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YUCCA MOUNTAIN – SUPPLEMENTAL RESPONSES – REQUEST FOR ADDITIONAL INFORMATION (RAI) –VOLUME 2, CHAPTER 2.1.1.3, SET 3, AND CHAPTER 2.1.1.4, SET 8 (U.S. DEPARTMENT OF ENERGY'S SAFETY ANALYSIS REPORT SECTIONS 1.6 AND 1.7) – Identification of Hazards and Initiating Events and Identification of Event Sequences

References:
1. Ltr, Jacobs to Williams, dtd 4/09/09, "Yucca Mountain - Request For Additional Information – Volume 2, Chapter 2.1.1.3, Set 3 (U.S. Department of Energy's Safety Analysis Report Sections 1.6 and 1.7)"

2. Ltr, Williams to Jacobs, dtd 7/31/09, "Yucca Mountain – Request For Additional Information –Volume 2, Chapter 2.1.1.3, Set 3 (U.S. Department of Energy's Safety Analysis Report Sections 1.6 and 1.7) - Identification of Hazards and Initiating Events

3. Ltr, Jacobs to Williams, dtd 6/24/09, "Yucca Mountain - Request For Additional Information – Volume 2, Chapter 2.1.1.4, Set 7, Set 8 & Set 9 (Department of Energy's Safety Analysis Report Section 1.7)"

4. Ltr, Williams to Jacobs, dtd 9/22/09, "Yucca Mountain – Request For Additional Information – Volume 2, Chapter 2.1.1.4, Set 8 (Department of Energy's Safety Analysis Report Section 1.7) – Identification of Event Sequences

The purpose of this letter is to transmit the U.S. Department of Energy's (DOE) supplemental responses to four Requests for Additional Information (RAI) provided by the Nuclear Regulatory Commission during a public teleconference held on November 5, 2009. Question Number 2 relates to RAI Number 10 from Chapter 2.1.1.3 Set 3, transmitted by Reference 1. The original DOE response was provided by Reference 2. Question Numbers 1, 3, and 4 relate to RAI Number 4 from Chapter 2.1.1.4 Set 8, transmitted by Reference 3. The original DOE response was provided by Reference 4.

The DOE response to Question Number 1 from RAI Number 4 of Chapter 2.1.1.4 Set 8 contains two attachments provided on Optical Storage Media (OSM), as Enclosure 5.

NMSS25

There is one commitment in the supplemental response to Question 1. If you have any questions regarding this letter, please contact me at (202) 586-9620, or by email to jeff.williams@rw.doe.gov.

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OTM:SEG-0199

Enclosures (5):

1. Supplemental Response to Question 1 (RAI Volume 2, Chapter 2.1.1.4, Set 8, Number 4
2. Supplemental Response to Question 2 (RAI Volume 2, Chapter 2.1.1.3, Set 3, Number 10
3. Supplemental Response to Question 3 (RAI Volume 2, Chapter 2.1.1.4, Set 8, Number 4
4. Supplemental Response to Question 4 (RAI Volume 2, Chapter 2.1.1.4, Set 8, Number 4
5. Optical Storage Media – DVD containing two attachments

cc w/enclosures 1 through 4:
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<u>EIE Document Components:</u>

Supplemental_Question_1_Attachment_1.pdf	93 kB
Supplemental_Question_1_Attachment_2.pdf	93 kB

RAI Volume 2, Chapter 2.1.1.4, Eighth Set, Number 4, Supplemental Question 1:

Given the apparently limited margin for error associated with categorization of event sequences involving loss of shielding due to operator errors (e.g., ESD18) and potentially high dose rates associated with worker exposure to unshielded canisters, it is not clear whether the DOE plans to implement engineered or procedural measures to ensure worker doses are kept as low as reasonably achievable (RAIs 2.2.1.1.3-3-014 and 2.2.1.1.4-8-004). Clarify what engineered or procedural measures, if any, address the potential for worker exposure reflected in event sequence ESD18 and analogous event sequences.

