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ATTN: Document Control Desk
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YUCCA MOUNTAIN - REQUEST FOR ADDITIONAL INFORMATION - VOLUME 2, CHAPTER 2.1.1.5, SET 1 (DEPARTMENT OF ENERGY'S SAFETY ANALYSIS REPORT SECTION 1.8) – Consequence Analyses

Reference: Ltr, Jacobs to Williams, dtd 07/22/09, "Yucca Mountain - Request For Additional Information – Volume 2, Chapter 2.1.1.5, Sets 1 & 2 (Department of Energy's Safety Analysis Report Section 1.8)"

The purpose of this letter is to transmit the U.S. Department of Energy's (DOE) responses to three Requests for Additional Information (RAI), identified in the above-referenced letter. Each response to RAI numbers 1, 2, and 6 of Set 1 is provided as a separate enclosure (Enclosures 1 through 3). DOE has previously submitted the responses to RAI numbers 5 and 7 on August 21, 2009. The remaining responses from Set 1 will be submitted on or before November 5, 2009.

DOE references, not previously submitted to NRC, are provided on an optical storage media (OSM) as Enclosure 4. Additionally, an OSM, provided as Enclosure 5, contains electronic attachments. The electronic attachments contain complex data files that are required by NRC staff to evaluate DOE's responses. The electronic attachments are not intended to be accessed through ADAMS and will be made available to the public, upon request.

There are two commitments in the enclosed responses. One commitment is in the response to RAI number 1 and one commitment is in the response to RAI number 2. If you have any questions regarding this letter, please contact me at (202) 586-9620, or by email to jeff.williams@rw.doe.gov.

Steven E Gomlug (for)
Jeffrey R. Williams, Supervisor
Licensing Interactions Branch
Regulatory Affairs Division
Office of Technical Management

OTM: SEG-0002

NMSSaS

Enclosures (5):
1. Response to RAI, Volume 2, Chapter 2.1.1.5, Set 1, Number 1
2. Response to RAI, Volume 2, Chapter 2.1.1.5, Set 1, Number 2
3. Response to RAI, Volume 2, Chapter 2.1.1.5, Set 1, Number 6
4. Optical Storage Media – DVD containing nine references
5. Optical Storage Media – DVD containing electronic reference attachments

cc w/enclosures 1 through 4:
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EIE Document Components:

BSC (Bechtel SAIC Company). *GROA Airborne Release Dose Calculation.* 000-PSA-MGR0-01200-000-00C. 1,736 KB [Electronic data file included in Encl 5]

BSC (Bechtel SAIC Company) 2007. *Initial Handling Facility Worker Dose Assessment.* 51A-00C-IH00-00100-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. 7,139 KB [Electronic data file included in Encl 5]

BSC 2007. *Canister Receipt and Closure Facility #1 Worker Dose Assessment.* 060-00C-CR00-00100-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. 8,614 KB

BSC 2007. *Wet Handling Facility and Low-Level Waste Facility Worker Dose Assessment.* 050-00C-WH00-00200-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. 12,551 KB [Electronic data file included in Encl 5]

BSC 2007. *Subsurface Worker Dose Assessment.* 800-00C-SS00-00600-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. 2,162 KB [Electronic data file included in Encl 5]

BSC 2008. *Repository ALARA Goal Compliance.* 000-30R-MGR0-04000-000 Rev. 000. Las Vegas, Nevada: Bechtel SAIC Company. 1,237 KB

BSC 2008. *Worker Dose Estimate for a Nominal Throughput.* 000-30R-MGR0-03300-000 Rev. 001. Las Vegas, Nevada: Bechtel SAIC Company. 304 KB

BSC 2008. *Receipt Facility Worker Dose Assessment.* 200-00C-RF00-00100-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. 10,732 KB

BSC 2008. *Aging Facility and Site Worker Dose Assessment.* 000-00C-MGR0-04200-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. 2,024 KB [Electronic data file included in Encl 5]

RAI Volume 2, Chapter 2.1.1.5, First Set, Number 1:

Explain the discrepancies between worker organ dose results and total effective dose equivalent (TEDE), shown in SAR Tables 1.8-25 and 1.8-36.

