BSC

Engineering Change Notice

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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: 2
7. Reason for Change: Make minor editorial corrections to address CR-4922 and CR-4924.			
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10. Description of Change: (Address any "Yes" answers) Revised Section 4.2.3 to correct page number for reference NRC 2003a. Deleted last sentences of first paragraph of Sections 6.3.4.2 and E.2.4.2. Revised fifth paragraphs of Section 6.3.4.2 and E.2.4.2 to remove discussion of historical drop incidents. Revised Sections 6.4.2.2 and E.3.2.1 to clarify that subsurface worker doses do include doses from Category 1 event sequences in surface facilities. Revised Table 34 and Table E-14 to correct one value and a references for another value. One dose result in Table E-14 was reduced from 71 mrem to 53 mrem for the public dose from normal operations plus frequency weighted Category 1 event sequences. The conclusion that the public dose is below the performance criterion of 100 mrem remains valid.			
11. Originator: (Print/Sign/Date) Dale T. Dexheimer <i>D. Dexheimer</i> 8/25/05			
Checker: (Print/Sign/Date) Kathy Ashley <i>Kathy Ashley</i> 8/25/05			
Approved: (Print/Sign/Date) MARK WISENIBURG <i>Mark Wiseniburg</i> 8/25/2005			

This assumption is used in Sections 3.1.2, 6.1.3, 6.1.4, and 6.2.1.3.

- 4.2.3 For evaluating public doses for Category 1 and Category 2 event sequences using MACCS2, radioactive materials are assumed to be released in a 1-hr duration. The period of long-term exposure to ground contamination and intake of contaminated food is 1 year.

Basis: The use of a short-term release is consistent with a drop or collision event. A release duration longer than 1-hr would provide more time for atmospheric dispersion and result in lower χ/Q values and lower doses. The use of 1-hr χ/Q values for accident releases is conservative and consistent with Regulatory Guide 1.145 [DIRS 103651], Section 1.3. Using 1 year as the value for long-term exposure to ground contamination and intake of contaminated food will also result in a higher dose rate than the exposure period of 30 days recommended in Interim Safety Guide-5 (NRC 2003a, p. 11).

This assumption is used in Sections 3.1.2, 3.2.2, 6.1.3, and 6.1.4.

- 4.2.4 For calculating annual public doses from normal operations using MACCS2 (ORNL 1998) [DIRS 164761]), the release duration is assumed to be 24 hour. All releases are assumed to result in an acute individual exposure during plume passage and a chronic individual exposure to ground contamination and contaminated food after plume passage. Annual doses include long-term exposure to ground contamination and intake of contaminated food for a 1 year period.

Basis: The sensitivity run discussed in Section 6.3.4.1 showed that the use of the release duration of 24 hour, which is the longest duration allowed by MACCS2, instead of 1 year, for normal operations is conservative.

This assumption is used in Sections 3.1.2, 3.2.2, 6.1.1.1, 6.1.3, 6.1.4, 6.2.1.5, and 6.3.4.

- 4.2.5 For evaluating seismic event doses, it is assumed that the maximum total receipt at the repository is 63,000 MTHM of commercial SNF. It is also assumed that for the purposes of calculating buildup of activity on the DTF 1, DTF 2 and FHF HEPA filters and ducting surfaces from SNF releases, the SNF received is PWR SFAs. Using an average PWR assembly weight of 0.475 MTHM/SFA (BSC 2004f [DIRS 169061], p. 8), the total throughput is 132,632 SFAs. It is further assumed that the entire released particulate activity from the SFAs using normal operations ARFs accumulates on HVAC surfaces without credit for decay or HEPA filter change out.

Basis: The total acceptance of commercial SNF may not exceed 63,000 MTHM as determined from *Civilian Radioactive Waste Management System Requirements Document* (DOE 2004b [DIRS 171945], Table 2). It is a bounding assumption that the 63,000 MTHM is PWR SFAs, because PWR SFAs typically have higher enrichment and burnup than BWR SFAs (Table 3). SNF with a combined higher enrichment and a higher burnup, in general, has a higher total initial radionuclide inventory. Thus, this assumption is bounding with respect to the total curie inventory which is used in dose calculations.

6.3.4.1 Sensitivity Analysis

A maximum release duration of 24 hour allowed in MACCS2 (ORNL 1998 [DIRS 164761]) is used for annual releases for normal operations (Assumption 4.2.4). MACCS2 Run 1 and Run 13 (Table 20) were made with 24-hr and 1-hr release durations, respectively. The resulting doses from the shorter 1-hr release duration are higher than the longer 24-hr release duration. The result is considered reasonable because the radionuclides inhaled and ingested at an earlier time for the shorter release duration have a slightly longer time to decay and produce alpha and beta particles. Therefore, the use of a shorter release duration of 1 day instead of 1 year with the same amount of radionuclide releases for normal operations is conservative.

