RAI Volume 2, Chapter 2.1.1.5, First Set, Number 3:

Assess worker exposure to airborne radioactive material inside the Wet Handling Facility during normal operations. SAR Section 1.8.2.2.1 indicates that airborne releases of radionuclides are expected during normal operations in the Wet Handling Facility. Information is needed on

- Room locations for releases of radioactive material into the air from individual fuel assemblies during normal operations
- Indoor radionuclide concentrations in air during normal operations
- Worker access to these rooms during normal operations
- Indoor worker exposure to airborne radionuclides

1. RESPONSE

The assessment of potential worker exposure to airborne radioactive material in the Wet Handling Facility (WHF) during normal operations includes two sources of airborne radioactivity. One source of airborne radionuclides is from surface facility and subsurface facility airborne releases that subsequently enter the WHF through the ventilation intake as discussed in SAR Section 1.8.4.1.1. The second source is from resuspension of surface contamination when handling casks within the WHF as discussed in SAR Section 1.8.4.1.2. No airborne releases are expected from sealed canisters in surface facilities during normal operations, except for those opened in the WHF.

Surface facility airborne radionuclide releases occur primarily during WHF normal operations and from contamination resuspension from canisters located at the Aging Facility. Subsurface releases from normal repository operations are from resuspension of waste package surface contamination, and neutron activation of air and silica dust in the emplacement drifts. The airborne releases from the subsurface facility, Aging Facility, and WHF are discussed in SAR Sections 1.8.2.2.1 and 1.8.2.2.2. Airborne exposure to workers in the WHF arises from releases which originate in the WHF, subsurface facility, and Aging Facility; and subsequently enter the WHF ventilation intake. The WHF releases result from cutting open dual-purpose canisters (DPCs) and preparing transportation casks for lid removal. Commercial spent nuclear fuel assemblies containing failed fuel rods and/or crud deposits may release airborne radionuclides during the cooling or flushing (SAR Section 1.2.5.1.2.1) of a transportation cask or DPC (SAR Section 1.2.5.3.4.1.1) prior to opening these containers. The steam created by the cooling process exits the cask or DPC through vent piping into a liquid/gas separator vessel. The collected liquid is pumped back to the WHF pool water treatment system. The gaseous releases are routed directly to the heating, ventilation, and air-conditioning system, passing through the high-efficiency particulate air filters prior to discharge to the outside environment (SAR Section 1.2.5.2.3.2).

There are no unfiltered releases to the environment or releases directly into interior rooms of the WHF from its operations, thus there are no rooms with a direct release of radioactive material from individual fuel assemblies during normal operation. As further explained in the response to RAI 2.2.1.1.5-004, releases of fission gases from small cladding failures during the short time that the assemblies are in the pool would be insignificant.

The first source of potential worker exposure to airborne radionuclides in the WHF is from airborne releases that subsequently enter the WHF. As noted in SAR Section 1.8.4.1.1, the WHF releases that pass through the high-efficiency particulate air filters to the outside environment are conservatively modeled as if the discharged radionuclides reenter the WHF ventilation system intake. The indoor radionuclide concentrations within all rooms of the WHF, due to the WHF release and from the subsurface and Aging Facility releases, are conservatively assumed to be equal to the concentration at the ventilation system intake. Those concentrations are provided in Tables 1, 2, and 3 for the subsurface facility, Aging Facility, and WHF releases, respectively. The total annual potential WHF individual worker dose from these airborne releases from working 2,000 hours/year is estimated to be 15 mrem/yr (SAR Table 1.8-32).

The second source of potential worker exposure to airborne radionuclides in the WHF is from the release of surface contamination when handling sealed casks or canisters (SAR Section 1.8.4.1.2). The annual airborne potential dose to WHF workers due to this source is estimated to be 4 mrem/yr. The airborne equilibrium isotopic concentrations evaluated are the dominant beta/gamma emitting isotopes of ^{60}Co and ^{90}Sr at 4.4×10^{-7} μCi/m^3, and the dominant alpha-emitting isotopes of ^{239}Pu and ^{241}Am at 4.4×10^{-8} μCi/m^3. This analysis is applicable to rooms with workers present during cask and canister handling operations, including the transportation cask vestibule (Room 1001), loading room (Room 1007), cask preparation area (Room 1016), site transporter vestibule (Room 1023), and canister transfer room (Room 2004).