1. RESPONSE

The preclosure safety analysis (PCSA) presented in SAR Section 1.6.1 describes the iterative process implemented among the PCSA, engineering, and operations organizations to attain an acceptable event sequence categorization that fully meets the requirements of 10 CFR Part 63. The DOE set and achieved the objective of demonstrating that no event sequences exceeded the Category 1 event sequence screening threshold, thereby screening out the potential for direct worker exposure beyond occupational limits. The PCSA demonstrated that ESD18 event sequences (i.e., ESD18-DSTD-SEQ2, ESD18-TAD-SEQ2, ESD18-HLW-SEQ2, and ESD18-DPC-SEQ2) involving loss of shielding due to operator error and/or equipment failure in the Canister Receipt and Closure Facility (CRCF) are Category 2. The calculated frequencies for these event sequences are based on engineered features, procedural safety controls, and other administrative controls modeled in the fault trees. The fault trees were developed with those design features and controls necessary to achieve acceptable levels of categorization, focusing primarily on engineered features that control the occurrence of an unshielded canister, even though a worker must also be present to obtain an unwanted exposure. Achieving that objective did not necessitate modeling of all administrative controls and engineered features available to control worker access to areas of potential exposure to an unshielded canister. In addition, conservative failure probability screening values were used for some human reliability basic events. Because no Category 1 event sequences resulted, these screening values were not further refined and the results remain conservative.

Table 1 describes the operations associated with ESD18 along with the engineered features and procedural administrative controls implemented to protect workers from being exposed to unshielded canisters. Based on these features and controls, the fault tree models for ESD18 have been updated to include the significant contributors to the event sequence frequencies and to take into account the following:

- Design features and administrative access controls for high radiation areas as part of the ALARA program, which are consistent with Regulatory Guide 8.38, that would need to be circumvented or violated before a worker could gain access to an area that could lead to exposure;
- Updated number of demands, where a demand is an operation that could result in an opportunity for exposure (i.e., an unshielded canister) summarized in Table 3, considering a conservative 100% staging (rather than the expectation of less than 20%) of

DOE standardized spent nuclear fuel (SNF) canisters, HLW canisters, and multicanister overpacks (MCOs);

- Normalizing the basic events to a "per demand" failure probability; in particular, those associated with programmable logic controller (PLC) hourly failure probability.

The details and rationale for these updates are provided in Table 2, and the updated fault trees are provided in Attachment 1. Based on these updates, event sequence frequencies for ESD18 remain in Category 2 with a maximum frequency of 0.4, as summarized in Table 4, without reliance on additional engineered features. The results presented in Table 4 combine previously separated waste forms (i.e., HLW canisters with DOE standardized SNF canisters and MCOs; transportation, aging, and disposal (TAD) canisters with dual purpose canisters).

To provide additional defense-in-depth, and to ensure that there is a larger margin between these event sequence frequencies (ESD18) and the Category 1 event sequence threshold, the existing important to safety (ITS) interlock that prevents opening the port slide gate unless the canister transfer machine (CTM) shield skirt is lowered will be modified to also prevent raising the CTM shield skirt if any port slide gate is open. This interlock acts in concert with the CTM bell slide gate/shield skirt interlock to prevent energizing the CTM trolley motor unless (1) the CTM bell slide gate is closed and then (2) the CTM shield skirt is raised. This interlock will now prevent premature port slide gate opening without the shield skirt lowered over the port and prevent movement of the CTM bell and shield skirt away from the port unless the port slide gates are closed. Modeling the modified port slide gate/CTM shield skirt interlock in the fault trees, direct exposure event sequences during canister transfer operations are more than two orders of magnitude below the Category 1 event sequence threshold, as summarized in Table 4. The updated fault trees, taking into account the modified port slide gate/CTM shield skirt interlock are provided in Attachment 2 for ESD18-TMP-SHLD-LOSS and ESD18-TMP-SHLD-LOSS-DSTD. This same modification will be applied to the design of the Receipt Facility (RF), the Wet Handling Facility (WHF), and the Initial Handling Facility (IHF).

The DOE will review analogous direct exposure event sequences in the CRCF, the RF, the WHF, and the IHF to ensure that such event sequences are properly evaluated. If necessary, design features and operational controls will be included in the models and added to the design to achieve margins to the Category 1 event sequence threshold similar to those for ESD18.

2. COMMITMENTS TO NRC

The DOE commits to update the license application as described in Section 3. The changes will be included in a future license application update.