In SAR Tables 1.8-25 and 1.8-36, DOE has listed worker TEDE of 1.3 rem and the maximum dose equivalent to an individual organ as <0.01 rem/yr. Effective dose equivalent is defined as a weighted sum of organ dose equivalents and organ weighting factors. Organ weighting factors are defined to sum to unity. Based on these definitions, it is not clear why worker dose for an individual organ (or tissue) is less than the TEDE.

1. RESPONSE

SAR Table 1.8-25 provides a summary of potential radiation worker doses from normal operations and Category 1 event sequences. The table lists four dose contributors (airborne releases from normal operations, direct radiation from external contained sources, direct radiation from normal operations within the facility, and doses from Category 1 event sequences) for four exposure categories (total effective dose equivalent, highest total organ dose equivalent, shallow dose equivalent to skin, and lens dose equivalent). An entry "NA" in a column of the table indicates that the potential dose contribution was not calculated for the column of interest.

The row labeled "Total" in SAR Table 1.8-25 contains the sums of only those contributions to an exposure category that were specifically calculated. These sums are not intended for demonstration of compliance with performance objectives. Thus, the totals in the columns for organs, (i.e., total organ, skin, and lens) include only the calculated contribution due to airborne releases from normal operations and exclude direct radiation contributions. Because the "Total" row contains only the sum of the doses reported in the table and does not represent an actual total dose, this row will be deleted.

SAR Table 1.8-36 contains dose results to demonstrate compliance with the preclosure performance objectives. In the row for the category "Radiation Workers Exposure," the whole-body dose equivalent contribution from direct radiation will be added to the results column for the "Limits" category "50 rem/yr organ or tissue dose other than the lens of the eye."

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 Table 1.8-25, delete the row "Total." In SAR Table 1.8-36, change the results entries to include the contribution from direct radiation in the row for the category "Radiation Workers Exposure."

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

Provide documentation of (a) dose calculations to support radiation worker dose results presented in SAR Section 1.8.4.2 and Table 1.8-25; (b) organ dose results (maximally exposed organ/tissue, lens of the eye, and shallow dose to the skin) for radiation workers presented in SAR Table 1.8-36. For example BSC (2008b) presents calculations of total effective dose equivalent for radiation workers in the Receipt Facility, but doses to individual organs are not calculated. Also, explain how different external radiation source terms used in the DOE worker dose assessments at other facilities affect the organ doses estimates, and identify the facility with the largest dose equivalent to an individual organ/tissue, lens of the eye, and shallow dose to the skin for radiation workers.

1. RESPONSE

1.1 DOCUMENTS SUPPORTING RADIATION WORKER DOSE RESULTS

SAR Section 1.8.4.2 provides the estimated maximum annual dose to an individual radiation worker in any surface or subsurface facility as 1.3 rem for a Receipt Facility (RF) operator. SAR Table 1.8-25 provides a summary of the potential dose contributions to the estimated maximally exposed radiation worker in the RF. The dose contributions include airborne radionuclide releases from normal operations, direct radiation from external contained sources from normal operations, and direct radiation within a facility from normal operations. The source for both SAR Table 1.8-25 and the value of 1.3 rem reported in SAR Section 1.8.4.2 is *Preclosure Consequence Analyses* (BSC 2008a, Table 65). Dose calculations supporting the values reported in Table 65 of the consequence analysis (BSC 2008a) are identified in the following sections.

1.1.1 Surface and Subsurface Airborne Releases from Normal Operations

Table 65 of the consequence analysis (BSC 2008a) references Table 13 of the same document for the whole body and organ dose contributions to the maximally exposed radiation worker in the RF. Table 13 of the consequence analysis (BSC 2008a) references *GROA Airborne Release Dose Calculation* (BSC 2007a, Table 15); the doses estimated in Table 15 include both inhalation and submersion doses from surface and subsurface facility airborne releases.