Workers can access all WHF rooms during normal operations without occupancy limitations associated with airborne radionuclides, based on the estimated concentrations of airborne radionuclides described above.

2. COMMITMENTS TO NRC

None.

3. DESCRIPTION OF PROPOSED LA CHANGE

None.

Table 1. WHF Indoor Radionuclide Concentrations from Subsurface Releases

	A	B
Radionuclide	**Release Rate (Ci/yr)**	**WHF Concentration (µCi/cc)**
^{28}Al	4.0×10^{-3}	7.3×10^{-16}
^{241}Am	4.9×10^{-5}	8.9×10^{-18}
^{243}Am	5.5×10^{-7}	1.0×10^{-19}
^{41}Ar	1.5×10^{1}	2.7×10^{-12}
^{243}Cm	2.6×10^{-7}	4.7×10^{-20}
^{244}Cm	3.4×10^{-5}	6.2×10^{-18}
^{60}Co	2.9×10^{-3}	5.3×10^{-16}
^{137}Cs	6.8×10^{-3}	1.2×10^{-15}
^{154}Eu	1.7×10^{-5}	3.1×10^{-18}
^{55}Fe	8.2×10^{-5}	1.5×10^{-17}
^{42}K	8.0×10^{-4}	1.5×10^{-16}
^{24}Na	3.7×10^{-3}	6.8×10^{-16}
^{63}Ni	6.3×10^{-6}	1.1×10^{-18}
^{147}Pm	3.0×10^{-6}	5.5×10^{-19}
^{238}Pu	5.7×10^{-5}	1.0×10^{-17}
^{239}Pu	4.4×10^{-6}	8.0×10^{-19}
^{240}Pu	7.9×10^{-6}	1.4×10^{-18}
^{241}Pu	6.2×10^{-4}	1.1×10^{-16}
^{31}Si	5.2×10^{-4}	9.5×10^{-17}
^{151}Sm	5.3×10^{-6}	9.7×10^{-19}
^{90}Sr	6.8×10^{-4}	1.2×10^{-16}
^{90}Y	6.8×10^{-4}	1.2×10^{-16}

NOTE: $[X/Q] = 5.76 \times 10^{-6}$ sec/m^3
c1 = 3.16×10^{7} sec/yr
c2 = 1.0×10^{6} cc/m^3
c3 = 1.0×10^{6} µCi/Ci

Col B = Col A * [X/Q] / c1 / c2 * c3

Table 2. WHF Indoor Radionuclide Concentrations from Aging Facility Releases

	A	B
Radionuclide	**Release Rate (Ci/yr)**	**WHF Concentration (uCi/cc)**
^{60}Co	2.9×10^{-2}	1.7×10^{-15}
^{241}Am	2.9×10^{-3}	1.7×10^{-16}

NOTE: $[X/Q] = 1.89 \times 10^{-6}$ sec/m^3
c1 = 3.16×10^{7} sec/yr
c2 = 1.0×10^{6} cc/m^3
c3 = 1.0×10^{6} µCi/Ci

