BSC

Engineering Change Notice

1. QA: QA

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Complete only applicable items.

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3. Document Identifier: 000-00C-MGR0-00900-000-00C	4. Rev.: 00C	5. Title: Preclosure Consequence Analyses for License Application	6. ECN: 1
7. Reason for Change: Make minor editorial corrections in Table E-5 and Paragraph 4.2.6, correct reference citation and several cited values in Table E-12 from FGR-11 to ICRP-72 basis, and correct dose result value for the facility worker organ dose in Table E-14.			
8. Supersedes Change Document: ☐ Yes If, Yes, Change Doc.: _____ ☒ No			
9. Change Impact:			
Inputs Changed: ☐ Yes ☒ No		Results Impacted: ☒ Yes ☐ No	
Assumptions Changed: ☐ Yes ☒ No		Design Impacted: ☐ Yes ☒ No	
10. Description of Change: (Address any "Yes" answers) One dose result in Table E-14 changed from 0.37 rem to 0.23 rem for the facility worker organ dose. This is the only impact from correcting the cited values in Table E-12. The conclusion that the facility worker organ dose is below the performance criterion of 50 rem remains valid.			
11. Originator: (Print/Sign/Date) Dale T. Dexheimer <i>D. Dexheimer</i> 8/17/05			
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This assumption is used in Sections 6.1.4.4.

- 4.2.6 For normal operations and Category 1 event sequences, it is assumed that radionuclides are released from the primary confinement areas (transfer cells and DPC cutting areas, etc.) within a surface facility.

Basis: For Category 1 event sequences involving drops or collisions, or both, of SNF, release of radioactive materials would occur during transfer (BSC 2005i [DIRS 174467], Section 6.3.1.3) and would only occur inside a waste transfer cell. During normal operations, radioactive materials could be released during the opening of a transportation cask and that also occurs inside waste transfer cell. There may be some other small releases that could result from the potential events discussed in Section 6.1.6. However, the releases from those events would involve 1) only minor surface contamination, 2) involve only small fractions of the assumed 1% normal operations release and/or 3) be so infrequent that their dose contribution to aggregated doses would be inconsequential compared to those from normal operation.

This assumption is used in 3.1.2.1 and 3.1.2.2.

- 4.2.7 For Category 1 and Category 2 event sequences, the DR is assumed to be 1.0 for commercial SNF. For Category 2 event sequences, the DR is assumed to be 1.0 for HLW in a canister. The DR is the fraction of fuel rods that is assumed to fail by cladding breach during an event sequence or the fraction of HLW that is damaged by crush or impact, or both. Bounding source terms for Category 2 event sequences involving naval SNF already include a DR, as documented in Gisch 2004 ([DIRS 171579], p. 1) and Griffith 2003 ([DIRS 168871, Enclosure pages 3 and 4).

Basis: These are bounding assumptions for commercial SNF, HLW, and naval SNF because the use of a DR of 1 assumes 100% of the fuel is damaged and naval SNF source terms already include a DR that provides bounding source terms.

This assumption is used in Sections 3.1.3.1, 6.1.3, 6.1.4, 6.2.1, 6.3.4 and Appendix E.

- 4.2.8 For Category 2 event sequences, the cask leak path factor $(LPF)_{\text{cask}}$ is assumed to be 0.1 for SNF in a transportation cask and 0.01 for HLW in a canister in a transportation cask, and 1.0 for naval SNF in a transportation cask or in a canister. The $(LPF)_{\text{cask}}$ is the fraction of the ARF that reaches the ventilation system after local deposition, consisting of plate-out and gravitational settling, within a transportation cask.

Basis: This is a conservative assumption. For rail casks involved in end, corner, or side impacts, at an impact speed of 60 mph, NUREG/CR-6672 (Sprung et al. 2000 [DIRS 152476], Table 7.19) calculated an $(LPF)_{\text{cask}}$ of 0.02 for particles and 0.0008 for cesium, which are smaller than the conservatively assumed $(LPF)_{\text{cask}}$ of 0.1. Both the canister and the cask are assumed to have an LPF of 0.1 because HLW is shipped inside a canister within a transportation cask. The combined LPF for HLW is equal to 0.01 (i.e., $0.1 \times 0.1 = 0.01$). An $(LPF)_{\text{cask}}$ of 1.0 for naval SNF is a bounding value because it assumes a 100% release.