1.1.2 Direct Radiation from External Contained Sources

Table 65 of the consequence analysis (BSC 2008a) references Table 15 of the same document for direct radiation dose from contained sources for the maximally exposed radiation worker in the RF. Table 15 of the consequence analysis (BSC 2008a) references *GROA Worker Dose Calculation* (BSC 2008b, Table 6), which references *GROA External Dose Rate Calculation* (BSC 2007b, Table 9). *GROA External Dose Rate Calculation* (BSC 2007b) provides the dose calculations for radiation worker annual whole body doses due to direct radiation from stationary external contained sources that include aging overpacks on the aging pads and transportation casks in truck and railcar buffer areas.

1.1.3 Direct Radiation Within the Facility From Normal Operations

Table 65 of the consequence analysis (BSC 2008a) references Table 14 of the same document for the radiation worker annual whole body dose due to direct radiation from contained sources within the facility during normal operations. Table 14 of the consequence analysis (BSC 2008a) references *GROA Worker Dose Calculation* (BSC 2008b, Table 1), which provides the dose calculations. The normal operation annual whole body doses from direct radiation within the facility are based on the number of work crews per facility and the expected annual number of casks and containers processed within the facility. Those annual doses are provided in the study *Repository ALARA Goal Compliance* (BSC 2008c) that is based on *Worker Dose Estimate for a Nominal Throughput Informal Study* (BSC 2008d), which adjusts doses estimated in the following individual facility dose assessments to the maximum repository throughput at full-scale steady state operation: *Receipt Facility Worker Dose Assessment* (BSC 2008e), *Initial Handling Facility Worker Dose Assessment* (BSC 2007c), *Canister Receipt and Closure Facility #1 Worker Dose Assessment* (BSC 2007d), and *Wet Handling Facility and Low-Level Waste Facility Worker Dose Assessment* (BSC 2007e). Site and subsurface radiation worker annual doses are estimated in *Aging Facility and Site Worker Dose Assessment* (BSC 2008f) and *Subsurface Worker Dose Assessment* (BSC 2008g).

1.2 DOCUMENTS SUPPORTING ORGAN DOSE RESULTS

Organ dose results (maximally exposed total organ dose equivalent, lens (of the eye) dose equivalent, and shallow dose to the skin) for radiation workers presented in SAR Table 1.8-36 are for the estimated maximally exposed radiation worker in the RF. The organ dose results presented in SAR Table 1.8-36 include only contributions from airborne releases from normal operations that are based on *GROA Airborne Release Dose Calculation* (BSC 2007a, Table 15). Calculations of organ dose contributions due to resuspension of surface contamination within a facility were not performed in that calculation but are estimated in Tables 1, 2, and 3. Also, the organ doses in SAR Table 1.8-36 do not include direct radiation contributions from external contained sources and contained sources within a facility during normal operations. Those contributions are included in the total organ dose equivalent and lens (of the eye) dose equivalent doses per SAR Equations 1.8-7 and 1.8-11 in Tables 3 and 4.

Organ doses due to resuspension of surface contamination for each facility are estimated in Tables 1, 2, and 3 based on the same method used to estimate the whole body dose from resuspension described in the individual facility worker dose assessments identified in Section 1.1.3. The radioactive surface contamination is based on the radionuclide resulting in the highest dose consequence; for beta/gamma emitters, ^{60}Co or ^{90}Sr, and for alpha emitters, ^{239}Pu or ^{241}Am. The organ of maximum dose is the bone surface. Table 1 provides the input parameters for each facility and includes the equilibrium airborne concentrations of beta/gamma and alpha emitters, number of casks processed per year, number of work crews per facility, and worker exposure time per cask. Table 2 provides the estimated worker resuspension dose contributions for each facility and the combined doses that are the sums of maximum beta/gamma and alpha doses.

Table 3 provides a summary of radiation worker dose contributions for each facility including direct radiation from external contained sources and contained sources within a facility, airborne

releases, and resuspension of surface contamination. The appropriate dose contributions from Table 3 are combined based on the equations from SAR Section 1.8.1.1 to estimate radiation worker whole body and organ doses in Table 4. These organ doses include direct radiation doses from external contained sources, direct radiation doses within a facility from normal operations, and contributions from resuspension of surface contamination.