3. DESCRIPTION OF PROPOSED LA CHANGE

Update the event sequence frequencies for ESD18 in SAR Table 1.7-11 and the waste form throughputs in SAR Table 1.7-5. Modify appropriate SAR figures for CTM and port slide gate logic diagrams to reflect the modified function of the existing ITS interlock that prevents opening the port slide gate unless the CTM shield skirt is lowered to also prevent raising the CTM shield skirt if any port slide gate is open.

4. REFERENCES

BSC (Bechtel SAIC Company) 2009. *Canister Receipt and Closure Facility Reliability and Event Sequence Categorization Analysis*. 060-PSA-CR00-00200-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20090112.0004.

Regulatory Guide 8.38, Rev. 1. 2006. *Control of Access to High and Very High Radiation Areas in Nuclear Power Plants*. Washington, D.C.: U.S. Nuclear Regulatory Commission. ACC: MOL.20071030.0095.

Table 1. Canister Receipt and Closure Facility Canister Transfer Operations and Features to Protect Workers from Direct Exposure

Step No.	Operation	Design Features that Protect Against Worker Direct Exposure	Administrative Controls that Protect against Worker Direct Exposure
1.	Delivery of cask transfer trolley or site transporter, holding a TC or AO, into a cask unloading room	1. Each cask unloading room (Rooms 1023 and 1024) and waste package positioning room (Rooms 1018 and 1019) have a transfer port slide gate providing access to the canister transfer room (Room 2004) and a shield door providing access to either the cask preparation room (Room 1026) or the waste package loadout room (Room 1015). 2. An interlock prevents the transfer port slide gate from opening until the shield door to the preparation or loadout room is closed; likewise, the shield door cannot be opened if the transfer port slide gate is open.	Procedures consistent with Regulatory Guide 8.38 that control worker access to the canister transfer room, cask unloading room, and waste package positioning room during transfer operations. Procedural Safety Control 13 (SAR Table 1.9-10) requires that port slide gates are verified to be closed at the completion of a canister transfer operation that uses the port.
2.	Positioning of a TC or AO in a cask unloading room with lid removed	1. An interlock prevents the CTM slide gate from opening unless the CTM skirt is lowered in place. 2. An interlock prevents opening of the transfer port slide gate unless the CTM shield skirt is lowered, and for AOs the CTM is centered over the transfer port slide gate. 3. An interlock prevents the transfer port slide gate from opening until the shield door to the preparation room is closed; likewise, the shield door cannot be opened if the port slide gate is open.	
3.	Lifting of a canister from an AO, TC, or staging rack	1. A CTM centered switch is interlocked to the transfer port or TAD canister staging rack slide gates to prevent the gates from opening without the CTM centered in place. 2. An interlock prevents the CTM slide gate from opening unless the CTM skirt is lowered in place. 3. An interlock prevents the transfer port or staging rack slide gates from opening unless the CTM shield skirt is lowered and in place. 4. An interlock prevents the transfer port slide gate from opening until the shield door to the preparation room is closed; likewise, the shield door cannot be opened if the transfer port slide gate is open.	
4.	Movement of the CTM	1. A modification to an interlock to prevent the CTM shield skirt from being lifted until the transfer port or staging rack slide gate is closed. 2. An interlock prevents raising the CTM shield skirt when the CTM slide gate is open. 3. An interlock prevents CTM movement when the CTM shield skirt is lowered.	
5.	Lowering of a canister into a staging area or a WP in the waste package positioning rooms	1. A CTM shield skirt-in-place switch is interlocked to the transfer port or staging rack slide gate to prevent the gates from opening without the CTM in place. 2. An interlock prevents the CTM slide gate from opening unless the CTM skirt is lowered in place. 3. An interlock prevents opening of the transfer port or staging rack slide gates unless the CTM shield skirt is lowered in place.	

Step No.	Operation	Design Features that Protect Against Worker Direct Exposure	Administrative Controls that Protect against Worker Direct Exposure
		4. An interlock prevents the transfer port slide gate from opening until the shield door to the loadout room is closed; likewise, the shield door cannot be opened if the transfer port slide gate is open. 5. A modification to an interlock to prevent the CTM shield skirt from being lifted until the transfer or staging port slide gate is closed. 6. An interlock prevents the transfer port slide gate from opening unless the WPTT (with shield ring) is present. 7. For TAD WPs, an interlock prevents the transfer port slide gate from opening unless the TAD WP is present.	

NOTE: AO = aging overpack; TC = transportation cask; WP = waste package; WPTT = waste package transfer trolley.