Table E-5. Sum of Public Doses From Normal Operations and Category 1 Event Sequences (ICRP-72)

Event Sequence Identifier	Releases from:	MAR (1)	Number of events/year (2)	Public TEDE at 100 m (mrem/event) ^a (3)	Public TEDE at 11 km (mrem/event) ^b (4)	Public TEDE at 100 m (mrem/year) ^a (5)=(2)×(3)	Public TEDE at 11 km (mrem/year) ^b (6)=(2)×(4)
N.O.	Surface releases from 1% of 3,600 MTHM of Average PWR SFAs per year, HEPA-filtered	NA	NA	NA	NA	Annual Dose 5.8×10^0 ^c	Annual Dose 6.2×10^{-1} ^c
N.O.	Subsurface releases of waste package surface contamination, activated air and silica dust, unfiltered	NA	NA	NA	NA	Annual Dose 1.1×10^{-2} ^c	Annual Dose 1.5×10^{-2} ^c
N.O.	Direct radiations from stored casks ^f	NA	NA	NA	NA	Annual Dose 3.1×10^0	Annual Dose NA
GET-03B	Collision involving a Maximum PWR commercial SNF assembly	1 ^d	0.5 ^e	$1.2 \times 10^{+1}$ (Note d)	5.4×10^{-2} (Note d)	Frequency Weighted Dose 6.0×10^0	Frequency Weighted Dose 2.7×10^{-2}
GET-03D	Drop of a Maximum PWR commercial SNF assembly onto another assembly	2 ^d	0.5 ^e	$2.4 \times 10^{+1}$ (Note d) ^d	1.1×10^{-1} (Note d)	Frequency Weighted Dose $1.2 \times 10^{+1}$	Frequency Weighted Dose 5.4×10^{-2}
Total:						$2.7 \times 10^{+1}$	7.1×10^{-1}

NOTES:

^a Onsite member of the public is located at 100 m away from a DTF or the FHF and at 3 km away from the subsurface exhaust shafts and is exposed to radiation for a period of 2,000 hour (Assumption 4.2.13)

^b Offsite member of the public is located at 11 km away from a DTF or the FHF, and at 8 km away from the subsurface exhaust shafts and is exposed to radiation for a period of 8,760 hour (Assumption 4.2.13)

^c Table E-2, columns 1, 2, and 3

^d Table E-4

^e Table 9, column 3.

^f Direct radiations from stored casks to North Perimeter Security Station (30C) from BSC 2005c ([DIRS 172488], Table 7b) corresponding to the maximum onsite public dose location for releases in Assumption 4.1.13.

DTF = Dry Transfer Facility (DTF 1 or DTF 2); FHF = Fuel Handling Facility; HEPA = high-efficiency particulate air [filter]; NA = not applicable; PWR = pressurized water reactor; SNF = spent nuclear fuel.

E.2.2.2 Sum of Combinations of Category 1 Event Sequences Dose

The dose impact of combinations of Category 1 event sequences is evaluated. Three combinations of Category 1 event sequences were identified for consideration in the consequence analysis (BSC 2005i [DIRS 174467], Section 7.2.1):

- Two commercial SNF assembly drops within 1 year
- Two commercial SNF assembly collisions within 1 year
- One drop and one collision of commercial SNF assemblies within 1 year.

The collision event involves one PWR or BWR SFA; the drop event potentially affects two PWR or BWR SFAs.

The case of the two commercial SNF assembly drops has the highest MAR (i.e., four SFAs) and, hence, has the highest radiation dose among the three cases.

The radiation doses resulting from two commercial SNF assembly drops and normal operations from Table E-5 results are $5.8 + 0.011 + 3.1 + 2 \times 24$ mrem/year = $5.7 \times 10^{+1}$ mrem/year for

E.3.2 Category 1 Event Sequences

E.3.2.1 Surface Facility Worker Dose

Category 1 event sequence scenarios and estimated maximum worker dose consequences from releases are shown in Table E-12. Dose consequences in mrem received by the maximally exposed worker for the Category 1 event sequence releases are calculated in BSC (2005a [DIRS 173590], Table 7d). In addition, the direct radiation dose from a single Category 1 event sequence in the DTF 1, DTF 2 or FHF is 10 mrem/event BSC 2005l ([DIRS 173483], Section 8).

Table E-12. Maximum Worker Doses From Category 1 Event Sequence Releases (ICRP-68)

Facility ^a	Category 1 Event Sequences ^a	χ/Q (s/m ³) ^a	TEDE ^a (mrem)	TODE ^a (mrem)	SDE ^a (mrem)	LDE ^a (mrem)
DTF 1	Drop	7.0×10^{-4}	$1.0 \times 10^{+1}$	$8.4 \times 10^{+1}$	$1.2 \times 10^{+2}$	$1.3 \times 10^{+2}$
	Collision	7.0×10^{-4}	5.1×10^0	$4.2 \times 10^{+1}$	$5.9 \times 10^{+1}$	$6.5 \times 10^{+1}$
DTF 2	Drop	3.8×10^{-4}	5.6×10^0	$4.6 \times 10^{+1}$	$6.4 \times 10^{+1}$	$7.0 \times 10^{+1}$
	Collision	3.8×10^{-4}	2.8×10^0	$2.3 \times 10^{+1}$	$3.2 \times 10^{+1}$	$3.5 \times 10^{+1}$
FHF	Drop	9.1×10^{-4}	$1.3 \times 10^{+1}$	$1.1 \times 10^{+2}$	$1.5 \times 10^{+2}$	$1.7 \times 10^{+2}$
	Collision	9.1×10^{-4}	$6.7 \times 10^{+1}$	$5.5 \times 10^{+1}$	$7.7 \times 10^{+1}$	$8.4 \times 10^{+1}$

NOTES: ^a BSC 2005a [DIRS 173590], Table 7d

DTF = Dry Transfer Facility; FHF = Fuel Handling Facility; LDE = lens dose equivalent; mrem = one thousandth of a rem; rem = roentgen equivalent man; SDE = shallow dose equivalent to skin; TEDE = total effective dose equivalent; TODE = total organ dose equivalent.