1.3 EXTERNAL RADIATION SOURCE TERM EFFECT ON ORGAN DOSES

Because the total organ dose equivalent includes an effective dose equivalent component per SAR Equation 1.8-7, the radiation worker organ dose estimates for a facility will be affected by the external radiation source terms used within the facility itself and at other facilities that contribute to direct radiation from external contained sources. Those other facilities are the Aging Facility and buffer areas for transportation casks on trucks and railcars.

1.4 FACILITY WITH LARGEST ORGAN DOSE EQUIVALENTS

As shown in Table 4, for radiation workers, the facility with the largest dose equivalent to an individual organ/tissue or lens of the eye is the RF, and the facility with the largest shallow dose equivalent to the skin is the Wet Handling Facility.

2. COMMITMENTS TO NRC

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

3. DESCRIPTION OF PROPOSED LA CHANGE

In SAR Table 1.8-36, change the entries in the "Results" column for the category row "Radiation Workers Exposure," for the limits row "50 rem/yr organ or tissue dose other than the lens of the eye" and for the limits row "15 rem/yr lens of the eye dose" to include the contributions from the deep dose equivalent and from resuspension of surface contamination in the RF.

In SAR Table 1.8-25, change the entry in the "Highest Total Organ Dose Equivalent" column for the category row "Surface and subsurface airborne release from normal operations," to include the contribution from resuspension of surface contamination in the RF.

4. REFERENCES

BSC (Bechtel SAIC Company) 2007a. *GROA Airborne Release Dose Calculation.* 000-PSA-MGR0-01200-000-00C. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080326.0010.

BSC 2007b. *GROA External Dose Rate Calculation.* 000-PSA-MGR0-01300-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071023.0003 .

BSC 2007c. *Initial Handling Facility Worker Dose Assessment.* 51A-00C-IH00-00100-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20070529.0035.

BSC 2007d. *Canister Receipt and Closure Facility #1 Worker Dose Assessment.* 060-00C-CR00-00100-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20070425.0013; ENG.20070524.0004.

BSC 2007e. *Wet Handling Facility and Low-Level Waste Facility Worker Dose Assessment.* 050-00C-WH00-00200-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071017.0002.

BSC 2008a. *Preclosure Consequence Analyses.* 000-00C-MGR0-00900-000-00E. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080310.0031.

BSC 2008b. *GROA Worker Dose Calculation.* 000-PSA-MGR0-01400-000-00C. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080327.0010.

BSC 2008c. *Repository ALARA Goal Compliance.* 000-30R-MGR0-04000-000-000. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080205.0014.

BSC 2008d. *Worker Dose Estimate for a Nominal Throughput Informal Study.* 000-30R-MGR0-03300-000-001. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080204.0013.

BSC 2008e. *Receipt Facility Worker Dose Assessment.* 200-00C-RF00-00100-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080331.0003.

BSC 2008f. *Aging Facility and Site Worker Dose Assessment.* 000-00C-MGR0-04200-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080131.0001.

BSC 2008g. *Subsurface Worker Dose Assessment.* 800-00C-SS00-00600-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080331.0006.

Table 1. Input Parameters for Facility Radiation Worker Resuspension Dose Calculation

Symbol	Dose Conversion Factors	^{60}Co	^{90}Sr	^{239}Pu	^{241}Am	
	ICRP 68 Inhalation Dose Factors					
DCF_{bs}	Bone Surface	8.8×10^{-9}	1.8×10^{-8}	1.7×10^{-4}	1.6×10^{-3}	(Sv/Bq)
DCF_{inh}	Effective	2.9×10^{-8}	1.5×10^{-7}	4.7×10^{-5}	3.9×10^{-5}	(Sv/Bq)
	Federal Guidance Report No. 13 Submersion Dose Factors					
DCF_{sde}	Skin	1.45×10^{-13}	9.20×10^{-15}	1.86×10^{-17}	1.28×10^{-15}	(Sv-m^3/Bq-s)
DCF_{sub}	Effective	1.19×10^{-13}	9.83×10^{-17}	3.49×10^{-18}	6.77×10^{-16}	(Sv-m^3/Bq-s)
Symbol	**Fixed Parameters**	**Value**			**Units**	
RF	Respirable Fraction	1			dimensionless	
BR	Breathing rate	3.33×10^{-4}			(m^3/s)	
—	Units conversion	3.7×10^{9}			(mrem-Bq/Sv-μCi)	
—	Units conversion	60			(sec/min)	
Symbol	**Facility Parameters**	**WHF**	**CRCF**	**IHF**	**RF**	**LLWF**
OP	number of casks per year (casks/yr)	50	214	90	273	6
Crews	number of work crews (crews)	6	5	5	5	2
tmin	exposure time per cask (min)	2812	825	810	1507	180
C	β–γ airborne concentration (μCi/m^3)	4.4×10^{-7}	1.5×10^{-7}	5.1×10^{-8}	1.3×10^{-7}	8.2×10^{-8}
	α airborne concentration (μCi/m^3)	4.4×10^{-8}	1.5×10^{-8}	5.1×10^{-9}	1.3×10^{-8}	8.2×10^{-9}
Source:		BSC 2007e	BSC 2007d	BSC 2007c	BSC 2008e	BSC 2007e