For the twelve MACCS2 base cases, a particle deposition velocity of 0.01 m/s is used. For sensitivity analysis, a particle deposition velocity of 0.001 m/s is used in MACCS2 Run 14 (Table 20) with results showing a dose decrease by a factor of about 2 at 100 m and increase by a factor of about 1.7 at 11 km. Because the 100m doses are the more limiting, i.e. closer to regulatory limits, a particle deposition velocity of 0.01 m/s provides more conservative results for compliance evaluations.

MACCS2 Run 15 (Table 20) has shown that the calculated doses decrease by approximately a factor of 3 by use of an average PWR assembly instead of a maximum PWR assembly. Thus the use of the maximum PWR radionuclide inventory is conservative.

MACCS2 Run 16 (Table 20) has shown that without HEPA filters the calculated doses at 100 m and 11 km away from the release point for a drop event involving two PWR SFAs could exceed the 100 mrem and 15 mrem dose limits for onsite and offsite members of the public, respectively.

MACCS2 Run 17 (Table 20) with a 40 m vent height has shown, by comparing to Run 1 with a 30 m vent height, that calculated doses decrease by a factor of about 3 at 100 m and increase by a factor of about 1.06 at 11 km. Because the 100m doses are the more limiting, i.e. close to regulatory limits, a 30 m vent height provides more conservative results for compliance evaluations.

6.3.4.2 Treatment of Uncertainty

Uncertainties in consequence analyses are addressed by using conservative inputs and assumptions. For calculating public and worker doses for Category 1 event sequences involving drops and collisions, it is conservatively assumed that 100% fuel rod cladding is breached (Assumption 4.2.7).

A comparison between MACCS2 Run 15 and Run 4 (Table 20) has shown that using the average PWR assembly inventory instead of the maximum PWR assembly inventory, the calculated doses for Category 1 event sequences involving drops and collisions decrease by a factor of about 3.

Uncertainties in calculating public doses for Category 2 event sequences are addressed by using conservative inputs and bounding assumptions. The bounding assumptions include the use of the bounding MAR (i.e., the maximum possible number of SFAs allowed in a certified cask) for a

transportation cask, bounding source terms, 100% fuel rod cladding breach, and 95th percentile weather condition (i.e., χ/Q values). The bounding MAR (i.e., 36 PWR or 74 BWR SFAs in a transportation cask) is at least a factor of 1.5 higher than the average value of the MAR. A comparison between MACCS2 Run 4 and Run 15 (Table 20) has shown that the bounding PWR and BWR source terms are at least a factor of 3 higher than the average PWR and BWR source terms.

The assumption of a 100% fuel rod cladding breach (Assumption 4.2.7) is very conservative. Run 4 (Table 20) has shown that the use of the 95th percentile weather condition is about a factor of 3 higher than the mean value.

The information on conservatism provided in this section ensures that uncertainties in inputs are treated with a reasonable degree of conservatism.

6.3.5 Direct Radiation Exposures During Normal Operations, Category 1 Event Sequences, and Category 2 Event Sequences

Offsite direct exposures originate only from the surface facilities, because subsurface facilities, such as the emplacement drifts, are shielded by massive rock. Surface facilities with potential sources of contribution to offsite direct exposures include the transportation cask buffer/staging area and the SNF aging system.

Other facilities, such as the CHF, DTF 1, DTF 2, and the FHF, provide concrete shielding for the exterior walls except for the entrance vestibules. This shielding typically reduces the dose rate outside the building to 0.25 mrem/hour (BSC 2005f [DIRS 173614], Section 4.9.1.3) except during cask handling operations around the vestibule. These dose rates result in a negligible contribution to the public dose at the site boundary located at 11 km (see Section 4.1.4) from the surface facilities.

The transportation cask buffer/staging area provides space for staging of shielded truck and rail casks. The dose rate from an individual cask is regulated by the NRC (e.g., 10 mrem/hour at any point 2 m from the outer lateral surface of the transport vehicle specified in 10 CFR 71.47(b)(3) [DIRS 173375] for exclusive use shipment only). With multiple casks in the staging area, the dose rate will increase, depending on the cask staging configurations. This radiation level affects the worker dose, but poses no impact on the public dose at the site boundary because of the large distance factor.

In addition, 10 CFR 20.1301(a)(2) [DIRS 173165] requires that each licensee shall conduct operations so that the dose in any unrestricted area from external sources does not exceed 0.002 rem (2 mrem) in any 1 hour. This requirement applies to normal operations and Category 1 event sequences.