Table 2. List of Updates and Basic Events for ESD18

Basic Event Title	Basic Event Description	Current Failure Probability	Updated Failure Probability	Rationale for Update
060-OPFAILSG-HFI-NOD	Operator fails to close CTM slide gate with can in bell	1.00×10^{-3}	1.00×10^{-3}	No change.
060-SLDGATE-IEL-FOD	CTM Slide gate interlock fails (cannot move CTM if CTM slide gate is open)	2.75×10^{-5}	2.75×10^{-5}	No change to basic event failure probability. The basic event description has been modified by adding "cannot move CTM if CTM slide gate open" to improve clarity.
060-OPDIREXPOSE1-HFI-NOD	Operator violates admin control and enters canister transfer room	NA	9.00×10^{-4}	This basic event represents the probability of a worker violating the radiation protection program including procedures, signs, and alarms and enters the canister transfer room during canister handling operations (BSC 2009, Eq. E-35).
060-OPDIREXPOSE3-HFI-NOD	Operator violates admin control and opens shield door during transfer	NA	9.00×10^{-4}	This basic event represents the probability of a worker violating the radiation protection program, including procedures, signs, and alarms, and attempts to open the shield door during canister transfer operations (BSC 2009, Eq. E-35).
060-OPDIREXPOSE2-HFI-NOD	Operator fails to stage WP or AO – direct exposure	1.00×10^{-4}	1.00×10^{-4}	No change in probability value. The description of this basic event has been changed to reflect failing to stage a WP for ESD18-TMP-SHLD-LOSS-DSTD, or failing to stage a WP or an AO for ESD18-TMP-SHLD-LOSS.
060-CR---IEL00A--IEL-FOD	Interlock A from port slide gate fails	2.75×10^{-5}	2.75×10^{-5}	No change.
060-CR---IEL00B--IEL-FOD	Interlock B from port slide gate fails	2.75×10^{-5}	2.75×10^{-5}	No change.
060-CR---IELCCF--IEL-CCF	Common cause failure of interlocks from port slide gate	1.29×10^{-6}	1.29×10^{-6}	No change.
060-PROB-AO	Probability of AO in process	4.60×10^{-1}	NA	This basic event has been deleted based on a conservative assumption that an AO or a WP is always in process.
060-CR-CASK-UNLOADING	Canister is exposed during mid-unloading	1.00	NA	This basic event has been deleted. The deletion does not affect the fault tree because it is a basic event with a probability of one tied to an AND gate.

Basic Event Title	Basic Event Description	Current Failure Probability	Updated Failure Probability	Rationale for Update
060-PORTSLIDEGTE-IEL-FOD	Port slide gate interlock fails (WP or AO present)	2.75×10^{-5}	2.75×10^{-5}	No change. The basic event description has been modified by addition of "WP or AO present" to improve clarity.
060-OPFAILRSTINT-HFI-NOM	Operator fails to reset interlock after maintenance	1.00×10^{-2}	1.00×10^{-2}	No change.
060-OPSTAGERACK1-HFI-NOD	Exposure due to Operator failure during canister staging	3.00×10^{-5}	NA	This basic event has been changed to an AND gate to allow for taking into account the probability of a worker violating the radiation protection program.
060-OPFAIL-CAN-STAGE	Operator failure during canister staging	NA	3.00×10^{-5}	This basic event represents the probability of operator failing to close a staging port slide gate after a canister has been staged. It is assigned the same failure probability as 060-OPSTAGERACK1-HFI-NOD.
060-CR---IESKT--IEL-FOD	Skirt interlock fails (cannot open port slide gate if skirt is up)	2.75×10^{-5}	2.75×10^{-5}	No change to basic event failure probability. Basic event description has been changed to reflect the modification of the existing ITS interlock that prevents opening the port slide gate unless the CTM shield skirt is lowered to also prevent raising the CTM shield skirt if any port slide gate is open
060-CR-M-IESKT--IEL-FOD	Skirt interlock fails (cannot open gate if skirt is up or raise skirt if port is open)	2.75×10^{-5}	2.75×10^{-5}	No change to basic event failure probability. Basic event description has been changed to reflect the modification of the existing ITS interlock that prevents opening the port slide gate unless the CTM shield skirt is lowered to also prevent raising the CTM shield skirt if any port slide gate is open
060-OPCTMDIREXP1-HFI-NOD	Operator fails to close port slide gate before raising shield skirt	8.00×10^{-6}	8.00×10^{-3}	The failure probability and description for this basic event have been changed to represent only the operator failure to close the port slide gate before lifting the shield skirt without credit for the radiation protection program. Credit for administrative controls that protect against worker direct exposure is taken in a separate basic event (060-OPDIREXPOSE1-HFI-NOD), which is tied to an AND gate along with this basic event.
060-OPSHSKTEXP1-HFI-NOD	Operator fails to lower shield skirt before opening port slide gate	NA	8.00×10^{-3}	This basic event represents the probability of operator failure to lower the CTM shield skirt before opening the port slide gate.