NOTE: CRCF = Canister Receipt and Closure Facility; DCF = Dose Conversion Factor; IHF = Initial handling facility; LLWF = Low-Level Waste Facility; RF = Receipt Facility; WHF = Wet Handling Facility.

Table 2. Facility Radiation Worker Potential Resuspension Dose Contributions

		Radiation Worker Potential Resuspension Doses (mrem/yr)				
		β–γ nuclides		α-nuclides		Combined
Facility	Parameter	^{60}Co	^{90}Sr	^{239}Pu	^{241}Am	(mrem/yr)
WHF	SDE_{res} (mrem/yr)	3.3×10^{-4}	2.1×10^{-5}	4.3×10^{-9}	2.9×10^{-7}	3.3×10^{-4}
	EDE_{res} (mrem/yr)	2.7×10^{-4}	2.3×10^{-7}	8.0×10^{-10}	1.5×10^{-7}	2.7×10^{-4}
	CDE_{res} (mrem/yr)	6.7×10^{-3}	1.4×10^{-2}	1.3×10^{1}	1.2×10^{2}	1.2×10^{2}
	$TEDE^{inh}_{res}$ (mrem/yr)	2.2×10^{-2}	1.1×10^{-1}	3.6	3.0	—
	$TEDE_{res}$ (mrem/yr)	2.2×10^{-2}	1.1×10^{-1}	3.6	3.0	3.7
CRCF	SDE_{res} (mrem/yr)	1.7×10^{-4}	1.1×10^{-5}	2.2×10^{-9}	1.5×10^{-7}	1.7×10^{-4}
	EDE_{res} (mrem/yr)	1.4×10^{-4}	1.2×10^{-7}	4.1×10^{-10}	8.0×10^{-8}	1.4×10^{-4}
	CDE_{res} (mrem/yr)	3.4×10^{-3}	7.0×10^{-3}	6.7	6.3×10^{1}	6.3×10^{1}
	$TEDE^{inh}_{res}$ (mrem/yr)	1.1×10^{-2}	5.9×10^{-2}	1.8	1.5	—
	$TEDE_{res}$ (mrem/yr)	1.1×10^{-2}	5.9×10^{-2}	1.8	1.5	1.9
IHF	SDE_{res} (mrem/yr)	2.4×10^{-5}	1.5×10^{-6}	3.1×10^{-10}	2.1×10^{-8}	2.4×10^{-5}
	EDE_{res} (mrem/yr)	2.0×10^{-5}	1.6×10^{-8}	5.8×10^{-11}	1.1×10^{-8}	2.0×10^{-5}
	CDE_{res} (mrem/yr)	4.8×10^{-4}	9.9×10^{-4}	9.3×10^{-1}	8.8	8.8
	$TEDE^{inh}_{res}$ (mrem/yr)	1.6×10^{-3}	8.2×10^{-3}	2.6×10^{-1}	2.1×10^{-1}	—
	$TEDE_{res}$ (mrem/yr)	1.6×10^{-3}	8.2×10^{-3}	2.6×10^{-1}	2.1×10^{-1}	2.7×10^{-1}
RF	SDE_{res} (mrem/yr)	3.4×10^{-4}	2.2×10^{-5}	4.4×10^{-9}	3.0×10^{-7}	3.4×10^{-4}
	EDE_{res} (mrem/yr)	2.8×10^{-4}	2.3×10^{-7}	8.3×10^{-10}	1.6×10^{-7}	2.8×10^{-4}
	CDE_{res} (mrem/yr)	7.0×10^{-3}	1.4×10^{-2}	1.3×10^{1}	1.3×10^{2}	1.3×10^{2}
	$TEDE^{inh}_{res}$ (mrem/yr)	2.3×10^{-2}	1.2×10^{-1}	3.7	3.1	—
	$TEDE_{res}$ (mrem/yr)	2.3×10^{-2}	1.2×10^{-1}	3.7	3.1	3.8
LLWF	SDE_{res} (mrem/yr)	1.4×10^{-6}	9.0×10^{-8}	1.8×10^{-11}	1.3×10^{-9}	1.4×10^{-6}
	EDE_{res} (mrem/yr)	1.2×10^{-6}	9.7×10^{-10}	3.4×10^{-12}	6.7×10^{-10}	1.2×10^{-6}
	CDE_{res} (mrem/yr)	2.9×10^{-5}	5.9×10^{-5}	5.6×10^{-2}	5.2×10^{-1}	5.2×10^{-1}
	$TEDE^{inh}_{res}$ (mrem/yr)	9.5×10^{-5}	4.9×10^{-4}	1.5×10^{-2}	1.3×10^{-2}	—
	$TEDE_{res}$ (mrem/yr)	9.6×10^{-5}	4.9×10^{-4}	1.5×10^{-2}	1.3×10^{-2}	1.6×10^{-2}