Col B = Col A * [X/Q] / c1 / c2 * c3

Table 3. WHF Indoor Radionuclide Concentrations from WHF Releases

	A	B			A	B
Radionuclide	**Release Rate (Ci/yr)**	**WHF Concentration (µCi/cc)**		**Radionuclide**	**Release Rate (Ci/yr)**	**WHF Concentration (µCi/cc)**
^{241}Am	2.0×10^{-5}	1.2×10^{-15}		^{237}Np	4.7×10^{-9}	2.7×10^{-19}
^{242}Am	1.5×10^{-7}	9.0×10^{-18}		^{239}Np	4.7×10^{-7}	2.7×10^{-17}
^{242m}Am	1.6×10^{-7}	9.0×10^{-18}		^{231}Pa	1.0×10^{-12}	5.8×10^{-23}
^{243}Am	4.7×10^{-7}	2.7×10^{-17}		^{107}Pd	1.9×10^{-9}	1.1×10^{-19}
^{137m}Ba	1.2×10^{-3}	7.1×10^{-14}		^{147}Pm	1.1×10^{-4}	6.6×10^{-15}
^{14}C	1.1	6.6×10^{-11}		^{144}Pr	9.3×10^{-7}	5.4×10^{-17}
^{113m}Cd	2.8×10^{-7}	1.6×10^{-17}		^{238}Pu	5.5×10^{-5}	3.2×10^{-15}
^{144}Ce	9.3×10^{-7}	5.4×10^{-17}		^{239}Pu	2.9×10^{-6}	1.7×10^{-16}
^{36}Cl	1.9×10^{-2}	1.1×10^{-12}		^{240}Pu	6.9×10^{-6}	4.0×10^{-16}
^{242}Cm	1.3×10^{-7}	7.5×10^{-18}		^{241}Pu	8.5×10^{-4}	4.9×10^{-14}
^{243}Cm	3.0×10^{-7}	1.7×10^{-17}		^{242}Pu	3.8×10^{-8}	2.2×10^{-18}
^{244}Cm	5.0×10^{-5}	2.9×10^{-15}		^{106}Ru	4.9×10^{-6}	2.8×10^{-16}
^{245}Cm	4.9×10^{-9}	2.8×10^{-19}		^{125}Sb	6.5×10^{-6}	3.8×10^{-16}
^{246}Cm	2.3×10^{-9}	1.3×10^{-19}		^{79}Se	1.1×10^{-9}	6.2×10^{-20}
^{60}Co	1.5×10^{-1}	8.9×10^{-12}		^{151}Sm	3.6×10^{-6}	2.1×10^{-16}
^{134}Cs	4.7×10^{-4}	2.7×10^{-14}		^{126}Sn	8.7×10^{-9}	5.0×10^{-19}
^{135}Cs	6.5×10^{-8}	3.8×10^{-18}		^{90}Sr	9.0×10^{-4}	5.2×10^{-14}
^{137}Cs	8.7×10^{-3}	5.0×10^{-13}		^{99}Tc	2.1×10^{-7}	1.2×10^{-17}
^{154}Eu	4.2×10^{-5}	2.4×10^{-15}		^{230}Th	1.7×10^{-12}	9.6×10^{-23}
^{155}Eu	1.0×10^{-5}	6.0×10^{-16}		^{232}U	4.7×10^{-10}	2.7×10^{-20}
^{55}Fe	2.7×10^{-1}	1.5×10^{-11}		^{234}U	1.3×10^{-8}	7.5×10^{-19}
^{3}H	5.7×10^{2}	3.3×10^{-8}		^{235}U	1.1×10^{-10}	6.6×10^{-21}
^{129}I	5.0×10^{-2}	2.9×10^{-12}		^{236}U	4.0×10^{-9}	2.3×10^{-19}
^{85}Kr	6.3×10^{3}	3.7×10^{-7}		^{238}U	3.4×10^{-9}	2.0×10^{-19}
^{93m}Nb	8.5×10^{-9}	4.9×10^{-19}		^{90}Y	9.0×10^{-4}	5.2×10^{-14}
^{94}Nb	1.4×10^{-12}	8.0×10^{-23}		^{93}Zr	1.9×10^{-8}	1.1×10^{-18}

NOTE: $[X/Q] = 1.8 \times 10^{-3}$ sec/m^3
c1 = 3.2×10^{7} sec/yr
c2 = 1.0×10^{6} cc/m^3
c3 = 1.0×10^{6} µCi/Ci

Col B = Col A * [X/Q] / c1 / c2 * c3

RAI Volume 2, Chapter 2.1.1.5, Second Set, Number 4:

Clarify the statement in SAR Section 1.8.3.1.2 (Normal Operations Surface Facility Releases) that onsite public doses are based on ground level releases. If the airborne TEDE doses presented in Tables 1.8-28 and 1.8-32 are derived from elevated vent release points, provide the heights used for the vents to perform the χ/Q calculations.