Basic Event Title	Basic Event Description	Current Failure Probability	Updated Failure Probability	Rationale for Update
060-CR---PLC001--PLC-SPO	Inadvertent signal sent due to PLC failure	3.65×10^{-7}	2.06×10^{-5} for ESD18-TMP-SHLD-LOSS-DSTD or 1.03×10^{-5} for ESD-TMP-SHLD-LOSS	The probability of this basic event has been changed to normalize the hourly PLC failure probability of 3.65×10^{-7} per hour with the number of demands. This basic event represents the probability of a spurious signal due to PLC failure from any of the seven port slide gates. This basic event conservatively assumes that unshielded canisters are continuously present in the staging areas as well as in the loading and unloading ports. For ESD18-TMP-SHLD-LOSS-DSTD, this failure probability per demand is (3.65×10^{-7} probability of failures/hour × 50 years × 365 days/year × 24 hours/day × 7 ports) / 54,208 demands = 2.06×10^{-5}. For ESD-TMP-SHLD-LOSS, this failure probability per demand is (3.65×10^{-7} probability of failures/hour × 50 years × 365 days/year × 24 hours/day × 2 ports / 30,934 demands = 1.03×10^{-5}.

NOTE: AO = aging overpack; DPC = dual-purpose canister; NA = not applicable; WP = waste package.

Table 3. Total Number of Demands (Exposure Opportunities) for Canister Transfer Operations

		Transfer Operations							
Canister Type	Number of Canisters	From TC	To WP	To AO	From AO	To SA	From SA	Total Transfer Operations	Total Demands
HLW Canister	9,801	1	1	–	–	1	1	4	39,204
DOE Standardized Canisters	3,300	1	1	–	–	1	1	4	13,200
MCOs	451	1	1	–	–	1	1	4	1,804
DPCs	346	1	–	1	–	–	–	2	692
TAD Canisters in Transportation Casks	6,978	1	1	1	1	–	–	4	27,912
TAD Canisters Loaded in WHF	1,165	–	1	–	1	–	–	2	2,330
Total	22,041	–							85,142

NOTE: AO = aging overpack; DPC = dual-purpose canister; SA = staging area; TC = transportation cask; WP = waste package.

Table 4. ESD18 Event Sequence Frequencies

Waste Form	Using Updated Fault Trees	Using Updated Fault trees with Modified Interlock
DOE Standardized SNF Canisters, HLW Canisters, and MCOs	4.0×10^{-1}	8.4×10^{-3}
TAD Canisters and DPCs	2.3×10^{-1}	4.8×10^{-3}

NOTE: DPC = dual-purpose canister; SNF = spent nuclear fuel.

RAI Volume 2, Chapter 2.1.1.3, Third Set, Number 10, Supplemental Question 2:

What is the significance of certain modeling assumptions which could increase or decrease the computed event sequence frequencies for categorization of event sequences involving loss of shielding due to operator errors (most of which were previously raised in RAI 2.2.1.1.3-3-010, but are also related to RAIs 2.2.1.1.3-3-014 and 2.2.1.1.4-8-004). Confirm or disconfirm each of the following postulates related to event sequence ESD18 and answer the question: What would be the combined effect on event sequence probability for ESD18?

(a) Postulate 1: There are two port slide gate operations per canister transfer, and any open port gate could expose a worker in the canister transfer room to the waste form below (in a loaded or partially unloaded transportation cask, a staging area, or a partially or fully loaded waste package).