Dose	Description	Formulas
Submersion	Shallow dose equivalent	$SDE_{res} = C \times DCF_{sde} \times 3.7{\times}10^{9} \times tmin \times 60 \times OP$ / crews (mrem/yr)
	Effective dose equivalent	$EDE_{res} = C \times DCF_{sub} \times 3.7{\times}10^{9} \times tmin \times 60 \times OP$ / crews (mrem/yr)
Inhalation	CDE bone surface	$CDE_{res} = C \times DCF_{bs} \times 3.7{\times}10^{9} \times RF \times BR \times tmin \times 60 \times OP$ / crews (mrem/yr)
Total	Annual inhalation dose	$TEDE^{inh}_{res} = C \times DCF_{inh} \times 3.7{\times}10^{9} \times RF \times BR \times tmin \times 60 \times OP$ / crews (mrem/yr)
	Annual inhalation + submersion	$TEDE_{res} = TEDE^{inh}_{res} + EDE_{res\ (mrem/yr)}$
Combined	SDE_{res}, EDE_{res}, CDE_{res} or $TEDE_{res}$	Maximum(β–γ) + Maximum(α)

NOTE: CDE = committed dose equivalent; CRCF = Canister Receipt and Closure Facility; EDE = effective dose equivalent; IHF = Initial handling facility; LLWF = Low-Level Waste Facility; RF = Receipt Facility; SDE = shallow dose equivalent to skin; TEDE = total effective dose equivalent; WHF = Wet Handling Facility.

