00. Las Vegas, Nevada: Sandia National Laboratories.

Swain, A.D. and Guttmann, H.E. 1983. Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications Final Report. NUREG/CR-1278. Washington, D.C.: U.S.