Relevant sources to postulate: RAI 2.2.1.1.3-3-010, part b, bullet 2. "It is not clear how many times the port slide gate is operated per canister or object lifted in, for example, the CRCF ESD18 fault trees." Additional relevant source is discussion of basic events 060-OPCTMDirExp1-HFI-NOD and 060-OpStageRack1-HFI-NOD in Appendix E of *Canister Receipt and Closure Facility Reliability and Event Sequence Categorization Analysis* (BSC 2009).

(b) Postulate 2: For staged canisters, there are two canister transfers per loading operation (one into the staging rack and one out of the staging rack).

Relevant sources to postulate: Table 6.3-11 of *Canister Receipt and Closure Facility Reliability and Event Sequence Categorization Analysis* (BSC 2009).

(c) Postulate 3: 88% of the DOE standard canisters are staged and 20% of the high-level radioactive waste (HLW) canisters are staged.

Relevant sources to postulate: RAI 2.2.1.1.3-3-010, with respect to the difference between fault trees ESD18-TMP-SHLD-LOSS-DSTD and ESD18-TEMP-SHIELD-LOSS. Additional relevant source is discussion of basic events 060-OPCTMDirExp1-HFI-NOD and 060-OpStageRack1-HFI-NOD in Appendix E of *Canister Receipt and Closure Facility Reliability and Event Sequence Categorization Analysis* (BSC 2009).

(d) Postulate 4: None of the port slide gates are protected by an interlock to prevent raising the canister transfer machine (CTM) shield skirt or moving the CTM shield bell if the slide gate is open; thus, one may be able to move a CTM away from an open port.

Relevant sources to postulate: SAR Table 1.2.4-4. Additional relevant source is discussion of basic events 060-OPCTMDirExp1-HFI-NOD and 060-OpStageRack1-HFI-NOD in Appendix E of *Canister Receipt and Closure Facility Reliability and Event Sequence Categorization Analysis* (BSC 2009).

(e) Postulate 5: An individual may be present in the canister transfer room either because he/she violated administrative controls and entered the room (0.0009/transfer) or the supervisor failed to check the port gate position following transfer operations and a worker entered the room (0.003/transfer).

Relevant sources to postulate: RAI 2.1.1.3-3-010, with respect to the question regarding when operators enter the transfer room during normal activities for each of the waste forms being processed. Additional relevant source is discussion of basic events 060-OPCTMDirExp1-HFI-NOD and 060-OpStageRack1-HFI-NOD in Appendix E of *Canister Receipt and Closure Facility Reliability and Event Sequence Categorization Analysis* (BSC 2009).

1. RESPONSE

1.1 NUMBER OF OPERATIONS PER CANISTER TRANSFER

Postulate 1: There are two port slide gate operations per canister transfer, and any open port gate could expose a worker in the canister transfer room to the waste form below (in a loaded or partially unloaded transportation cask, a staging area, or a partially or fully loaded waste package).

The postulate is correct with additional clarification. There are two port slide gate operations that open a port per canister transfer. An open port slide gate could expose a worker in the canister transfer room if the open port is above a loaded or partially loaded staging area, an uncovered loaded or partially loaded transportation cask, an uncovered loaded aging overpack, or an uncovered loaded or partially loaded waste package.

The analysis documented in Section E6.5.3.4.5 of *Canister Receipt and Closure Facility Reliability and Event Sequence Categorization Analysis* (BSC 2009) did not consistently account for two port slide gate operations per canister transfer. The correct number of demands, where a demand is an operation that could result in an opportunity for exposure (i.e., an unshielded canister) is summarized in Table 3 of the response to the first supplemental question on RAI 2.2.1.1.4-8-004. Using the updated fault trees provided in the response to the first supplemental question on RAI 2.2.1.1.4-8-004, in conjunction with the correct number of demands per canister transfer, results in the same categorization (i.e., no Category 1 direct exposure event sequences).

1.2 NUMBER OF CANISTER TRANSFERS FOR STAGED CANISTERS

Postulate 2: For staged canisters, there are two canister transfers per loading operation (one into the staging rack and one out of the staging rack).

Postulate 3: 88% of the DOE standard canisters are staged and 20% of the HLW canisters are staged.

These postulates correctly reflect the analysis documented in *Canister Receipt and Closure Facility Reliability and Event Sequence Categorization Analysis* (BSC 2009). However, the analysis incorrectly used fault tree ESD18-TMP-SHLD-LOSS rather than ESD18-TMP-SHLD-LOSS-DSTD for the 20% of the HLW canisters.