Table 3. Facility Radiation Worker Potential Dose Contribution Summary

	Direct Radiation (mrem/yr)		Airborne Release (mrem/yr)				Resuspension (mrem/yr)			
	A	B	C	D	E	F	G	H	I	J
	Facility Direct	Direct External Contained	Airborne Release Inhalation and Submersion	Airborne Release Inhalation	Airborne Release Submersion	Airborne Release Submersion	Resuspension Inhalation and Submersion	Resuspension Inhalation	Resuspension Submersion	Resuspension Submersion
Facility Name	**EDE dir**	**EDE ext**	**TEDE air**	**CDE air**	**EDE air**	**SDE air**	**TEDE res**	**CDE res**	**EDE res**	**SDE res**
Canister Receipt and Closure Facility-1	300	0.12	2.9×10^{-1}	4.8	3.2×10^{-2}	1.5	1.9	6.3×10^{1}	1.4×10^{-4}	1.7×10^{-4}
Canister Receipt and Closure Facility-2	300	1.5	2.1×10^{-1}	6.2	1.3×10^{-2}	4.7×10^{-1}	1.9	6.3×10^{1}	1.4×10^{-4}	1.7×10^{-4}
Canister Receipt and Closure Facility-3	300	1.8	2.0×10^{-1}	6.5	1.0×10^{-2}	3.2×10^{-1}	1.9	6.3×10^{1}	1.4×10^{-4}	1.7×10^{-4}
Receipt Facility	1300	0.47	2.5×10^{-1}	5.4	2.4×10^{-2}	1.1	2.8	1.3×10^{2}	2.8×10^{-4}	3.4×10^{-4}
Wet Handling Facility	400	0.4	1.5×10^{1}	5.7×10^{1}	2.4	1.3×10^{2}	3.7	1.2×10^{2}	2.7×10^{-4}	3.3×10^{-4}
Initial Handling Facility	800	3.7	1.3×10^{-1}	2.1	1.7×10^{-2}	7.0×10^{-1}	2.7×10^{-1}	8.8	2.0×10^{-5}	2.4×10^{-4}
Low-Level Waste Facility	700	0.42	2.7×10^{-1}	3.3	3.5×10^{-2}	1.7	1.6×10^{-2}	5.2×10^{-1}	1.2×10^{-6}	1.4×10^{-6}
Aging Facility	200	10	2.8×10^{-1}	9.6	1.1×10^{-2}	3.8×10^{-1}	—	—	—	—
Subsurface Facility (North Portal)	200	—	1.3×10^{-1}	1.8	1.7×10^{-2}	7.1×10^{-1}	—	—	—	—

NOTE: The maximum organ for CDE at all locations is the bone surface.
— means resuspension included in Airborne Release contribution.
CDE = committed dose equivalent; EDE = effective dose equivalent; SDE = shallow dose equivalent; TEDE = total effective dose equivalent.

Source: Column A: BSC 2008b, Table 3
Column B: BSC 2008b, Table 6
Column C: BSC 2007a, Table 15
Column D: BSC 2007a, Attachment A, Release.xls [BWR-Inhalation Dose AI7:AI36 + Aging Facility BR11:BR40 + Subsurface BS17:BS46]
Column E: BSC 2007a, Attachment A, Release.xls [BWR-Inhalation Dose AH7:AH36 + Aging Facility CD11:CD40 + Subsurface CE17:CE46]
Column F: BSC 2007a, Attachment A, Release.xls [BWR-Inhalation Dose AK7:AK36 + Aging Facility CG11:CG40 + Subsurface CH17:CH46]
Columns G to J: Table 2 Combined results

Table 4. Facility Radiation Worker Dose Summary

	Facility Radiation Worker Potential Dose (rem/yr)			
Facility Name	A Total TEDE	B Total TODE	C Total SDE	D Total LDE
Canister Receipt and Closure Facility-1	0.3	0.4	<0.01	0.3
Canister Receipt and Closure Facility-2	0.3	0.4	<0.01	0.3
Canister Receipt and Closure Facility-3	0.3	0.4	<0.01	0.3
Receipt Facility	1.3	1.4	<0.01	1.3
Wet Handling Facility	0.4	0.6	0.1	0.5
Initial Handling Facility	0.8	0.8	<0.01	0.8
Low-Level Waste Facility	0.7	0.7	<0.01	0.7
Aging Facility	0.2	0.2	<0.01	0.2
Subsurface Facility (North Portal)	0.2	0.2	<0.01	0.2

NOTE: Formula Column A: TEDE = TEDEair + TEDEres + EDEdir + EDEext
Formula Column B: TODE = CDEair + CDEres + EDEdir + EDEext + EDEair + EDEres
Formula Column C: SDE = SDEair + SDEres
Formula Column D: LDE = SDE + TEDE

CDE = committed dose equivalent; EDE = effective dose equivalent; LDE = lens (of the eye) dose equivalent; SDE = shallow dose equivalent; TEDE = total effective dose equivalent; TODE = total organ dose equivalent.