The dose requirements in 10 CFR Part 20 [DIRS 173165] include contributions from direct exposures. Direct exposures from the SNF aging system arise from the effects of neutron and gamma skyshine. These effects depend on site-specific fuel characteristics of initial enrichment,

in BSC 2005a ([DIRS 173590], Table 7b). 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 32. Maximum Worker Doses From Category 1 Event Sequence Releases (FGR-11)

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}	$1.6 \times 10^{+1}$	$1.4 \times 10^{+2}$	$1.2 \times 10^{+2}$	$1.3 \times 10^{+2}$
	Collision	7.0×10^{-4}	7.8×10^0	$6.8 \times 10^{+1}$	$5.9 \times 10^{+1}$	$6.7 \times 10^{+1}$
DTF 2	Drop	3.8×10^{-4}	8.5×10^0	$7.4 \times 10^{+1}$	$6.4 \times 10^{+1}$	$7.3 \times 10^{+1}$
	Collision	3.8×10^{-4}	4.2×10^0	$3.7 \times 10^{+1}$	$3.2 \times 10^{+1}$	$3.6 \times 10^{+1}$
FHF	Drop	9.1×10^{-4}	$2.0 \times 10^{+1}$	$1.8 \times 10^{+2}$	$1.5 \times 10^{+2}$	$1.7 \times 10^{+2}$
	Collision	9.1×10^{-4}	$1.0 \times 10^{+1}$	$8.9 \times 10^{+1}$	$7.7 \times 10^{+1}$	$8.7 \times 10^{+1}$

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

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.

6.4.2.2 Subsurface Facility Worker Dose

There are no Category 1 event sequences associated with the subsurface facility (BSC 2005i [DIRS 174467, Section 6.3.6). Therefore, there is no subsurface worker dose from subsurface facility Category 1 event sequences. However, subsurface worker doses do include doses from surface facility Category 1 event sequences.

6.4.3 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 33 at the location of the highest worker doses: DTF 1 for facility workers and CHF for construction workers.

Table 34. Summary Preclosure Dose Performance Criteria and Evaluation Results (FGR-11)

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	0.84 mrem/year ^{a, c} (Table 25) 0.11 mrem/year ^{a, d} (Table 24) 0.97 mrem/year ^{a, e} (Section 6.3.2.2)
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	0.84 mrem/year ^{a, c} (Table 25)
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)	56 mrem/year ^{i, c} (Table 33) 32 mrem/year ^{h, d} (Table 24) 73 mrem/year ^{h, e} (Table 33)
	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	0.10 rem (Max. TEDE Table 26)
	50 rem organ or tissue dose other than the lens of the eye	1.1 rem (Max. TODE Table 26)
	15 rem lens of the eye dose	0.13 rem (Max. LDE Table 26)
	50 rem shallow dose to skin	0.022 rem (Max. SDE Table 26)
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 33) 0.016 rem/year ^{k, d} (Table 33) 1.9 rem/year ^{k, e} (Table 33)
	50 rem organ or tissue dose other than the lens of the eye	0.38 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 m

ⁱ 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 0.019 rem (TODE Table 29)+ 2 events x 0.18 rem/event (TODE Table 32) = 0.38 rem

ⁿ 0.011 rem (LDE Table 29)+ 2 events x 0.17 rem/event (LDE Table 32) = 0.35 rem

^o 0.009 rem (SDE Table 29)+ 2 events x 0.15 rem/event (SDE Table 32) = 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.

E.2.4.1 Sensitivity Analysis

A maximum release duration of 24 hour allowed in MACCS2 (ORNL 1998 [DIRS 164761]) is used for annual releases for normal operations (Assumption 4.2.4). MACCS2 Run 1i and Run 13i (Table E-1) were made with 24-hr and 1-hr release durations, respectively. The resulting doses from the shorter 1-hr release duration are higher than the longer 24-hr release duration. The result is considered reasonable because the radionuclides inhaled and ingested at an earlier time for the shorter release duration have a slightly longer time to decay and produce alpha and beta particles. Therefore, the use of a shorter release duration of 1 day instead of 1 year with the same amount of radionuclide releases for normal operations is conservative.

For the twelve MACCS2 base cases, a particle deposition velocity of 0.01 m/s is used. For sensitivity analysis, a particle deposition velocity of 0.001 m/s is used in MACCS2 Run 14i (Table E-1) with results showing a dose decrease by a factor of about 2 at 100 m and increase by a factor of about 1.7 at 11 km. Because the 100m doses are the more limiting, i.e. closer to regulatory limits, a particle deposition velocity of 0.01 m/s provides more conservative results for compliance evaluations.