Table 3 of the response to the first supplemental question on RAI 2.2.1.1.4-8-004 provides the number of demands conservatively considering 100% staging of DOE standardized spent nuclear fuel canisters, HLW canisters, and multicanister overpacks. Using the updated fault trees provided in the response to the first supplemental question on RAI 2.2.1.1.4-8-004, in conjunction with the correct number of canister transfers for staged canisters, results in the same categorization (i.e., no Category 1 direct exposure event sequences).

1.3 INTERLOCK BETWEEN PORT SLIDE GATE AND CANISTER TRANSFER MACHINE SHIELD SKIRT

> Postulate 4: None of the port slide gates are protected by an interlock to prevent raising the CTM shield skirt or moving the CTM shield bell if the slide gate is open; thus, one may be able to move a CTM away from an open port.

This postulate correctly reflects the design as described in the SAR. However, as committed to in the response to the first supplemental question on RAI 2.2.1.1.4-8-004, the existing important to safety interlock that prevents opening the port slide gate unless the CTM shield skirt is lowered will be modified to also prevent raising the CTM shield skirt if any port slide gate is open. This interlock acts in concert with the CTM bell slide gate/shield skirt interlock to prevent energizing the CTM trolley motor unless (1) the CTM bell slide gate is closed, and (2) the CTM shield skirt is raised. This interlock will prevent premature port slide gate opening without the shield skirt lowered over the port and prevent movement of the CTM bell and shield skirt away from the port unless the port slide gates are closed.

In conjunction with the other changes described in the response to the first supplemental question on RAI 2.2.1.1.4-8-004, the aforementioned modification of the interlock function adds significant margin (over two orders of magnitude) between the ESD18 event sequence frequencies and the Category 1 event sequence threshold.

1.4 ADMINISTRATIVE CONTROLS AND SUPERVISORY OVERSIGHT

> Postulate 5: An individual may be present in the canister transfer room either because he/she violated administrative controls and entered the room (0.0009/transfer) or the supervisor failed to check the port gate position following transfer operations and a worker entered the room (0.003/transfer).

This postulate is partially correct. The analysis documented in Section E6.5.3.4.5 of *Canister Receipt and Closure Facility Reliability and Event Sequence Categorization Analysis* (BSC 2009) demonstrates that the probability that a worker will violate administrative controls by entering the canister transfer room during canister transfer is 0.0009 per transfer.

As documented in Section E6.5.3.4.6 of the event sequence categorization analysis (BSC 2009), the probability of the supervisor failing to check the port gate position following transfer operations is 0.003 per transfer. This probability is not necessarily per canister transfer, nor does it imply that a worker enters the canister transfer room. The supervisor check occurs once all canisters are in their proper receptacle, such as a waste package that can contain up to six canisters. Nonetheless, the fault trees conservatively model this failure on a per canister transfer (demand) basis. The probability that a worker will enter the canister transfer room is conservatively omitted (i.e., assumed to be one) in several exposure opportunities in the current analysis. The updated fault trees provided in the response to the first supplemental question on RAI 2.2.1.1.4-8-004 demonstrate that taking into account the probability of a worker entering the canister transfer room during transfer operations results in the same categorization (i.e., no Category 1 direct exposure event sequences).

1.5 OVERALL EFFECT OF POSTULATES ON EVENT SEQUENCE PROBABILITIES

The updated ESD18 analysis provided in the response to the first supplemental question on RAI 2.2.1.1.4-8-004 demonstrates that taking into account the cumulative effect of all of the postulates in this RAI supplemental question results in the same categorization (i.e., no Category 1 direct exposure event sequences).

2. COMMITMENTS TO NRC

None.

3. DESCRIPTION OF PROPOSED LA CHANGE

None.

4. REFERENCES

BSC (Bechtel SAIC Company) 2009. *Canister Receipt and Closure Facility Reliability and Event Sequence Categorization Analysis*. 060-PSA-CR00-00200-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20090112.0004.

RAI Volume 2, Chapter 2.1.1.4, Eighth Set, Number 4, Supplemental Question 3:

It is not clear whether the approach of a throughput multiplier described in Attachment III of the response to RAI 2.2.1.1.4-8-004, a) excludes any initiating events, such as direct exposure initiated by operator error or fire, or b) whether this approach retains disaggregation by operational step.