E.3.2.1 Subsurface Facility Worker Dose

There are no Category 1 event sequences associated with the subsurface facility. Therefore, there is no subsurface worker dose from Category 1 event sequences.

E.3.3 Worker Dose TEDE Summary

The results of worker dose calculations from *Geologic Repository Operations Area Worker Dose Assessment* (BCS 2005c [DIRS 172488]) are provided in this section. The calculated annual doses to repository workers include contributions from external radiation and from exposure to airborne radioactivity potentially caused by indoor operations. The TEDE is calculated by summing the dose contributions from inhalation, submersion, and direct external radiation (BSC 2005c [DIRS 172488], Section 4.1). Potential repository worker TEDE doses from both normal operations and Category 1 events are summarized in Table E-13 at the location of the highest worker doses: DTF 1 for facility workers and CHF for construction workers..

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Table E-14. Summary Preclosure Dose Performance Criteria and Evaluation Results (ICRP-68 and ICRP-72)

Standard	Limits	Results
Public Exposures		
Preclosure standard: 10 CFR 63.204 [DIRS 173273]; Preclosure Performance Objective for normal operations and Category 1 event sequences per 10 CFR 63.111(a)(2)	15 mrem/year ^b	0.71 mrem/year ^{a, c} (Table E-5) 0.11 mrem/year ^{a, d} (Table E-4) 0.86 mrem/year ^{a, e} (Section E.2.2)
Constraint specified for air emissions of radioactive material to the environment; not a dose limitation per 10 CFR 20.1101(d) [DIRS 173165] ^f	10 mrem/year ^b	0.71 mrem/year ^{a, b} (Table E-5)
Dose Limits for Individual Members of the Public for normal operations and Category 1 event sequences per 10 CFR 20.1301 [DIRS 173165] ^f	100 mrem/year ^{b, g} (general public or construction workers)	71 mrem/year ^{h, b} (Table E-5) 24 mrem/year ^{h, d} (Table E-4) 63 mrem/year ^{h, e} (Table E-13)
	2 mrem/hr in any unrestricted area from external sources	< 2 mrem/hr ⁱ
Preclosure Performance Objective for any Category 2 event sequence per 10 CFR 63.111 (b)(2) [DIRS 173273]	5 rem ^b	0.089 rem ^b (Table E-6)
	50 rem organ or tissue dose other than the lens of the eye	0.70 rem (Table E-6)
	15 rem lens of the eye dose	0.11 rem (Table E-6)
	50 rem shallow dose to skin	0.024 rem (Table E-6)
Facility Workers' Exposures		
Occupational Dose Limits for Adults from normal operations and Category 1 event sequences per 10 CFR 20.1201 [DIRS 173165] ^f	5 rem/year ^b	1.9 rem/year ^{k, c} (Table E-13) 0.014 rem/year ^{k, d} (Table E-13) 1.9 rem/year ^{k, e} (Table E-13)
	50 rem organ or tissue dose other than the lens of the eye	0.23 rem ^m
	15 rem lens of the eye dose	0.35 rem ⁿ
	50 rem shallow dose to skin	0.31 rem ^o

NOTES: ^a Results for public exposures are calculated at the site boundary^b TEDE^c Sum of TEDEs from normal operations and frequency weighted Category 1 event sequences in 1 year^d TEDE from a single maximum Category 1 event sequence in 1 year^e Sum of TEDEs from normal operations and any combination of Category 1 event sequences in 1 year^f 10 CFR 63.111(a)(1) [DIRS 173273] requires operations area to meet the requirements of 10 CFR Part 20 [DIRS 173165]^g 10 CFR 20.1301(a)(1); dose limit to the extent applicable (maximum of general public and construction worker)^h Onsite public dose at 100 mⁱ 10 CFR 63.111(b)(1) would require repository design objectives for Category 1 event sequences and normal operations to meet 10 CFR 63.111(a)(1) requirements (10 CFR Part 20)^j Onsite construction worker maximum dose from operating facilities at CHF^k The highest annual facility worker at DTF 1^l Shielding design criterion limits dose rate to 0.05 mrem/hr at unrestricted area surface BSC 2005f [DIRS 173614], Section 4.9.1.4].^m 0.011 rem (TODE Table E-9) + 2 events x 0.11 rem/event (TODE Table E-12) = 0.23 remⁿ 0.010 rem (LDE Table E-9) + 2 events x 0.17 rem/event (LDE Table E-12) = 0.35 rem^o 0.009 rem (SDE Table E-9) + 2 events x 0.15 rem/event (SDE Table E-12) = 0.31 rem

EDE = effective dose equivalent; LDE = lens dose equivalent; mrem = one thousandth of a rem; rem = roentgen equivalent man; SDE = shallow dose equivalent to skin; TEDE = total effective dose equivalent; TODE = total organ dose equivalent.