MACCS2 Run 15i (Table E-1) has shown that the calculated doses decrease by approximately a factor of 3 by use of an average PWR assembly instead of a maximum PWR assembly. Showing the use of the maximum PWR radionuclide inventory is conservative.

MACCS2 Run 16i (Table E-1) has shown that without HEPA filters the calculated doses at 100 m and 11 km away from the release point for a drop event involving two PWR SFAs could exceed the 100 mrem and 15 mrem dose limits for onsite and offsite members of the public, respectively.

MACCS2 Run 17i (Table E-1) with a 40 m vent height has shown, by comparing to Run 1 with a 30 m vent height, that calculated doses decrease by a factor of about 3 at 100 m and increase by a factor of about 1.06 at 11 km. Because the 100m doses are the more limiting, i.e. close to regulatory limits, a 30 m vent height provides more conservative results for compliance evaluations.

E.2.4.2 Treatment of Uncertainty

Uncertainties in consequence analyses are addressed by using conservative inputs and assumptions. For calculating public and worker doses for Category 1 event sequences involving drops and collisions, it is conservatively assumed that 100% fuel rod cladding is breached (Assumption 4.2.7).

A comparison between MACCS2 Run 15i and Run 4i (Table E-1) has shown that using the average PWR assembly inventory instead of the maximum PWR assembly inventory, the calculated doses for Category 1 event sequences involving drops and collisions decrease by a factor of about 3.

Uncertainties in calculating public doses for Category 2 event sequences are addressed by using conservative inputs and bounding assumptions. The bounding assumptions include the use of the bounding MAR (i.e., the maximum possible number of SFAs allowed in a certified cask) for a

transportation cask, bounding source terms, 100% fuel rod cladding breach, and 95th percentile weather condition (i.e., χ/Q values). The bounding MAR (i.e., 36 PWR or 74 BWR SFAs in a transportation cask) is at least a factor of 1.5 higher than the average value of the MAR. A comparison between MACCS2 Run 4i and Run 15i (Table E-1) has shown that the bounding PWR source terms are at least a factor of 3 higher than the average PWR source terms.

The assumption of a 100% fuel rod cladding breach (Assumption 4.2.7) is very conservative. Run 4i (Table E-1) has shown that the use of the 95th percentile weather condition is about a factor of 3 higher than the mean value.

The information on conservatism provided in this section ensures that uncertainties in inputs are treated with a reasonable degree of conservatism.

E.2.5 Direct Radiation Exposures During Normal Operations, Category 1 Event Sequences, and Category 2 Event Sequences

Offsite direct exposures originate only from the surface facilities, because subsurface facilities, such as the emplacement drifts, are shielded by massive rock. Surface facilities with potential sources of contribution to offsite direct exposures include the transportation cask buffer/staging area and the SNF aging system.

Other facilities, such as the CHF, DTF 1, DTF 2, and the FHF, provide concrete shielding for the exterior walls except for the entrance vestibules. This shielding typically reduces the dose rate outside the building to 0.25 mrem/hour (BSC 2005f [DIRS 173614], Section 4.9.1.3) except during cask handling operations around the vestibule. These dose rates result in a negligible contribution to the public dose at the site boundary located at 11 km (see Section 4.1.4) from the surface facilities.

The transportation cask buffer/staging area provides space for staging of shielded truck and rail casks. The dose rate from an individual cask is regulated by the NRC (e.g., 10 mrem/hour at any point 2 m from the outer lateral surface of the transport vehicle specified in 10 CFR 71.47(b)(3) [DIRS 173375] for exclusive use shipment only). With multiple casks in the staging area, the dose rate will increase, depending on the cask staging configurations. This radiation level affects the worker dose, but poses no impact on the public dose at the site boundary because of the large distance factor.

In addition, 10 CFR 20.1301(a)(2) [DIRS 173165] requires that each licensee shall conduct operations so that the dose in any unrestricted area from external sources does not exceed 0.002 rem (2 mrem) in any 1 hour. This requirement applies to normal operations and Category 1 event sequences.

The dose requirements in 10 CFR Part 20 [DIRS 173165] include contributions from direct exposures. Direct exposures from the SNF aging system arise from the effects of neutron and gamma skyshine. These effects depend on site-specific fuel characteristics of initial enrichment, burnup, and cooling time, along with facility layout, site layout, and site boundary characteristics.

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 subsurface facility Category 1 event sequences. However, subsurface worker doses do include doses from surface facility 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..

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.2.2.2)
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)	53 mrem/year ^{h,b} (Table E-13) 24 mrem/year ^{h,d} (Table E-4) 63 mrem/year ^{i,e} (Table E-13)
	2 mrem/hr in any unrestricted area from external sources	< 2 mrem/hr ^f
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.