1. RESPONSE

The maximum throughput multipliers described in Attachment III of the response to RAI 2.2.1.1.4-8-004 do not exclude any initiating events. The maximum throughput multipliers are associated with the number of demands for all event sequences including direct exposure event sequences initiated by operator error, system or component failures, or fire event sequences in all waste handling facilities with the exception of direct exposure event sequences in the buffer area of intrasite operations for the reasons detailed in Section 1.1 below. These throughput multipliers do not affect the level of aggregation considered in the preclosure safety analysis and are simply the ratio of the total throughput count for all canister types to the canister type with the maximum throughput count. The throughput count for a canister type is the number of canisters multiplied by the number of operations for those canisters.

1.1 FIRE EVENT SEQUENCES FOR INTRASITE OPERATIONS

The frequency of 0.3 for fire event sequence documented in *Intra-site Operations and BOP Reliability and Event Sequence Categorization Analysis* (BSC 2009, Table 6.8-3) represents the probability of a fire in the buffer area during the entire preclosure period without taking into account the presence of a waste form. Therefore, the waste form throughput multipliers do not apply to these fire event sequences.

Fire event sequences for intrasite operations are Category 2 event sequences and, therefore, calculation of worker dose for such event sequences is not required. Nonetheless, to illustrate the low consequences of such events, the maximum dose received by an individual working near a cask immersed in a fire is not expected to exceed 100 mrem per event.

1.1.1 Frequency Determination

The fire initiating event frequency for the buffer area is developed based on the methodology described in *Intra-site Operations and BOP Reliability and Event Sequence Categorization Analysis* (BSC 2009, Attachment F). Based on this methodology, fires for areas outside facilities are initiated by various activities associated with any one of the facilities. As described in the analysis (BSC 2009), the fire initiating event mean frequency is 9.2×10^{-4} per facility per year. With six facilities, the buffer area fire frequency per year is $9.2 \times 10^{-4} \times 6 = 5.5 \times 10^{-3}$ per year. The total expected number of buffer area fires over the 50-year preclosure period is $5.5 \times 10^{-3} \times 50 = 0.3$ fires. The mean frequency of fire in the buffer area is inclusive of all waste forms in the buffer area and all fire sizes. Large fires that could degrade shielding occur less frequently than smaller fires. Furthermore, workers would not normally be present in the buffer area so that incidents of exposure would be less than 0.3 over the 50-year preclosure period.

1.1.2 Potential Consequences

In order to comply with 10 CFR 71.51 requirements, the dose rate at 1 m from the external surface of a transportation cask in a loss of shielding due to a fire event must be demonstrated to be less than 1 rem/hr. A fire large enough to degrade shielding will discourage close approach (e.g., 1 m or less) by personnel. Even if hypothetical conditions are assumed such that a worker is exposed to direct radiation at 1 m from a cask immersed in a large fire in the buffer area with damaged neutron shielding for 5 minutes, the total dose received by the worker, which is dominated by the closest cask at 1 m, would be less than 100 mrem (1,000 mrem per hour × 0.08 hours). At 10 m from the cask, the total dose received by a worker for five minutes would be less than 10 mrem.

2. COMMITMENTS TO NRC

None.

3. DESCRIPTION OF PROPOSED LA CHANGE

None.

4. REFERENCES

BSC (Bechtel SAIC Company) 2009. *Intra-Site Operations and BOP Reliability and Event Sequence Categorization Analysis*. 000-PSA-MGR0-00900-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20090112.0008.

RAI Volume 2, Chapter 2.1.1.4, Eighth Set, Number 4, Supplemental Question 4:

The end-state frequency in the RAI response regarding Canister Receipt and Closure Facility event sequence ESD18, documented in Table 1 of the response to RAI 2.2.1.1.4-8-004, appears inconsistent with Table 1 in the response to RAI 2.2.1.1.3-3-010, which provided corrected values for cut set values that include failure to reset a bypassed interlock.

1. RESPONSE

The correct end-state frequencies for ESD18 in the Canister Receipt and Closure Facility are provided in the response to RAI 2.2.1.1.4-8-004, Supplemental Question 1.

2. COMMITMENTS TO NRC

None.

3. DESCRIPTION OF PROPOSED LA CHANGE

None.