The airborne release TEDE values for workers in SAR Table 1.8-28 and for the onsite public in Table 1.8-32 appear to come from BSC (2008ak, Table 15). Table 15 is based on χ/Q values that appear to come from BSC (2007al, Table 32). BSC (2007al, Section 3.2.4) discusses the exit velocities for the various handling facilities and how ARCON96 compared exit velocities to wind speeds to determine the elevated release heights. BSC (2007al, Table 1) provides site elevations for the highest release points. BSC (2007al, Table 32) is the original average χ/Q calculations. These values are listed as the source for BSC (2008ak, Table 8) which is used for the dose calculations given in BSC (2008ak, Table 15). Table 15 is the source for SAR Tables 1.8-28 and 1.8-32 for the airborne TEDE values.

1. RESPONSE

The onsite public annual average atmospheric dispersion factors in SAR Table 1.8-13 are based on ground-level releases from only the aging pads and subsurface exhaust shafts. The remainder of the releases are from surface facilities and are modeled as elevated vent releases.

The airborne release total effective dose equivalent values for workers in SAR Table 1.8-28 and for the onsite public in Table 1.8-32 are determined from the χ/Q values in SAR Table 1.8-13 that are based on elevated vent releases from surface facilities as calculated in *GROA Airborne Release Dispersion Factor Calculation* (BSC 2007, Table 32). For the surface facilities, the dispersion factor calculation (BSC 2007, Section 3.2.4 and Table 1) provides ventilation discharge parameters including exit velocities and exhaust elevations for each release vent. The heights of the facility elevated vents used in determining the onsite atmospheric dispersion factors in SAR Table 1.8-13 are based on those exhaust vent elevations. Table 1 of this response presents the requested release vent height information used to determine the onsite χ/Q values in SAR Table 1.8-13 as tabulated in the dispersion factor calculation (BSC 2007, Attachment II, Worksheet "Exhaust" of spreadsheet "GROA XQ Calculation.xls").

Design development has resulted in small changes to the vent heights used in the dispersion factor calculation (BSC 2007). These changes are not expected to result in significant changes in the χ/Q values.

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

In SAR Section 1.8.3.1.2 (Normal Operation Surface Facility Releases), change the third sentence to indicate that for offsite public doses, releases due to normal surface operations are modeled as ground-level releases and for onsite public doses, releases are modeled as ground-level releases from the aging pads and as elevated vent releases from surface facilities.

Update SAR Table 1.8-13 to reflect revised χ/Q values as necessary.

4. REFERENCES

BSC (Bechtel SAIC Company) 2007. *GROA Airborne Release Dispersion Factor Calculation*. 000-PSA-MGR0-00600-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071213.0003.

Table 1. Vent Heights for Potential Releases from Surface Facilities

Facility[a]	Release Point Code[b]	Vent Height (Release Height Relative to Grade) (feet)
CRCF-1	060a	112
	060b	112
CRCF-2[c]	070a	112
	070b	112
CRCF-3[c]	080a	112
	080b	112
RF	200a	113
	200b	113
WHF	050a	125
	050b	60.5
IHF	51A	111
LLWF	160	90

NOTE: [a]CRCF = Canister Receipt and Closure Facility; IHF = Initial Handling Facility; LLWF = Low-Level Waste Facility; RF = Receipt Facility; WHF = Wet Handling Facility.
[b]The release point code is the facility area number with a lower case letter if there is more than one discharge per facility (BSC 2007, Table 1).
[c]In BSC 2007, CRCF 2 and CRCF 3 are assumed to be identical to CRCF 1.

Source: Worksheet "Exhaust" of spreadsheet "GROA XQ Calculation.xls" (BSC 2007, Attachment II).