RAI Volume 2, Chapter 2.1.1.5, Set 1, Number 6:

Demonstrate that throughput assumptions in the DOE consequence analysis are in compliance with 10 CFR 63.21(c)(5).

In BSC (2008al, Table 3), DOE presents annual maximum and nominal worker doses for different throughput and source term assumptions. In BSC (2008al, Table 3 footnote b on Assumption 3.1.1), DOE indicates that nominal worker doses, derived from nominal facility throughput values, are used for comparison with regulatory limits. It is not clear how the nominal worker doses comply with 10 CFR 63.21(c)(5), which require an analysis assuming that operations at the GROA are carried out at the maximum capacity and rate of receipt.

1. RESPONSE

The *GROA Worker Dose Calculation* (BSC 2008) provides a compilation of potential worker doses in the geologic repository operations area. The dose calculation (BSC 2008, Table 3) provides two columns of worker dose estimates labeled as "maximum" and "nominal" individual worker doses. The "maximum" individual worker dose estimates are used for as low as is reasonably achievable (ALARA) considerations to reveal repository operations for improvement under ALARA principles as the repository design matures. The "nominal" individual worker dose estimates are used to evaluate the entire repository at full operations capability with the rates of receipt as stated in SAR Section 1.2.1.1.2, as specified in 10 CFR 63.21(c)(5). The dose calculation (BSC 2008, Section 6.1.4) states that there are no Category 1 event sequences that contribute to the worker dose, and as a result, 10 CFR Part 20 is the controlling regulation for annual worker dose. The facility "maximum" worker doses are conservative preliminary estimates based on estimated maximum waste form processing capabilities of each individual facility and maximum source terms for dose rate estimates. The maximum exposure estimates identify high dose-causing operations for future consideration as potential dose reduction design initiatives under the project's ALARA program that may be applied to either the waste handling facilities or individual operational steps, and they also identify any throughput constraints on facility operations that may prove beneficial to dose management.

The sum of the maximum waste form processing capabilities for all facilities is 1,055 casks/year as shown in Table 1 and exceeds the entire repository maximum annual rates of receipt in SAR Section 1.2.1.1.2. Therefore, these facility "maximum" worker dose estimates reflect worker doses significantly greater than for the repository at full operating capability with the repository maximum annual rates of receipt.

The facility "nominal" worker dose estimates in the dose calculation (BSC 2008, Table 3) reflect worker doses for the entire repository at full operating capability with the repository maximum capacity and rate of receipt as stated in SAR Section 1.2.1.1.2. As shown in Table 1, facility "nominal" worker dose estimates are based on total annual throughputs for all waste handling facilities of 500 casks/year, which is consistent with the repository maximum throughput in one year of 3,000 metric tons of heavy metal, including commercial spent nuclear fuel and high-level

radioactive waste, up to 24 naval canisters, 179 DOE spent nuclear fuel canisters, and 763 high-level radioactive waste canisters, as provided in SAR Section 1.2.1.1.2.

In summary, the use of the term "nominal" with facility worker dose estimates in the dose calculation (BSC 2008) reflects the condition of the entire repository at full operating capability with the geologic repository operations area operating consistent with the repository maximum capacity and rate of receipt as stated in SAR Section 1.2.1.1.2, as specified in 10 CFR 63.21(c)(5). The detailed design will assure that 10 CFR Part 20 exposure limits and project ALARA objectives are met for these rates of receipt.

2. COMMITMENTS TO NRC

None.

3. DESCRIPTION OF PROPOSED LA CHANGE

None.

4. REFERENCES

BSC (Bechtel SAIC Company) 2008. *GROA Worker Dose Calculation.* 000-PSA-MGR0-01400-000-00C. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG. 20080327.0010.

Table 1. Facility and Repository Maximum Annual Throughput Bases for Worker Dose Estimates

Facility	Facility Maximum Throughput Basis (Cask/yr)	Repository Maximum Throughput Basis (Cask/yr)
Receipt Facility	273	210
Canister Receipt and Closure Facilities (3 total)	642 (214 each)	216 (72 each)
Initial Handling Facility	90	24
Wet Handling Facility	50	50
Total at Annual Receipt	1055	500