RAI Volume 2, Chapter 2.1.1.6, Second Set, Number 5:

> Explain why a spurious command to lift or lower an aging overpack (AO) or shielded transfer cask (STC) could lead to the Site Transporter (ST) moving in the wrong direction, as shown in INT-2-ST-COLLISION - Site Transporter Collision fault tree (BSC 2008c Figure B2.4-3).
>
> In BSC 2008c Figure B2.4-3, DOE describes a collision fault tree that contains "ST Moves in Wrong Direction" (INT-6-ST-WRONG-DIR) that may be caused by "Direction Controller Fails" (ISO-ST-CT002_CT-FOH) or "Spurious Command to Lift/Lower AO or STC" (ISO-ST-HC002-HC-SPO). It is not clear how spurious command to lift/lower AO or STC will cause the ST to move in the wrong direction.

1. RESPONSE

The site transporter is a diesel/electric self-propelled tracked vehicle that is designed to transport an aging overpack between facilities and to and from the aging pads. It is also capable of transporting shielded transfer casks. The aging overpack is supported by two rear forks and each fork is supported at both ends during lifting, transfer, and lowering operations. The aging overpack is engaged by the site transporter by first inserting the two site transporter rear forks into the aging overpack bottom lift slots. The two front support arms of the site transporter are rotated to engage with the front end of the two rear forks as they emerge from the lift slots on the opposing side of the aging overpack. After ensuring that engagement is complete, the aging overpack is raised and the site transporter is ready for a transfer. The site transporter car body serves as the mounting point for the other systems of the site transporter and is in the load path to the ground of the forces that are applied to the site transporter. The car body travels on four track drive systems, two on each side of the car body.

In *Intra-Site Operations and BOP Reliability and Event Sequence Categorization Analysis* (BSC 2009, Figure B2.4-3), the fault tree titled "INT-2-ST-COLLISION" contains an "OR" gate titled "ST Moves in Wrong Direction" (INT-6-ST-WRONG-DIR). This gate may be caused by either a basic event titled "Direction Controller Fails" (ISO-ST---CT002---CT--FOH) or a basic event titled "Spurious Command to Lift/Lower AO or STC" (ISO-ST---HC002---HC--SPO).

When the "INT-2-ST-COLLISION" fault tree was prepared, it was judged that if one side of the aging overpack or shielded transfer cask could be spuriously lifted or lowered during site transporter movement, the suspended weight would be shifted to one side of the site transporter tracks. The weight shift could then potentially cause a slowing of the track movement on that side, thereby causing the site transporter to turn to that side, heading in the wrong direction. The contribution of this failure to the fault tree was captured in the basic event with a probability of 5.23×10^{-7} titled "Spurious Command to Lift/Lower AO or STC" (ISO-ST---HC002---HC--SPO).

Two design features preclude the site transporter moving in the wrong direction due to a shift in weight. First, the site transporter design incorporates a load-sharing subsystem. Specifically,

during the lift sequence, both the front support arms and the rear forks are monitored to ensure that the load is adequately shared and that no lift device is operating at less than full effectiveness. In addition, the track speed is monitored for proper coordination among the four track drives. Each track drive system is driven by its own electric motor through its own gear reduction and final chain drive reduction. During forward or reverse operations, the motors are synchronized. During turns, the outside tracks are driven faster, and for very sharp turns, the tracks are counter-rotated to turn the machine about its own vertical centerline. Load redistributions have no effect on the synchronization.

An examination of the "INT-2-ST-COLLISION" fault tree shows that the "Spurious Command to Lift/Lower AO or STC" basic event (failure probability of 5.23×10^{-7}) does not contribute significantly to the INT-6-ST-WRONG-DIR gate. This gate is dominated by the "Direction Controller Fails" (ISO-ST---CT002---CT--FOH) basic event (failure probability of 6.9×10^{-5}). In addition, the "Spurious Command to Lift/Lower AO or STC" basic event has a small contribution to the cutsets generated in the "INT-2-ST-COLLISION" fault tree (less than one percent), as seen in Table B2.4-2 of *Intra-Site Operations and BOP Reliability and Event Sequence Categorization Analysis* (BSC 2009).

Therefore, based on the load sharing controls and synchronization of track drives, this is a low-frequency basic event, which has a small contribution to the fault tree, and is consequently no longer considered a viable causal event.

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.